ENGINEERING DESIGN AND OPERATIONS PLAN

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North Weld Landfill, Unit 2
Weld County, Colorado

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1.0 INTRODUCTION

This Engineering Design and Operations Plan (EDOP) has been prepared by Golder Associates Inc. (Golder) for Unit 2 of the North Weld Landfill (NWLF) located in Weld County, Colorado. NWLF is owned and operated by Waste Management Disposal Services of Colorado, Inc. (WMDSC). Unit 2 will add an additional 155 acres of waste disposal area to the existing 122-acre waste disposal footprint at the NWLF facility, hereinafter referred to as Unit 1. Unit 2 will continue to be regulated under Sections 2 and 3 of the Colorado Department of Public Health and Environment (CDPHE) "Regulations Pertaining to Solid Waste Sites and Facilities," 6 CCR 1007-2, Part 1 as amended November 17, 2015 (adopted date of Regulations) (CDPHE 2015) and applicable sections of the Weld County Code.

A Certificate of Designation (CD) and Use by Special Review (USR) permit for Unit 1 at NWLF were first issued by Weld County on June 27, 1990, and November 14, 1990, respectively. In accordance with Sections 1.3 and 1.6 of the Regulations, a new CD and USR permit are being sought from Weld County for the expanded NWLF facility to encompass the full parcel boundary and 277-acre waste disposal footprint.

The engineering design and operational requirements for Unit 1 at NWLF are described in the Updated Design and Operations Plan for the North Weld Sanitary Landfill (Rust 1997). For that reason, the content of this EDOP only relates to the engineering design and operations of Unit 2. The Unit 2 waste disposal footprint will be contiguous to the north of the existing Unit 1 and will piggyback over the existing northern side slope of the Unit 1 waste disposal area.

1.1 Purpose and Scope

This EDOP contains the information necessary to demonstrate that the siting of Unit 2 meets all location restrictions; that the site-specific geologic and hydrogeologic condition of the Unit 2 waste disposal area have been adequately characterized; and that the engineering design, waste acceptance and operational procedures, environmental monitoring programs, planned closure and post-closure activities, and operational recordkeeping for Unit 2 will be in accordance with current Regulations.

This EDOP contains 12 Site Development Plan drawings (identified as Sheets 1 through 10) in Appendix A that show the proposed engineering design and development of Unit 2. Reports from the site-specific geotechnical and hydrogeologic site characterization field investigations of the Unit 2 area conducted in 2016 are presented in Appendix B. Engineering calculations to support the design of Unit 2 are provided in Appendix C. The Drainage Report and surface water calculations are presented in Appendix D. An updated Construction Quality Assurance (CQA) Plan for NWLF is provided in Appendix E. The NWLF Waste Identification Plan is provided in Appendix F. The Groundwater Monitoring Plan for the NWLF facility is provided in Appendix G. The names, contact information, and qualifications of individuals currently responsible for the operations and management of NWLF are provided in Appendix H. An Alternative Liner Demonstration for the Unit 2 liner system is provided in Appendix I. The CDPHE approval letter for the use

of an alternative leachate collection system drainage layer and drain line material at NWLF is presented in Appendix J. The CDPHE and Weld County Department of Public Health and Environment (WCDPHE) approval letters for the use of alternative daily cover (ADC) materials at NWLF are provided in Appendix K.

1.2 Facility History

NWLF is located at 40,000 Weld County Road 25 near the intersection of Weld County Road 25 and Colorado State Highway 14 (co-signed with Weld County Road 82) within unincorporated Weld County, Colorado. The site is approximately 9 miles east of Interstate Highway 25 (I-25) and 5 miles west of the Town of Ault. The Unit 1 and Unit 2 waste disposal areas at NWLF are located in Section 7, Township 7 North, Range 66 West of the Sixth Principal Meridian.

As previously referenced, Waste Services Corporation received a CD from the Weld County Board of County Commissioners on June 27, 1990, authorizing the development of the first four phases of NWLF (Phases 1, 2, 3A, and 3B), which provide approximately 122 acres of waste disposal area. This disposal area is referred to throughout this EDOP as Unit 1. A USR permit (USR-895) for solid waste disposal within Unit 1 was adopted by the Weld County Board of County Commissioners on November 14, 1990.

Construction of the first disposal module of Unit 1 was completed in December 1991. Site civil improvements were completed in January 1992 and NWLF first received waste on February 3, 1992. Waste Services Corporation merged with an indirect subsidiary of Waste Management, Inc. on July 12, 1991, and such entity changed its name to WMDSC in December 1993. WMDSC continues to be an indirect subsidiary of Waste Management, Inc.

The Unit 2 waste disposal footprint lies immediately adjacent to Unit 1 to the north and provides approximately 155 acres of additional waste disposal area. WMDSC continues to own about 185 acres of adjacent buffer property surrounding the Unit 1 and Unit 2 waste disposal areas, as shown in Figure 1.

In 2006, Waste Management of Northern Colorado allocated approximately 28 acres in the northwest quarter of Section 7, Township 7 North, Range 66 West of the Sixth Principal Meridian as a separate USR (USR-1527) for an administrative and maintenance facility for their commercial trucking operations. The limits of USR-1527 are shown in Figure 1. The CD and USR boundaries for the expanded NWLF facility will exclude the limits of USR-1527.

1.3 Service Area

The primary service area of NWLF is the Northern Front Range Service Area (NFRSA), which includes the cities, towns, and surrounding rural communities of Central and Northern Weld and Eastern Larimer Counties in Colorado, and Southern Laramie County in Wyoming. NWLF also accepts waste from outside the NFRSA.

1.4 Accepted Wastes

NWLF is a non-hazardous, municipal solid waste (MSW) facility that accepts household, municipal, commercial, and industrial solid wastes, as approved. No regulated hazardous wastes, regulated radioactive wastes, or regulated polychlorinated biphenyls (PCB) are accepted by the facility. WMDSC has implemented rigorous waste identification and acceptance programs at NWLF, which are presented in detail in the Waste Identification Plan provided in Appendix F of this EDOP. The purpose of the Waste Identification Plan is to provide procedures to identify and screen wastes, specifically those that may require special handling, to ensure that no regulated hazardous wastes, regulated radioactive wastes, or regulated PCB wastes are accepted at the NWLF facility. If any of these regulated wastes are identified in incoming waste loads, the material is rejected by the facility and will be managed as required by the Regulations. Additionally, NWLF will notify the CDPHE if required by the Regulations.

2.0 GEOLOGIC AND HYDROGEOLOGIC SITE CHARACTERIZATION

This section provides an overview of regional and site-specific geologic and hydrogeologic conditions of the Unit 2 site, based on information previously presented in the Updated Design and Operations Plan for the North Weld Sanitary Landfill (Rust 1997) for Unit 1; publically available geologic and hydrogeologic data sources; the site-specific Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016a); and Report of Hydrogeological Characterization, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016c) provided in Appendix B. Additional background geologic and hydrogeologic characterization of the region is also provided in the *Hydrogeologic Site Characterization Report, North Weld Sanitary Landfill, Weld County, Colorado* (ATEC 1993) previously submitted to the CDPHE as technical support for Unit 1.

2.1 Regional Conditions

This subsection summarizes the geologic and hydrogeologic conditions of the region. A more detailed discussion of the geologic and hydrogeologic conditions specific to the Unit 2 site is provided in Section 2.2 and in the site-specific characterization reports provided in Appendix B.

2.1.1 Regional Geologic Setting

NWLF is located within the Denver-Julesburg (DJ) Basin in northeastern Colorado. The DJ Basin is a north–south structural basin that covers 70,000 square miles of northeast Colorado, southeast Wyoming, and northwest Nebraska. The basin formed during the Laramide Orogeny and is characterized by its asymmetry with gentle east flank and faulted, steeply dipping west flank. The basin contains sedimentary units from the Paleozoic age (Cambrian Period) (oldest) to the Cenozoic age (Tertiary Period) (youngest). The thickest part of the DJ Basin occurs north of Denver, where it is approximately 13,000 feet thick. Approximately 70% of the sedimentary rock in the DJ Basin is composed of sandstone, shale, and limestone units of Cretaceous age (Higley and Cox 2007). The regional dip of the sedimentary strata in the area of NWLF is between one and two degrees below horizontal toward the southeast (Swift River 2016a).

2.1.2 Regional Hydrogeologic Setting

The DJ Basin is considered to be composed of four Cretaceous-age bedrock aquifers overlying the Pierre Shale, which marks the base of the basin. From youngest to oldest, they include the Dawson, Denver, Arapaho, and Laramie-Fox Hills formations. Each of these formations, depending on location within the basin, can be from a few hundred feet to more than 1,000 feet thick. In the NWLF area, only the Laramie-Fox Hills formations remain. Sandstone and conglomerate are the principal water-yielding material in the bedrock aquifers, constituting less than half of the formations. Shale, claystone, and siltstone constitute the remainder of the bedrock formations. The water-bearing sandstone and conglomerate occur as thick layers that extend over large areas and also as thinner lenses of limited areal extent. The water-yielding rocks typically are interlayered with shale (Swift River 2016c).

Regionally, the deepest continuous bedrock groundwater zone significant to NWLF is the Fox Hill Sandstone, where groundwater flow direction is toward the southeast (Swift River 2016c).

2.1.3 Regional Groundwater Quality

Typical groundwater analysis of the Laramie-Fox Hills Aquifer indicates that groundwater in the aquifer is predominantly described as a sodium-bicarbonate type of overall poor quality for human consumption (Swift River 2016c). Groundwater routinely exhibits elevated concentrations of total dissolved solids (TDS) and sulfate (CGS 2003).

2.2 Site-specific Conditions

Site-specific geologic and hydrogeologic conditions of the Unit 2 area of the NWLF site were evaluated and characterized during geotechnical and hydrogeologic site investigations performed by Swift River Environmental Services, LLC between February 10 and March 22, 2016. Detailed descriptions of the site investigations are presented in reports provided in Appendices B-1 and B-2.

2.2.1 Site Topography

The NWLF site is topographically characterized as an upland area of relatively uniform slope toward the regional drainage feature (i.e., Coalbank Creek bed) located approximately 0.25 miles east of the NWLF property boundary. The area of the NWLF property where Unit 2 will be developed is topographically bounded by the Weld County Road 25 embankment to the west, a man-made stormwater runoff channel constructed along the USR-1527 boundary to the northwest, the Weld County Road 84 embankment to the north, the man-made Pierce Lateral agricultural canal to the east, and Unit 1 to the south.

Based on aerial mapping from January 26, 2016 (Aero-Metric, Inc.), and February 21, 2016 (Miller Creek Aerial Mapping), natural, pre-development topographic elevations within the Unit 2 area of the NWLF site range from a high of approximately 5,150 feet above mean sea level (ft AMSL) in the southwestern portion of the site to a low of 5,068 ft AMSL near the Pierce Lateral Canal to the east. The existing topography within the Unit 2 area is crossed by a few very shallow drainage swales, none of which include perennial surface water flow features. The total natural topographic relief across the Unit 2 area is approximately 80 feet, with natural topographic slopes between 1% and 5% and averaging approximately 1.5% to the east.

2.2.2 Soils and Geologic Units

2.2.2.1 Surficial Soils

Surficial soil types at the NWLF site were identified by the National Resources Conservation Service (NRCS) Web Soil Survey. The Custom Soil Resource Report for Weld County, Colorado, Southern Part provided in Appendix B-3 shows that the soils within the Unit 2 waste disposal footprint predominantly consist of Olney fine sandy loam (NRCS 2016).

2.2.2.2 Quaternary Deposits

The NWLF site is located in an upland area which is covered by as much as 30 feet of Pleistocene-age eolian (wind-deposited) deposits and as much as 20 feet of undifferentiated Pleistocene- to Holocene-age glacial outwash alluvium. Within the Unit 2 area of the NWLF site, their combined thickness ranges between 17 and 45 feet.

Consistent with the lithology of the adjacent Unit 1 site to the south, the eolian deposits generally consist of clayey silt and very fine to fine-grained silty sand and range from 7 to 20 feet in thickness within the Unit 2 waste disposal footprint. The underlying glacial outwash alluvium consists of interbedded coarser-grained sand and fine gravel with varying amounts of silt and clay interspersed within the sand and gravel and range from less than 10 to approximately 25 feet in thickness (Swift River 2016c). Descriptions and index properties of these strata are detailed in the Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development provided in Appendix B-1. Cross-sections depicting the proposed Unit 2 excavation grades relative to the existing geologic strata are also presented in Sheets 5A and 5B of the Site Development Plans provided in Appendix A and in Appendix B-1 (preliminary facility design grades).

Permeability tests were performed on undisturbed samples and remolded disturbed samples collected from the eolian deposits, as discussed below:

- Two relatively undisturbed samples (classified as CL material) collected from the approximate depth of the proposed liner grades indicated an average in situ hydraulic conductivity of 3.6×10^{-3} cm/sec (Swift River 2016c).
- Five disturbed bulk samples (classified as CL material) collected from shallower depths (less than 10 feet below ground surface [ft bgs]) within the Unit 2 waste disposal footprint were remolded to 97% maximum dry density and 2.5% above optimum moisture content to evaluate possible use as liner material. Remolded hydraulic conductivities ranged from 2.8×10^{-7} to 2.5×10^{-8} cm/sec (Swift River 2016c), suggesting that suitable material may be available on site for use in liner system construction.

2.2.2.3 Bedrock Formations

The Laramie Formation is the uppermost bedrock formation underlying the glacial outwash alluvium in the Unit 2 area of the NWLF site. The Laramie Formation consists of a weathered surface occurring at varying depths below ground surface and is characterized as a mixture of claystone, siltstone, fine-grained sandstone, and shale interstratified with laterally discontinuous lignite (Swift River 2016c). The Laramie Formation is present beneath the entire NWLF site. Within the proposed Unit 2 waste disposal footprint, the Laramie Formation occurs at depths ranging from 17 to 45 ft bgs and measured up to 30 feet in thickness. Underlying the Laramie Formation are the Fox Hills formation and Pierre Shale. As reported in the Report of Hydrogeologic Characterization of North Weld Landfill Unit 2 provided in Appendix B-2, these sedimentary materials are expected to be much less permeable than the overlying eolian deposits, on the order of 10^{-6} cm/sec (Swift River 2016c).

The bedrock formations locally dip gently (1.7°) to the southeast, similar to the regional eastward dip of the DJ Basin and eastward slope of local surface topography.

No evidence of structure features were observed during the field investigation. Review of the United States Geological Survey (USGS) Interactive Fault Map (USGS 2014 and Morgan et al 2012) also did not identify any known faults having displacement in Holocene time or within 200 feet of the NWLF facility.

2.2.3 Hydrogeology

Permeable sandstones within the lower portion of the Laramie Formation and the Fox Hills formation form the Laramie-Fox Hills Aquifer that generally consist of interbedded layers of fine-grained sandstone, siltstone, and shale, with a combined thickness of about 200 feet (Swift River 2016c). The shallower water-bearing strata within the Laramie Formation are typically separated from deeper water-bearing strata of the Fox Hills Formation by several feet of fine-grained materials, including clayey silts, silty clays, and hard siltstones or claystone layers.

2.2.3.1 Groundwater Occurrence

Groundwater identified during the site-specific hydrogeologic field program in the vicinity of the Unit 2 waste disposal area was encountered within the following formations, listed from shallowest to deepest:

- Alluvium/Laramie Formation: Discontinuous saturated alluvial deposits of gravelly sands and sandstones were encountered in three monitoring wells at the contact between the alluvium and the Laramie Formation between 38 feet and 48 feet below top of well casing. These zones are present along only the eastern boundary of the Unit 1 and Unit 2 waste disposal areas. These zones appear to be unconfined.
- Laramie Formation: Localized, discontinuous water-bearing sands and lignite seams within the Laramie formation were encountered in two monitoring wells along the eastern Unit 2 boundary between 46 feet and 56 feet below top of well casing. These isolated zones appear to be confined and hydraulically separated from the deeper, continuous Fox-Hills groundwater zone (aquifer).
- Fox Hills Aquifer: The regional zone of saturation within the Fox Hills Sandstone was encountered across both Unit 1 and Unit 2 areas of the NWLF site, where water levels can be correlated and mapped together across the site. This zone appears to be confined beneath all or most of the NWLF site and represents the uppermost continuous saturated zone. Groundwater flow within this zone is south-southwestward, consistent with conditions routinely monitored at Unit 1.

All water-bearing strata encountered during the hydrogeologic field program occurred below the Unit 2 design subgrades (defined as the bottom grades of the liner system). A minimum of 10 feet of separation is demonstrated between the discontinuous water-bearing zones encountered at the contact between the alluvium and Laramie Formation along the western boundary of Unit 2 and the base of the permanent leachate collection sump liner system. Further, the minimum separation between the base of the liner and the top of the Fox Hills Aquifer is approximately 60 feet.

2.2.3.2 Hydraulic Characteristics

Hydraulic characterization of the water-bearing zones encountered in the vicinity of the Unit 2 area of the NWLF site is discussed in detail in Section 5.2 of the Report of Hydrogeologic Characterization of North Weld Landfill Unit 2 provided in Appendix B-2. A summary of the hydrogeologic characteristics (arithmetic means) is presented below (Swift River 2016c):

- Alluvium/Laramie Formation:
  - Hydraulic conductivity: 4.1 x 10^{-2} cm/sec
- Laramie Formation:
  - Hydraulic conductivity: 2.0 x 10^{-3} cm/sec
- Fox Hills Aquifer:
  - Hydraulic conductivity:
    - Unit 1: 5.7 x 10^{-4} cm/sec (Rust 1997)
    - Unit 2: 1.2 x 10^{-2} cm/sec
  - Horizontal groundwater seepage velocity:
    - Unit 1: 30 feet/year
    - Unit 2: 180 feet/year

The differences in hydraulic characteristics of the Fox Hills Aquifer between the Unit 1 and Unit 2 characterization are reflections of the natural variability of the lithologic properties of the Fox Hills Sandstone.

2.2.4 Groundwater Chemistry

Groundwater quality in the Unit 2 area of the NWLF site is discussed in Section 5.3 of the Report of Hydrogeologic Characterization of North Weld Landfill Unit 2 provided in Appendix B-2. A summary of the basic water quality of the water-bearing zones encountered in the Unit 2 area of the NWLF site is presented below (Swift River 2016c):

- Alluvium/Laramie Formation:
  - Magnesium, sulfate, and bicarbonate type.
  - Tetrachloroethene (PCE) detected in TW-1 at 5.8 micrograms per liter (µg/L). TW-1 is located up-gradient from the active operations of Unit 1; therefore, the detection is not attributable to the NWLF facility.
- Laramie Formation:
  - Calcium-magnesium and sulfate-bicarbonate type.
- Fox Hills Aquifer:
  - Calcium, magnesium, sulfate, bicarbonate type.
  - Regionally described as a sodium-bicarbonate type with elevated TDS ranging from 200 to 2,000 mg/L.

- Poor groundwater quality for human consumption exceeding the TDS Secondary Maximum Contaminant Level of 250 mg/L.
- Chloroform detected in TW-6 at 6.4 µg/L. TW-6 is located up-gradient from the active operations of Unit 1; therefore, the detection is not attributable to the NWLF facility.

2.2.5 Climate

The climate of the region is characterized by generous sunshine, little precipitation except in spring, low daytime humidity, large day–night temperature variations, occasional extreme cold, light winds, and localized thunderstorms (CSU 2000).

The nearest land-based weather station maintained by the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information is located approximately 12 miles to the south-southeast in Greeley (Greeley UNC). Meteorological data from the station was available for the period between March 1967 and March 2016 (NOAA 2016b). Within this time period, the average daily maximum and minimum temperatures were 65°F and 36°F, respectively, with an arithmetic mean of 51° F. During the winter months, the average winter temperature was 30°F; during the summer months, the average temperature was 71°F. Annual precipitation ranged from 8.34 to 22.2 inches with an arithmetic mean of 14.4 inches. Average annual snowfall was 38 inches. The climate's demand for water, referred to as potential evapotranspiration, is calculated as approximately 54 inches (NOAA 2016a and NMSU 1996), or 390% more than the actual supply of water (i.e., precipitation).

2.3 Surrounding Land Usage

NWLF is located in a rural area of unincorporated Weld County. However, the area is considered an urbanizing area by Weld County due to the proximity of the site to parcels annexed by the Town of Severance. The surrounding areas are primarily zoned agricultural and are used for crop production, with the exception of the Pierce Lateral agricultural canal located immediately to the east, the Belmont Farms residential subdivision located across Colorado State Highway 14 to the southwest, and the Waste Management of Northern Colorado commercial trucking facility (USR-1527) located immediately northwest of the NWLF site. A number of feedlots and dairy operations are located within two miles of the facility, but all are topographically down slope to the site. An oil and gas field, the Black Hollow Field, is located approximately one mile to the north of the NWLF site as well as other oil and gas wells in the vicinity.

2.4 Groundwater Wells

A summary of groundwater wells located within one mile of the NWLF boundary is presented in Section 4.3 of the Report of Hydrogeological Characterization, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016c) provided in Appendix B-2.

3.0 LOCATION RESTRICTIONS AND SITE STANDARDS

The following subsections address the location of Unit 2 of the NWLF facility relative to the location restrictions and site standards presented in Section 3.1 of the Regulations. In all cases, the location of the Unit 2 waste disposal footprint complies with required location restrictions and site standards.

3.1 Airport Location Restrictions

The NWLF site is not located within a five-mile radius of any airport runways; therefore, notification of the Federal Aviation Administration (FAA) or providing evidence regarding mitigation of a potential bird hazard is not required. Yankee Field Airport, Bellmore Farms Airport, and WKR Airport are the nearest private airport facilities used by piston-type aircraft, all located greater than seven miles from the NWLF site (AirNav 2016). Fort Collins Municipal Airport and Greeley-Weld County Airport are the nearest airports potentially used by turbojets, both located approximately 13 miles from the NWLF site (FAA). The location of the NWLF site relative to these airports is shown in Figure 3.

3.2 Wetlands

Unit 2 of the NWLF facility is not located in a swamp, marsh, bog, or similar area that could be defined as a wetland according to the United States Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) Wetlands Mapper (USFWS 2016), as shown in Figure 4.

As previously reported in the Unit 1 Hydrogeologic Site Characterization Report (ATEC 1993), an ephemeral streambed at one time ran from the west-central portion of the Unit 1 waste disposal footprint to the southeast property boundary. The location of the streambed can be seen in the USGS Severance Quadrangle map (USGS 2016b) shown in Figure 2 and the USFWS NWI Map in Figure 4. Based on historical site reconnaissance prior the development of the Unit 1 waste disposal area, it was determined that this feature did not appear to have the typical characteristics of a true water course, such as a defined channel, but rather existed as a surface water drainage course. The historical development of the NWLF facility has altered the site topography and corresponding surface water flow patterns across the site such that the historical surface water drainage course no longer exists.

3.3 Faults

There are no known faults that have had a displacement in Holocene time within 200 feet of the NWLF site, as mapped by the USGS Interactive Fault Map (USGS 2016a) and as shown in Figure 5. The closest known fault of Holocene activity is the Derby Fault which lies more than 42 miles to the southwest of the NWLF site (CGS 2008).

3.4 Seismic Impact Zones

The NWLF site is not located in a “seismic impact zone,” defined in the Regulations as an area with a 10% or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a

percentage of the earth's gravitational pull, will exceed 0.10g in 250 years. Based on the USGS Seismic Design Maps Tool (USGS 2016a) the peak horizontal ground acceleration (PGA) with a 2% probability of exceedance in 50 years (approximately equivalent to 10% in 250 years) for the NWLF site is 0.080g. A PGA of 0.080g indicates a low risk of seismic activity.

3.5 Unstable Areas

3.5.1 Soil Conditions

As discussed in Section 2.2.2 of this EDOP, the soil conditions at the NWLF site consist of surficial eolian deposits, primarily Olney fine sandy loam overlying between 17 and 45 feet of glacial outwash alluvial deposits. These materials pose little risk of instability.

Two laboratory consolidation tests on undisturbed samples of glacial outwash material collected from depths below the Unit 2 design subgrades indicate the potential for up to 1.5 feet of total consolidation (primary and secondary) from the development of Unit 2. As discussed in Sections 5.1 and 5.2 of this EDOP, differential settlement of alternative liner system floor grades and leachate collection gravel drain lines resulting from potential consolidation was taken into account as part of the engineering design of the Unit 2 facility and is not predicted to adversely impact the performance or integrity of the liner or leachate collection system.

Based on the Colorado Geological Survey Geologic Hazard Maps (White and Greenman 2008 and CGS 2016a), the NWLF site is not located in mapped areas of collapsible soils, swelling soils, heaving bedrock, or landslides. Additionally, the nearest geologic hazard (ground subsidence) area regulated under Weld County Code is located near Firestone, Colorado, approximately 33 miles to the southwest of the NWLF site.

3.5.2 Geologic or Geomorphologic Features

No geologic or geomorphologic features, including karst features, exist on the NWLF site (Braddock and Cole 1978).

3.5.3 Human-made Features or Events

No potentially unstable human-made features are present on the NWLF site, as summarized below:

- The nearest abandoned coal mines include the Owl, Eaton, and Star Mines, all located approximately seven miles southeast of the NWLF site (CGS 2016a, Turner and Murray-Williams 1983, and ATEC 1993). The distance of the abandoned coal mines from the NWLF site indicates that subsidence due to mining activities would be unlikely.
- The side slopes of the existing Unit 1 disposal area are no greater than 4H:1V (Rust 1997) and pose negligible slope stability risk.

3.6 Topography

As discussed in Section 2.2.1 of this EDOP, the topography of the NWLF site is characterized by relatively uniform slopes between 1% and 5% to the east. Existing (undeveloped) surface water drainage across the Unit 2 area of the NWLF site generally runs across the soil surface as sheet flow from west to east and infiltrates into the ground prior to reaching the topographic low along the Pierce Lateral canal on the eastern NWLF property boundary. The existing site topography is shown in the USGS Severance Quadrangle Map presented in Figure 2. Surface water run-on controls consisting of a run-on diversion channel to divert surface water run-on from areas upgradient of the Unit 2 waste disposal footprint around the landfill will be constructed as part of the development of the Unit 2 waste disposal area; run-on controls are discussed in greater detail in Section 5.4 of this EDOP and in the Drainage Report provided in Appendix D.

The prevailing wind direction at the NWLF site is from the north (WRCC 2002). Due to the relatively minimal topographic relief of the site and surrounding areas, significant natural protection from prevailing winds is not available. Operational requirements and nuisance controls will be implemented to provide suitable protection from prevailing winds to the extent necessary and are discussed in Section 7.0 of this EDOP.

3.7 Floodplains

The NWLF site is not located within a floodplain or flood hazard area defined by the Federal Emergency Management Agency (FEMA 2016). The nearest FEMA-mapped floodplain is a Zone A 100-year floodplain located to the northeast-east of the site along the Coalbank Creek drainage area, as shown in Figure 6.

3.8 Isolation of Waste

The NWLF facility isolates waste from the public and the environment through the use of an approved alternative liner system meeting the requirements of Section 3.2 of the Regulations and Section 258.40 of Title 40 of the Code of Federal Regulations (CFR 258.40 2015). The alternative liner system is described in Section 4.6.1 of this EDOP. An Alternative Liner Demonstration for the Unit 2 alternative liner system is provided in Appendix I.

3.9 Surface and Groundwater Waste Placement

No waste will be placed below or into surface water or groundwater. As discussed in Section 2.2.3.1 of this EDOP, the lowest elevation of the Unit 2 design subgrades (defined as the bottom grades of the liner system) will be separated from the uppermost discontinuous water-bearing zones encountered along the western boundary of Unit 2 by a minimum of 10 feet and from the uppermost continuous saturated zone, the Fox Hills Aquifer, by a minimum of 60 feet.

Surface water run-on and runoff controls are described in Section 5.4 of this EDOP and in the Drainage Report provided in Appendix D.

4.0 FACILITY DESIGN

4.1 Site Development Plans

The Site Development Plans provided in Appendix A graphically depict the layout, development, and design of the Unit 2 waste disposal area at the NWLF site and include the following engineering drawings:

- Sheet 1 Cover Sheet
- Sheet 2 Existing Site Conditions
- Sheet 3 Subgrade Plan and Leachate Collection System Layout
- Sheet 4A Final Grading and Stormwater Management Plan, Unit 2
- Sheet 4B Site-wide Facility Final Grading Plan
- Sheet 5A Cross Section A-A
- Sheet 5B Cross Section B-B
- Sheet 6 Landfill Details
- Sheet 7 Temporary Leachate Collection Sump Details
- Sheet 8 Permanent Leachate Collection Sump Details
- Sheet 9 Stormwater Management System Details (Sheet 1 of 2)
- Sheet 10 Stormwater Management System Details (Sheet 2 of 2)

4.2 Facility Configuration

The Unit 2 waste disposal area of the NWLF facility will consist of approximately 155 acres of waste disposal footprint located directly north of and contiguous to the existing Unit 1 waste disposal footprint. The waste disposal footprint of Unit 2 is limited by a minimum offset of 175 feet from the property boundary, as shown in Sheet 2 of the Site Development Plans provided in Appendix A.

Unit 2 will consist of two primary waste disposal phases, identified as Phases 4 and 5 and shown in Sheet 3 of the Site Development Plans provided in Appendix A. These phases will be further subdivided into modules to limit the area of exposed liner and active waste disposal area open at one time. Module development is expected to proceed from west to east with temporary leachate collection sumps constructed at the downgradient (i.e., east) end of modules until ultimate build-out of each phase when permanent leachate collection sumps will be constructed along the eastern boundary of each phase.

It is anticipated that Phase 4, the southern of the two Unit 2 phases, will be developed first. The liner system in Phase 4 will tie in to the existing liner systems of Phases 1 and 2 in Unit 1 and waste placement will piggyback over top of the existing northern side slope of Unit 1 to reach final site grades, as shown in Sheets 4A and 4B and on cross section A-A in Sheet 5A of the Site Development Plans in Appendix A. Existing cover within the piggyback area of Unit 1 may be removed prior to additional waste placement in this area. The fill sequencing plan may be modified to address future conditions while still providing a

systematic approach to site development and waste filling, and ensuring control over surface water run-on and runoff.

4.3 Site Access

The NWLF site is accessed from Weld County Road 25 approximately 200 feet north of the intersection of Colorado State Highway 14. Right- and left-turn deceleration and acceleration lanes were constructed along Highway 14 prior to the development of Unit 1 at the NWLF site. No additional site access infrastructure beyond maintenance of existing roadways and access lanes is anticipated as part of the development of Unit 2.

4.4 Site Facilities

Existing site facilities developed to support the operations of Unit 1 at the NWLF site are expected to remain and continue to support the development and operation of the Unit 2 waste disposal area. These facilities include the following (locations shown in Sheet 2 of Site Development Plans in Appendix A):

- Landfill office
- Scale house
- Maintenance shop and equipment yard
- Public and employee parking areas
- Paved access road

No new structures are anticipated to be required to support the development or operations of Unit 2. A new/additional scale house and/or scales may be constructed in the future and would be located north of the existing scale house along the west side of the property.

4.5 Engineered Containment Systems

The Unit 2 waste disposal area will be designed, constructed, and maintained with engineered containment systems that meet current Regulations, including an alternative liner system, a composite liner with a high-density polyethylene (HDPE) geomembrane below permanent leachate collection system sumps, and a water balance final cover. Each engineered containment system is discussed in greater detail in the following subsections.

4.5.1 Alternative Liner System

The Unit 2 waste disposal area will be constructed with an alternative liner system that meets the performance standards set forth in Section 2.1.15 of the Regulations and in 40 CFR Part 258.40(a)(1). The alternative liner system for Unit 2 is the same liner system design previously approved by CDPHE and WCDPHE and constructed for the Unit 1 waste disposal area at the NWLF site. A detail of the alternative liner system is shown in Sheet 6 of the Site Development Plans provided in Appendix A.

The alternative liner system will consist of the following components, listed from top of liner down to existing foundation material:

- A 6-inch-thick granular leachate collection drainage layer installed over the liner floor area and composed of soils exhibiting a hydraulic conductivity equal to or greater than 1 x 10^{-2} cm/sec;
- A 6-inch-thick protective soil layer installed over the liner side slope area;
- A 24-inch-thick compacted cohesive soil liner composed of on-site or imported soils exhibiting a hydraulic conductivity no greater than 1 x 10^{-7} cm/sec; and
- Prepared subgrade material composed of conditioned and compacted existing subsurface material.

The bottom grades of the liner system (referred to throughout this EDOP as subgrade) are shown in Sheet 3 of the Site Development Plans provided in Appendix A. Permanent excavation side slopes were designed to not exceed 3H:1V and liner floor grades were designed to slope toward the centerline of each phase in a herringbone pattern at approximately 2.8% (average) and to slope along the centerline of each phase toward the leachate collection sumps at approximately 2.15% (average). The Regulations do not specify a minimum separation between the bottom of the liner system and groundwater for municipal solid waste landfills. As previously discussed in Sections 2.2.3 and 3.8 of this EDOP, the Unit 2 subgrade design reflects a minimum vertical separation distance of 10 feet from the uppermost discontinuous water-bearing zones encountered along the eastern boundary of Unit 2 and a minimum vertical separation distance of approximately 60 feet from the uppermost continuous saturated zone, the Fox Hills Aquifer, based on water level measurements taken during the 2016 hydrogeologic site characterization field investigation.

The alternative liner system will be constructed under a comprehensive CQA program to verify that the soil materials are prepared and installed as intended and as required to ensure performance. A copy of the current NWLF CQA Plan is provided in Appendix E.

Following each liner construction project, a certification report will be prepared to document that the liner system and leachate collection system were constructed in accordance with the approved CQA Plan and all CDPHE and WCDPHE requirements. The certification report will be signed and sealed by a professional engineer (PE) registered by the State of Colorado and submitted to the CDPHE and the WCDPHE, with a copy placed into the Operating Record.

An alternative liner demonstration indicating that the alternative liner system for the Unit 2 waste disposal area will reasonably ensure groundwater protection considering expected waste characteristics, site construction, and site setting is provided in Appendix I of this EDOP. Groundwater protection is demonstrated through technical evaluation and modeling that maximum contaminant levels (MCLs) listed in Table 1 of 40 CFR 258.40 will not be exceeded at the Unit 2 point of compliance (POC). For conservatism, the alternative liner demonstration does not consider the additional thickness of compacted cohesive soil

liner or the second liner (60-mil HDPE geomembrane) within permanent leachate collection sumps, which are the most probable locations for a potential release.

The alternative liner demonstration consisted of the following analyses:

- A Hydrologic Evaluation of Landfill Performance (HELP) model analysis was performed to estimate leachate generation rates and impingement rates through the alternative liner system, assuming various waste depths and cover configurations throughout the operational life of the facility. The HELP analysis is discussed in greater detail in Section 5.1.1 of this EDOP.
- Steady-state and transient MULTIMED modelling of leachate transport from the base of the alternative liner system was performed to estimate leachate constituent concentrations downgradient of Unit 2 at the point of compliance.
  - The steady-state modeling estimated a dilution factor (DF) reciprocal of 4.5×10^{-3} compared to the maximum required DF reciprocal of 7.1×10^{-2} to ensure MCLs are not exceeded at the Unit 2 POC, conservatively indicating maximum potential leachate constituent concentrations at least 16 times less than MCLs.
  - The transient modeling predicted that leachate constituents are not predicted to be detected above laboratory reporting limits (i.e., practical quantitation limits or PQLs) at the Unit 2 POC through the operational life and post-closure period of the facility.

4.5.2 Leachate Collection Sump Secondary Liner

A second liner (60-mil HDPE geomembrane) will be installed within permanent leachate collection sumps to create a composite liner system where leachate head may accumulate. Details and cross-sections of the composite liner system for the permanent sumps are shown in Sheet 8 of the Site Development Plans provided in Appendix A.

The leachate collection sump liner system, including the sump profile, will consist of the following components, listed from top of the liner system down to existing foundation material:

- A 12-inch-thick granular leachate collection drainage layer installed over the sump area and composed of soils exhibiting a hydraulic conductivity equal to or greater than 1×10^{-2} cm/sec;
- A 10-ounce per square yard (oz/sq. yd.) non-woven geotextile installed over the sump area and extended a minimum of three feet beyond the limits of the sump;
- A leachate collection and recovery sump housing the leachate extraction riser and auxiliary monitoring pipes, backfilled with three feet of drainage gravel exhibiting a hydraulic conductivity equal to or greater than 1.0 cm/sec;
- A 9-foot x 9-foot 60-mil HDPE geomembrane rub sheet;
- A 60-mil HDPE (smooth) geomembrane liner;
- A 30-inch-thick compacted cohesive soil liner composed of on-site or imported soils exhibiting a hydraulic conductivity no greater than 1×10^{-7} cm/sec; and
- Prepared subgrade material composed of conditioned and compacted existing subsurface material.

Construction of permanent leachate collection sumps, including primary and secondary liners, will be performed in accordance with the current NWLF CQA Plan provided in Appendix E.

4.5.3 Water Balance Alternative Final Cover

A water balance alternative final cover (AFC) system will be constructed over all waste placed at the NWLF facility once final grades are developed. The water balance final cover system for Unit 2 was designed in accordance with the streamlined guidance provided in the CDPHE "Final Guidance Document, Water Balance Covers in Colorado" (CDPHE 2013).

As discussed in Section 5.3.2.2 of the Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development provided in Appendix B-1, the NWLF site is located within Colorado Ecozone 3. Within Ecozone 3, the average grain-size distribution from the soils encountered within the Unit 2 waste footprint (i.e., 40% sand, 40% silt, and 20% clay) plots within the acceptable zone for a 2.5-foot-thick water balance cover overlying a daily cover foundation layer. A detail of the water balance final cover is shown in Sheet 6 of the Site Development Plans provided in Appendix A. The water balance final cover system for Unit 2 will be constructed in accordance with the requirements of the NWLF CQA Plan provided in Appendix E.

Sheets 4A and 4B of the Site Development Plans provided in Appendix A show the proposed top of final cover grades for Unit 2 and for the full NWLF facility, respectively. The final grades for Unit 2 include a maximum finished grade elevation of 5,255.5 ft AMSL compared to the existing maximum finished grade elevation of 5,210 ft AMSL within the Unit 1 waste disposal footprint. Consistent with the final closure design for Unit 1, the Unit 2 closure design includes 4H:1V side slopes (or less) and a top deck crown slope of 5%. In this way, the NWLF site will be left in a condition of good aesthetic appearance with consistent grading to blend with the surrounding topography and without visible differentiation between Units 1 and 2.

Final cover stormwater controls will be constructed overtop of the AFC, as discussed in Section 5.4 of this EDOP; the full thickness of the water balance final cover will be maintained below all final stormwater controls.

Closure and post-closure care of the facility will be performed and maintained in accordance with the Closure and Post-closure Plan discussed in Section 9.0 of this EDOP.

4.6 Leachate Collection System Design and Management

The leachate collection system was designed to collect leachate and contact surface water runoff from the waste mass and provide for an efficient means of removal. Liner grades were designed to provide positive drainage within the leachate collection system in order to meet the leachate travel time requirement of 12 months and maintain no greater than one foot of leachate head on the liner throughout the life of the facility, in consideration of maximum potential future consolidation of foundation soils (see Section 5.2 of this

EDOP). To demonstrate that the maximum head on the liner system will be maintained at less than 12 inches, HELP modeling was performed assuming various waste depths and cover configurations to estimate maximum head buildup throughout the operational life of the Unit 2 waste disposal area. The results of HELP analyses and travel time calculations are discussed in Section 5.1.1 and 5.1.2 of this EDOP and are presented in greater detail in Appendices C-1 and C-2, respectively.

The leachate collection system will consist of a 6-inch-thick granular leachate collection drainage layer installed over the liner floor area and composed of soils exhibiting a hydraulic conductivity equal to or greater than 1 x 10^{-2} cm/sec. CDPHE has also approved the equivalent use of 8.5 inches of glass cullet material with a minimum hydraulic conductivity of 1 x 10^{-2} cm/sec for the leachate collection drainage layer. A copy of the CDPHE approval letter is provided in Appendix J. Prior to the use of glass cullet material in leachate collection drainage layer construction, hydraulic conductivity testing will be performed to verify that the glass cullet will meet the hydraulic conductivity requirement of 1 x 10^{-2} cm/sec.

As previously discussed in Section 4.5.1 of this EDOP, the floor grades and overlying leachate collection drainage layer will slope toward the centerline of each phase. Along the centerline, gravel drain lines will be constructed at approximately 2.15% slope towards leachate collection sumps constructed at the low point in each module. Gravel drain lines will consist of a minimum of one foot of gravel material exhibiting a minimum hydraulic conductivity of 1.0 cm/sec wrapped in a 10-oz/sq. yd. non-woven geotextile to prevent the migration and accumulation of fines.

As previously discussed in Section 4.2 of this EDOP, temporary leachate collection sumps will be constructed at the downgradient (i.e., east) end of modules until ultimate build-out of each phase when permanent leachate collection sumps will be constructed along the eastern boundary of each phase. Temporary leachate collection sumps will consist of a minimum of 2.5 feet of gravel material exhibiting a minimum hydraulic conductivity of 1.0 cm/sec overlying the alternative liner system described in Section 4.5.1 of this EDOP. Vertical 18-inch-diameter riser pipes will be seated on 1-inch-thick HDPE flat stock within the temporary leachate collection sumps to allow for leachate extraction. Design details for temporary sumps are shown in Sheet 7 of the Site Development Plans provided in Appendix A. Temporary sumps will be removed as part of construction of adjacent modules to allow for liner tie-in and eventual waste placement in the sump areas.

Permanent leachate collection sumps are described in Section 4.5.2 of this EDOP. Design details for permanent sumps are shown in Sheet 8 of the Site Development Plans provided in Appendix A. Within the permanent leachate collection sumps, perforated leachate extraction and auxiliary monitoring pipe sections will be connected to solid-wall riser pipes that will extend up the eastern sideslope of Unit 2 to allow for leachate extraction and monitoring. A pipe loading analysis of the HDPE sump pipes is discussed in Section 5.1.3 of this EDOP and is presented in greater detail in Appendix C-3.

4.7 Cover Materials

Sufficient amounts of adequate cover will be readily available for use throughout the operating life of the Unit 2 waste disposal area to minimize nuisance conditions, prevent ponding, and complete site closure. Cover soils will be obtained from existing stockpiles on site and/or from excavation of Unit 2 modules. Excavated soils will be segregated into separate stockpiles for unclassified soils (i.e., general fill), potential liner construction materials, and potential final cover materials. All on-site soils are considered suitable for use as daily and/or intermediate cover.

4.7.1 Daily Cover

Daily cover will be placed over the active disposal area at the end of each operating day, or at more frequent intervals if necessary to control nuisance conditions. Daily cover will consist of six inches of earthen material or ADC materials which have been approved by the CDPHE and the WCPDHE for use at NWLF. Letters of approval from the CDPHE and the WCDPHE for the usage of ADC materials at NWLF are included in Appendix K of this EDOP.

If ADC is used, the following operational requirements will apply:

- Shredding or the use of shredded construction and demolition (C&D) debris that contains any asbestos will not be used as ADC;
- Stockpiles of segregated select C&D debris to be used as ADC will be located only on lined areas of the landfill. Stockpiles will be managed to control nuisance conditions;
- Select C&D used as ADC will be a minimum of six inches thick and achieve complete coverage of the underlying solid waste. If the C&D ADC is insufficient to achieve complete coverage of the underlying waste, soil or other approved ADC will be used to provide complete coverage;
- When any ADC is used, soil will be used for daily cover at least once every seven days and will remain in place;
- C&D and other approved materials used for ADC are still considered a waste. Accordingly, the Weld County Solid Waste User Fee will be collected for these materials;
- Approved ADC materials will be managed in a manner such that dust does not constitute a hazard to human health; and
- Stormwater that comes in contact with materials used as ADC will be treated as leachate and managed as described in Section 8.3 of this EDOP.

ADC materials and/or cover soil may also be used to improve trafficability of haul routes and unloading areas over previously-placed wastes. Dust generation of cover materials will be controlled as discussed in Section 7.5.5 of this EDOP.

4.7.2 Intermediate Cover

A minimum of one foot of intermediate cover soil will be placed over areas left temporarily unused for greater than one month, in accordance with the Regulations. Intermediate cover will also be placed over disposal areas that have reached final waste grades but are not anticipated to receive final cover for at least one month.

The intermediate cover will consist of unclassified on-site soils and will be graded to provide stormwater drainage away from the working face to avoid contact with waste. Prior to further waste disposal within intermediate-covered areas, the cover soils may be stripped and reclaimed (stockpiled) for future use.

4.8 Landfill Capacity

Total permitted airspace of the NWLF facility, defined as the three-dimensional gross volume of the landfill available for waste disposal, is as follows:

- Unit 1: 15,274,520 cubic yards (cy) (Rust 1997 design)
  - As of January 1, 2017 (estimated): 3,985,000 cy remaining
- Unit 2: 26,636,000 cy
- NWLF total: 41,910,520 cy
  - As of January 1, 2017 (estimated): 30,621,000 cy remaining

These capacities represent the volume from the top of the leachate collection drainage layer/protective soil layer to the bottom of the final cover system, and include volume consumed by placement of daily and intermediate soil cover.

4.9 Soil Balance

Earthen materials to be used for compacted cohesive soil liner construction and protective material for liner system sideslopes, final cover construction, daily and intermediate cover, and structural fill required for the development of the Unit 2 waste disposal area will be obtained from on-site excavation, where possible. Based on the results of the site characterization discussed in Section 2.2 of this EDOP and presented in Appendix B, there appears to be sufficient volumes of adequate soil types available for use to construct and operate Unit 2 through the life of the facility.

From a soil balance perspective, the development of Unit 1 at NWLF is projected to result in a net surplus of approximately 2,178,000 cy of soil on site. Soil balance requirements for the development and operation of Unit 2 are projected as follows:

- Unit 2 gross excavation to liner subgrade (base of liner): 4,400,000 cy
- Structural fill required for cell/berm construction: 350,000 cy
- Liner system construction:
  - Compacted cohesive soil liner material: 500,000 cy
  - Protective liner material: 13,000 cy
- Daily and intermediate soil cover needs (13% of permitted airspace): 3,500,000 cy
- Final cover system: 800,000 cy

The NWLF site is projected to have an overall surplus of approximately 1,415,000 cy of soil after completion of the ultimate buildout, operation, and final closure of Unit 2.

5.0 ENGINEERING CALCULATIONS

5.1 Leachate Collection System Design Calculations

As discussed in Section 4.6 of this EDOP, the leachate collection system was designed to collect leachate and contact surface water runoff from the waste mass and provide for an efficient means of removal. The leachate collection system was designed to meet composite liner requirements set forth in the CDPHE Regulations for maximum head on liner and maximum leachate travel times.

5.1.1 Leachate Head on Liner (HELP Analysis)

The HELP version 3.07 (USACE 1997) was used to model leachate generation and corresponding hydrologic performance of the alternative liner and leachate collection systems in Unit 2. The HELP analysis is described in detail in Appendix C-1.

Various operational conditions were initially modeled, representing the most critical typical operational scenarios anticipated to occur throughout the life of the landfill from a leachate generation standpoint. Meteorological data was generated using the synthetic weather generator (WGEN) built into the HELP model. Material properties for the alternative liner system, final cover system, and waste mass were derived from site-specific laboratory test data (Swift River 2016a) and HELP default soil types. Post-consolidation liner grades were used in the analysis. The results of the initial analysis are presented in Appendix C-1 and demonstrate that the peak head on the alternative liner system is expected to be less than 12 inches throughout all open/daily cover, intermediate cover, and closed conditions of Unit 2.

The results of the initial HELP analysis indicated that the operational scenario modeling 70 feet of in-place waste with intermediate cover for a 10-year period (Scenario 3) results in the most critical head buildup of the alternative liner system. The maximum head buildup on the alternative liner system is expected to be less than 12 inches.

The HELP model results also indicated that operational conditions consisting of 6 feet of waste with daily cover (Scenario 1) and 70 feet of waste with daily cover (Scenario 2) result in very similar critical leachate generation and impingement (i.e., leakage) rates through the alternative liner system. This observation indicates that leachate generation at the NWLF site is primarily driven by the moisture content of the waste and limited to the first lift of waste placed. Subsequent waste lifts do not contribute to additional generation of leachate, primarily due to storage capacity and evaporation of precipitation within the cover soils. This behavior is also consistent with site-specific observations from throughout the operational life of Unit 1 at NWLF, where generation of leachate has been observed to significantly decrease once the first lift of waste is placed in the active phase.

5.1.2 Leachate Travel Time

The maximum travel time for leachate to report to a permanent leachate collection sump was calculated using Darcy's Law along the longest leachate flow paths within Phases 4 and 5 of Unit 2. The results of travel time calculation show that the longest flow paths result in travel times of less than 365 days in both Phases 4 and 5 of Unit 2, and in consideration of reductions to leachate collection system floor grades due to differential consolidation of foundation soils. The detailed calculation is provided in Appendix C-2.

5.1.3 Leachate Collection Header Pipe Strength

Pipe strength calculations were completed to verify the structural integrity of the leachate collection header pipes (6-inch- and 18-inch-diameter SDR 17 HDPE) under the overburden pressure of the maximum height of waste and cover soils. The detailed calculations are provided in Appendix C-3. The calculations obtained factors of safety against wall crushing and wall buckling and estimated ring deflection. All factors of safety exceeded the minimums recommended by the Plastic Pipes Institute (PPI) for thermoplastic pipe applications.

5.2 Foundation Consolidation Calculations

Potential consolidation of the foundation soils beneath Unit 2 and corresponding total and differential settlement of liner system floor grades were estimated using consolidation properties of on-site material. Index and consolidation properties (i.e., the compression index [C_c], recompression index [C_r], and coefficient of secondary consolidation [C_α]) were determined through two consolidation tests of undisturbed soil samples collected during the site characterization field program (Swift River 2016a). The tests were conducted on soil samples collected from below the Unit 2 subgrade grades.

Results of the consolidation tests, along with the estimated loading from the maximum waste and cover soil profile, were used to compute potential foundation consolidation. It was assumed that consolidation will occur up to the top of the Laramie formation, as defined in the Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016a).

Consolidation calculations were based on Terzaghi's one-dimensional consolidation model. Points were selected along both the leachate collection header trench and liner floor to evaluate differential settlement on final floor slopes and leachate conveyance. Total predicted consolidation under the maximum waste and cover soil was conservatively estimated to be up to 1.5 feet, with the maximum predicted differential settlement resulting in a calculated decrease in the slope of the liner floor from 2.8% (design grade) to 2.64%, and a decrease in leachate collection gravel drain line from 2.15% (design grade) to 2.12%. These post-consolidation slopes were used in leachate head buildup and travel time calculations. The foundation consolidation calculations are provided in Appendix C-4.

5.3 Global Slope Stability Analyses

Global stability analyses were performed to evaluate the stability of subgrade/liner excavation slopes, typical waste filling slopes, and final cover grades for Unit 2. As discussed in Section 3.4 of this EDOP, NWLF is not located in a seismic impact zone; therefore, slope stability analyses were only run for static loading conditions. A detailed discussion of the slope stability analyses is provided in Appendix C-5.

Five cross-sections were analyzed for global slope stability analyses at various intermediate/operational geometries throughout the operational life of Unit 2 considered to be representative of worst-case conditions from a slope stability perspective:

- Section A: cross-section cut through the maximum depth of excavation (i.e., longest excavation slope) required for liner construction
- Section B: cross-section cut in a north-south alignment through an intermediate filling condition in Phase 4 that terminates at the 2H:1V step between the liner systems of Phases 4 and 5
- Section C: cross-section cut in an east–west alignment through an intermediate filling condition in Phase 4
- Section D: cross-section cut through the maximum thickness of waste (i.e., maximum driving force)
- Section E: cross-section cut through maximum permitted waste grades at the location of minimum height of the perimeter berm (i.e., minimum resisting force)

Critical failure surfaces (failure surfaces with the lowest factor of safety) were determined by limit-equilibrium analysis (2-D) using Spencer's method of slices. Circular and block failure surfaces were considered, and in all cases circular failure surfaces yielded the lowest factors of safety. Minimum allowable factors of safety for short-term conditions (excavation and intermediate fill) and long-term conditions (final closure) were defined as 1.30 and 1.50, respectively.

Minimum factors of safety calculated against static stability failure were found to be above minimum allowable factors of safety for all cross sections and operational conditions evaluated.

5.4 Surface Water Management

5.4.1 Approach to Surface Water Management

The general concept for management of stormwater for Unit 2 of NWLF will be to manage the runoff completely separate from the existing Unit 1 structures and return flow to historic drainage patterns, to the extent practical. Additionally, the stormwater management system was designed to retain runoff from the developed footprint of the site on-site in order to comply with the requests of the neighboring properties, specifically the Pierce lateral agricultural canal to the east and Colorado Department of Transportation (CDOT) to the south of the NWLF site.

5.4.2 Temporary Surface Water Management

Surface water within the active landfill will be managed through a series of temporary berms and/or channels that will divert run-on away from the active area and direct runoff toward temporary surface water ponds or the permanent stormwater retention pond. Surface water runoff that is not contact water may be managed via gravity drainage or pumping for use on-site and/or to the stormwater retention pond. Details for the temporary stormwater control structures and other best management practices (BMPs) will be provided to the CDPHE for informational purposes with the construction packages for each cell prior to construction. Any temporary surface water controls will be designed to handle a 25-year, 24-hour storm event.

5.4.3 Final Stormwater Management System

Permanent surface water structures and erosion control measures will be constructed over the life of Unit 2 to limit stormwater run-on and mange runoff. Components of the stormwater management system that will be constructed throughout the development of Unit 2 will include the following:

- A run-on diversion channel;
- A dissipation basin;
- Landfill perimeter channels;
- Landfill bench channels;
- A downchute channel with stilling basin;
- Culverts;
- A low-water crossing; and
- A retention pond.

Peak flows from the 100-year, 24-hour storm event were used to size permanent stormwater management structures, in accordance with CDPHE Regulations and exceeding Weld County Code design requirements. Detailed hydrologic and hydraulic calculations and design details for permanent stormwater management structures are provided in the Drainage Report provided in Appendix D. The locations of the permanent stormwater management structures for Unit 2 are shown in Sheet 4A of the Site Development Plans provided in Appendix A. For reference, a site-wide site plan with stormwater management structures for the full NWLF site (Units 1 and 2) is shown in Sheet 4B. Sheets 9 and 10 provide details for the Unit 2 stormwater management structures.

5.5 Soil Erosion Potential Evaluation

An evaluation of the effects of erosion due to rainfall on the proposed water balance final cover system was performed. The analysis consisted of using the Revised Universal Soil Loss Equation, Version 2 (RUSLE2) erosion modeling software (USDA 2010) to estimate the amount of soil loss caused by sheet and rill erosion of the final cover after one year and five years of vegetative growth on the final cover. RUSLE2 calculations are provided in Appendix C-6. Annual soil loss due to erosion at one and five years was predicted to be 2.9 tons/acre/year and 1.4 tons/acre/year, respectively, and less than the targeted soil loss tolerance of 5 tons/acre/year.

6.0 CONSTRUCTION QUALITY ASSURANCE

The CQA requirements for liner system construction, leachate collection sump construction, and AFC construction at NWLF are outlined in the Construction Quality Assurance (CQA) Plan for the NWLF, provided in Appendix E. The NWLF CQA Plan addresses monitoring, testing, and documentation requirements necessary for approved construction.

7.0 OPERATIONAL INFORMATION

7.1 Operating Hours

The hours of operation of NWLF vary seasonally but generally range from 6:00 a.m. to 6:00 p.m. Monday through Saturday. The facility also periodically operates on Sundays as needed. Hours are subject to change to accommodate operational needs and may be extended to accommodate increased residential and commercial waste volume, clean-up projects, special waste contracts, or other operational variables. Standard hours of operation and all changes in operational hours are posted at the entrance to the NWLF site.

7.2 Facility Management and Personnel

The WMDSC is the owner and operator of the NWLF. The qualifications, names, and addresses of the individuals currently operating the landfill and having the authority to take corrective action in the event of noncompliance are provided in Appendix H.

Current staffing for the NWLF facility, which may vary over the life of the facility, includes the following:

Site Manager	1
Operations Specialist	1
Scale Attendants	2
Equipment Operators	5
Mechanics	2
Laborers	1
Facility Engineer (PT)	1
Operations Manager (PT)	1
Total	**14**

7.3 Facility Equipment

Current equipment at the NWLF facility, which may vary over the life of the facility (make, model, and quantity), includes the following:

Equipment	Quantity	Use
Scrapers (Cat 627)	1	Earth moving
Landfill Compactors (Cat 836)	2	Refuse compaction
Motor Grader (Cat 140H)	1	Road/drainage maintenance
Dozer (Cat D8)	1	Earth moving and refuse pushing
Loader/Backhoe (Cat 430)	1	Multi-purpose
Tractor (John Deere 2755)	1	Multi-purpose
Forklift (Champ CB40)	1	Loading and transport
Sweeper (Broce RCT350)	1	Dust and track-out control
Water Truck (3,500 gal)	1	Dust control
Pick-up/Service Trucks	6	Maintenance, employee use

7.4 Site Security

A combination of physical barriers, signs, and staffed entrance facilities (office and scale house) are in place at NWLF and are used to secure the facility and prevent unauthorized access and use of the facility, as summarized below:

- A lockable gate is in place at the site entrance and is closed and locked at all times when the facility is closed and unattended.
- A six-foot fence with an additional one foot of barbed wire will be installed around the perimeter of the facility.
- No trespassing signs are posted along the landfill boundary fence.
- As discussed in Section 7.1 of this EDOP, the standard hours of operation are posted at the entrance to the NWLF site. In addition, a sign which lists prohibited waste types is located at the entrance to the facility.
- A staffed office is located at the entrance of the NWLF facility. Contractors and visitors are instructed to sign in at the office. Customer vehicles entering the facility are instructed to bypass the office and report directly to the staffed scale house. Office and scale house personnel have radio contact with other NWLF personnel to report any unauthorized activities. Trained personnel are stationed at the scale house during all operating hours to monitor, screen, and control access by all users and visitors
- WMDSC coordinates with the Windsor-Severance Fire District to ensure they have access 24 hours a day to be able to respond to an after-hours emergency, if necessary.

7.5 Control of Nuisance Conditions

In order to minimize nuisance conditions (odors, noise, vector scavenging, dust, fire, and windblown litter) that can be associated with landfilling operations, the NWLF facility implements the nuisance control programs discussed in the following subsections.

7.5.1 Odor Control

Potential odors produced by incoming waste during the course of daily operations typically dissipate within a short distance from the active disposal area. For the purposes of controlling odors from migrating off site, the Unit 2 waste disposal footprint was designed with a minimum setback from the NWLF property line of at least 175 feet. Additionally, effective application of daily and intermediate cover over active waste disposal areas will mitigate long-term odor migration. If odors from waste materials becomes a nuisance condition, alternative operating techniques will be taken to minimize the condition, including the placement of additional cover material.

7.5.2 Noise Control

A noise monitoring and hearing conservation program has been implemented to protect the hearing of the employees and to ensure the facility is maintaining compliance with local noise ordinances. The program includes noise surveys of each piece of operating equipment, which determines if hearing protection should be worn by the equipment operator.

7.5.3 Vectors

Disease and nuisance vectors such as flies, mosquitoes, and rodents have not been an issue at the NWLF site throughout the development and operation of the Unit 1 waste disposal area. Potential vector conditions are controlled primarily by proper grading and positive drainage to eliminate the potential for standing water and the development of insect breeding areas and through the effective use of daily and intermediate cover. A commercial vector control company will be retained if disease and/or nuisance vectors become a significant problem.

7.5.4 Bird and Wildlife Control

Significant bird populations are expected around the active waste disposal area due to the presence of organic waste matter. Placement of daily and intermediate cover over active waste disposal areas helps to reduce nuisance bird conditions. Additional deterrents, such as noisemakers, visual scare techniques (birdlines, reflective tape, balloons, kites, owl decoys, etc.), and/or distress calls will be considered if birds become a persistent nuisance.

7.5.5 Dust Control

Dust generation (particulate emissions) at NWLF can occur from soil excavation, soil transport and placement, refuse compaction, and vehicular and equipment travel along site access roads. Dust raised from vehicular movement is controlled by wetting roads with water and/or applying commercially available dust suppressant compounds. Additional procedures used for controlling particulate emissions at NWLF consist of the following:

- Paving and sweeping certain primary on-site access roads;
- Monitoring visible dust emissions from unpaved site access roads by facility personnel to determine the need for and frequency of dust suppression watering;
- Minimizing the size of the active working disposal area, to the extent practical;
- Minimizing the size of borrow areas and areas disturbed from soil stockpiles, to the extent practical;
- Applying leachate within the constructed waste disposal limits (i.e., within lined areas of the landfill);
- Revegetation of inactive areas; and
- Posting and enforcing speed limit signs on site access and haul roads.

7.5.6 Fire Protection and Control

The office, scale house, and maintenance buildings are equipped with suitable fire extinguishers for suppression of any minor fires and for personnel safety. Fire protection for landfill equipment and vehicles is provided by portable fire extinguishers attached to each piece of equipment, vehicle, or machinery and/or automatic fire suppression systems.

Operational practices will limit the risk of fire in the landfill. Waste deliveries to the landfill will be checked in accordance with the Waste Identification Plan provided in Appendix F. No burning of waste is permitted at NWLF. Vehicles containing burning materials that would otherwise be accepted at the facility are directed to an inspection area where the vehicle driver can safely extinguish the fire. The vehicle is then directed to an isolated disposal area on site where the individual load can be safely unloaded from the vehicle and inspected by facility personnel. In this manner, NWLF is able to confirm that no burning material remains in the disposed waste.

In order to manage accumulation of wind-blown tumbleweeds and prevent them from becoming a nuisance condition, NWLF has received permission from the CDPHE and the WCDPHE to burn weeds that have accumulated along internal fence lines and wind screens. NWLF will obtain a case-by-case burn permit from the WCDPHE, in consultation with the local fire protection district, and comply with weed-burning restrictions typically in effect within the agricultural district of Weld County.

Additional fire protection coverage is available from the Windsor Severance Fire District via telephone communication.

7.5.7 Control of Windblown Litter

To minimize nuisance conditions associated with windblown litter, the following procedures are implemented at NWLF:

- The size of the active waste disposal areas will be limited to the smallest practical area for the number and types of vehicles using the facility. Segregation and size of active disposal areas will be at the discretion of facility management to provide for safe, secure operations without compromising containment of windblown litter.
- Daily cover will be applied at a minimum thickness of six inches or ADC will be applied over each lift of waste placed. Twelve inches of intermediate cover soil will be placed over areas that will not receive additional waste for a period greater than 30 days.
- Litter screens and temporary fencing will be strategically placed around the active disposal areas to minimize the escape of windblown litter. Design and placement of litter screens and temporary fences will be at the discretion of facility management.
- Other operational techniques may be employed to minimize migration of off-site litter, such as the current 40-foot-high, 3,500-foot-long litter fence in place along the southern and southeastern boundaries.
- Disposal operations will be halted when sustained winds of 40 miles per hour (mph) or greater or gusts of 55 mph or greater, are expected to persist for one hour or longer.
- Temporary laborers may be used on an “as required” basis to collect windblown litter that escapes the active disposal area.
- Windblown material generated during disposal operations will be collected and returned to the landfill working face.

- Adjacent properties (provided permission has been granted by the property owner) will be policed periodically to retrieve any litter which escapes vehicles using the facility.
- Vehicles entering the facility are required to have loads covered or adequately secured. This requirement will be communicated by signage at the facility entrance.
- Conditions of off-site litter resulting from landfill operations will be responded to within one business day of notification to the facility manager.

7.5.8 Control of Tracked-out Mud on Highways

The following procedures are implemented at NWLF to minimize nuisance conditions associated with mud tracked out onto adjacent highways:

- Extended pavement of internal roads leading up to the exit gate of the facility.
- Rumble strips or equivalent tracking control devices are provided along the exit route.
- Sweeping of paved internal roads will be performed, as necessary, to minimize accumulation of dirt and mud that could be carried out onto adjacent public roadways.

In the event significant quantities of mud are tracked onto State Highway 14, NWLF will work with CDOT to clean the road segment in the proximity to the landfill, to the extent allowed, as soon as practical and safe.

7.6 Record Keeping

A facility Operating Record has been developed for the NWLF facility and is maintained in the on-site office. This Operating Record will continue to be maintained throughout the development and operation of the Unit 2 waste disposal area. The Operating Record includes (and will continue to include) records of the following:

- This Engineering Design and Operations Plan (EDOP);
- Significant changes to the approved EDOP, accepted waste streams, facility design, or operating plan(s) or procedures;
- Incoming waste volumes;
- Internal/third-party inspection records;
- Training topics and procedures;
- CQA certification reports and construction as-built drawings and details;
- Design documentation for controlling leachate or gas condensate and documentation on the amounts of leachate and gas condensate collected;
- Water quality monitoring results, including demonstrations, certifications, findings, data, or other documents required by the Regulations;
- Landfill gas monitoring results, including remediation plans required by the Regulations;
- Closure and post-closure care plans and any monitoring, testing, or analytical data associated with closure or post-closure as required by the Regulations;
- Closure and post-closure cost estimates and financial assurance documentation;
- Inspection records and agency approvals/correspondence; and
- Information demonstrating compliance with waivers from the Regulations.

8.0 ENVIRONMENTAL MONITORING PROGRAMS

8.1 Groundwater Monitoring

The Groundwater Monitoring Plan (GWMP) for the NWLF site was recently revised and approved by the CDPHE. The GWMP documents the approved groundwater monitoring network and monitoring procedures for the facility. The current GWMP for the site (Swift River 2016b) will be updated to include additional groundwater monitoring wells strategically located to effectively monitor the Unit 2 waste disposal footprint in accordance with the Regulations. The updated GWMP will be provided to the CDPHE for approval prior to the development of Unit 2. Because the revised GWMP was recently approved by the CDPHE and sampling, data evaluation, and reporting procedures from this plan will apply to the Unit 2 monitoring wells, CDPHE approval of groundwater monitoring requirements for Unit 2 wells should be streamlined. The updated and approved GWMP will be placed in Appendix G of this EDOP.

8.2 Surface Water Monitoring

Surface water discharges from the NWLF facility are managed in accordance with the Stormwater Management Plan (SWMP), North Weld Landfill (WMC 2016), issued and approved under the Colorado Discharge Permit System (CDPS) Permit No. COR-900412 issued by the CDPHE Water Quality Control Division. The SWMP was developed in accordance with the requirements of the Colorado Water Quality Control Act (CRS 1973 as amended) and the CDPS. The COR-900412 permit authorizes NWLF to discharge stormwater associated with non-extractive industrial activity from the facility.

The SWMP includes provisions for:

- Identification and evaluation of potential stormwater pollutant sources;
- Sampling and analysis of surface water as required by the stormwater permit;
- Personnel training for implementation and maintenance of facility stormwater controls and for spill prevention and response procedures;
- Conducting inspections of facility stormwater management structures and potential sources of stormwater contaminants; and
- Reporting to the CDPHE – Water Quality Control Division, at frequencies as required by the permit.

A copy of the current SWMP (separate cover) is maintained at the NWLF office.

8.3 Leachate Minimization, Management, and Monitoring

8.3.1 Leachate Minimization

Minimizing leachate generation at NWLF is accomplished by a combination of the following design and operational factors:

- Construction of modules suitably sized for the rate/volumes of waste received;
- Placement of intermediate cover over external finished slopes and contouring of covered waste areas to provide positive slopes to prevent stormwater runoff from contacting the waste, avoid ponding within the landfill footprint, and direct runoff outside of the landfill footprint; and
- Installation of temporary and permanent ditches and berms along the perimeter of waste placement areas to prevent run-on from entering the landfill footprint.

8.3.2 Contact Water Management

Stormwater runoff that has contacted exposed waste (i.e., contact water) will be treated as leachate and managed in accordance with the leachate management procedures discussed herein. The WMDSC may elect to manage contact water as stormwater in the future, to the extent practical, and provided the contact water runoff is only from areas covered with at least six inches of adequate daily cover.

Module separation berms will be constructed along the edges of each module, as necessary, for containment of waste and to limit run-on into the cell from surrounding areas and to prevent contact water from discharging to unlined areas. Contact water will be directed away from the active face by downstream filling patterns and allowed to percolate through the waste into the leachate collection system.

8.3.3 Leachate Collection

Leachate generated in the landfill, either from precipitation entering the active waste footprint or from liquids which may be generated as a result of gravity drainage and long-term loading and consolidation of the waste mass, will drain to the leachate collection system and ultimately report to leachate collection sump. As discussed in Section 4.6 of this EDOP, the leachate collection system will consist of a 6-inch-thick granular leachate collection drainage layer installed over the liner floor area and composed of soils exhibiting a hydraulic conductivity equal to or greater than 1×10^{-2} cm/sec. Temporary leachate collection sumps will be constructed at the downgradient (i.e., east) end of modules until ultimate build-out of each phase when permanent leachate collection sumps will be constructed along the eastern boundary of each phase.

The leachate collection system LCRS is designed to limit the maximum buildup of head on the liner system (outside of the sumps) to less than 12 inches and promote transport of leachate from the most distant point of the leachate collection system to the leachate collection sump in less than 365 days.

8.3.4 Leachate Monitoring and Removal

Leachate will be monitored on a quarterly basis at temporary and permanent sump locations, or as site conditions warrant. The monitoring frequency may be changed as determined by the facility manager based on leachate quantities generated at the NWLF site. A record of the leachate monitoring events is maintained in the facility Operating Record.

Removal of leachate from leachate collection sumps (both temporary and permanent) will be accomplished using submersible pumps lowered down the leachate extraction riser pipes on an as needed basis. Leachate will generally be removed from the sumps when an approximate one-foot depth of liquid is measured on the liner adjacent to the sump.

Precipitation events over newly constructed liner areas may create circumstances when the one-foot depth limit is temporarily exceeded. When this potential exists, leachate depth measurements will be performed to coincide with rainstorm events. Leachate found to be in excess of the one-foot depth will be promptly removed from the sump after the appropriate management method is determined.

Leachate at NWLF will be sampled and analyzed on an annual basis (if leachate is present) for all Appendix IA and IB constituents (CPDHE 2015) in accordance with the GWMP provided in Appendix G. Additionally, NWLF may elect to analyze leachate samples for Table 3 constituents (Agricultural Standards) as defined in the CDPHE Water Quality Control Commission "Basic Standards for Groundwater," 5 CCR 1002-41 as amended May 9, 2016, to evaluate suitability for application on final cover (see Section 8.3.5 of this EDOP).

8.3.5 Leachate Management

The leachate management method employed will depend on the quality of the leachate. The typical leachate management strategy at the site will be to apply the leachate within the constructed waste disposal limits (i.e., within lined areas of the landfill) primarily to manage fugitive dust. The primary elements associated with leachate application include the following:

1. Leachate will be pumped from the sumps into a water truck for transport to the application area(s). In lieu of a water truck, an alternative method for transporting and applying leachate may be used provided application conforms with Items 2 and 3 below.
2. Leachate will be applied over areas with daily cover at rates that will avoid runoff or significant amounts of standing water.
3. The application areas will be located away from the active disposal area.
4. In the event that analytical leachate data indicates that leachate quality meets Agricultural Standards (CDPHE 2016b), the leachate may be applied to final cover areas of the landfill. Otherwise, application will be limited to areas that are without final cover and away from exterior side slopes within lined areas of the landfill. Should NWLF elect not to consider the option of applying leachate to final cover areas, it may elect to exclude Agricultural Standards from the analysis.
5. Leachate analytical data and pumping records will be maintained at the NWLF office and be available for review.

8.4 Landfill Gas Monitoring and Control

8.4.1 Gas Monitoring

The facility monitors landfill gas near the property boundary and within facility structures on a quarterly basis. At ultimate buildout, landfill gas will be monitored at the following gas probes, spaced approximately 500 feet around the full waste disposal footprint:

- Unit 1, Phase 1: GP-19 and GP-20 (GP-14 through GP-18 abandoned to allow for development of Unit 2)
- Unit 1, Phase 2: GP-6, GP-7, and GP-10 through GP-13
- Unit 1, Phase 3a: GP-3 through GP-5
- Unit 1, Phase 3b: GP-21 through GP-23
- Unit 2, Phase 4: GP-24, GP-25, GP 36 through 39
- Unit 2, Phase 5: GP-26 through GP-35
- Facility structures (gas probes and interior monitoring):
  - Maintenance shop: GP-1
  - Landfill office: GP-2

The locations of existing Unit 1 gas probes and approximate locations of Unit 2 gas probes are shown in Sheets 4A and 4B of the Site Development Plans provided in Appendix A. Future modifications to the landfill gas monitoring network may be considered as site conditions change or as new information about the site is known. Any such modifications will be made in accordance with Sections 2.3.2 and 2.3.4 of the Regulations.

Existing Unit 1 gas probes were constructed using one-inch inside diameter PVC casing with glued joints installed in six-inch-diameter borings. Future Unit 2 gas probes will be constructed using PVC threaded joints. The PVC will have drilled holes or will be slotted to within about 5 to 10 feet of ground surface. The annular space of the probes will be gravel-packed to approximately one foot above the slotted interval of the PVC. The remaining annular space will be backfilled with dry bentonite. Probes will be installed such that the bottom coincides with the elevation of the deepest portion(s) of the landfill. Any clearly identifiable preferential pathways will be intersected and monitored for landfill gas. The top of the gas probe screens will extend to the base of an overlying confining layer (if present) or within five feet of ground surface (whichever is deepest).

Copies of quarterly gas monitoring reports are submitted to the CDPHE and the WCDPHE. Copies are also maintained in the NWLF Operating Record on site.

8.4.2 Gas Control

If landfill gas levels are detected exceeding 25% of the lower explosive limit (LEL) (equivalent to 1.25% by volume for methane) within facility structures or exceeding the LEL (equivalent to 5% by volume for methane) at site boundaries, the following actions will be taken in accordance with the Regulations:

- Immediately take all necessary steps to ensure protection of human health.
- Notify the CDPHE and the WCDPHE.
- Within seven days of detection, place documentation of the explosive gas levels detected and description of the actions taken in the facility Operating Record.
- Within 60 days of detection, implement an approved remediation plan, place an approved copy of the plan in the facility Operating Record, and notify the CDPHE and the WCDPHE that the plan has been implemented. The plan will describe the nature and extent of the condition and the proposed remedy.

8.4.3 Title V Operating Permit and Construction Permit

NWLF operates under a Title V Operating Permit and Construction Permit issued by the Air Pollution Control Division (APCD) of the CDPHE. These permits regulate the management of emissions related to non-methane organic compounds (NMOCs), volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and fugitive particulates at the facility. The permits include provisions for identification/evaluation of emissions sources, conducting inspections, implementing/maintaining emissions controls, and submitting compliance reports to the APCD.

The facility also performs NMOC calculations at frequencies as prescribed by the APCD to determine an annual NMOC emission rate to assess the need for active gas emissions controls at the site in order to maintain compliance with Title V Operating Permit requirements. At such time as NMOC threshold levels necessitate an active control system, a gas collection and control system (GCCS) will be installed at the site. The GCCS design, which will likely include a network of gas extraction wells installed within the landfill waste mass, an on-site blower/flare system for emission control, and gas collection lines to transport the gas from the extraction wells to the flare, will be submitted to the APCD for approval in accordance with permit requirements. Construction reports documenting the installation of the system will also be submitted to the APCD for approval

Copies of the current Title V Operating and Construction permits are maintained at the NWLF office.

9.0 CLOSURE AND POST-CLOSURE PLAN

9.1 Closure Design

The closure design for Unit 2, including a description of the water balance final cover, is discussed in Section 4.5.3 of this EDOP. Final surface water controls are discussed in Section 5.4 of this EDOP and in the Drainage Report provided in Appendix D.

9.2 Final Closure

Final closure activities will include installation of alternative water balance final cover over any remaining uncapped area(s) of the landfill, and may include removal of site buildings/infrastructure (including fuel tanks), grading disturbed areas to restore pre-development drainage patterns (where practical), and revegetation of all disturbed areas. Features such as the stormwater control channels, detention pond, and/or roads that are necessary during the post-closure period will remain in place. Final grading will promote positive drainage of surface water runoff and eliminate depressions to prevent surface water ponding.

After the site is closed, no off-site waste will be accepted for disposal. However, any refuse generated on site as a result of construction activities will continue to be disposed in the landfill until final cover placement has been completed.

9.3 Closure Notifications

Prior to beginning final closure of NWLF, WMDSC will notify the CDPHE and the WCDPHE in accordance with applicable regulations and place notice of the intent to close the landfill in the Operating Record.

9.4 Closure Schedule

Final closure activities will be initiated no later than 30 days after final design grades at the site are reached and will be completed no later than 180 days following the beginning of final closure activities. Extension to either of these time frames may be sought by WMDSC, dependent upon successful demonstration to the CDPHE that all steps necessary to prevent threats to human health and the environment from the unclosed landfill phase have and will continue to be taken.

9.5 Closure Certification

Following completion of closure, a certification report will be prepared to document that the final cover and any associated surface water control structures were constructed in accordance with the approved Closure Plan. The certification report will be signed and sealed by a PE registered by the State of Colorado and submitted to the CDPHE and the WCDPHE, with a copy placed into the Operating Record.

9.6 Largest Landfill Area Ever Requiring Final Cover

In accordance with Section 3.5.1(A)(2) of the Regulations, an estimate is required of the largest area of the landfill ever needing final cover during the active life. This estimate is updated as necessary to reflect current operating conditions and submitted to the CDPHE and the WCDPHE. The current maximum area requiring final cover is 100 acres. As indicated, the maximum area will be periodically reviewed and adjusted as necessary to reflect site conditions.

9.7 Post-closure

In 2016, the Hazardous Materials and Waste Management Division (HMWMD) of CDPHE issued the "End of Post-Closure Care for Solid Waste Sites and Facilities" policy (CDPHE 2016a) that defines criteria by which the CDPHE will determine when post-closure care and maintenance may end at landfills. The policy states that the CDPHE can approve a proposal to end post-closure care after completing a performance-based evaluation that the solid waste unit is stable, secure, and will be protective of human health and the environment for the long term. The guiding principle for terminating post-closure care is whether a site has demonstrated stability to the point where only minimal maintenance is necessary going forward in order to ensure the waste left behind remains in a safe condition.

In accordance with the above referenced policy, minimal maintenance activities (repair of minor erosion rills and reseeding) can potentially be handled through another regulatory mechanism such as an environmental covenant (EC). It is the intent of NWLF to place an EC on the property once the facility is closed or develop a post-closure care plan consistent with the CDPHE's policy on ending post-closure care. The purpose of the EC or post-closure care plan is to ensure protection of human health and the environment by minimizing the potential for exposure to solid waste that remains in the landfill following closure. This objective will be accomplished by prohibiting those activities that may interfere with the landfill cover or its monitoring or control systems and by creating a review and approval process to ensure that any such intrusive activities are conducted with appropriate precautions to avoid or eliminate hazards. Following closure, the landfill will most likely serve as open space or some other end use strategy that is protective of human health and the environment for the long term.

The post-closure care period for NWLF will be 30 years unless a demonstration is made to CDPHE and WCDPHE that a shorter time period is sufficient to protect human health and the environment or if CDPHE determines, in consultation with WCDPHE, that a longer period is necessary for protection of human health and the environment.

Post-closure inspections will typically be conducted annually. The inspector will assess the conditions of the site and recommend corrective actions for any items needing attention. Items to be inspected include nuisance conditions, the final cover system, groundwater monitoring wells, gas monitoring probes, the surface water management system, and site security.

Post-closure maintenance will be performed as needed on the final cover system, surface water management system, perimeter fencing, and environmental monitoring systems to prevent nuisance conditions, ensure site security, and overall site integrity.

Post-closure environmental monitoring at the landfill includes provisions for:

- Groundwater monitoring consistent with 6 CCR 1007-2, Part 1 (Appendix B) requirements.
- Monitoring leachate levels and managing any leachate extracted from the leachate collection sumps, as applicable.
- Monitoring of the facility gas monitoring system, any future gas collection/control systems, and implementation of corrective action, as applicable.

Upon completion of the post-closure care period, notification will either be given to the CDPHE, certified by a Professional Engineer registered by the State of Colorado, or approved by the CDPHE and the WCDPHE in accordance with Section 3.6.2 of the Regulations verifying that post-closure care has been completed in accordance with the approved Closure and Post-closure Plans. This notification will be placed in the facility Operating Record.

10.0 FINANCIAL ASSURANCE

A Financial Assurance Plan (separate cover) has been prepared in accordance with Section 1.8 of the Regulations that sets forth the closure and post-closure care costs for NWLF. The Financial Assurance Plan also describes the financial mechanism that is in place to ensure the payment of all associated closure and post-closure costs. Annual updates to the closure and post-closure care cost estimates include adjustments for inflation as well as any changes at the facility affecting closure and post-closure care costs. Accordingly, the financial assurance instrument is also updated annually. In accordance with the Regulations, cost estimates are replaced every five years.

The current financial assurance plan covers closure and post-closure activities in Unit 1, and is updated as necessary to reflect current site conditions. The financial assurance plan will be updated to include Unit 2 prior to initiating disposal operations in Unit 2.

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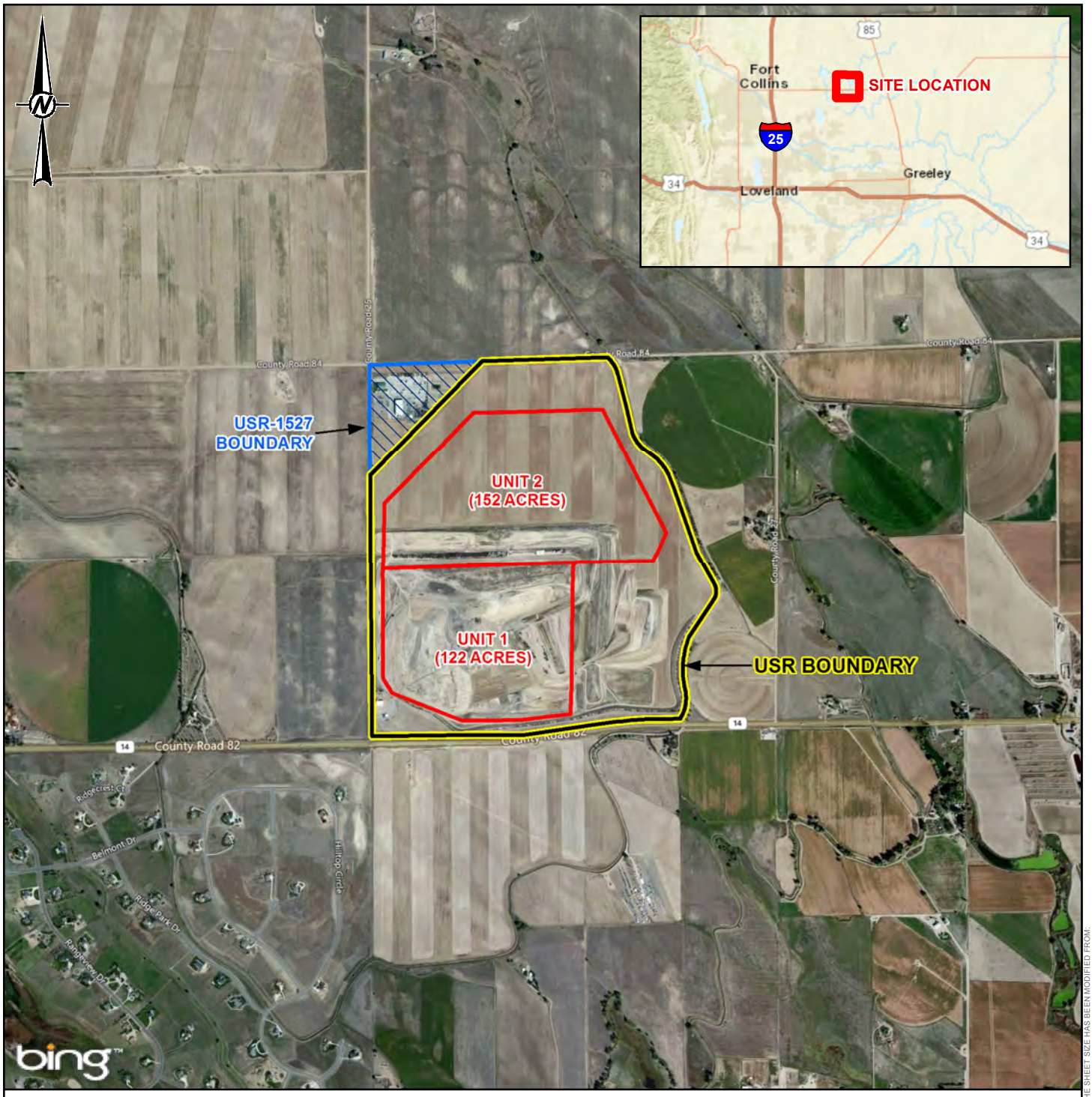
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FIGURES



LEGEND

- PROPOSED NORTH WELD LANDFILL USE BY SPECIAL REVIEW (USR) BOUNDARY
- USR-1527 (WASTE MANAGEMENT OF NORTHERN COLORADO)
- LIMIT OF WASTE

0 1,000 2,000 4,000 Feet

REFERENCE

1. AERIAL IMAGERY: IMAGERY EXPORTED FROM GOOGLE EARTH USING GOOGLE EARTH PRO LICENSE. IMAGE CAPTURED 9/7/2013.
2. COORDINATE SYSTEM: NAD83 STATE PLANE COLORADO NORTH, US FEET.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

PROJECT
NORTH WELD LANDFILL, UNIT 2
ENGINEERING DESIGN AND OPERATIONS PLAN
WELD COUNTY, CO

TITLE
SITE VICINITY MAP

CONSULTANT
Golder Associates

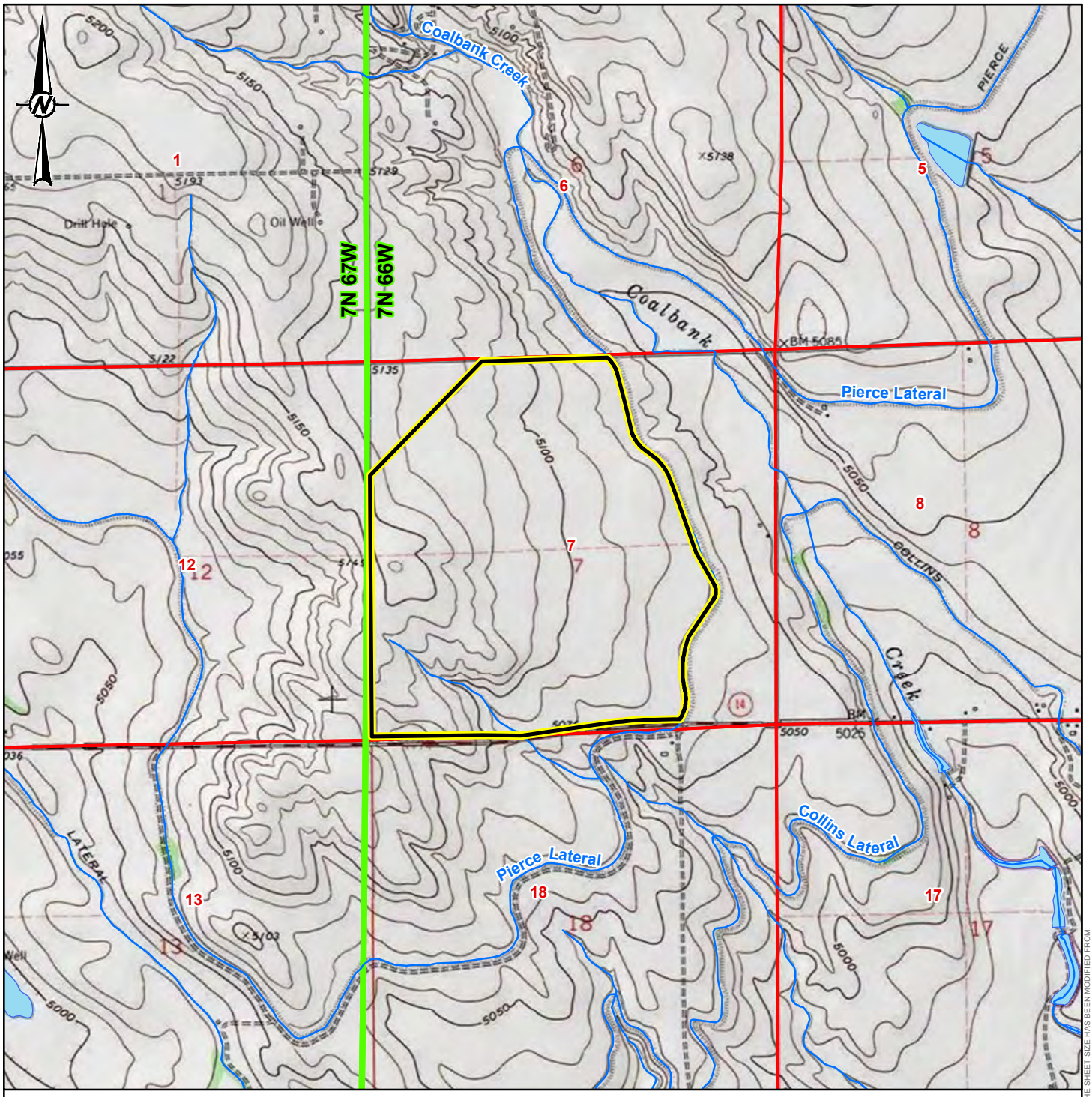
YYYY-MM-DD	2016-10-27
PREPARED	KJC
DESIGN	KJC
REVIEW	JAR
APPROVED	MEM

PROJECT
1538880

FIGURE
1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: M:\NorthWeld_F\Mapping\8_5x11_NWLF_Fig01_SiteVicinity.mxd



LEGEND

- PROPOSED NORTH WELD LANDFILL USE BY SPECIAL REVIEW (USR) BOUNDARY
- TOWNSHIP/RANGE BOUNDARY
- 7 SECTION BOUNDARY

0 1,000 2,000 4,000 Feet

REFERENCE

1. TOPOGRAPHIC BACKGROUND MAPPING: USGS 7.5' TOPOGRAPHIC QUADRANGLE "SEVERANCE, CO".
2. HYDROLOGIC DATA: NATIONAL HYDROLOGY DATASET (NHD), USGS.
3. COORDINATE SYSTEM: NAD83 STATE PLANE COLORADO NORTH, US FEET.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

PROJECT
NORTH WELD LANDFILL, UNIT 2
ENGINEERING DESIGN AND OPERATIONS PLAN
WELD COUNTY, CO

TITLE
USGS TOPOGRAPHIC MAP

CONSULTANT
Golder Associates

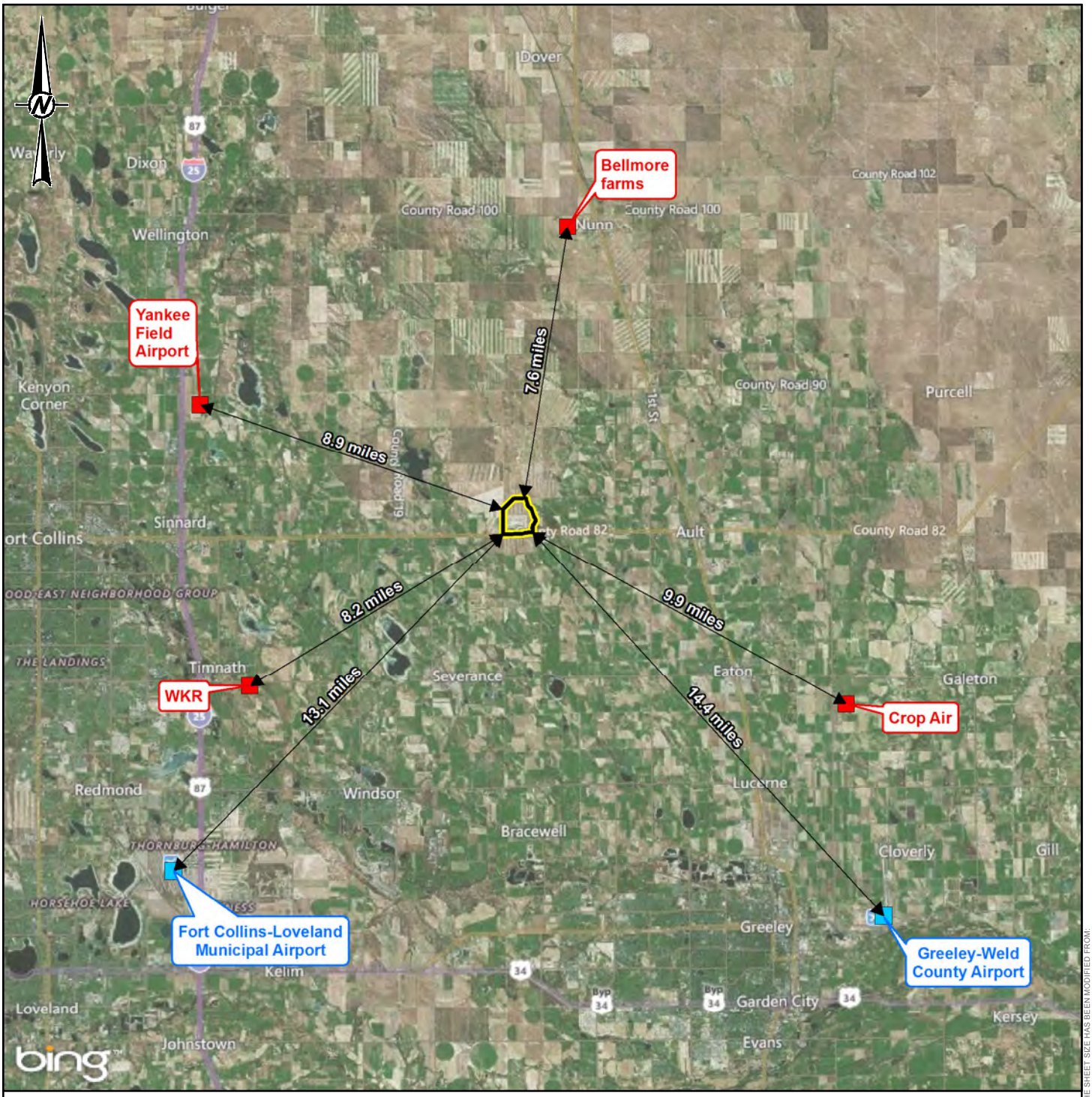
YYYY-MM-DD	2016-10-27
PREPARED	KJC
DESIGN	KJC
REVIEW	JAR
APPROVED	MEM

PROJECT
1538880

FIGURE
2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: M:\NorthWeld\F\Mapping\8_5x11_NWLF_Fig02_TopoQuad.mxd



LEGEND

- PROPOSED NORTH WELD LANDFILL USE BY SPECIAL REVIEW (USR) BOUNDARY
- PRIVATE AIRPORT
- PUBLIC AIRPORT

Miles
0 2 4 8

REFERENCE

1. BACKGROUND MAPPING: ESRI BASEMAP SERVICES, BING MAPS, MICROSOFT CORPORATION.
2. AIRPORT DATA: AIRNAV.COM, FEDERAL AVIATION ADMINISTRATION.
3. COORDINATE SYSTEM: NAD83 STATE PLANE COLORADO NORTH, US FEET.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

PROJECT
NORTH WELD LANDFILL, UNIT 2
ENGINEERING DESIGN AND OPERATIONS PLAN
WELD COUNTY, CO

TITLE
AIRPORT PROXIMITY MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-10-27
PREPARED	KJC
DESIGN	KJC
REVIEW	JAR
APPROVED	MEM

PROJECT
1538880

FIGURE
3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 11in 0

Path: M:\NorthWeld_F\Mapping\8_5x11_NWLF_Fig03_Airports.mxd



LEGEND

- PROPOSED NORTH WELD LANDFILL USE BY SPECIAL REVIEW (USR) BOUNDARY
- STREAM
- RIVERINE WETLAND

0 500 1,000 2,000 Feet

REFERENCE

1. BACKGROUND MAPPING: ESRI BASEMAP SERVICES, BING MAPS, MICROSOFT CORPORATION.
2. WETLANDS DATASET: NATIONAL WETLANDS INVENTORY (NWI), US FISH AND WILDLIFE SERVICE.
3. STREAMS DATASET: NATIONAL HYDROLOGIC DATASET (NHD), USGS.
4. COORDINATE SYSTEM: NAD83 STATE PLANE COLORADO NORTH, US FEET.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

PROJECT
NORTH WELD LANDFILL, UNIT 2
ENGINEERING DESIGN AND OPERATIONS PLAN
WELD COUNTY, CO

TITLE
USFWS NATIONAL WETLANDS INVENTORY MAP

CONSULTANT
Golder Associates

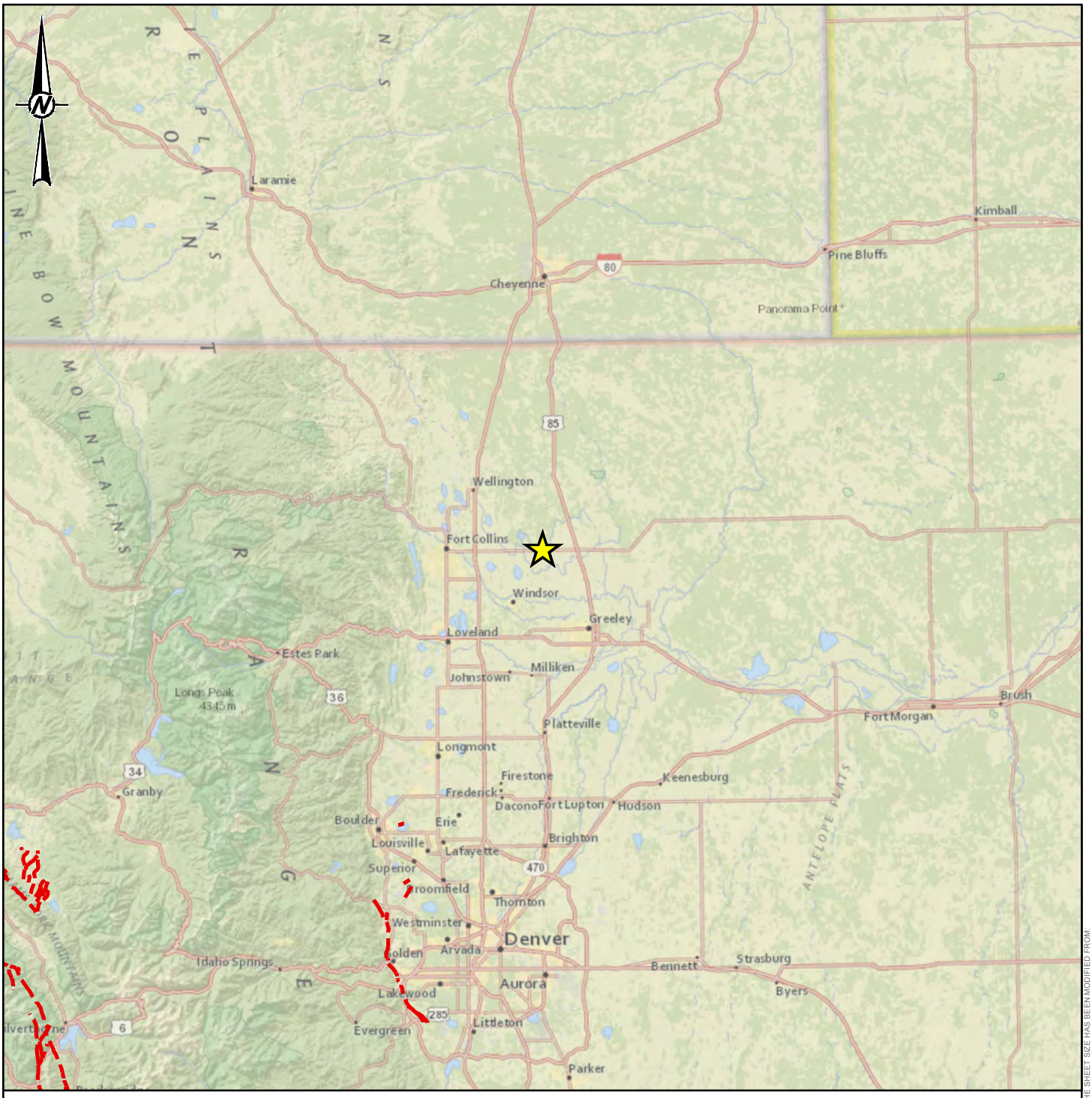
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DESIGN	KJC
REVIEW	JAR
APPROVED	MEM

PROJECT 1538880

FIGURE 4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: M:\North\Weld_F\Mapping\8_5x11_NWLF_Fig04_NWI.mxd



LEGEND

NORTH WELD LANDFILL LOCATION

QUATERNARY FAULTS

Miles

0 10 20 40

REFERENCE

1. BACKGROUND MAPPING: ESRI BASEMAP SERVICES, BING MAPS, MICROSOFT CORPORATION.
2. FAULT DATA: UNITED STATES GEOLOGIC SURVEY, COLORADO GEOLOGIC SURVEY.
3. COORDINATE SYSTEM: NAD83 STATE PLANE COLORADO NORTH, US FEET.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

PROJECT
NORTH WELD LANDFILL, UNIT 2
ENGINEERING DESIGN AND OPERATIONS PLAN
WELD COUNTY, CO

TITLE
USGS QUATERNARY FAULTS MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-10-24
PREPARED	KJC
DESIGN	KJC
REVIEW	JAR
APPROVED	MEM

PROJECT
1538880

FIGURE
5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: M:\NorthWeld\F\Mapping\8_5x11_NWLF_Fig05_QuaternaryFaults.mxd



LEGEND

PROPOSED NORTH WELD LANDFILL
USE BY SPECIAL REVIEW (USR) BOUNDARY

FEMA 100-YR FLOODPLAIN

0 500 1,000 2,000 Feet

REFERENCE

1. BACKGROUND MAPPING: ESRI BASEMAP SERVICES, BING MAPS, MICROSOFT CORPORATION.
2. FLOODPLAIN DATASET: FEDERAL EMERGENCY MANAGEMENT AGENCY. DIGITAL FLOOD INSURANCE RATE MAP SHOWN: PANEL 1205 OF 2250, MAP NUMBER 08123C1205E, UPDATED JANUARY 2016.
3. COORDINATE SYSTEM: NAD83 STATE PLANE COLORADO NORTH, US FEET.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

PROJECT
NORTH WELD LANDFILL, UNIT 2
ENGINEERING DESIGN AND OPERATIONS PLAN
WELD COUNTY, CO

TITLE
FEMA FLOODPLAIN MAP

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-10-27
PREPARED	KJC
DESIGN	KJC
REVIEW	JAR
APPROVED	MEM

PROJECT
1538880

FIGURE
6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 1 in 0

Path: M:\NorthWeld_F\Mapping\8_5x11_NWLF_Fig06_FEMA.mxd

ATTACHMENTS

U.S. Geological Survey - Earthquake Hazards Program

North Weld Landfill, Unit 2

Latitude = 40.589°N, Longitude = 104.825°W

Location



Reference Document

2015 NEHRP Provisions

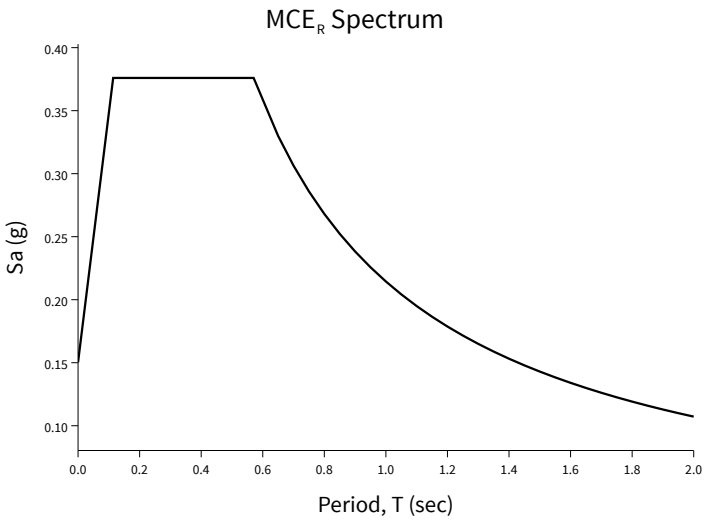
Site Class

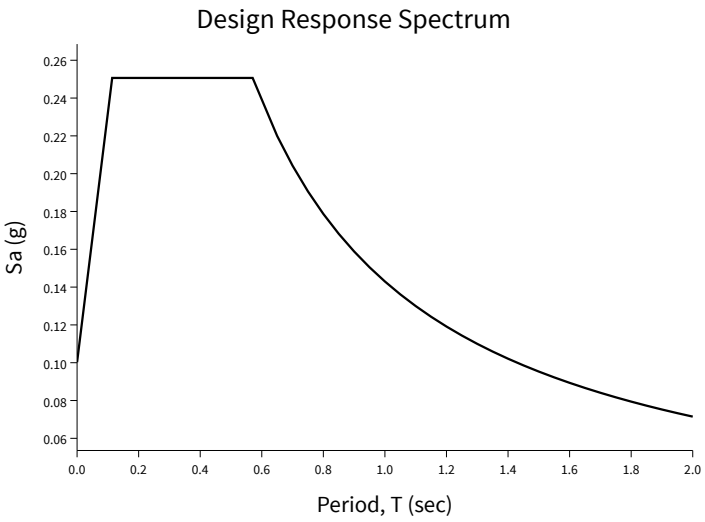
E: Soft Clay Soil

Risk Category

I or II or III

S_S =	0.157 g	S_{MS} =	0.376 g	S_{DS} =	0.251 g
S_1 =	0.051 g	S_{M1} =	0.214 g	S_{D1} =	0.143 g


MCE$_R$ Spectrum
Sa (g)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Period, T (sec)


Design Response Spectrum
Sa (g)
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Period, T (sec)

Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site class as Site Class , based on the site soil properties in accordance with Chapter 20.

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20 • Moisture content w ≥ 40%, and • Undrained shear strength $\bar{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		
For SI: 1ft/s = 0.3048 m/s 1lb/ft^2 = 0.0479 kN/m^2			

Site Coefficients and Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Risk-targeted Ground Motion (0.2 s)

$C_{RS}S_{SUH} = 0.936 \times 0.167 = 0.157$ g

Deterministic Ground Motion (0.2 s)

$S_{SD} = 1.500$ g

$S_S \equiv$ "Lesser of $C_{RS}S_{SUH}$ and S_{SD}" = 0.157 g

Risk-targeted Ground Motion (1.0 s)

$C_{R1}S_{1UH} = 0.916 \times 0.056 = 0.051$ g

Deterministic Ground Motion (1.0 s)

$S_{1D} = 0.600$ g

$S_1 \equiv$ "Lesser of $C_{R1}S_{1UH}$ and S_{1D}" = 0.051 g

Table 11.4-1: Site Coefficient F_a

Site Class	Spectral Reponse Acceleration Parameter at Short Period					
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S = 1.25$	$S_S \geq 1.50$
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.3	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.2	1.1	1.0	1.0
D (default)	1.6	1.4	1.2	1.2	1.2	1.2
E	2.4	1.7	1.3	1.2 *	1.2 *	1.2 *
F	See Section 11.4.7					

* For Site Class E and $S_S \geq 1.0$ g, see the requirements for site-specific ground motions in Section 11.4.7 of the 2015 NEHRP Provisions. Here the exception to those requirements allowing F_a to be taken as equal to that of Site Class C has been invoked.

Note: Use straight-line interpolation for intermediate values of S_S.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of F_a shall be taken as 1.0 per Section 11.4.2.

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_a shall not be less than 1.2 per Section 11.4.3.

For Site Class = E and S_S = 0.157 g, F_a = 2.400

Table 11.4-2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1-Second Period					
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 = 0.50$	$S_1 \geq 0.60$
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.8	0.8	0.8	0.8	0.8	0.8
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.5	1.5	1.5	1.5	1.5	1.4
D (determined)	2.4	2.2 [1]	2.0 [1]	1.9 [1]	1.8 [1]	1.7 [1]
D (default)	2.4	2.2 [1]	2.0 [1]	1.9 [1]	1.8 [1]	1.7 [1]
E	4.2	3.3 [1]	2.8 [1]	2.4 [1]	2.2 [1]	2.0 [1]
F	See Section 11.4.7					

[1] For Site Class D or E and $S_1 \geq 0.2$ g, site-specific ground motions might be required. See Section 11.4.7 of the 2015 NEHRP Provisions.

Note: Use straight-line interpolation for intermediate values of S_1.

Note: Where Site Class B is selected, but site-specific velocity measurements are not made, the value of F_v shall be taken as 1.0 per Section 11.4.2.

For Site Class = E and $S_1 = 0.051$ g, $F_v = 4.200$

Site-adjusted MCE_R (0.2 s)

$$S_{MS} = F_a S_S = 2.400 \times 0.157 = 0.376 \text{ g}$$

Site-adjusted MCE_R (1.0 s)

$$S_{M1} = F_v S_1 = 4.200 \times 0.051 = 0.214 \text{ g}$$

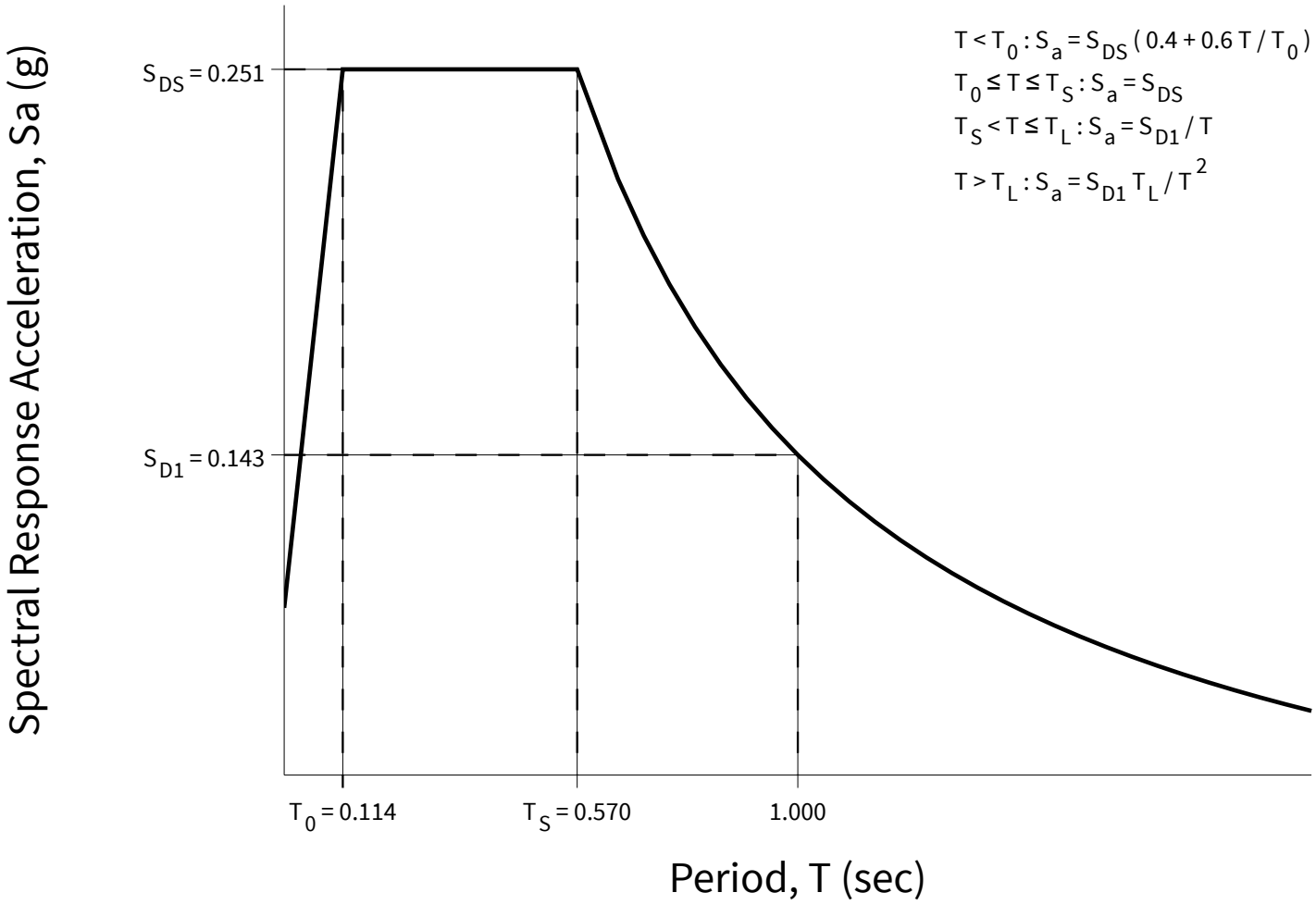
Design Spectral Acceleration Parameters

Design Ground Motion (0.2 s)	$S_{DS} = ⅔\, S_{MS} = ⅔ \times 0.376 = 0.251$ g
Design Ground Motion (1.0 s)	$S_{D1} = ⅔\, S_{M1} = ⅔ \times 0.214 = 0.143$ g

Design Response Spectrum

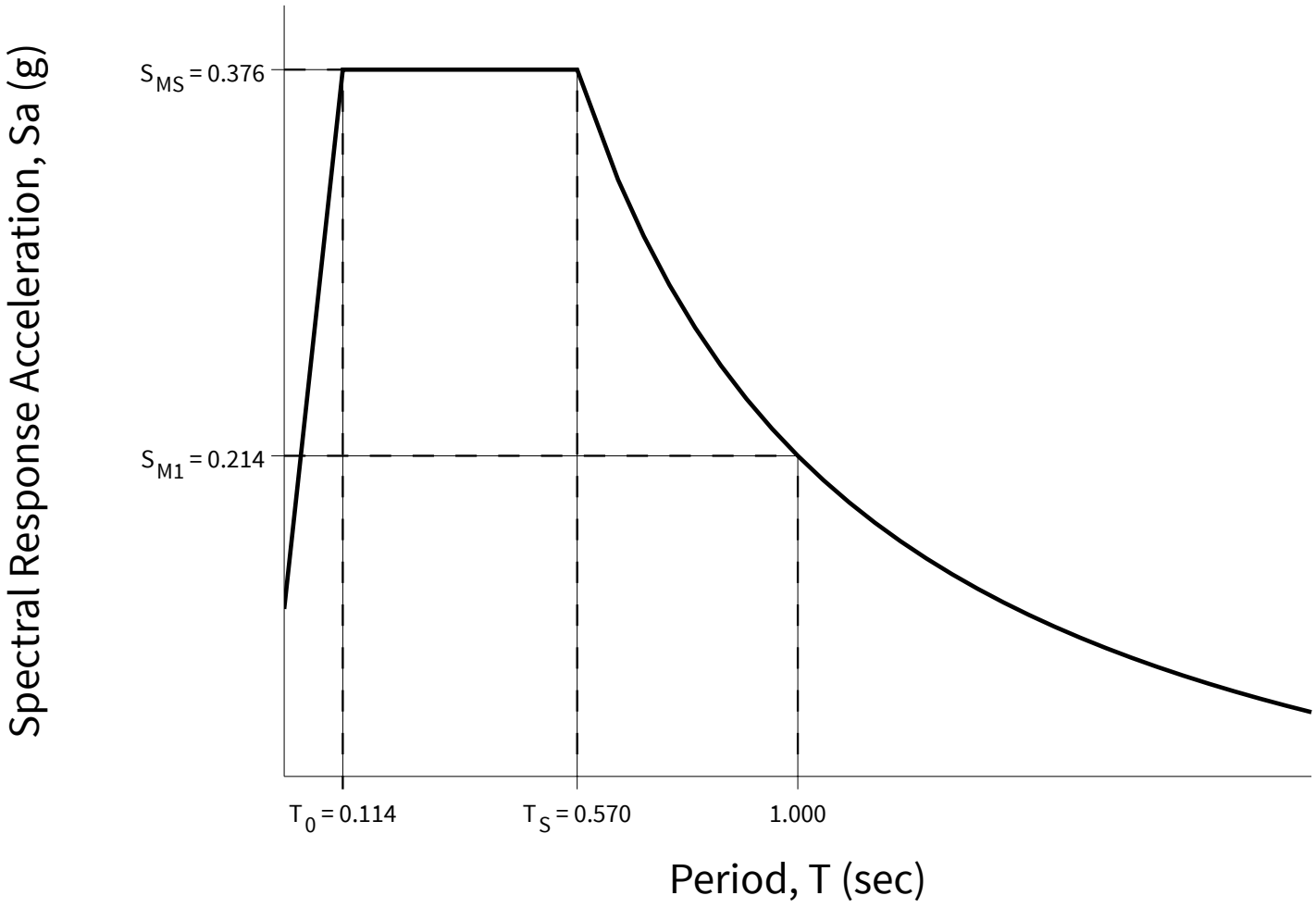
Long-Period Transition Period = T_L = 4 s

Figure 11.4-1: Design Response Spectrum



MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient for F_{PGA}

Site Class	Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration					
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA = 0.50	PGA ≥ 0.60
A	0.8	0.8	0.8	0.8	0.8	0.8
B (measured)	0.9	0.9	0.9	0.9	0.9	0.9
B (unmeasured)	1.0	1.0	1.0	1.0	1.0	1.0
C	1.3	1.2	1.2	1.2	1.2	1.2
D (determined)	1.6	1.4	1.3	1.2	1.1	1.1
D (default)	1.6	1.4	1.3	1.2	1.2	1.2
E	2.4	1.9	1.6	1.4	1.2	1.1
F	See Section 11.4.7					

Note: Use straight-line interpolation for intermediate values of PGA

Note: Where Site Class D is selected as the default site class per Section 11.4.2, the value of F_{pga} shall not be less than 1.2.

For Site Class = E and PGA = 0.080 g, $F_{PGA} = 2.400$

Mapped MCE_G

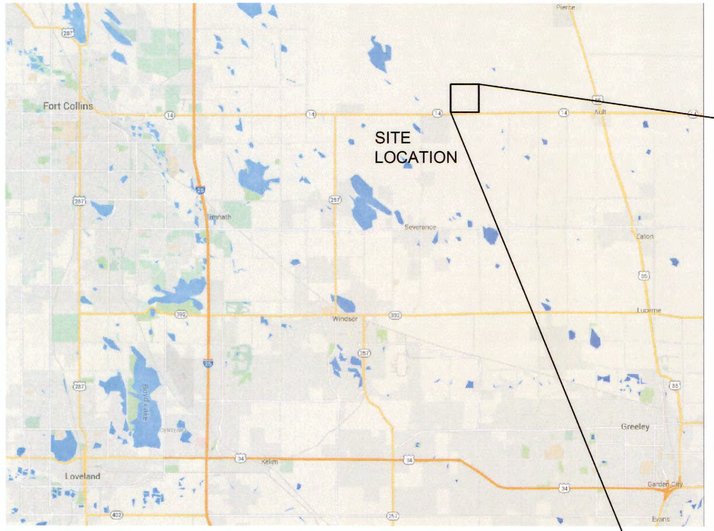
PGA = 0.080 g

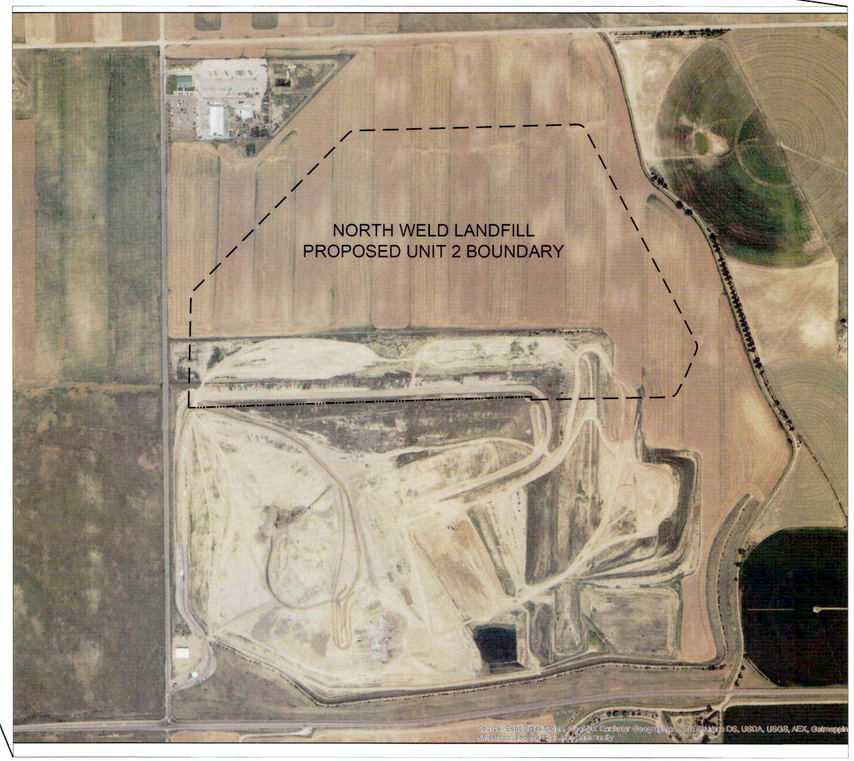
Site-adjusted MCE_G

$PGA_M = F_{PGA}PGA = 2.400 \times 0.080 = 0.192$ g

APPENDIX A
SITE DEVELOPMENT PLANS

NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO





Prepared for:

Waste Management Disposal Services of Colorado, Inc.
40,000 Weld County Road 25
Ault, Colorado 80610

Prepared by:

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

DRAWING LIST		
SHEET NO.	TITLE	REVISION
1	COVER SHEET	A
2	EXISTING CONDITIONS PLAN	A
3	SUBGRADE PLAN AND LEACHATE COLLECTION SYSTEM LAYOUT	A
4A	FINAL GRADING AND STORMWATER MANAGEMENT PLAN, UNIT 2	A
4B	SITE-WIDE FINAL GRADING PLAN	A
5A	CROSS SECTION A-A'	A
5B	CROSS SECTION B-B'	A
6	LANDFILL DETAILS	A
7	TEMPORARY LEACHATE COLLECTION SUMP DETAILS	A
8	PERMANENT LEACHATE COLLECTION SUMP DETAILS	A
9	STORMWATER MANAGEMENT SYSTEM DETAILS (SHEET 1 OF 2)	A
10	STORMWATER MANAGEMENT SYSTEM DETAILS (SHEET 2 OF 2)	A

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
GOLDER ASSOCIATES INC.
44 UNION BLVD, SUITE 300
LAKEWOOD, CO
USA
+1 (303) 980 0540
www.golder.com

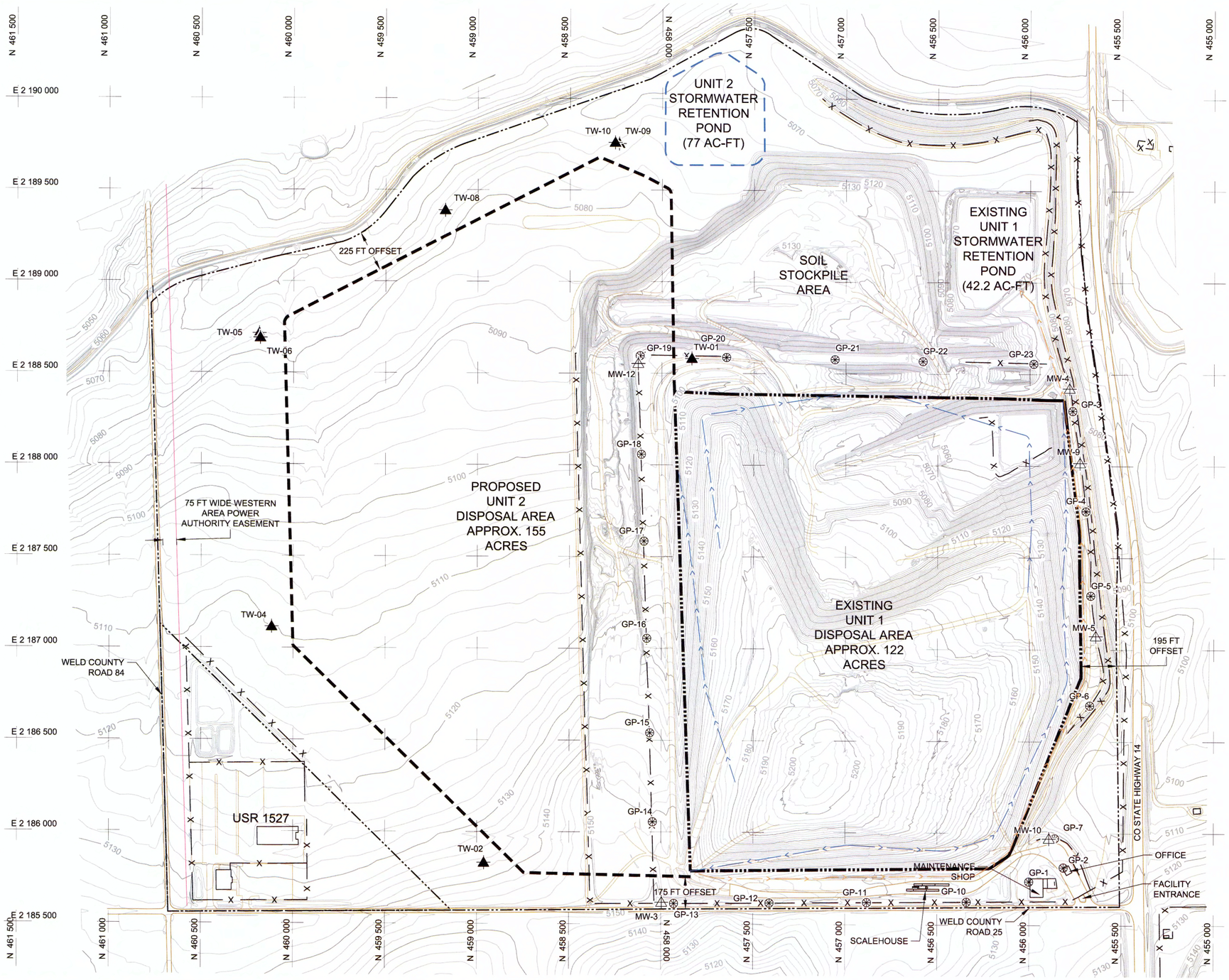
PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
COVER SHEET

COLORADO LICENSED
JEFFREY A. RUCH
0046801
PROFESSIONAL ENGINEER

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A001	A		1

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- 5280 — EXISTING TOPOGRAPHY (SEE NOTE 1)
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- X — EXISTING FENCE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- EXISTING ROADS
- EXISTING BUILDINGS
- MW-9 — EXISTING MONITORING WELL LOCATION
- TW-08 — TEMPORARY WELL LOCATION (SEE NOTE 5)
- GP-23 — EXISTING GAS PROBE LOCATION

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.
4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. TEMPORARY MONITORING WELLS INSTALLED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC AS PART OF 2016 HYDROGEOLOGIC SITE INVESTIGATION.
6. RETENTION POND DESIGN INCLUDES ALLOWANCE FOR 1-FT MINIMUM FREEBOARD ABOVE STORAGE CAPACITIES REPORTED ON THIS SHEET.

0 300 600
1" = 300' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates
GOLDER ASSOCIATES INC.
44 UNION BLVD, SUITE 300
LAKEWOOD, CO
USA
+1 (303) 980 0540
www.golder.com

PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

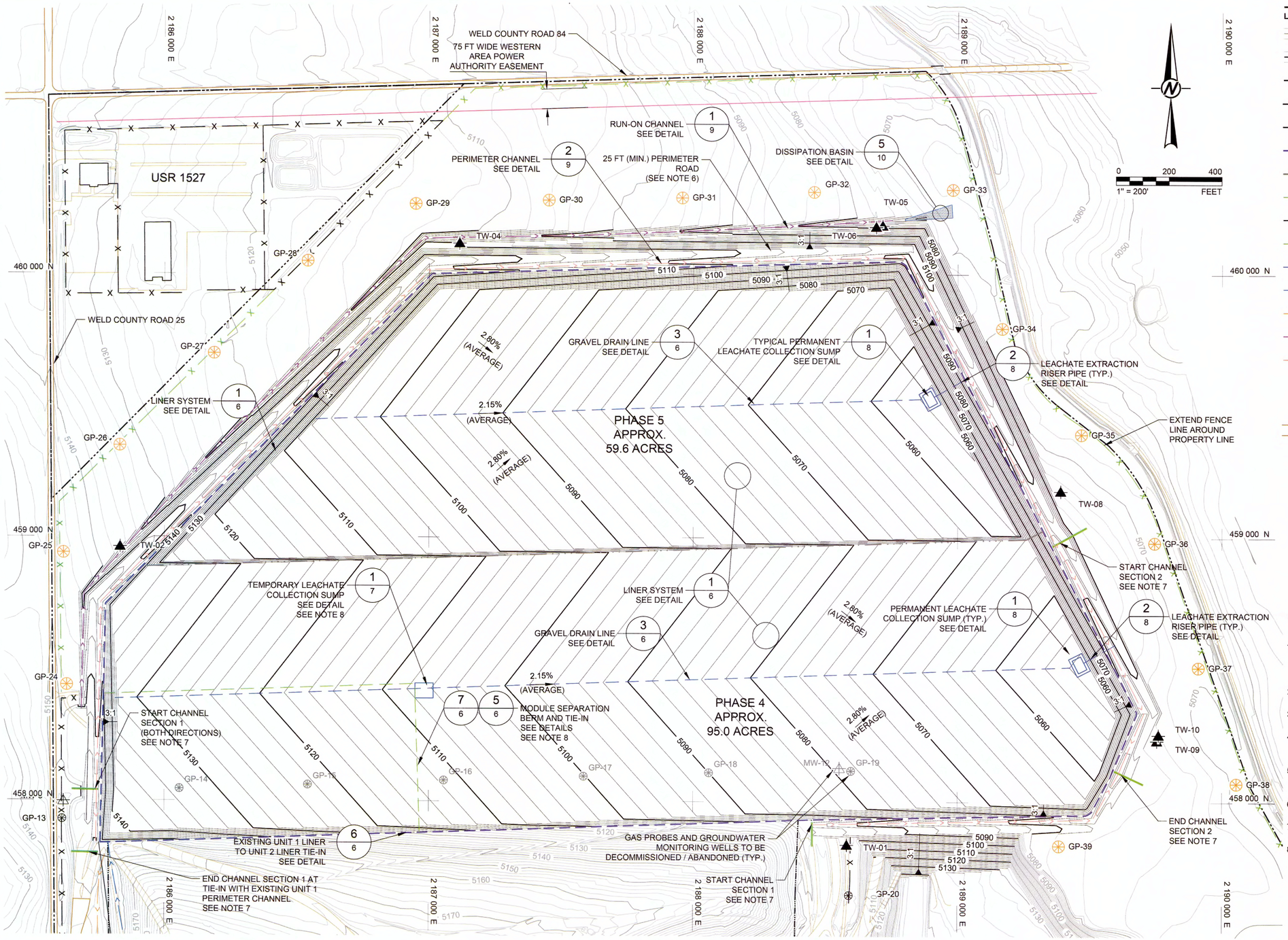
TITLE
EXISTING CONDITIONS PLAN

COLORADO LICENSED JEFFREY A. RUSCH PROFESSIONAL ENGINEER

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A002	A		2

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



LEGEND

- 5280 — EXISTING TOPOGRAPHY (SEE NOTE 1)
- 5280 — PROPOSED LINER SUBGRADE
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- PROPOSED PHASE BOUNDARY
- CONCEPTUAL MODULE BOUNDARY
- X — EXISTING FENCE
- X — PROPOSED FENCE
- GRAVEL DRAIN LINE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- UNIT 2 RUN-ON DIVERSION CHANNEL
- UNIT 2 PERIMETER CHANNEL
- START / END OF CHANNEL SECTION (SEE NOTE 7)
- 2.0% — SLOPE INDICATOR
- EXISTING ROADS
- EXISTING BUILDINGS
- MW-9 — EXISTING MONITORING WELL LOCATION
- TW-08 — TEMPORARY WELL LOCATION (SEE NOTE 5)
- GP-23 — EXISTING GAS PROBE LOCATION
- GP-35 — PROPOSED GAS PROBE LOCATION (APPROXIMATE) (INSTALLATION TO BE PHASED WITH LANDFILL DEVELOPMENT)
- GP-23 — EXISTING GAS PROBE LOCATION (TO BE DECOMMISSIONED / ABANDONED PRIOR TO UNIT 2 CONSTRUCTION)
- MW-9 — EXISTING MONITORING WELL LOCATION (TO BE DECOMMISSIONED / ABANDONED PRIOR TO UNIT 2 CONSTRUCTION)

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.
4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. TEMPORARY MONITORING WELLS INSTALLED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC AS PART OF 2016 HYDROGEOLOGIC SITE INVESTIGATION.
6. PERIMETER ROAD TO BE CONSTRUCTED IN PHASES AS UNIT 2 IS DEVELOPED.
7. SEE SHEET 9 FOR CHANNEL SECTION DIMENSIONS.
8. LOCATION OF TEMPORARY LEACHATE COLLECTION SUMPS AND MODULE SEPARATION BERMS WILL VARY BASED ON OVERALL FACILITY DEVELOPMENT. LOCATIONS SHOWN ON THIS DRAWING ARE CONCEPTUAL.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

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LAKEWOOD, CO
USA
+1 (303) 980 0540
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PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

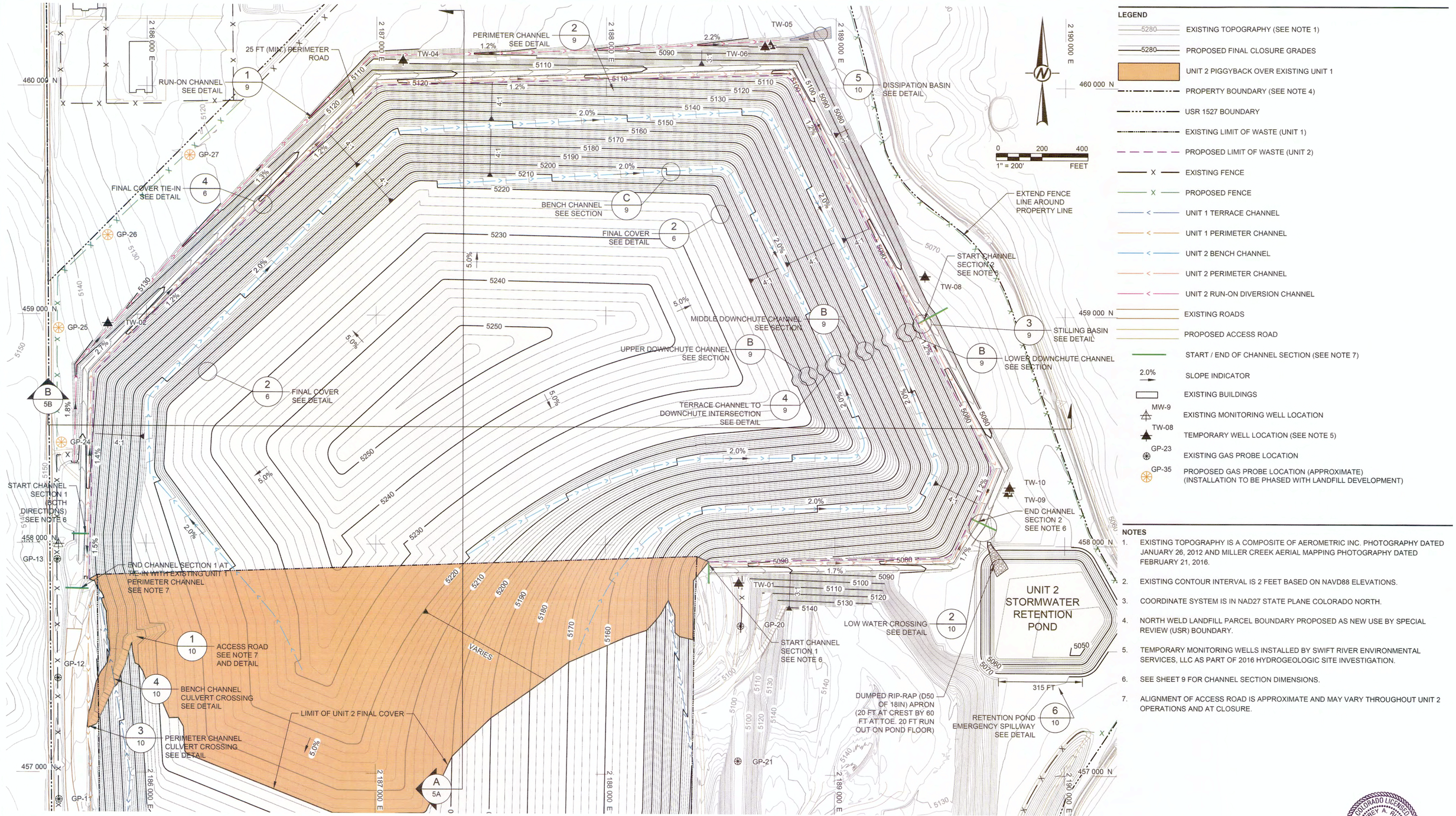
COLORADO LICENSED JEFFREY A. RUGER P. 00468 PROFESSIONAL ENGINEER

TITLE
SUBGRADE PLAN AND LEACHATE COLLECTION SYSTEM LAYOUT

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A003	A		3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

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LEGEND

- EXISTING TOPOGRAPHY (SEE NOTE 1)
- PROPOSED FINAL CLOSURE GRADES
- UNIT 2 PIGGYBACK OVER EXISTING UNIT 1
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- EXISTING FENCE
- PROPOSED FENCE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- UNIT 2 BENCH CHANNEL
- UNIT 2 PERIMETER CHANNEL
- UNIT 2 RUN-ON DIVERSION CHANNEL
- EXISTING ROADS
- PROPOSED ACCESS ROAD
- START / END OF CHANNEL SECTION (SEE NOTE 7)
- SLOPE INDICATOR
- EXISTING BUILDINGS
- MW-9 EXISTING MONITORING WELL LOCATION
- TW-08 TEMPORARY WELL LOCATION (SEE NOTE 5)
- GP-23 EXISTING GAS PROBE LOCATION
- GP-35 PROPOSED GAS PROBE LOCATION (APPROXIMATE) (INSTALLATION TO BE PHASED WITH LANDFILL DEVELOPMENT)

NOTES

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3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.
4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. TEMPORARY MONITORING WELLS INSTALLED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC AS PART OF 2016 HYDROGEOLOGIC SITE INVESTIGATION.
6. SEE SHEET 9 FOR CHANNEL SECTION DIMENSIONS.
7. ALIGNMENT OF ACCESS ROAD IS APPROXIMATE AND MAY VARY THROUGHOUT UNIT 2 OPERATIONS AND AT CLOSURE.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
GOLDER ASSOCIATES INC.
44 UNION BLVD, SUITE 300
LAKEWOOD, CO
USA
+1 (303) 980 0540
www.golder.com

COLORADO LICENSED
JEFFREY A. RUSCH
37705
PROFESSIONAL ENGINEER

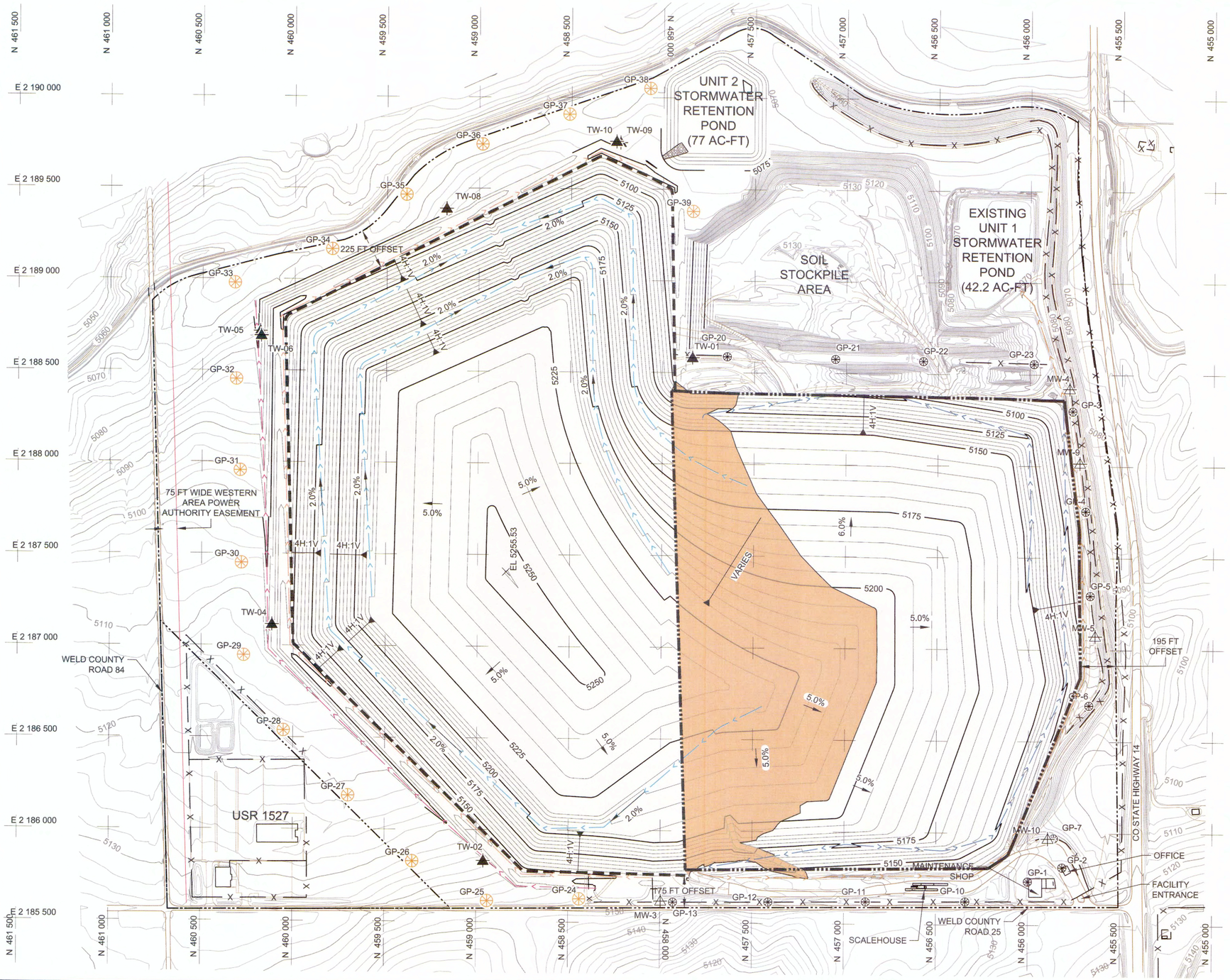
PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
FINAL GRADING AND STORMWATER MANAGEMENT PLAN, UNIT 2

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A004	A		4A

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D

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LEGEND

- 5280 — EXISTING TOPOGRAPHY (SEE NOTE 1)
- 5280 — PROPOSED FINAL CLOSURE GRADES
- UNIT 2 PIGGYBACK OVER EXISTING UNIT 1
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- EXISTING FENCE
- PROPOSED FENCE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- UNIT 2 BENCH CHANNEL
- UNIT 2 PERIMETER CHANNEL
- UNIT 2 RUN-ON DIVERSION CHANNEL
- EXISTING ROADS
- PROPOSED ACCESS ROAD
- 2.0% — SLOPE INDICATOR
- EXISTING BUILDINGS
- MW-9 — EXISTING MONITORING WELL LOCATION
- TW-08 — TEMPORARY WELL LOCATION (SEE NOTE 5)
- GP-23 — EXISTING GAS PROBE LOCATION
- GP-35 — PROPOSED GAS PROBE LOCATION (APPROXIMATE) (INSTALLATION TO BE PHASED WITH LANDFILL DEVELOPMENT)

NOTES

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4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. TEMPORARY MONITORING WELLS INSTALLED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC AS PART OF 2016 HYDROGEOLOGIC SITE INVESTIGATION.
6. RETENTION BASIN DESIGN INCLUDES ALLOWANCE FOR 1-FT MINIMUM FREEBOARD. CAPACITIES REPORTED ON THIS SHEET DO NOT INCLUDE VOLUME OF FREEBOARD.
7. ALIGNMENT OF ACCESS ROAD IS APPROXIMATE AND MAY VARY THROUGHOUT UNIT 2 OPERATIONS AND AT CLOSURE.

0 300 600
1" = 300' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

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GOLDER ASSOCIATES INC.
44 UNION BLVD, SUITE 300
LAKEWOOD, CO
USA
+1 (303) 980 0540
www.golder.com

PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

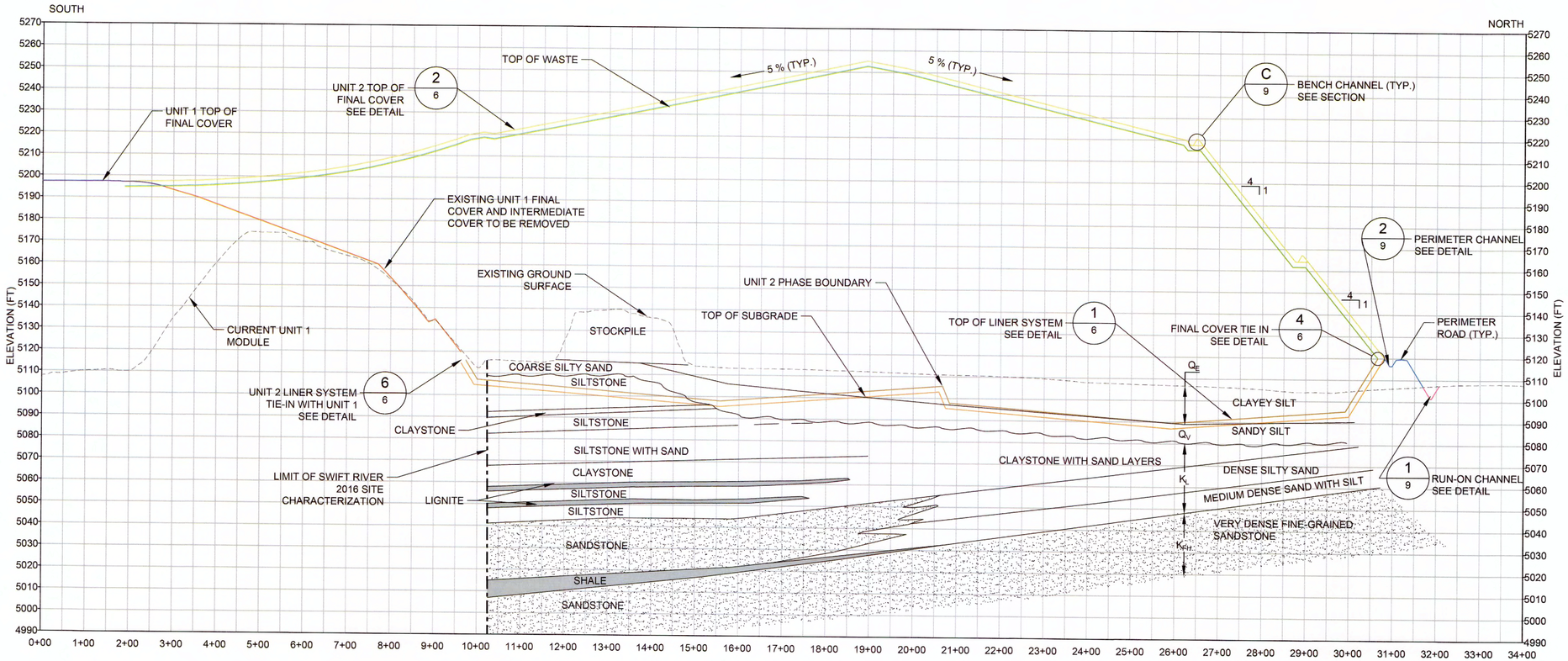
COLORADO LICENSED JEFFREY A. RUSCH 0046801 PROFESSIONAL ENGINEER

TITLE
SITE-WIDE FINAL GRADING PLAN

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A004B	A		4B

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE 1" = 150'
VERT. SCALE 5X

A/5A CROSS-SECTION A-A

NOTE

1. SUBSURFACE DATA AND STRATIGRAPHIC INTERPRETATION PROVIDED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC BASED ON 2016 GEOLOGIC AND HYDROGEOLOGIC SITE CHARACTERIZATION FIELD INVESTIGATION.

LEGEND

Q_E = Quaternary Eolian

Q_V = Quaternary Verdos

K_L = Top of Cretaceous Laramie Formation

K_{FH} = Top of Cretaceous Fox Hills Sandstone

= Erosional Surface

= Predominantly Sand and Sandstone

= Predominantly Lignite and Shale

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
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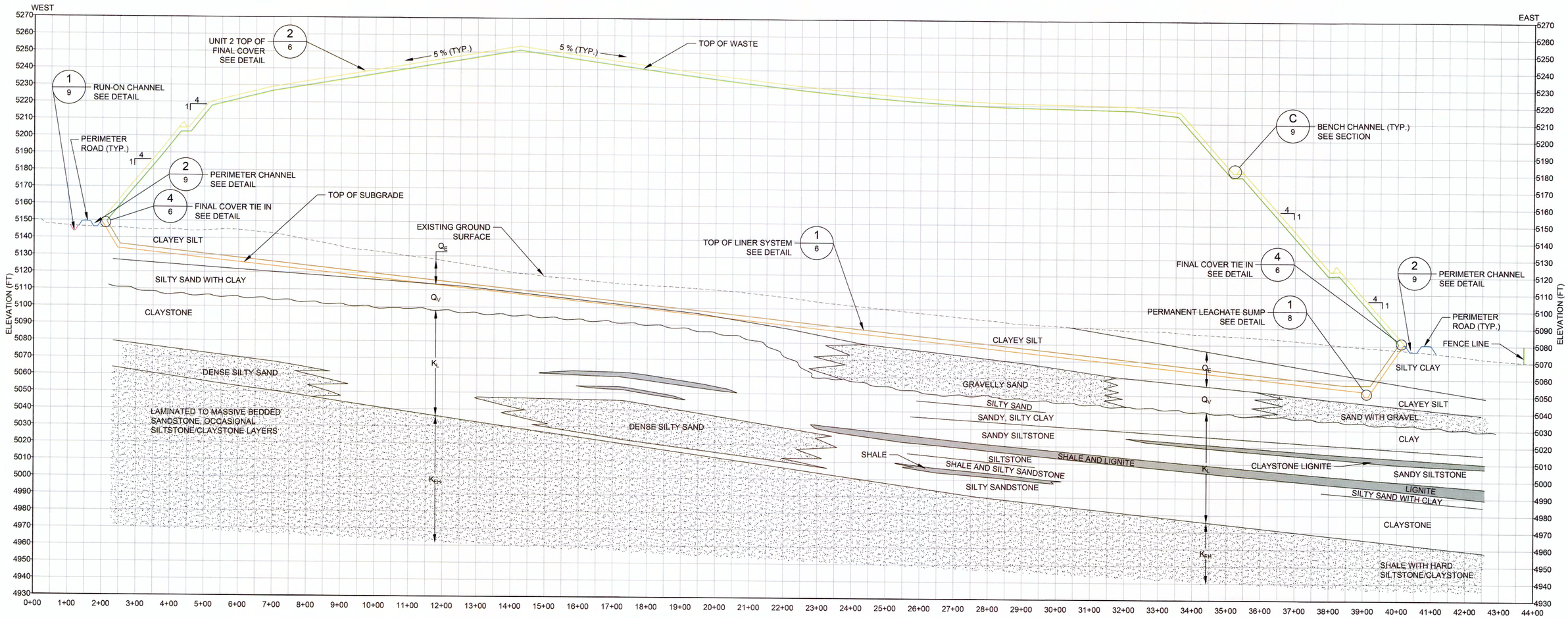
PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
CROSS SECTION A-A'

COLORADO LICENSED JEFFREY A. RUSH 0046801 PROFESSIONAL ENGINEER

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A005	A		5A

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IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI D



SCALE 1" = 150'
VERT. SCALE 5X

B / 5B CROSS SECTION B-B'

LEGEND

- Q_E = Quaternary Eolian
- Q_V = Quaternary Verdos
- K_L = Top of Cretaceous Laramie Formation
- K_{FH} = Top of Cretaceous Fox Hills Sandstone
- = Erosional Surface
- = Predominantly Sand and Sandstone
- = Predominantly Lignite and Shale

NOTE

1. SUBSURFACE DATA AND STRATIGRAPHIC INTERPRETATION PROVIDED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC BASED ON 2016 GEOLOGIC AND HYDROGEOLOGIC SITE CHARACTERIZATION FIELD INVESTIGATION.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

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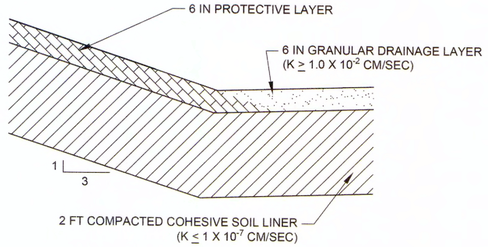
PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
CROSS SECTION B-B'

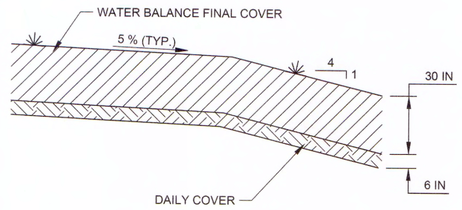
COLORADO LICENSED JEFFREY A. RUSCH 0044601 PROFESSIONAL ENGINEER

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A005B	A		5B

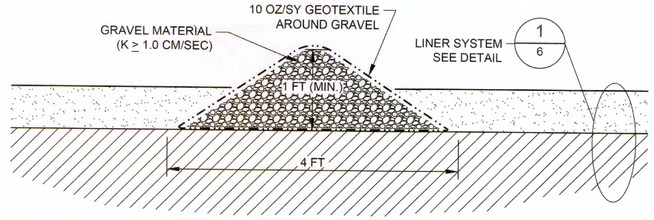
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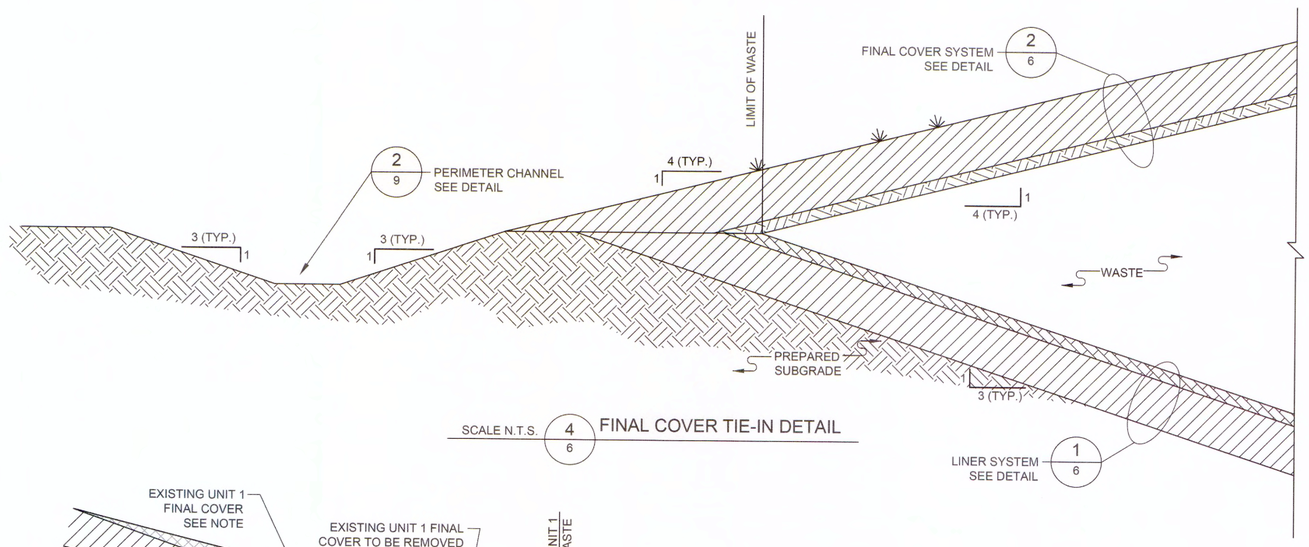
SCALE N.T.S. 1/6 LINER SYSTEM DETAIL



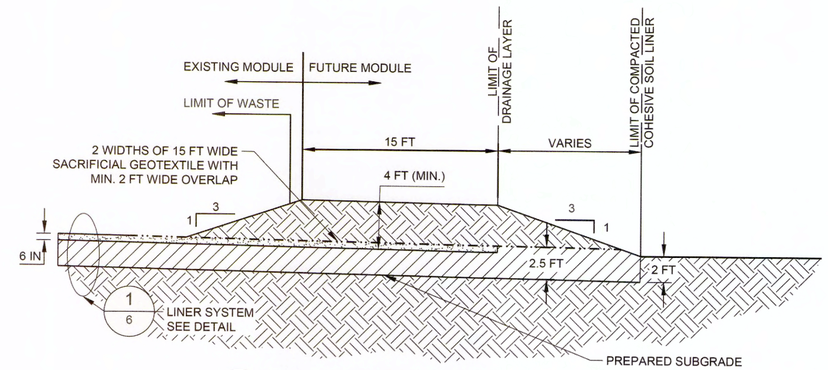
SCALE N.T.S. 2/6 FINAL COVER DETAIL



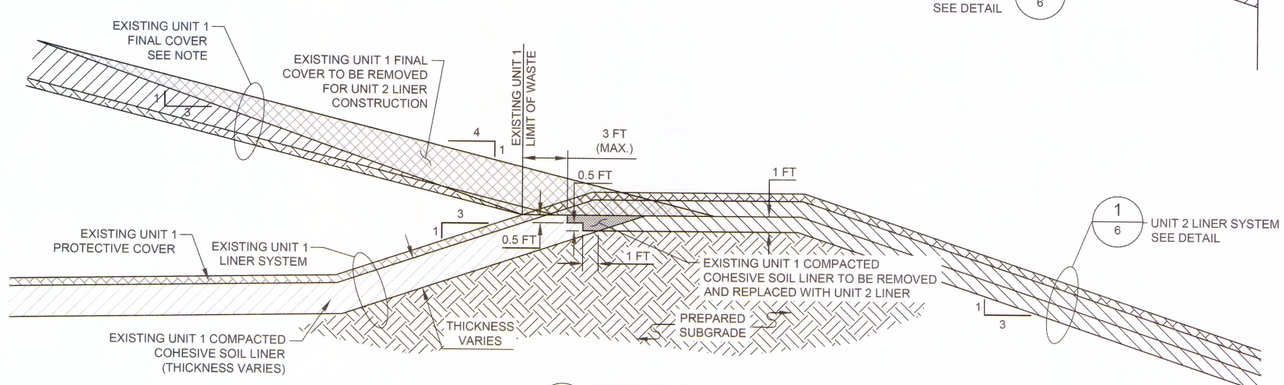
SCALE N.T.S. 3/6 GRAVEL DRAIN LINE DETAIL



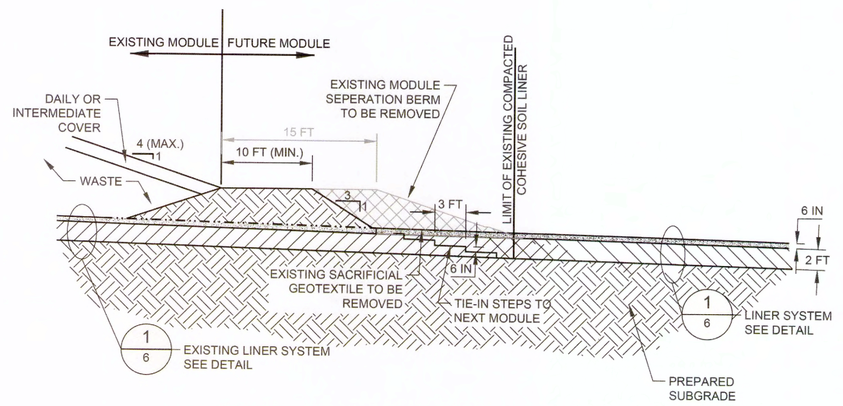
SCALE N.T.S. 4/6 FINAL COVER TIE-IN DETAIL



SCALE N.T.S. 5/6 MODULE SEPARATION BERM DETAIL



SCALE N.T.S. 6/6 EXISTING UNIT 1 LINER TO UNIT 2 LINER TIE-IN



SCALE N.T.S. 7/6 MODULE SEPARATION BERM TIE-IN DETAIL

NOTE
DURING CONSTRUCTION, COMPACTED COHESIVE SOIL LINER SHALL BE BENCHED (STEPPED) INTO EXISTING COHESIVE SOIL LINER AS SHOWN. GRANULAR DRAINAGE LAYER SHALL BE MADE CONTINUOUS BETWEEN MODULES.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL
SERVICES OF COLORADO, INC.

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PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
LANDFILL DETAILS

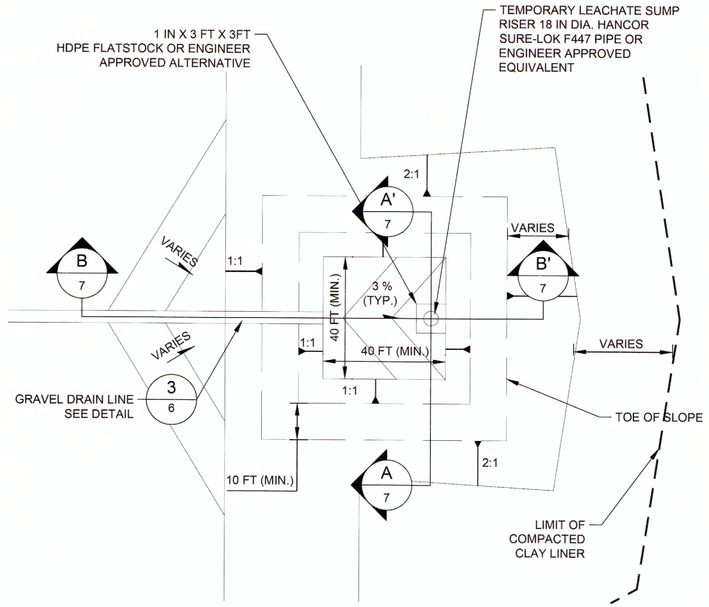
COLORADO LICENSED
JEFFREY A. RUSH
0046801
PROFESSIONAL ENGINEER

PROJECT NO.	CONTROL	REV.	of	SHEET
1538880	A006	A		6

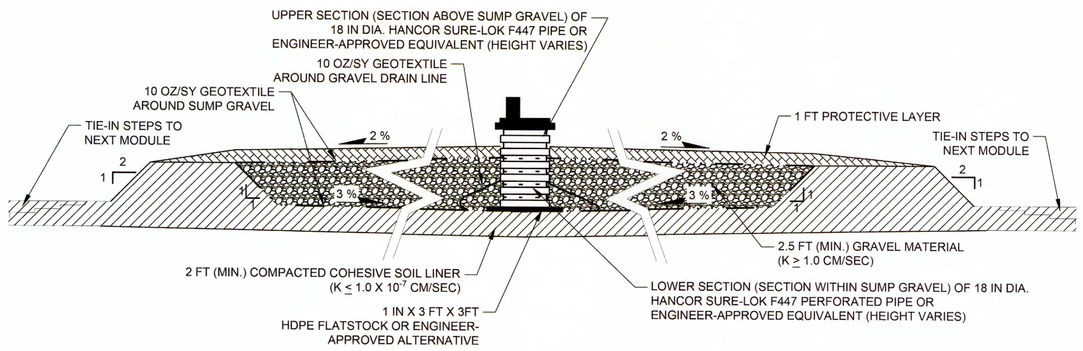
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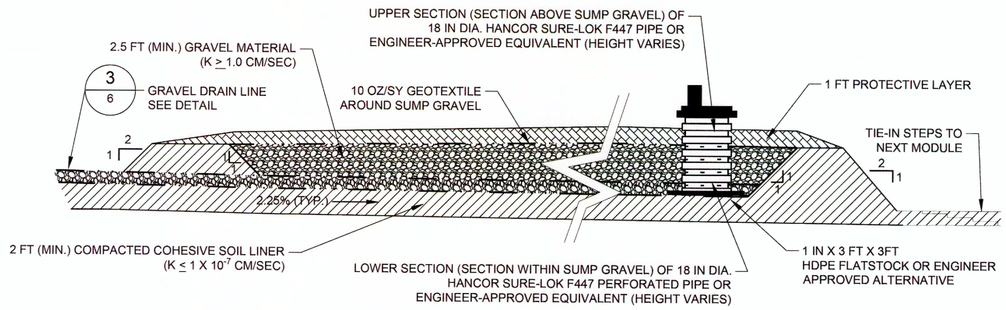
0 1in



SCALE N.T.S. 1/7 TYPICAL TEMPORARY LEACHATE SUMP COLLECTION SUMP DETAIL



SCALE N.T.S. A/7 TEMPORARY SUMP SECTION



SCALE N.T.S. B/7 TEMPORARY SUMP SECTION

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR CDPHE EDOP SUBMITTAL	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL
SERVICES OF COLORADO, INC.

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USA
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www.golder.com

COLORADO LICENSED
JEFFREY A. RUST
NO. 0046901
PROFESSIONAL ENGINEER

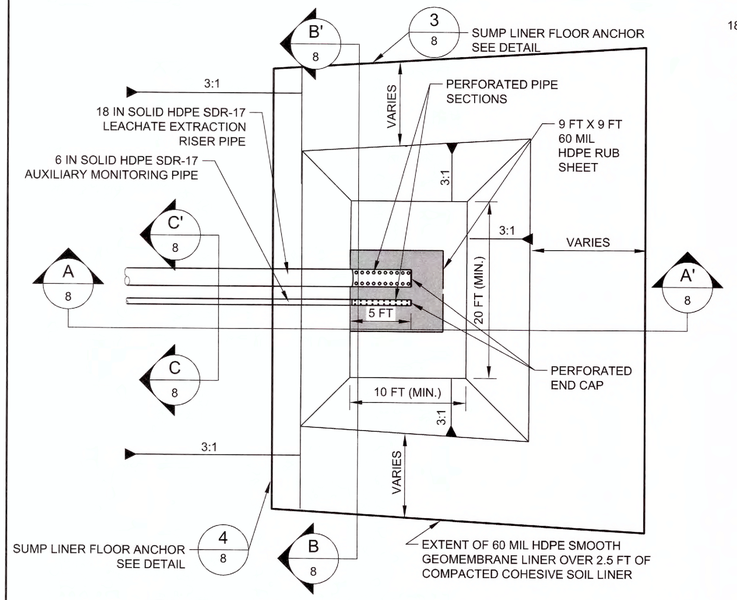
PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
TEMPORARY LEACHATE COLLECTION SUMP DETAILS

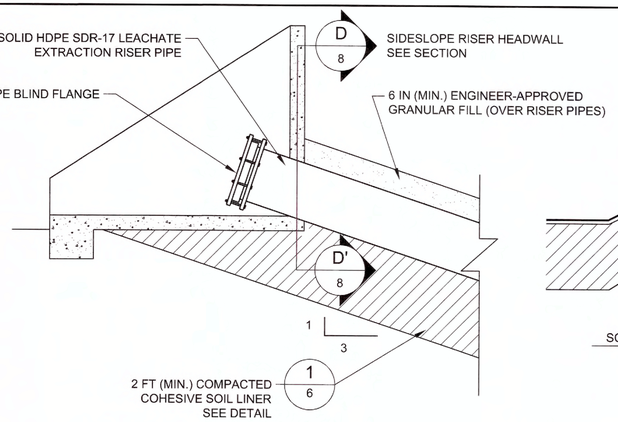
PROJECT NO.	CONTROL	REV.	of	SHEET
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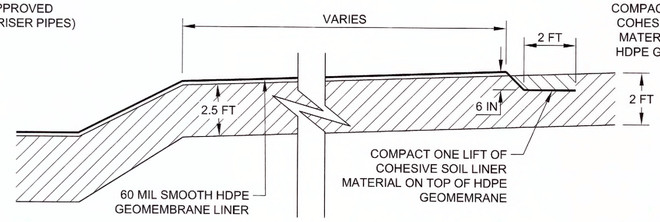
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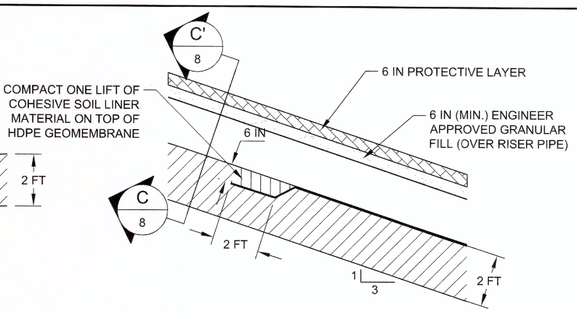
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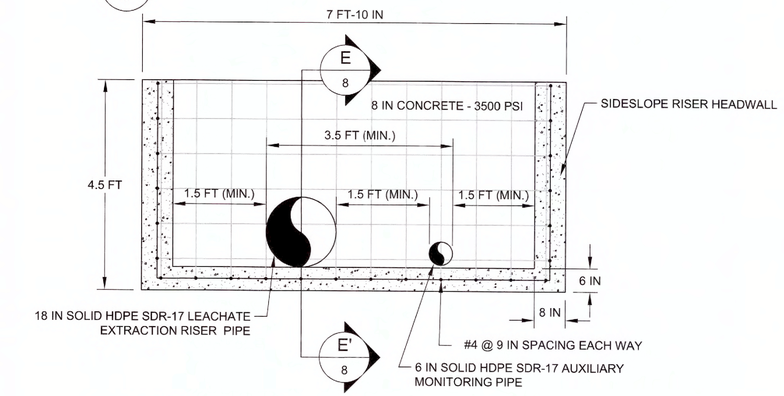
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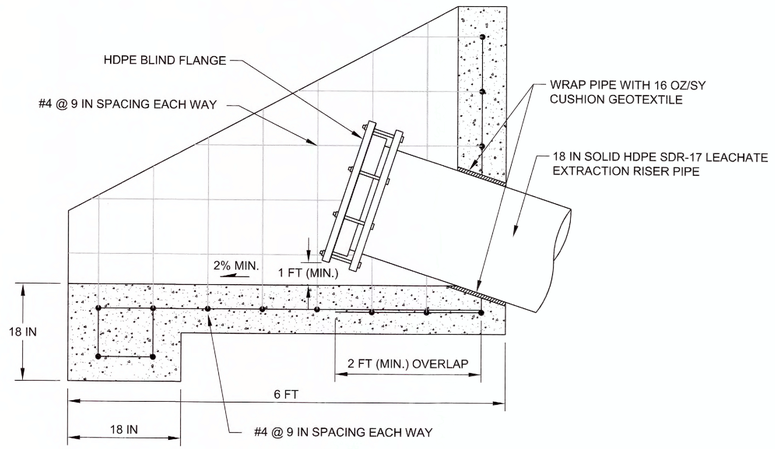
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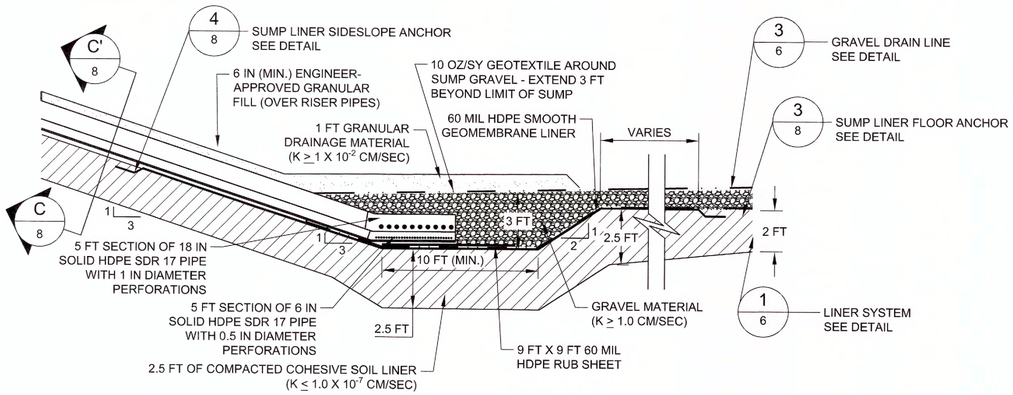
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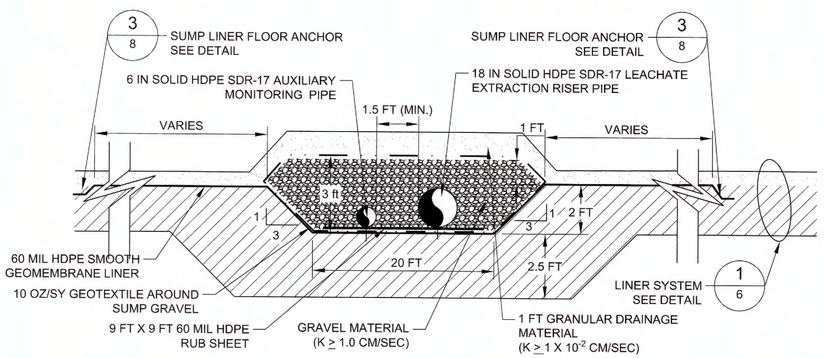
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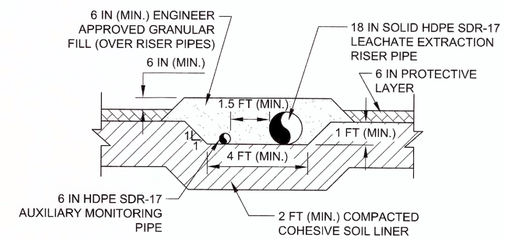
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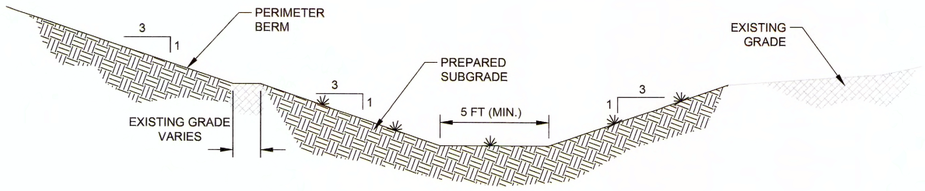
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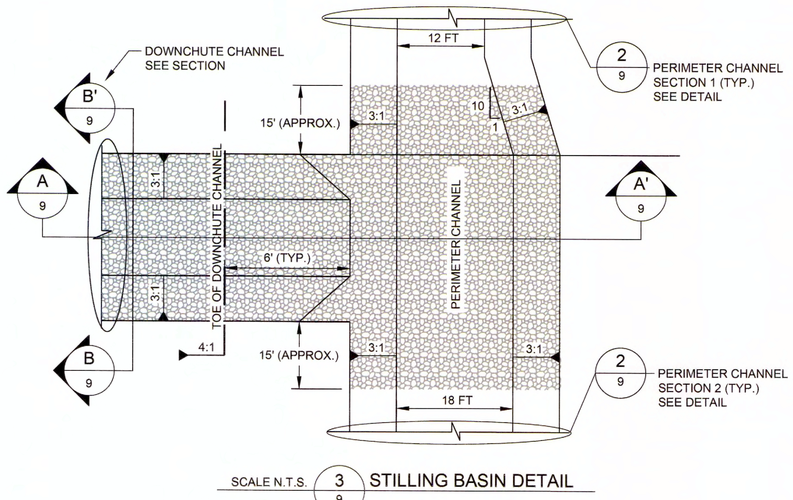
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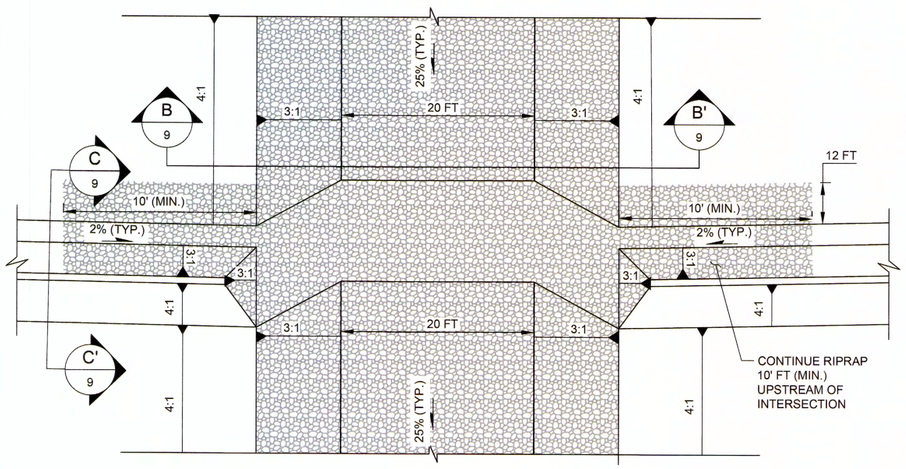
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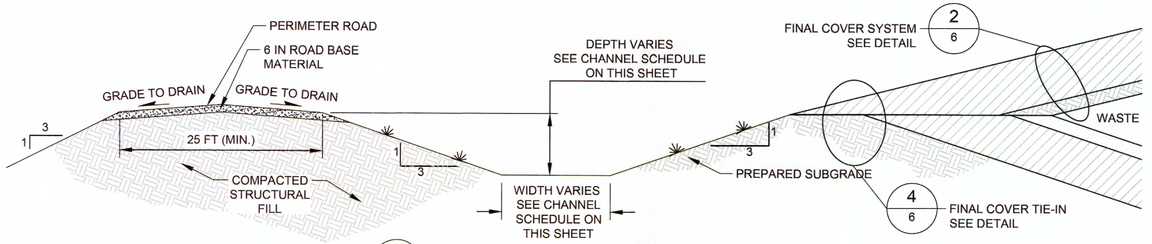
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SCALE N.T.S. 3/9 STILLING BASIN DETAIL

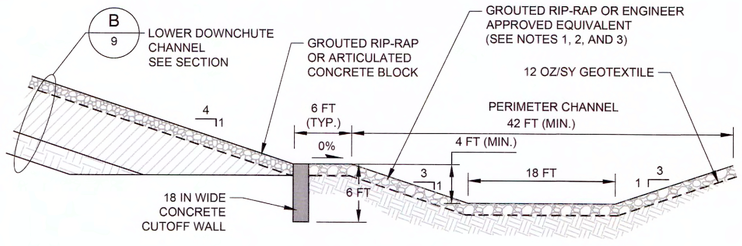


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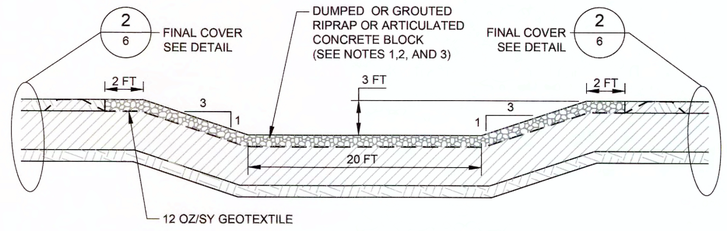
PERIMETER CHANNEL SCHEDULE					
CHANNEL	SIDESLOPE (SS) (H:V)	MINIMUM CHANNEL SLOPE (%)	MINIMUM CHANNEL BOTTOM WIDTH (B) (FT)	MINIMUM CHANNEL DEPTH (D) (FT)	CHANNEL LINING
SECTION 1	3:1	1.2	12	3	GRASS
SECTION 2	3:1	1.2	18	4	TRM
SECTION 3	3:1	1.2	20	4	TRM



SCALE N.T.S. A/9 STILLING BASIN SECTION

NOTES

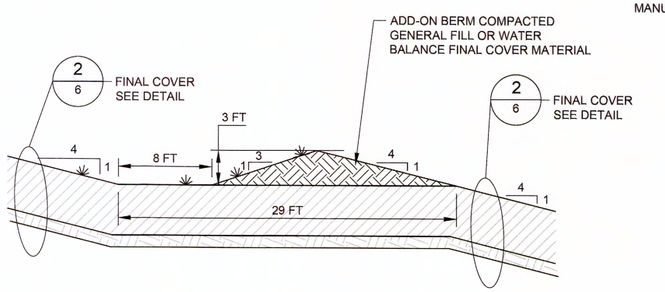
1. RIPRAP SHALL BE PLACED TO A THICKNESS OF 1.5 TIMES THE D_{50} DIMENSION.
2. LOWER DOWNCHUTE AND STILLING BASIN RIPRAP SHALL HAVE D_{50} OF 24 IN.
3. RIPRAP SHALL BE GROUTED TO ONE HALF OF LAYER THICKNESS (MINIMUM).



SCALE N.T.S. B/9 DOWNCHUTE CHANNEL SECTION

NOTES

1. RIPRAP SHALL BE PLACED TO A THICKNESS OF 1.5 TIMES THE D_{50} DIMENSION.
2. UPPER DOWNCHUTE CHANNEL DUMPED RIPRAP SHALL HAVE D_{50} OF 6 IN. MIDDLE DOWNCHUTE CHANNEL DUMPED RIPRAP SHALL HAVE D_{50} OF 18 IN. LOWER DOWNCHUTE CHANNEL GROUTED RIPRAP SHALL HAVE D_{50} OF 24 IN AND SHALL BE GROUTED TO ONE HALF OF LAYER THICKNESS (MINIMUM).
3. ARTICULATED CONCRETE BLOCK (ACB) MAY BE SUBSTITUTED FOR RIPRAP IN DOWNCHUTE CHANNEL. ACB SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.



SCALE N.T.S. C/9 BENCH CHANNEL SECTION

ALL BENCH CHANNELS SHALL BE GRASS-LINED

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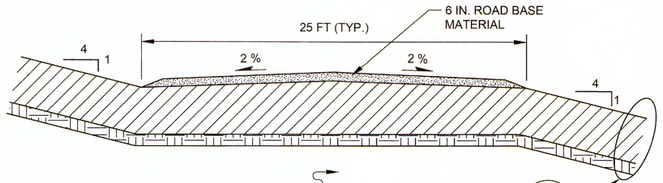
PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
STORMWATER MANAGEMENT SYSTEM DETAILS *(SHEET 1 OF 2)*

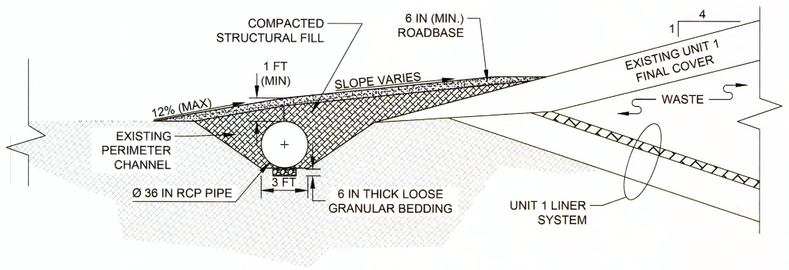
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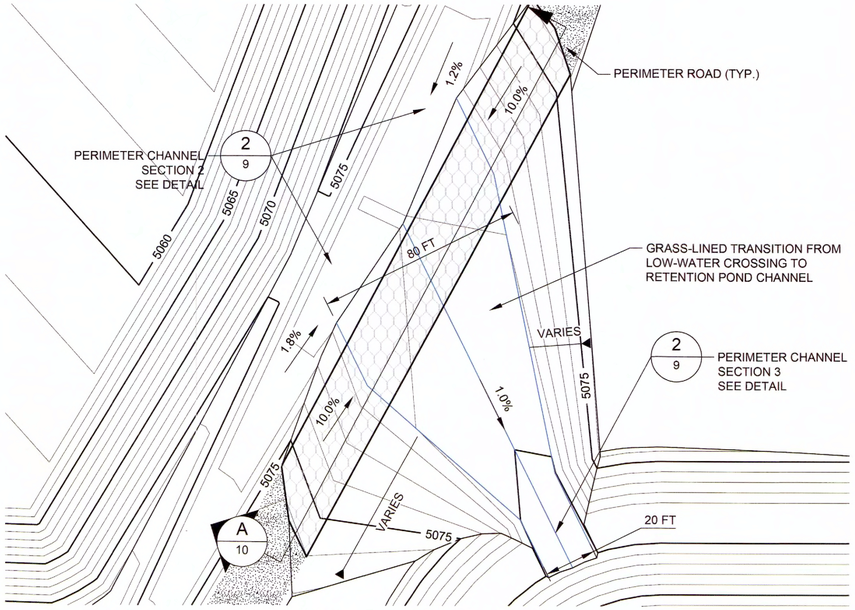
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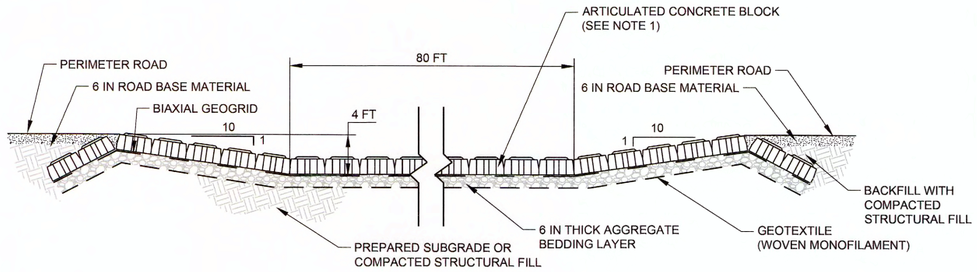
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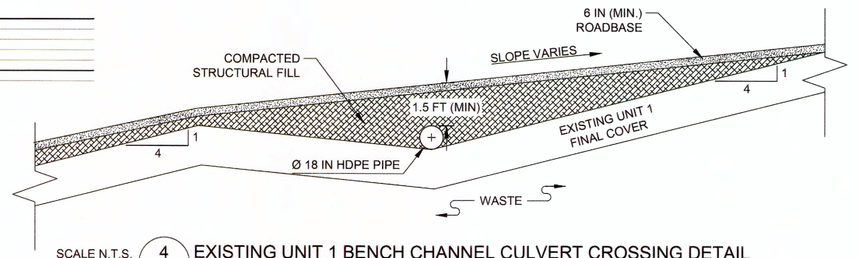


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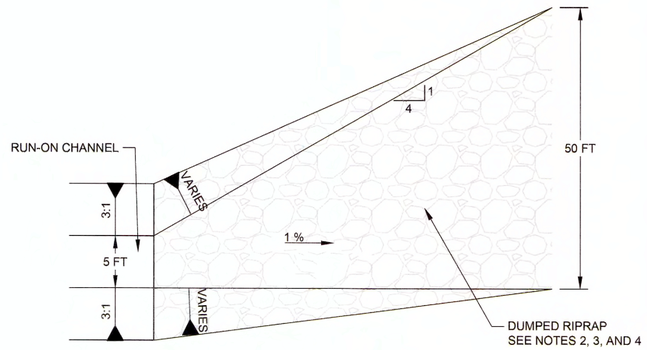


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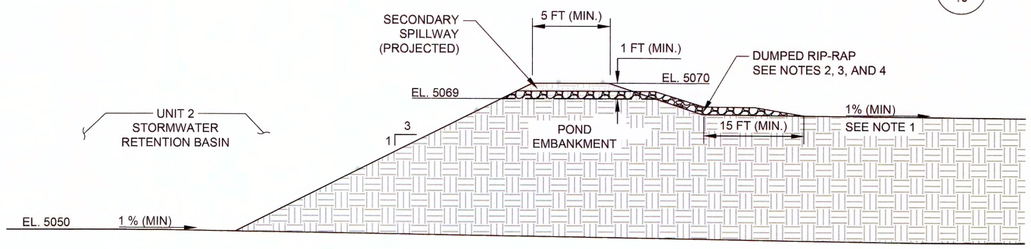
1. ARTICULATED CONCRETE BLOCK SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.



SCALE N.T.S. 4/10 EXISTING UNIT 1 BENCH CHANNEL CULVERT CROSSING DETAIL



SCALE N.T.S. 5/10 DISSIPATION BASIN PLAN VIEW DETAIL



SCALE N.T.S. 6/10 RETENTION BASIN SPILLWAY DETAIL

NOTES

1. EXISTING GRADE DOWNSTREAM OF EMERGENCY SPILLWAY VARIES. SPILLWAY DISCHARGE AREA WILL BE REGRADED TO DRAIN DURING UNIT 2 OPERATIONS.
2. RIPRAP SHALL BE PLACED TO A THICKNESS OF 1.5 TIMES THE D_{50} DIMENSION.
3. RIPRAP SHALL HAVE A D_{50} OF 6 IN.
4. RIPRAP SHALL BE PLACED ON 12 OZ/SY GEOTEXTILE.

COLORADO LICENSED (PREV. "A" AUDIT) 0038501 PROFESSIONAL ENGINEER

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WELD COUNTY, COLORADO

TITLE
STORMWATER MANAGEMENT SYSTEM DETAILS *(SHEET 2 OF 2)*

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APPENDIX B
GEOTECHNICAL AND HYDROGEOLOGIC CHARACTERIZATION REPORTS

APPENDIX B-1

REPORT OF GEOTECHNICAL INVESTIGATION, NORTH WELD LANDFILL UNIT 2, PERMITTING AND DEVELOPMENT (SWIFT RIVER ENVIRONMENTAL SERVICES, LLC; DECEMBER 2016)

FINAL REPORT

REPORT OF GEOTECHNICAL INVESTIGATION NORTH WELD LANDFILL UNIT 2

PERMITTING AND DEVELOPMENT

WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

Prepared by

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

An Alaska Native Corporation

26 West Dry Creek Circle, Suite 470 ♦ Littleton, Colorado ♦ 303-695-4660

DECECMBER 2016

FINAL REPORT

REPORT OF GEOTECHNICAL INVESTIGATION

North Weld Landfill Unit 2

Permitting and Development

Prepared by

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC
An Alaska Native Corporation

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December 2016

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D – GEOTECHNICAL LABORATORY TESTING RESULTS

E – CHEMICAL LABORATORY TESTING RESULTS

F – SOIL WATER CHARACTERISTICS TESTING RESULTS

1 INTRODUCTION

This "Report of Geotechnical Investigation" describes activities conducted by Swift River Environmental Services, LLC (Swift River) to assist Waste Management Disposal Services of Colorado (WMDSC) with the Geotechnical Investigation of the North Weld Landfill (NWLF) Unit 2 Permitting and Development. The purpose for the Geotechnical Investigation was to develop a thorough understanding of soil conditions that must be addressed by landfill design and environmental monitoring. This was accomplished through a process of subsurface investigation, using borings, temporary piezometers, and shallow excavations, and laboratory testing of soil samples. The physical target of field investigation and testing was the natural soil material that comprise the space that will become, and immediately underlies, the landfill cells. A hydrogeologic investigation of NWLF Unit 2 area geologic and groundwater conditions also was performed; the results of that investigation are presented in a separate report.

The existing permitted NWLF (Unit 1) consists of a 122-acre waste disposal footprint. The planned NWLF Unit 2 is contiguous and north of the existing waste disposal footprint and will add approximately 155 acres to the landfill footprint. Planning, designing, and permitting of NWLF Unit 2 include completion of the Geotechnical Investigation, as described below.

A "Workplan for Hydrogeologic Characterization and Geotechnical Investigation" (Workplan, dated February 2016) was prepared by Swift River and approved for implementation by WMDSC. The Geotechnical Investigation work closely followed the approved Workplan and consisted of the following tasks:

- Pre-field work planning and subcontracting and mobilization to the field;
- Oversight and stratigraphic logging of 22 Geotechnical Investigation soil borings and collection of disturbed and undisturbed soil samples;
- Installation of temporary piezometers;
- Oversight and sample collection from five test pits excavated by backhoe;
- Development of boring logs and cross-sections;

- Soil sample assessment and selection of samples for laboratory analyses;
- Soil sample submittal to laboratories for analysis;
- Review and interpretation of analytical data; and
- Preparation of this Report of Geotechnical Investigation for submittal to WMDSC.

The locations of the soil borings, test pits, and temporary piezometers are shown in the Site Plan in **Figure 1**, included in **Appendix A**. Any adjustments to boring locations were maintained within the 500-feet square grid block shown on **Figure 1**. The adjusted boring locations do not affect the conclusions of this report.

1.1 Purpose of Investigation

The Geotechnical Investigation was performed to characterize soil types to be removed for landfill construction and to determine soil types and physical properties within 20 feet below the Unit 2 "planned base grades". The identification and characterization of the soil to be removed from the NWLF Unit 2 serves three main purposes:

- Identify possible challenges to excavation (i.e., hard layers/rock and presence of water within or near base grade);
- Evaluate possible sources of cover or liner material and identify for segregation during excavation;
- Provide engineering properties to the landfill designers.

The "planned base grades" considered for this Geotechnical Investigation were developed by WMDSC as a preliminary estimate for the Unit 2 cell bottom configuration. The planned disposal cell base grades are subject to change based on the findings of this investigation and the Hydrogeologic Characterization of North Weld Landfill Unit 2[1], as well as other design considerations. The "20-feet below base grade" depth objective for geotechnical borings was selected to provide design flexibility in the event that a lower elevation base grade is determined through the Unit 2 design process.

[1] The "Hydrogeologic Characterization of North Weld Landfill Unit 2, Final Report" is a separate report completed in December 2016.

2 SITE CONDITIONS

The following section describes the general site conditions that influenced the Geotechnical Investigation.

2.1 Development History

NWLF is located on land that primarily was undeveloped agricultural land used for dry-land farming prior to the development of the current landfill operation. Geological and geotechnical investigations began in 1989 to evaluate the property for potential development as a municipal solid waste disposal site. NWLF received its initial Certificate of Designation (CD) from the Weld County Board of County Commissioners on June 28, 1990 (Weld County, 1990), and construction of the first disposal cell was completed in December 1991. NWLF opened to the public for its first receipt of municipal solid waste on February 3, 1992.

2.2 Topography

NWLF Unit 2 is topographically characterized as an upland area of gently undulating topography dissected by shallow drainages. The location is adjacent and contiguous to the active NWLF operation to the south, and currently is dryland farmed by a tenant farmer.

2.3 Regional Geology

NWLF is located on the northwestern flank of the Denver Basin, a large asymmetric syncline that began forming during the Colorado orogeny. The Basin includes sedimentary units from Paleozoic age through Cenozoic age, with the Pennsylvanian Fountain Formation as the oldest sedimentary unit in the Basin and the Dawson Arkose as the uppermost (i.e., youngest) bedrock unit. The regional dip of sedimentary strata in the area of NWLF is toward the southeast at about one to two degrees below horizontal. The regional dip increases west of NWLF with proximity to the uplifted Front Range. Unconsolidated surficial soil of alluvial and eolian deposits lie unconformably over the bedrock units. The alluvium primarily consists of interbedded sands and gravels of glacial and interglacial sediment

deposits with minor amounts of silt and clay. The wind-deposited eolian deposits, which generally blanket the region, are composed of very fine-grained materials, including silty sand and sandy silt. Floodplains of streams are underlain by sand and gravel deposits.

2.4 Local Geology

NWLF, including Unit 2, is located in an upland area, which is underlain by eolian deposits and glacial outwash alluvium overlying bedrock stratigraphy consisting of the Laramie Formation, Fox Hills Formation, and the Pierre Formation. The bedrock formations locally dip gently to the southeast. Consistent with the regional geology, the estimated dip in the bedrock from wells installed at NWLF is about one to two degrees to the southeast.

The permeable sandstones at the base of the Laramie Formation and the Fox Hills Sandstone form the Laramie-Fox Hills (LFH) Aquifer, and generally consist of interbedded layers of fine-grained sandstone, siltstone, and shale, with a combined thickness of as much as 300 feet. The Fox Hills Sandstone comprises the lowermost 100 feet (or more) of that interval. At depth, the sandstone and siltstone generally are poorly cemented and light to medium gray in color. In shallow depths and outcrops, the sandstone and siltstone can vary from friable to very hard, depending on the degree of iron mineralization (USGS, HA-730C).

The eolian (wind-deposited) materials at the site are as much as 25 feet in thickness. Alluvium deposits beneath the eolian deposits are as much as 35 feet thick and were encountered in borings and wells drilled at NWLF. As a result of natural erosion and landfill construction, the eolian or alluvial deposits are thin or absent in some areas. The Laramie Formation is present beneath the entire NWLF, including NWLF Unit 2. Within the proposed NWLF Unit 2 footprint, the Laramie Formation occurs at depths below natural ground surface ranging from about 20 to 45 feet, and is from 35 to over 60 feet in thickness.

3 SITE INVESTIGATION

This section describes the field activities that were performed for the Geotechnical Investigation.

3.1 Geotechnical Boring Locations and Depths

Swift River personnel walked and observed the NWLF Unit 2 area and staked 24 soil boring locations on February 5, 2016, as included the February 8, 2016 Workplan. The geotechnical soil boring locations staked were within the NWLF Unit 2 footprint at the approximate centers (as determined by GPS[2]) of grid blocks laid out using a 500 feet by 500 feet grid that is based on the NWLF site coordinate system. Twenty of the boring locations (NWE-1 through NWE-20) were located in the undisturbed portion of the proposed NWLF Unit 2 footprint, where soil derived from the active landfill development is not present, and four boring locations (NWE-21, NWE-22A, NWE-22B, and NWE-23) were located in the area of existing soil stockpiles along the north side of the NWLF Unit 1 area. NWE-22A and NWE-22B represented two options for proposed boring NWE-22 to be drilled in an area of the stockpile, where large sandstone slabs unearthed during NWLF excavation were stockpiled. To avoid drilling through these rock slabs, a field decision was made to drill the northernmost (NWE-22A) of these two locations during the Geotechnical Investigation. Alternate boring location NWE-22B was determined not to be necessary.

A review of past drilling activities along the northern border of the NWLF Unit 1 identified gas probe locations that provided stratigraphic information near the location of staked location NWE-23. Boring NWE-23 was not drilled because the depth of data available from the existing gas probe in this area (i.e., probe GP-19[3]) was comparable to planned boring depth. Drilled locations are shown on **Figure 1**, included in **Appendix A.**

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[2] Hand-held GPS (global positioning system) instruments were used to locate the pre-determined coordinates of the grid block centers. Off-sets from the pre-determined grid block centers were staked where those locations were within planted land.

[3] Boring record for probe GP-19 is provided in **Appendix C**

The total depth of each boring was determined based on present ground-surface elevation and the planned top of liner elevation supplied by WMDSC[4]. The planned base grade elevation (i.e., top of liner) map is shown on **Figure 3,** included in **Appendix A**. The planned depths of Geotechnical Investigation borings were to be 20 feet below base grade. Considering that base grade elevation represents the planned top of liner and the assumed maximum thickness of compacted soil liner system is 3.0 feet, all Geotechnical Investigation borings extended 23 feet below the planned base grade elevation at each boring location. The current ground-surface elevation at each boring location was estimated from the site topographic map (**Figure 1)**. The estimated ground-surface elevations and planned and actual drilling depths presented in the Workplan are presented in **Tables 1** and **2**, included in **Appendix B**.

3.2 Geotechnical Boring Method

The soil borings were drilled by Drilling Engineers, Inc. of Ft. Collins, Colorado. The geotechnical drilling program began on February 10, 2016 and was completed on February 18, 2016. Borings were drilled using a CME-75 drill rig using 8.25 inch outer diameter hollow-stem auger augers. The borings were sampled using five-foot continuous core samples, supplemented by split-barrel samples and thin-wall tube undisturbed samples, to develop lithologic boring logs for NWLF Unit 2. Descriptions and depths were recorded in the field and are presented in the soil boring records included in **Appendix C**.

Except for borings NWE-8/TP-1 and NWE-21/TP-2 (piezometer locations, as discussed below), the Geotechnical Investigation borings were backfilled with hydrated bentonite chips in the interval from the boring bottom to a level above planned base grade. All borings were filled with bentonite to at least 1.5 feet above planned base grade level and then with drill cuttings to the ground surface.

[4] Planned Base Grade map provided by WMDSC.

Boring record logs for the 22 borings advanced for the Geotechnical Investigation are included in **Appendix C**. A boring completion summary is presented in **Table 2**, in **Appendix B**.

3.2.1.1 Geotechnical Sample Collection and Selection

During boring advancement, **Swift River** collected soil samples for description and physical testing (of selected samples) from each five-foot long continuous core sample. Samples were marked with the boring number and depth. The retained soil samples were available during review of the lithologic field logs to aid in correlation and development of boring records and cross-sections across the NWLF Unit 2. Field descriptions were compared to laboratory soil classifications and adjustments made to final field descriptions (e.g., grain size and plasticity) as appropriate.

Four cross-sections were developed for this report and are included in **Appendix A**. The locations of the cross-sections are shown on **Figure 2**, included in **Appendix A**. The cross-sections (**Figures 4, 5, 6** and **7)** extend from west to east across the NWLF Unit 2, and are identified as follows.

- **Cross Section A-A'**: Soil borings NWE-6, NWE-9, NWE-12, NWE-15, and NWE-18.
- **Cross-Section B-B'**: Well TW-02, Soil borings NWE-3, NWE-5, NWE-8/TP-1, NWE-11, NWE-14, NWE-17 and TW-08.
- **Cross-Section C-C'**: Soil borings NWE-1, NWE-2, NWE-4, NWE-7, NWE-10, NWE-13, NWE-16, and NWE-20.
- **Cross-Section D-D'**: Soil borings NWE-21, NWE-22A, and NWE-19, TW-10, Gas Probes GP-16, GP-17, GP-18, GP-19, and former monitoring well MW-11.

One undisturbed sample was collected slightly below planned base grade elevation in each boring by ASTM D-1587 thin-walled tube method (i.e. thin-wall tube sampler). An undisturbed sample was not collected at boring NWE-22A because hard soil damaged the thin-walled tube sampler and prevented sampler penetration.

Starting below the undisturbed sample, standard penetration test samples were collected every five feet using the ASTM D-1586 method for split-barrel sampling and standard penetration tests. Continuous core samples were collected between the split-barrel samples.

3.2.1.2 Temporary Piezometers

No free water was encountered during advancement of the 22 geotechnical borings. Two soil borings (NWE-8 and NWE-21) appeared to have slightly higher soil moisture during boring advancement and were selected for the installation of temporary piezometers.

The two temporary piezometers were installed as follows.

- 2.0-inch inside diameter Schedule 40 PVC casing, screen, and bottom cap.
- Screen length of 5.0 feet of 0.010-inch factory-slotted well screen at NWE-8 and 10.0 feet of 0.010-inch factory-slotted well screen at NWE-21.
- The well screen positioned at the bottom of the boring to increase the potential for the accumulation of water in the piezometer.
- Casing stickup of approximately 3.0 feet above ground with a locking "J" cap
- The sand pack was installed with a 10/20 sand filter around the well screen to about 2.0 feet above the well screen.
- A 2.0-feet thick bentonite pellet seal was placed above the sand pack and hydrated with potable water.
- Bentonite chips were placed from the top of the seal to the ground surface.

Because the piezometers are completed as temporary for this investigation, concrete surface pads with protective posts were not installed. An orange traffic cone was placed on top of each well. At the discretion of WMDSC, these temporary piezometers will be abandoned or more permanent markers (e.g., steel T-posts) will be installed.

Measurements of the two piezometers made one day after installation and approximately 60 days later confirmed the absence of water. Consequently, the piezometers did not require well development.

Piezometer construction details are summarized in **Table 3**, included in **Appendix B**.

3.2.1.3 Test Pits

On March 22, 2016, five test pits were excavated in the NWLF Unit 2. These pits were located as shown on **Figure 1**. The test pit excavation was performed by WMDSC personnel using a wheeled backhoe with a maximum reach of about 15 feet below ground surface (BGS). The test pit sample collection was performed by **Swift River** personnel from backhoe buckets emptied at the ground surface. Two composite samples (5-gallon buckets) were taken from each test pit, one to represent a shallow depth range and the second to represent a deeper depth range. The test pit details and sample depth ranges are shown in **Table 4,** included in **Appendix B.** After the test pit sampling was completed, the pits were backfilled with excavated soil to the ground surface.

4 LABORATORY ANALYSES RESULTS

This section describes the laboratory testing performed on soil samples collected during the Geotechnical investigation.

4.1 Geotechnical Testing

Samples representative of soil types identified by subsurface sampling and observations by the field geologist were selected for geotechnical laboratory testing. The following tests were performed by three different laboratories.

Laboratory	Tests Performed
Advanced Terra Testing	Physical properties (grain size, Atterberg limits, moisture content, USCS classification) Compaction properties Consolidation Triaxial Shear and Direct Shear Permeability
Applied Soil Water Technologies	Soil Water Characteristics
TestAmerica, Inc.	Cation Exchange Capacity Agricultural Parameters

Following initial soil description and stratigraphic correlation (using cross-sections), nine disturbed soil samples from continuous core sampling and six undisturbed soil samples were selected for physical testing. Representative soil samples from test pits also were selected for physical testing. Samples were selected to determine physical properties determination for a range of soil types and stratigraphic positions and to satisfy the specific analytical requirements of Golder Associates Inc. (Golder), the firm retained by WMDSC for engineering design of NWLF Unit 2.

Analytical requirements, as provided by Golder, are as follows.

Test Requested	Test Method	Specific Instructions
Modified Proctor	ASTM D-1557	• Determine compaction properties for potential liner and final cover soil
Permeability	ASTM D-5084	• Run on remolded potential liner material • Recompact to 97% max dry density, 2.5% above optimum [moisture content] • Testing apparatus minimum confining stress (typically 5 or 10 PSI)
Consolidation	ASTM D-2435, Method B	• Run on UD from base grade o Method B, inundated, basic load schedule o Hold 4, 8, and 16 KSF load cycles to 1440 mins • Do not run on remolded samples
CU Triaxial	ASTM D-4767	• Run on UD from base grade o 20, 40, 80 PSI normal stresses
Direct Shear	ASTM D-3080	• Remolded liner material o Recompact to 97% max dry density, 2.5% below optimum o 25, 50, 100 PSI normal stresses • Remolded final cover material o Recompact to 85% max dry density, 2.5% below optimum [moisture content] o The suggested normal stresses (1, 2, 4 KSF) are OK

PCF = Pounds per cubic foot
PSI = Pounds per square inch
PSF = Pounds per square foot
KSF = Kips per square foot

Selected soil samples from the geotechnical borings were analyzed for grain-size analysis (including hydrometer analysis for the sub#200 sieve portion), moisture content, and Atterberg Limits. A summary of the results are shown in **Table 5,** included in **Appendix B**, and the laboratory testing reports are included in **Appendix D**.

A review of the data shows that in the test pits, shallow soil from the western part of NWLF Unit 2 appeared to have more fines (sub #200 sieve) and less sand than the eastern part. The fines content averaged over 80% in Pits #1 and #2, but was only 40% in the samples from Pits #3 and #4. However, in the geotechnical borings taken over the entire NWLF Unit 2, especially for samples selected from the 9 to 14 ft BGS range from continuous core

samplers, the fines content averaged over 75%. Considering the average of the four test pits, grain-size analysis shows a typical mixture of about 40% sand, 40% silt, and 20% clay. The average of the samples from soil borings yields a similar average makeup.

From these grain-size correlations, it appeared that shallow soil from the western and central portion of the NWLF Unit 2 could provide low permeability material for liner construction. Similarly, based solely on grain-size, it appeared that shallow soil from across the entire NWLF Unit 2 area could be suitable for use in a water balance final cover. Laboratory testing assignments were made considering these grain-size observations and the Golder analytical requirements, as noted above.

4.1.1 Compaction Properties Tests

Test pit excavations were made at five selected locations in the NWLF Unit 2 excavation footprint in order to obtain the large volume of composited shallow soil necessary for compaction properties testing, including determination of maximum dry density and optimum moisture content. Soil samples remolded consistent with the Golder requirements were tested to determine the permeability of compacted material potentially useful for liner construction and to determine direct shear properties (i.e., angle of internal friction and cohesion) for potential liner and final cover material. Four bulk soil samples were submitted for modified Proctor tests by ASTM Method D-1557.

- Test Pit #1 (sample depth 2-4 Ft BGS);
- Test Pit #2 (sample depth 5-9 Ft BGS);
- Test Pit #3 (sample depth 3-5 Ft BGS); and
- Test Pit #4 (sample depth 2-6 Ft BGS).

The laboratory data are included in **Appendix D**. The results showed a relatively narrow range of values, with optimum moisture content results ranging from 11.2 to 13.1 percent, and maximum dry density ranging from 119.0 to 122.2 PCF. The average of the four samples yielded an optimum moisture content of 12.0 percent and maximum dry density of 120.8 PCF. The results are summarized in **Table 6**.

4.1.2 Consolidation Tests

Consolidation testing was performed on two undisturbed samples taken slightly below the planned base grade in the NWLF Unit 2 from borings NWE-8 (sample depth 18-20 Ft BGS) and NWE-16 (sample depth 14-16 Ft BGS).

The consolidation tests were performed under loadings of 100, 200, 400, 800, 1600, 3200, 6400, 12800 and 25600 PSF. Wet density for the undisturbed samples were 107.6 PCF for the sample from NWE-8 and 90.8 PCF for the sample from NWE-16.

The first analysis of consolidation test results was the calculation of the over-consolidation ratio (OCR) for each sample. The method of Casagrande (1936) using the laboratory plot of void ratio versus log pressure was used. The midpoint depth of the two samples and the wet density was used to calculate the present effective vertical stress. The results suggest normal to slightly over-consolidated conditions. For the sample from NWE-8, the OCR=1.05, and for the sample from NWE-16, the OCR=1.04.

The compression index (C_c) can be calculated by several different methods. The simplest method is the slope of the void ratio versus log pressure curve.

For the sample from NWE-8, the $C_c = 0.22$

For the sample from NWE-16, the $C_c = 0.21$

For comparison, the compression index also can be calculated by the empirical method of Skempton (1944) using

$$C_c = 0.009(LL-10)$$

For NWE-8, LL = 28, so the corresponding $C_c = 0.16$

For NWE-16, LL = 30, so the corresponding $C_c = 0.18$

An alternative calculation of the compression index for low plasticity soils using the initial void ratio (e_0) uses the equation:

$$C_c = 0.75 (e_0-0.5)$$

For the sample from NWE-8, e_0 =0.711 , so the corresponding C_c = 0.158

For the sample from NWE-16, e_0 = 0.95, so the corresponding Cc = 0.338

The average C_c for the two samples was 0.18 for NWE-8 and 0.24 for NWE-16. The results for NWE-16 were skewed higher by the higher initial void ratio in that sample.

The swell index (C_s) for the soil can be estimated as about 1/5 to 1/10 of C_c. Using the average C_c value for both samples, this yields the range of swell index values as:

NWE-8: Cs = 0.018 to 0.036 and

NWE-16: Cs = 0.024 to 0.048.

An alternative calculation of the swell index comes from Nagaraj and Murty (1985) as:

$$C_s = 0.0463[LL\%/100]G_s$$

Gs is assumed to be 2.65 g/cc

For NWE-8, LL (liquid limit as %) = 28, so the corresponding C_s = 0.034

For NWE-16, LL = 30, so the corresponding C_c = 0.037

The consolidation test results are summarized in **Table 7** and the laboratory sheets are included in **Appendix D**.

4.1.3 Direct Shear Strength Tests

Direct shear was performed on remolded samples from Test Pit #2 (sample depth 5-9 Ft BGS) and Test Pit #3 (sample depth 3-5 Ft BGS). The sample from Test Pit #2 was selected to represent potential liner material and was remolded to specifications provided by

Golder. The sample was remolded to 97% maximum dry density at 2.5% below optimum moisture content, with normal stress of 25, 50, and 100 PSI. The sample from Test Pit #3 was selected to represent potential final cover material and was remolded to specifications provided by Golder. The sample was remolded to 85% maximum dry density at 2.5% below optimum moisture content, with normal stress of 1, 2, and 4 KSF.

The direct shear test results yielded peak shear stress friction angles of 26.4° and 29.9° and cohesion of 905 and 157 PSF for potential liner (Test Pit #2) and potential final cover (Test Pit #3) material, respectively. The direct shear test results are summarized in **Table 8** and the laboratory sheets are included in **Appendix D**.

4.1.4 Triaxial Shear Strength tests

Triaxial consolidated/undrained shear tests were performed on two undisturbed samples taken slightly below the planned base grade in the NWLF Unit 2 from boring NWE-9 (sample depth 17-19 Ft BGS) and boring NWE-14 (sample depth 17-19 Ft BGS). The confining pressures for the three test points for each sample, 20, 40, and 80 PSI, were provided by Golder.

The least squares regression analysis for the triaxial shear test for the sample from NWE-9 at a depth of 17 to 19 Ft BGS was reported by the laboratory to yield a negative y-intercept. However, on inspection of the graph, it was observed that the value is barely negative. Using a y-intercept of 0 allowed the calculation of approximate values for friction angle and assignment of 0 PSI for cohesion. The average drained friction angle was 35.0° for the sample from NWE-9 and 26.0° for the sample from NWE-9. The average undrained friction angle was 15.6° for the sample from NWE-9 and 14.1° for the sample from NWE-9.

The triaxial consolidated/undrained shear test results are summarized in **Table 9** and the laboratory sheets are included in **Appendix D**

4.1.5 Permeability tests

Tests were performed to determine the permeability that could be attained using site soil for liner material, and to measure the in-situ, undisturbed permeability of natural materials

below the disposal cell base grade. Permeability tests were run on the undisturbed samples from Boring NWE-7 (17-19 ft BGS) and Boring NWE-12 (14-16 ft BGS) taken at the planned base grade in the NWLF Unit 2, and on remolded samples from:

- Test Pit #1 (sample depth 2-4 Ft BGS);
- Test Pit #2 (sample depth 5-9 Ft BGS);
- Test Pit #3 (sample depth 5-10 Ft BGS);
- Test Pit #4 (sample depth 2-6 Ft BGS); and
- Test Pit #5 (sample depth 2-6 Ft BGS).

The range of permeability values for the undisturbed samples taken at planned base grade was from 2.1 x 10^{-3} to 5.2 x 10^{-3} cm/sec. These values can be considered in evaluation of vertical travel time for a potential release from a lined disposal cell or sump. However, they are applicable only to travel time through coarser-grained materials (i.e., silts, sands, and gravels) and not to travel time through finer-grained layers (e.g., clay or claystone).

The test pit samples were disturbed grab samples of material expected to be removed for disposal cell construction and available for liner or final cover construction. To simulate possible use as liner material, the samples selected for permeability testing were to be remolded at 97% maximum dry density and moisture content at 2.5% above optimum. Target density and moisture content, and testing confining stresses of 5 to 10 PSI, were based on instructions provided by Golder. As expected, the samples from test pits from the western portion of NWLF Unit 2 (expected to be finer-grained) had lower remolded permeability than the samples from test pits on the eastern portion of the NWLF Unit 2 area (expected to be slightly coarser-grained).

- **Western portion of NWLF Unit 2**: The range of values for remolded samples from test pits #1 and #2 was 2.5 x 10^{-8} to 6.8 x 10^{-8} cm/sec.
- **Eastern portion of NWLF Unit 2**: The range of values for remolded samples from test pits #3, #4, and #5 was 1.1 x 10^{-7} to 2.8 x 10^{-7} cm/sec

The permeability test results are summarized in **Table 10** and the laboratory sheets are included in **Appendix D**.

4.2 Soil Water Characteristics Testing

Soil samples representative of potential final cover material were collected from Test Pit #4 (sample depth 6-12 Ft BGS) and Test Pit #5 (sample depth 6-10 Ft BGS) and tested to determine unsaturated soil hydraulic properties. These soil properties were measured by a series of tests collectively referred to as water-storage or water-retention characteristics. These characteristics include wilting point, field capacity, and plant-available water content. Testing was done to determine unsaturated moisture retention properties that are needed for numerical modeling of unsaturated flow. Unsaturated hydraulic conductivity is defined by the saturated hydraulic conductivity and soil-water characteristic curve (SWCC) which is defined by the relationship between soil suction and soil moisture content.

The soil water characteristic curve test results are summarized in **Table 11** and the laboratory sheets are included in **Appendix E**.

4.3 Soil Chemical Analyses

Agricultural properties and cation exchange capacity (CEC) analyses were performed on disturbed boring samples and test pit samples.

4.3.1 Agricultural Properties

The agricultural properties testing for potential final cover material is for consideration in determining the likely success of establishing vegetation on the final landfill cover. The agricultural parameters determined are soil pH, total organic carbon, soil electrical conductivity, and sodium adsorption ratio. Tests were performed on shallow soil that could be segregated for ultimate use as final cover topsoil. Four samples from the test pits were selected for agricultural parameter analysis. These samples were:

- Test Pit #3, sample depth 3-5 Ft BGS;
- Test Pit #4, sampled depth 2-6 Ft BGS;
- Test Pit #4, sample depth 6-12 Ft BGS; and
- Test Pit #5, sample depth 6-10 Ft BGS.

The agricultural properties chemical analyses are summarized in **Table 12** and the laboratory sheets are included in **Appendix F**.

4.3.2 Cation Exchange Capacity

The CEC testing can be useful for determination of the behavior of liner and base grade soil that could be exposed to MSW landfill leachate. Eight samples were selected for analysis from continuous core boring samples and two from test pits. Four of the eight boring samples were selected as representative of possible liner material. These samples were:

- Boring NWE-4, sample depth 13-15 Ft BGS;
- Boring NWE-8, sample depth 13-15 Ft BGS;
- Boring NWE-12, sample depth 11-13 Ft BGS; and
- Boring NWE-17, sample depth 12-14 Ft BGS.

The CEC of these samples ranged from 8.9 to 15 milliequivalents per 100 grams (meq/100 gm). These values are consistent with a fine sandy loam or silt loam.

The remaining four boring samples were selected to be representative of the subgrade material beneath a landfill liner. This would represent the native undisturbed material beneath the NWLF Unit 2 after construction is completed. These samples were:

- Boring NWE-4, sample depth 18 Ft BGS;
- Boring NWE-8, sample depth 21 Ft BGS;
- Boring NWE-12, sample depth 17 Ft BGS; and
- Boring NWE-17, sample depth 17 Ft BGS.

The CEC of the subgrade material samples ranged from 10 to 12 meq/100 gram. These values also are representative of a fine sandy loam or silt loam.

CEC analyses also were done on two samples from test pits. These samples represented near-surface material from the western portion of the NWLF Unit 2 area that could be segregated during excavation for use as liner material. These samples were from:

- Test Pit #1, sample depth 2-4 Ft BGS; and
- Test Pit #2, sample depth 5-9 Ft BGS.

The CEC of the subgrade material samples ranged from 15 to 17 meq/100 gram. These values also are representative of a fine sandy loam or silt loam.

The laboratory chemical analyses are summarized in **Table 13** and the laboratory sheets are included in **Appendix F**.

5 FINDINGS

The following section presents a summary of the findings of the Geotechnical Investigation. The Geotechnical Investigation was performed to characterize the natural material (soil and rock) types to be removed for landfill construction and to determine material types and physical properties below the planned NWLF Unit 2 area base grade.

5.1 Investigation Summary

From February 10 to 18, 2016, Swift River personnel oversaw the advancement of 22 soil borings at the NWLF Unit 2. The borings were located on a 500 feet by 500 feet grid across the NWLF Unit 2, and extended to about 23 feet below the planned excavation base grade. Soil samples were collected by continuous core and split-barrel sampler and thin-wall tube (undisturbed samples) for physical testing and chemical analyses. Additionally, Swift River personnel oversaw the excavation of five test pits on March 22, 2016 for the collection of bulk grab samples from depths up to 12 feet below ground surface. Testing included:

- Grain size, moisture content, and plasticity by Atterberg limits;
- Compaction characteristics by modified Proctor method;
- Friction angle and cohesive strength by direct shear and consolidated undrained triaxial methods;
- Settlement characteristics by one-dimensional consolidation;
- Permeability by back pressure saturated - flow pump method;
- Unsaturated soil properties by soil water characteristic curve; and
- CEC and agricultural parameter values.

Test results and lithologic interpretation pertinent to the geotechnical characterization of the NWLF Unit 2 are summarized in Sections 5.2 and 5.3.

5.2 Geologic Characterization

5.2.1 Lithology

Four cross-sections were developed from the soil borings drilled as part of the Geotechnical Investigation. These cross-sections extended from west to east across the NWLF Unit 2, with three cross-sections across the northern and central portions of the investigation area, and the fourth cross section along the soil stockpile along the southern 500 feet of the NWLF Unit 2.

Consistent with the lithology of the adjoining NWLF Unit 1 to the south, the NWLF Unit 2 area is underlain by unconsolidated surficial deposits that lie unconformably over sedimentary bedrock. Most of the soil borings advanced for the Geotechnical Investigation were terminated within the upper part of the Laramie Formation. The surficial materials encountered above the Laramie Formation include eolian and alluvial deposits. The eolian deposits typically consist of clayey silt and very fine to fine-grained silty sand and were from seven to 20 feet thick across the NWLF Unit 2. The alluvium consists of interbedded coarser-grained sand and fine gravel with varying amounts of silt and clay interspersed within the sand and gravel. These deposits were from less than 10 feet to about 35 feet thick across the NWLF Unit 2.

The Laramie Formation is the uppermost bedrock formation underlying the NWLF Unit 2. Most of the NWLF Unit 2 soil borings advanced for the Geotechnical Investigation penetrated into the Laramie Formation. The Laramie Formation underlying the landfill is an eroded surface, occurring at varying depths below ground surface, and is characterized as a mixture of weathered claystone, siltstone, fine-grained sandstone interstratified with laterally discontinuous coal or lignite layers.

5.2.2 Structure

The lithologic cross sections illustrate a general stratigraphic dip toward the southeast. The structure within the shallow subsurface materials, as indicated by the inclination of stratigraphic contacts, is similar to the regional eastward dip of Denver Basin bedrock and the eastward slope of local surface topography. The planned base grade elevation for Unit 2

of the landfill ranges from about 9 to 24 feet below ground surface in the areas other than beneath the soil stockpile. The contact between eolian and alluvial deposits, typically marked by the presence of coarse sand and fine gravel, occurs below the planned base grade elevation in the northern portion of NWLF Unit 2 (Cross –Sections A-A', B-B', and C-C'). In the southern portion of NWLF Unit 2 (Cross-Section D-D'), part of the base grade elevation penetrates the alluvium and into the Laramie Formation.

- Cross-section, A-A - the planned excavation base grade depth remains within the eolian material.
- Cross-Section B-B' - the planned excavation base grade depth remains within the eolian material.
- Cross-Section C-C' – in the western portion of the cross-section (Borings NWE-1 and NWE-2), the planned excavation base grade extends into the coarser grained alluvial materials. Across the remainder of the section, the planned base grade is in finer-grained eolian material.
- Cross-Section D-D' – Across most of this cross-section, the planned excavation base grade depth extends into the alluvial materials. The planned base grade penetrates the alluvium and into siltstones and claystones of the uppermost portion of the Laramie Formation in the westernmost position of the section (from Boring NWE-21 to Gas Probe GP16)

5.2.3 Hydrogeology

No ground water was encountered during drilling of Geotechnical Investigation borings or test pit excavation. Piezometers were installed at borings NWE-8 and NWE-21 where an apparent increase in soil moisture was observed during drilling. The piezometers were installed with a five-feet long screen in NWE-8, set from 29 to 34 Ft BGS, and a 10-feet long screen in NWE-21, set from 66 to 76 Ft BGS. The piezometers were measured the day after installation and again about 60 days later and each time found not to contain water.

Uppermost groundwater across the NWLF area occurs within areally discontinuous water-bearing zones within eolian and alluvial deposits and the Laramie Formation (shallow zones). The uppermost, areally continuous saturated zone occurs in the Fox Hills Sandstone (deep zone). The shallower water bearing strata typically are separated from deeper water bearing strata by several feet of fine-grained materials, typically including clayey silts, silty

clays and hard siltstones or claystone layers. All water-bearing strata encountered during the Hydrogeologic Characterization Investigation (the results of which are provided in a separate report) occur below planned NWLF Unit 2 base grade level and have groundwater levels that also are below planned base grade levels in NWLF Unit 2.

5.3 Engineering Properties

The identification of the natural material to be removed from the NWLF Unit 2 serves three main purposes:

- Identify possible challenges to excavation (i.e., hard layers/rock and presence of water within or near planned base grade);
- Evaluate possible sources of cover or liner material and identify for segregation during excavation;
- Provide engineering properties of NWLF Unit 2 to the landfill designers.

5.3.1 Excavation Challenges

In general, the drilling to the planned base grade depth encountered non-indurated silts, sands, and clays. Harder drilling in indurated materials (sandstone, siltstone, and claystone) was encountered below the planned base grade depth. Split spoon and thin-wall tube samples collected near the planned base grade depth provided indication of potentially harder layers, mainly weathered siltstones and claystones. Standard penetration values exceeding 100 blows per foot were encountered below base grade, but hard, indurated soil or rock layers were encountered within the landfill footprint to the depth of excavation base grade at only a few locations. Harder drilling was encountered at or a few feet above the planned base grade depth in borings NWE-1, NWE-4, NWE-21, and NWE-22A.

5.3.2 Possible Sources of Construction Material

Soil materials excavated from above the coarser-grained (e.g., gravelly) alluvium and upper Laramie Formation could be useful for liner and final cover construction. Soil samples submitted for analyses showed behavior that could be developed during construction

indicating that materials potentially acceptable for these uses are present within the excavation footprint of NWLF Unit 2.

5.3.2.1 Liner Material

The boring logs and developed cross-sections indicate the presence of clayey silt with fine-grained sand to a typical depth of about 15 feet BGS. The permeability of the soil was evaluated for native conditions (undisturbed soil samples from below base grade depth) and remolded conditions (shallow soil from test pit grab samples). The undisturbed samples represent subgrade conditions and the compacted samples simulate liner material. The range of values from the undisturbed geotechnical boring samples was 2.1×10^{-3} to 5.2×10^{-3} cm/sec. The remolded samples from the test pits showed permeability ranging from 2.5×10^{-8} to 6.8×10^{-8} cm/sec in the western test pits (Test Pits #1 and #2), and 1.1×10^{-7} to 2.8×10^{-7} cm/sec in the eastern test pits (Test Pits #3, #4 and #5). Of interest for potential liner material is grain-size distribution and the percentage of sub #200 sieve fine-grained material. In the test pits, the western portion of the NWLF Unit 2 area appears to have more fines and less sand than the eastern portion. The fines content averaged over 80% in Pits #1 and #2, but was 40% in Pits #3 and #4. Deeper samples from borings, especially for samples from the 9 to 14 feet BGS range, have fines content averaging more than 75%. From these observations, it appears that shallow soil in the western and central part of the NWLF Unit 2 could be the best source of low permeability material suitable for liner construction; however, remolded samples from test pits in the eastern part of the NWLF Unit 2 also had permeabilities of 10^{-7} cm/sec.

5.3.2.2 Cover Material

The desired cover material will have a sand-silt-clay mixture that promotes vegetation growth. Grain-size analyses for the test pits shows a typical mixture of about 40% sand, 40% silt, and 20% clay. Shallow samples from the soil borings yield a similar average makeup.

The final cover for NWLF Unit 2 is desired to be a water balance cover with a vegetative layer. Determination of site-specific cover thickness will be based on soil gradation and physical

properties (i.e., moisture holding capacity). Two approaches are expected to be considered for determining final cover thickness: 1) a site-specific determination made by consideration of NWLF Unit 2 soil properties, including the results of soil-water characteristics testing (i.e., SWCC results) and 2) State of Colorado generic guidance for water-balance landfill covers.

The *Final Guidance Document – Water Balance Covers in Colorado* (CDPHE, 2013) includes definition of Colorado "ecozones" and a the result of generic calculations of moisture-holding characteristics summarized as a "tri-linear graph of soil texture" that uses weight percentage of clay, silt, and sand fractions to determine a potentially acceptable final cover thickness. NWLF Units 1 and 2 are located in Colorado Ecozone 3, as shown in **Figure 4** in **Appendix A**. The tri-linear graph of Water Storage Layer Thickness for Ecozone 3 is included as **Figure 5** in **Appendix A**. Considering the average soil grain-size distribution determined for NWLF Unit 2 excavated soil (i.e., 40% sand, 40% silt, and 20% clay), the determination is made that this soil plots within the zone where a 2.5 feet thick cover thickness requirement is acceptable. The Colorado guidance document suggests that blending excavated soil from the NWLF Unit 2 footprint could yield adequate material for the final cover thickness and vegetation coverage as prescribed by the guidance document.

An Alternative Demonstration derived from site-specific testing and analysis, including the SWCC results, might indicate that less soil thickness is required for a satisfactorily performing final cover, but such demonstration is outside the scope of this Geotechnical Investigation report.

APPENDIX A

FIGURES

Figure 1: Site Map and Geotechnical Investigation Locations
Figure 2: Geotechnical Investigation Locations and Cross-Section Locations
Figure 3: Planned Base Grade Elevation Map
Figure 4: Cross Section A-A'
Figure 5: Cross Section B-B'
Figure 6: Cross Section C-C'
Figure 7: Cross Section D-D'
Figure 8: Colorado Ecozone Map
Figure 9: Ecozone 3 Trilinear Graph

460500 N

459000 N

457500 N

456000 N

2190000 E

2188500 E

2187000 E

2185500 E

500'

TW-10

TW-9

TW-8

NWE-20

NWE-19

PIT-5

NWE-17

NWE-16

PIT-4

NWE-18

TW-5

TW-6

TW-1

GP-19

MW-12

MW-4

NWE-15

NWE-14

NWE-13

GP-18

NWE-22a

MW-9

NWE-12

NWE-11

NWE-10

PIT-3

NWE-9

NWE-8/TP-1

PIT-2

NWE-7

GP-17

TW-4

MW-5

NWE-6

NWE-5

NWE-4

GP-16

NWE-3

NWE-2

NWE-21/TP-2

PIT-1

NWE-1

TW-2

MW-10

MW-3

LEGEND

- SHALLOW LARAMIE WELL
- DEEP FOX HILLS WELL OR ABANDONED WELL
- PLANNED UNIT 2 LEACHATE COLLECTION SUMP
- 5100 EXISTING INDEX CONTOUR
- EXISTING UN-IMPROVED SITE ROAD
- **NWE-1** GEOTECHNICAL BORING
- **TW-1** SHALLOW TEMPORARY WELL
- **TW-2** DEEP TEMPORARY WELL
- **TP-1** TEMPORARY PIEZOMETER
- **PIT-1** TEST PIT
- **GP-16** GAS PROBE

TOPOGRAPHY AS OF FEBRUARY 21, 2016

N

TRUE NORTH

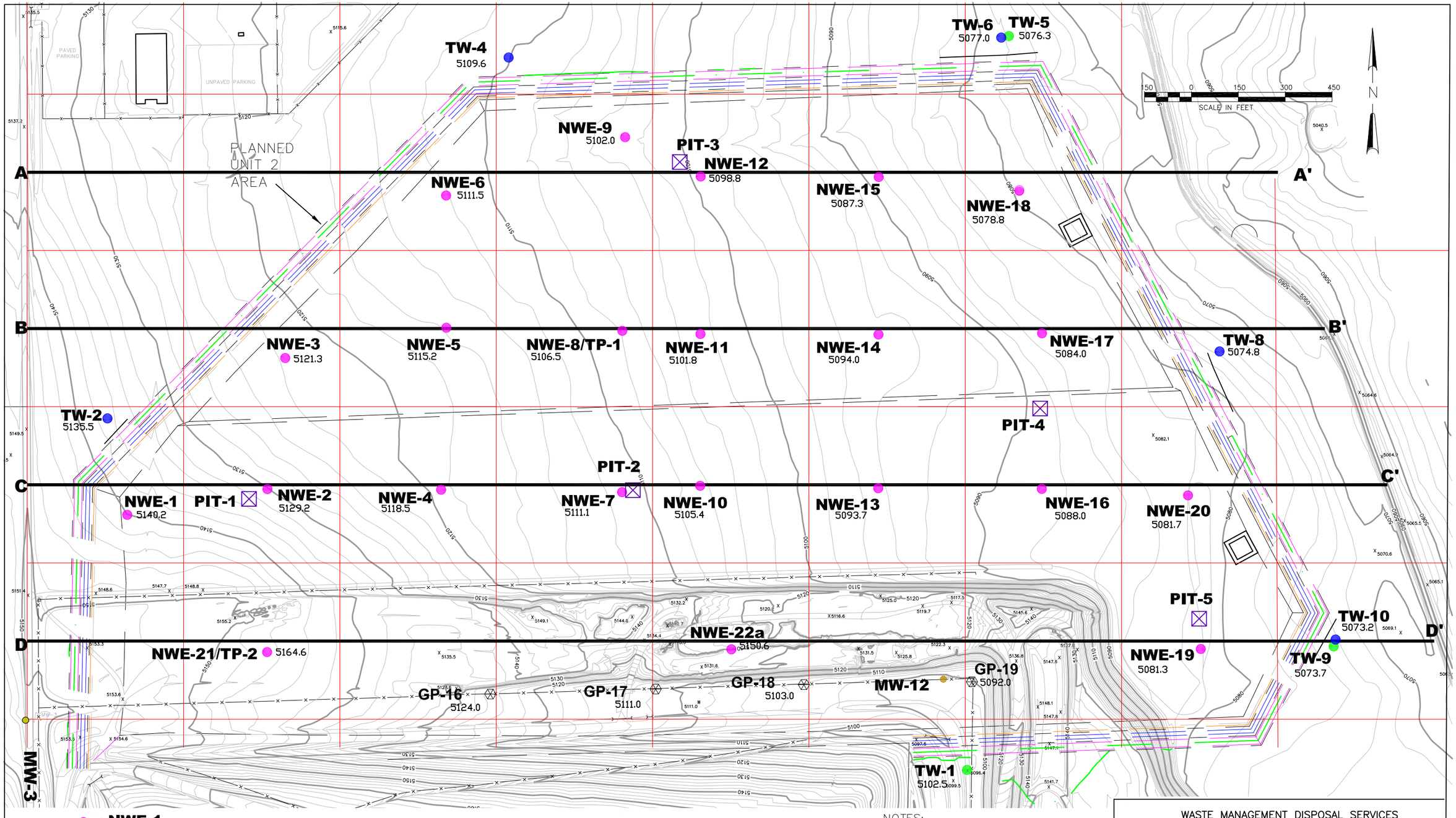
300 0 300 600 900

SCALE IN FEET

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 1
SITE MAP AND GEOTECHNICAL
INVESTIGATION LOCATIONS



- **NWE-1** GEOTECHNICAL BORING
- **TW-1** SHALLOW LARAMIE BORING/TEMPORARY WELL (3)
- **TW-2** DEEP FOX HILLS BORING/TEMPORARY WELL (5)
- PLANNED UNIT 2 LEACHATE COLLECTION SUMP
- **TP-1** TEMPORARY PIEZOMETER (2)
- **PIT-1** TEST PIT (5)
- **GP-16** GAS PROBE (4)
- 5102.0 GROUND SURFACE ELEVATION (FT USL)

NOTES:

TOPOGRAPHY AS OF 2/21/2016 (AERO-METRIC)

TOPOGRAPHIC CONTOUR INTERVAL = 2 FEET

WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 2
GEOTECHNICAL INVESTIGATION LOCATIONS AND CROSS-SECTION LOCATIONS

UNPAVED PARKING

PLANNED UNIT 2 AREA

TW-4

TW-6 TW-5

NWE-9 5092.5

PIT-3

NWE-12 5087.3

NWE-15 5079.4

NWE-18 5072.6

NWE-6 5097.7

NWE-5 5099.3

NWE-8/TP-1 5092.2

NWE-11 5089.2

NWE-14 5081.9

NWE-17 5075.1

TW-8

NWE-3 5107.4

TW-2

PIT-4

PIT-1

NWE-2 5114.0

NWE-1 5119.4

NWE-4 5106.3

PIT-2

NWE-7 5098.2

NWE-10 5095.0

NWE-13 5087.0

NWE-16 5079.7

NWE-20 5073.0

PIT-5

NWE-19 5075.2

TW-10

TW-9

NWE-21/TP-2 5113.6

NWE-22a 5094.4

GP-16

GP-17

GP-18

MW-12

GP-19

TW-1 5095.3

5070 5080 5090 5100 5110 5120

N

150 0 150 300 450

SCALE IN FEET

LEGEND

- NWE-1 GEOTECHNICAL BORING
- TW-1 SHALLOW LARAMIE BORING/TEMPORARY WELL (3)
- TW-2 DEEP FOX HILLS BORING/TEMPORARY WELL (5)
- PLANNED UNIT 2 LEACHATE COLLECTION SUMP
- TP-1 TEMPORARY PIEZOMETER (2)
- PIT-1 TEST PIT (5)
- GP-16 GAS PROBE (4)
- 5092.5 BASE GRADE ELEVATION (FT MSL)

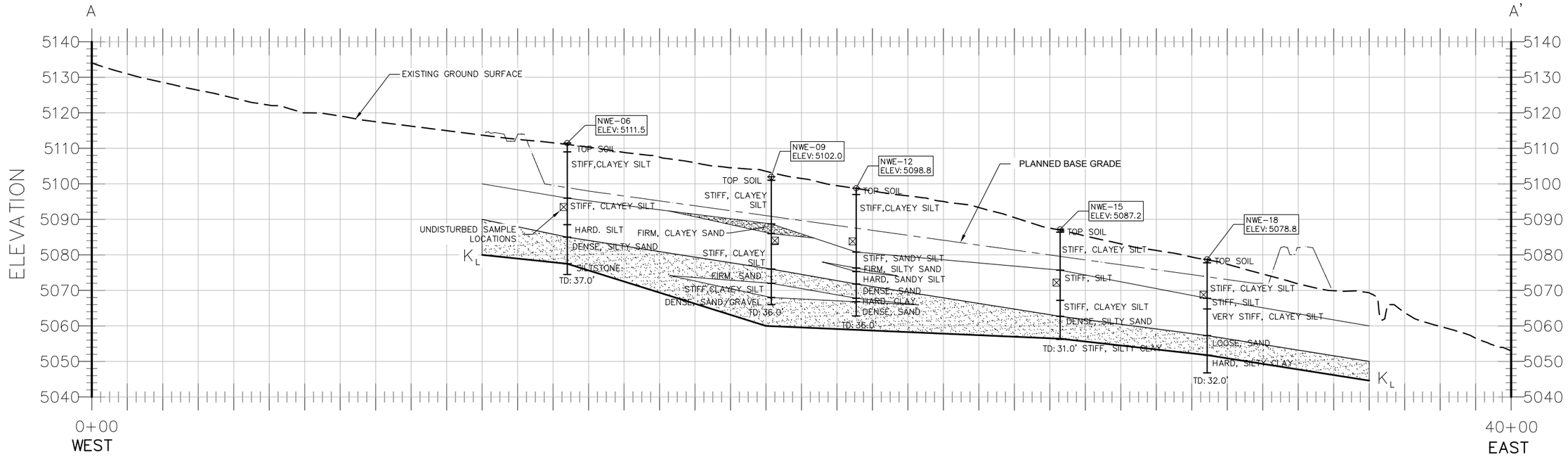
NOTE:

BASE GRADE MAP FROM WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 3
PLANNED BASE GRADE ELEVATION MAP



300 0 300 600

SCALE: 1"= 300'

VERTICAL EXAGGERATION OF 10X

LEGEND

NWE–01	Geotechnical Boring
TP–1	Temporary Piezometer
TW–1	Temporary Well
GP–16	Gas Probe

Undisturbed Sample

Groundwater Level (May 2016)

Well Screen

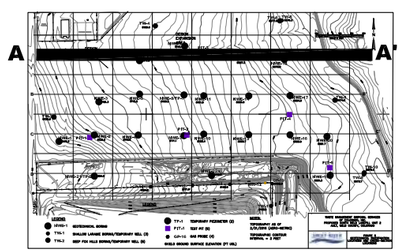
K_L = Top of Laramie FM

K_{FH} = Top of Fox Hills Sandstone

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

NOTE: See boring records for detailed description of subsurface material



See Figure 2 For Cross–Section Location

Cross–Section A–A' is aligned with east–west coordinate line 459750

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 4
CROSS–SECTION A–A'
APRIL 2016

B

B'

ELEVATION

5150 5140 5130 5120 5110 5100 5090 5080 5070 5060 5050 5040 5030 5020 5010 5000 4990 4980 4970

TW-2
ELEV: 5135.5
(PROJECTED)

EXISTING GROUND SURFACE

NWE-3
ELEV: 5121.2

NWE-5
ELEV: 5115.0

PLANNED BASE GRADE

NWE-8/TP-1
ELEV: 5106.4

NWE-11
ELEV: 5101.8

NWE-14
ELEV: 5094.0

NWE-17
ELEV: 5083.9

TW-8
ELEV: 5074.8
(PROJECTED)

TOP SOIL
STIFF, CLAYEY SILT

STIFF, SANDY SILT

FIRM, SILTY FINE SAND

K_L

HARD, CLAYSTONE

DENSE, SILTY FINE SAND
(SANDSTONE)

K_{FH}

TOP: FOX HILLS
DENSE, SANDSTONE

DENSE, BROWN SANDSTONE

K_{FH}

CLAYSTONE

MEDIUM DENSE, SILTY SAND

5014.0 (3/3/16)

TOP SOIL
FIRM, CLAYEY SILT

FIRM,CLAYEY SILT

VERY DENSE, SILTY FINE SAND

HARD, SANDY SILT

TD: 37.0'

TOP SOIL
STIFF, CLAYEY SILT

FIRM, CLAYEY SILT WITH SAND

DENSE, FINE/COARSE SAND

DENSE, SILTY SAND

TD: 38.5

UNDISTURBED SAMPLE
LOCATIONS

TOP SOIL
FIRM,
CLAYEY SILT

FIRM,
CLAYEY SILT

FIRM, SILT WITH
SAND

CLAYSTONE

TD: 38.0'

TOP SOIL
STIFF, CLAYEY SILT

STIFF, SANDY SILT

FIRM, SILT WITH SAND

HARD, SILT AND SILTSTONE

TD: 36.0'

TOP SOIL
SOFT, CLAYEY SILT

FIRM, SILTY CLAY

STIFF, SANDY SILT

FIRM, FINE/COARSE SAND

FIRM, SANDY SILT

VERY DENSE, FINE/COARSE SAND

VERY HARD, SANDY SILT

TD: 36.0'

TOP SOIL
STIFF, SILTY CLAY

STIFF, CLAYEY SILT

LOOSE, SILT FINE/COARSE SAND

STIFF, CLAYEY SILT W/ SAND LENSE

FIRM, SILT FINE/COARSE SAND

TD: 32.0'

TOP SOIL
STIFF, SILTY CLAY

FIRM, SAND W/
CLAY

STIFF, CLAYEY SILT

SILTY, FINE SAND

STIFF, SILTY CLAY

(3/4/16) 5035.8

SAND AND SILTSTONE

K_L

LIGNITE

DENSE, SILT, SILTSTONE
AND CLAYSTONE, THIN
LAYERS OF LIGNITE

CLAYEY SAND

DENSE, CLAYEY SILTS
WITH LIGNITE

TD: 104.0'

0+00
WEST

41+50
EAST

LEGEND

NWE-01	Geotechnical Boring
TP-1	Temporary Piezometer
TW-1	Temporary Well
GP-16	Gas Probe

Undisturbed Sample

Groundwater Level (May 2016)

Well Screen

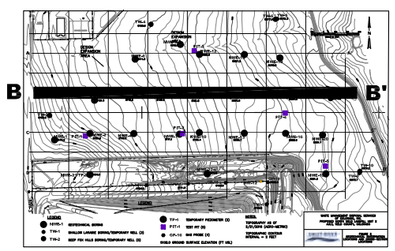
K_L = Top of Laramie FM

K_{FH} = Top of Fox Hills Sandstone

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

NOTE: See boring records for detailed description of subsurface material



See Figure 2 For Cross-Section Location

Cross-Section B-B' is aligned with east-west coordinate line 459250

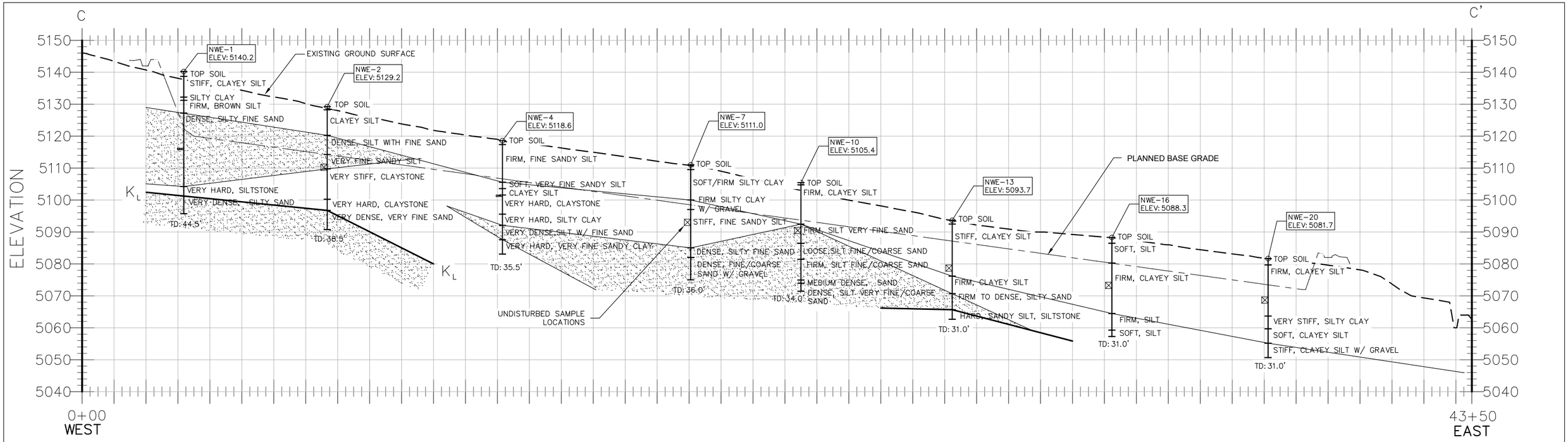
300 0 300 600

SCALE: 1"= 300'
VERTICAL EXAGGERATION OF 10X

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

FIGURE 5
CROSS-SECTION B-B'
APRIL 2016



300 0 300 600

SCALE: 1"= 300'

VERTICAL EXAGGERATION OF 10X

LEGEND

NWE-01	Geotechnical Boring
TP-1	Temporary Piezometer
TW-1	Temporary Well
GP-16	Gas Probe

Undisturbed Sample

Groundwater Level (May 2016)

Well Screen

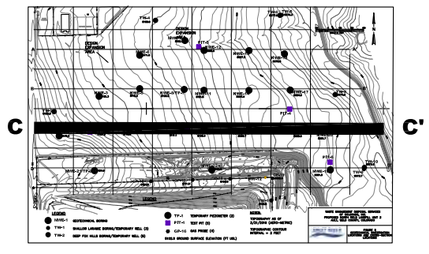
K_L = Top of Laramie FM

K_{FH} = Top of Fox Hills Sandstone

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

NOTE: See boring records for detailed description of subsurface material



See Figure 2 For Cross-Section Location

Cross-Section C-C' is aligned with east-west coordinate line 458750

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 6
CROSS-SECTION C-C'
APRIL 2016

D

D'

ELEVATION

5180
5170
5160
5150
5140
5130
5120
5110
5100
5090
5080
5070
5060
5050
5040
5030
5020
5010
5000

NWE-21/TP-2
ELEV: 5164.6

SOIL STOCK PILE

BROWN CLAY AND SILT
LOOSE, FINE/COARSE SAND

K_L

STIFF, CLAYEY SILT (SILTSTONE)

HARD CLAYSTONE

UNDISTURBED SAMPLE LOCATIONS

VERY DENSE, SILTY SAND

TD: 76.0'

MW-11
ELEV: 5126.0

SILTY VERY FINE SAND

SILTY COARSE SAND

SILTSTONE AND CLAYSTONE

TD: 159.0'

GP-16
ELEV: 5124.0
(ABANDONED)

CLAY

SAND

SILTSTONE

SAND AND CLAYSTONE

TD: 40.0'

SOIL STOCK PILE

GP-17
ELEV: 5111.4

CLAY

SAND

COAL

TD: 30.0'

NWE-22A
ELEV: 5150.5

DENSE SAND

STIFF TO HARD SILTSTONE

VERY HARD CLAYSTONE

VERY DENSE SANDSTONE

VERY HARD SILTSTONE

TD: 80.0'

GP-18
ELEV: 5103.3

CLAY

SAND

TD: 30.0'

SOIL STOCK PILE

TW-1
ELEV: 5102.5
(PROJECTED)

SILTY CLAY

CLAYEY SILT

SILTY SAND

FINE/COARSE SAND

SILTY SAND

CLAYSTONE

TD: 49.4'

GP-19
ELEV: 5092.0

CLAY

SAND

TD: 40.0'

EXISTING GROUND SURFACE

BASE OF STOCKPILE

PLANNED BASE GRADE

NWE-19
ELEV: 5081.3

SOFT, CLAYEY SILT

FIRM, CLAYEY SILT

STIFF, SANDY SILT

TD: 31.0'

TW-10
ELEV: 5073.2

FIRM, SILTY CLAY

FIRM, CLAYEY SAND

K_L

STIFF CLAY

TD: 98.5'

0+00
WEST

45+00
EAST

300 0 300 600

SCALE: 1"= 300'
VERTICAL EXAGGERATION OF 10X

LEGEND

NWE-01 Geotechnical Boring
TP-1 Temporary Piezometer
TW-1 Temporary Well
GP-16 Gas Probe

Undisturbed Sample

Groundwater Level (May 2016)

Well Screen

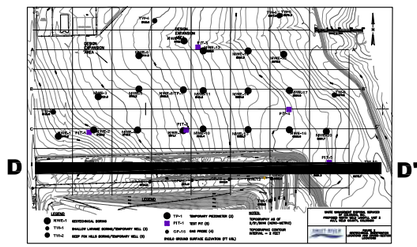
K_L = Top of Laramie FM

K_{FH} = Top of Fox Hills Sandstone

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

NOTE: See boring records for detailed description of subsurface material



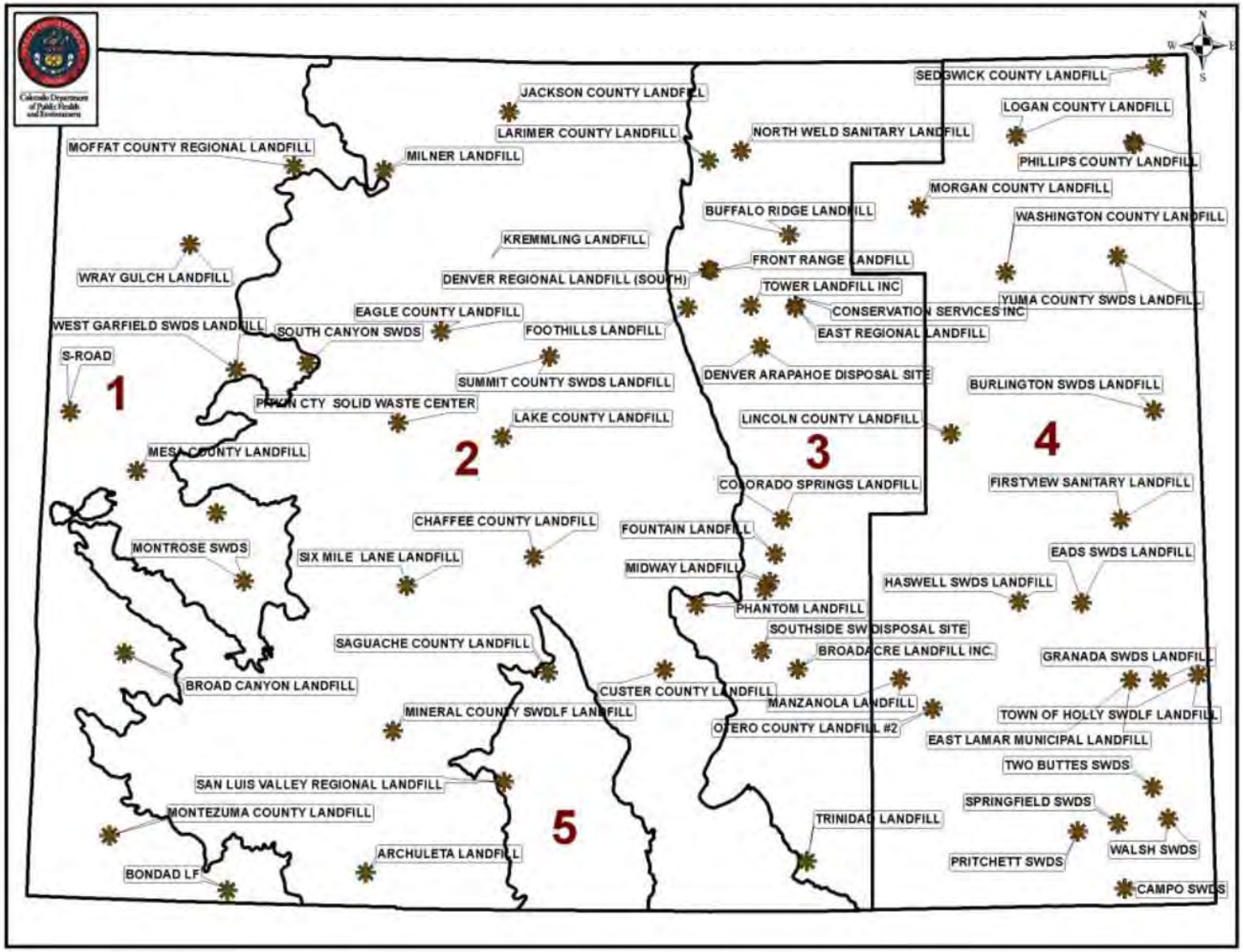
See Figure 2 For Cross-Section Location

Cross-Section D-D' is aligned with east-west coordinate line 458250

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

FIGURE 7
CROSS-SECTION D-D'
APRIL 2016

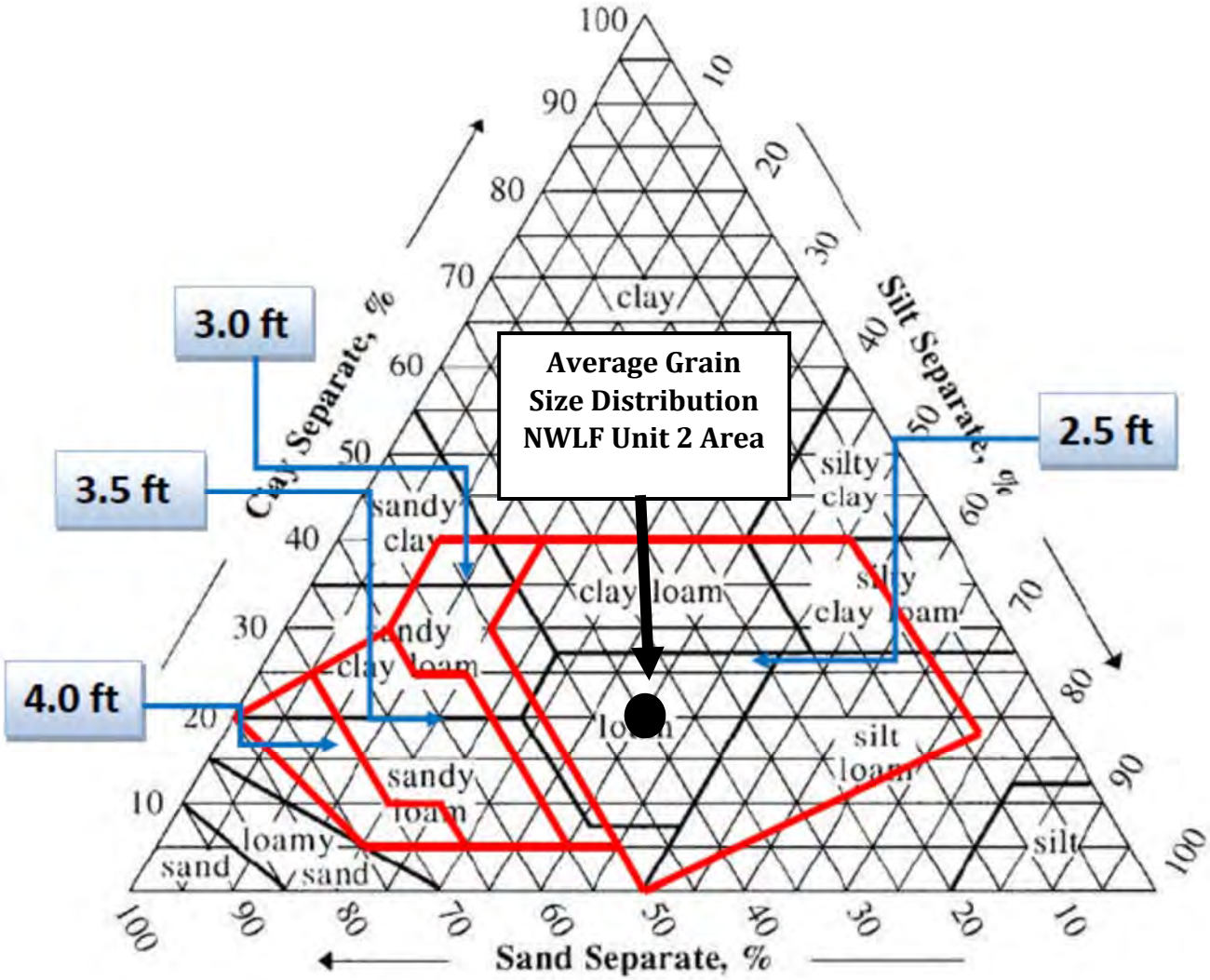


SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

From: *Final Guidance Document, Water Balance Covers in Colorado, March 2013*

Figure 8

Colorado Landfill Ecozone Map



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC	From: *Final Guidance Document, Water Balance Covers in Colorado, March 2013*	Figure 9 Ecozone Tri-Linear Graph

APPENDIX B

TABLES

Table 1: Estimated Elevations and Drilling Depths
Table 2: Boring Details
Table 3: Piezometer Details
Table 4: Test Pit Details
Table 5: Soil Test Summary
Table 6: Compaction Test Results
Table 7: Consolidation Test Results
Table 8: Direct Shear Test Results
Table 9: Triaxial Shear Test Results
Table 10: Permeability Test Results
Table 11: Soil Water Characteristic Curve Results
Table 12: Agricultural Parameters Results
Table 13: Cation Exchange Capacity Results

TABLE 1

Estimated Elevations and Drilling Depths

Boring Number	Approximate Ground Elevation (Ft MSL)	Top of Liner Elevation from 2012 Base Grade (Ft MSL)	Base of Liner Elevation Assume 3-Feet Thick Soil Liner (Ft MSL)	Approximate Depth to Base of Liner from Ground Surface (Ft BGS)	Target Boring Depth (Base of Liner + 20 Feet) (Ft BGS)	Explanation
NWE-01	5139	5118	5115	24	44	
NWE-02	5129	5114	5111	18	38	
NWE-03	5121	5107	5104	17	37	
NWE-04	5120	5108	5105	15	35	
NWE-05	5116	5101	5098	18	38	
NWE-06	5112	5098	5095	17	37	
NWE-07	5113	5100	5097	16	36	
NWE-08	5109	5094	5091	18	38	
NWE-09	5105	5093	5090	15	35	
NWE-10	5103	5094	5091	12	32	
NWE-11	5100	5088	5085	15	35	
NWE-12	5097	5086	5083	14	34	
NWE-13	5094	5087	5084	10	30	
NWE-14	5094	5082	5079	15	35	
NWE-15	5087	5079	5076	11	31	
NWE-16	5088	5080	5077	11	31	
NWE-17	5084	5075	5072	12	32	
NWE-18	5079	5073	5070	9	29	
NWE-19	5081	5075	5072	9	29	
NWE-20	5082	5074	5071	11	31	
NWE-21	5165	5113	5110	55	75	On soil stockpile along NWLF north side
NWE-22	5140	5100	5097	43	63	On soil stockpile along NWLF north side
NWE-22a	5150	5094	5091	59	79	On soil stockpile along NWLF north side
NWE-22b	5158	5107	5104	54	74	On soil stockpile along NWLF north side
NWE-23	5140	5088	5085	55	75	On soil stockpile along NWLF north side

Notes: Ft MSL = Elevation in feet above mean sea level
Ft BGS = Feet below ground surface

TABLE 2

Boring Details

Boring Number	Ground Surface Elevation at Planned Boring Location (Ft MSL)	Ground Surface Elevation at Actual Boring Location (Ft MSL)	Top of Liner Elevation at Actual Boring Location (Ft MSL)	Base Grade Elevation at Actual Boring Location (Ft MSL)	Depth to Base Grade from Ground Surface at Actual Boring Location (Ft BGS)	Actual Drilled Boring Depth (Ft BGS)	Undisturbed Sample Depth (Ft BGS)
NWE-01	5139	5140	5119	5116	24	44.5	24-24.5
NWE-02	5129	5129	5114	5111	18	38.5	18-20
NWE-03	5121	5121	5107	5104	17	37	17-19
NWE-04	5120	5119	5106	5103	15	35.5	17-17.7
NWE-05	5116	5115	5099	5096	19	38.5	18-20
NWE-06	5112	5112	5098	5095	17	37	17-19
NWE-07	5113	5111	5098	5095	16	36	17-19
NWE-08	5109	5107	5092	5089	17	38	18-20
NWE-09	5105	5102	5093	5090	13	36	17-19
NWE-10	5103	5105	5095	5092	13	34	14-16
NWE-11	5100	5102	5089	5086	16	36	17-19
NWE-12	5097	5099	5087	5084	15	36	14-16
NWE-13	5094	5094	5087	5084	10	31	14-16
NWE-14	5094	5094	5082	5079	15	36	17-19
NWE-15	5087	5087	5079	5076	11	31	14-16
NWE-16	5088	5088	5080	5077	11	31	14-16
NWE-17	5084	5084	5075	5072	12	32	14-16
NWE-18	5079	5079	5073	5070	9	32	9-11
NWE-19	5081	5081	5075	5072	9	31	9-11
NWE-20	5082	5082	5073	5070	12	31	12-14
NWE-21	5165	5165	5114	5111	54	76	57-59
NWE-22a	5150	5151	5094	5091	59	80	59-59.25

Notes: Elevations are estimated from NWLF Expansion Area topographic map
Base Grade Elevation is based on assumption of 3-feet thick soil liner system
Ft MSL = Elevation in feet above mean sea level
Ft BGS = Feet below ground surface

TABLE 3

Piezometer Details

Piezometer	Boring	Date Drilled	Depth Drilled (Ft BGS)	Well Bottom (Ft BGS)	Screen Bottom (Ft BGS)	Screen Top (Ft BGS)	Sand Pack Top (Ft BGS)	Bentonite Pellet Seal Top (Ft BGS)	Annular Seal
TP-01	NWE-08	2/17/2016	38	34	34	29	27	25	Bentonite chips to surface
TP-02	NWE-21	2/18/2016	76	76	76	66	64	62	Bentonite chips to surface

Note: Ft BGS = feet below ground surface
Bentonite pellet seal hydrated, bentonite chips to ground surface not hydrated

TABLE 4

Test Pit Details

Test Pit	Depth (ft bgs)	Date Excavated	Description	Notes
1	2-4	3/22/2016	Clayey silt	Selected for modified Proctor and permeability testing as possible LINER material and for CEC testing
	5-7	3/22/2016	Silty clay	Not tested
2	3-5	3/22/2016	Clayey silt	Not tested
	5-9	3/22/2016	Silty clay	Selected for modified Proctor and permeability testing as possible LINER material and for CEC testing
3	3-5	3/22/2016	Silt, clayey silt	Selected for modified Proctor testing as possible COVER material and Agricultural Parameters testing
	5-10	3/22/2016	Silty clay	Selected for permeability testing as possible LINER material
4	2-6	3/22/2016	Silty clay	Selected for modified Proctor testing as possible COVER material and Agricultural Parameters, and permeability testing as possible LINER material
	6-12	3/22/2016	Clayey silt	Selected for testing as possible COVER material, Agricultural Parameters and SWCC testing
5	2-6	3/22/2016	Clayey silt/silty clay	Selected for permeability testing as possible LINER material
	6-10	3/22/2016	Clayey silt	Selected for testing as possible COVER material, Agricultural Parameters and SWCC testing

Notes: CEC = Cation Exchange Capacity
Agricultural Parameters = pH, Sodium Adsorption Ratio (SAR), Electrical Conductance (EC) and Total Organic Carbon (TOC)
SWCC = Soil Water Characteristic Curve

TABLE 5
Soil Test Summary

Sample Location	Sample Depth (Ft BGS)	Sample Type	USCS	USDA Textural Class	Moisture Content (%)	Percent Retained					Plastic Limit	Liquid Limit	Plasticity Index
						Gravel	Sand	Sub #200 Sieve	Silt (estimate)	Clay (estimate)			
NWE-01	19-24	Continuous	SM	Sandy Loam	8.2	0.0	77.5	22.4	13.4	9	NP	NP	NP
NWE-02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-03	24-29	Continuous	SM	Sandy Loam	5.9	0.0	65.4	34.6	25.6	9	NP	NP	NP
NWE-04	9-14	Continuous	CL	Loam	10.2	0.3	38.0	61.6	40.6	21	14	34	20
NWE-05	9-14	Continuous	CL	Silt Loam	14.5	0.1	21.4	78.6	53.6	25	13	34	21
NWE-06	9-14	Continuous	CL	Silt Loam	14.0	0.0	13.7	86.4	60.4	26	14	35	21
NWE-07	14-17	Continuous	CL	Sandy Clay Loam	11.1	0.4	47.1	52.5	27.5	25	12	29	17
NWE-07	17-19	UD	CL	Loam/Clay Loam	NM	0.3	39.6	60.1	33.1	27	15	28	13
NWE-08	18-20	UD	CL	Clay Loam	NM	0.1	44.1	55.8	23.8	32	14	28	14
NWE-09	17-19	UD	SC	Sandy Loam/Sandy Clay Loam	NM	0.7	61.4	38.0	18.0	20	NP	NP	NP
NWE-10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-12	14-16	UD	CL	Loam	NM	1.5	41.4	57.1	40.1	17	12	29	17
NWE-13	9-14	Continuous	CL	Silt Loam	13.3	0.0	15.8	84.2	61.2	23	14	33	19
NWE-14	9-14	Continuous	CL	Silt Loam	12.8	0.0	20.5	79.6	55.6	24	14	34	20
NWE-14	17-19	UD	CL	Clay Loam	14.1	0.0	30.3	69.7	33.7	36	15	34	19
NWE-15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-16	14-16	UD	CL	Silt Loam	NA	0.0	24.5	75.5	55.5	20	15	30	15
NWE-17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-20	9-12	Continuous	CL	Silt Loam	14.1	0.0	19.8	80.2	54.2	26	13	33	20
NWE-21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NWE-22A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Test Pit #1	2-4	Grab	CL	Silt Loam	NM	0.5	18.6	81.0	62.0	19	14	36	22
Test Pit #2	5-9	Grab	CL	Silt Loam	NM	0	18.2	81.8	57.8	24	13	35	22
Test Pit #3	3-5	Grab	CL	Loam	NM	0	46.7	53.3	34.3	19	16	29	13
Test Pit #4	2-6	Grab	SC/SM	Sandy Loam	NM	0	73.8	26.2	9.2	17	NP	NP	NP
Test Pit #5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Average Values (Test Pits #1-#2)	0.2	18.4	81.4	59.9	21.5	13.5	35.5	22.0
Average Values (Test Pits #3-#4)	0.0	60.2	39.8	21.8	18.0	16.0	29.0	13.0
Average Values (Test Pits #1-#4)	0.1	39.3	60.6	40.8	19.8	14.3	33.3	19.0
Average Values (NWE-1 through NWE-22A borings)	0.2	37.4	62.4	39.7	22.7	13.7	31.8	18.0

Notes: Ft BGS = feet below ground surface
Continuous = Disturbed grab sample from 5-foot continuous core sampler
USCS = Unified Soil Classification System
PCF = pounds per cubic foot
NA = Not Analyzed NM = Not Measured NP = Non-Plastic
Clay percentage estimated from grain size graph; silt percentage calculated from (fines%-clay%)
UD = Undisturbed soil sample (thin-wall tube)
Grab = Grab sample from backhoe bucket

TABLE 6

Compaction Test Results

Sample Location	Sample Depth (Ft BGS)	Optimum Moisture Content (%)	Maximum Dry Density (PCF)
Test Pit #1	2-4	13.1	119.0
Test Pit #2	5-9	12.1	122.2
Test Pit #3	3-5	11.6	121.8
Test Pit #4	2-6	11.2	120.3
Average		**12.0**	**120.8**

Notes: Test performed by Modified Proctor Test ASTM D-1557, Method A
Ft BGS = feet below ground surface
PCF = pounds per cubic feet

TABLE 7

Consolidation Test Results

Overconsolidation Ratio (OCR)							
Sample Location	**Sample Depth (Ft BGS)**	**Sample Type**	**Wet Density (PCF)**	**Overburden Depth (ft BGS)**	**Present Effective Overburden Pressure (PSF)**	**Preconsolidation Pressure (PSF)**	**OCR**
NWE-8	18-20	UD	107.6	19	2044	2138	1.05
NWE-16	14-16	UD	90.8	15	1362	1412	1.04

Compression Index (Cc)							
Sample Location	**Sample Depth (ft BGS)**	**Sample Type**	**Liquid Limit**	**Method**			**Average**
				Slope void ratio plot	**Skempton**	**Low Plasticity Soil**	
NWE-8	18-20	UD	28	0.22	0.162	0.158	0.18
NWE-16	14-16	UD	30	0.21	0.180	0.338	0.24

Swell Index (Cs)							
Sample Location	**Sample Depth (ft BGS)**	**Sample Type**	**Liquid Limit**	**Method**			**Range**
				1/10 Cc	**1/5 Cc**	**Nagaraj and Murty**	
NWE-8	18-20	UD	28	0.018	0.036	0.034	0.018-0.036
NWE-16	14-16	UD	30	0.024	0.048	0.037	0.024-0.048

Notes: Test performed by ASTM D-2435, Method B
Ft BGS = feet below ground surface
UD = Undisturbed sample PCF = Pounds per cubic foot PSF = Pounds per square foot
OCR = Overconsonsolidation Ratio Cc = Compression Index Cs = Swell Index

Geotechnical Criteria from Das (2002), Principles of Geotechnical Engineering
Slope void ratio plot = Method to calculate Compression Index from Das (2002)
Skempton = Skempton (1944) method to calculate Cc, presented in Das (2002)
Low Plasticity Soil = Method to calculate Cc from Das (2002)
Nagaraj and Murty = Nagaraj and Murty (1985) method to calculate Cs, presented in Das (2002)
1/10 Cc and 1/5 Cc = Method to calculate Swell Index from Das (2002)

TABLE 8

Direct Shear Test Results

Sample Location	Sample Depth (Ft BGS)	Sample Type	Remolding Parameters			Peak Shear Stress Friction Angle	Peak Shear Stress Cohesion (PSF)	Utimate Shear Stress Friction Angle	Ultimate Shear Stress Cohesion (PSF)
			% Maximum Dry Density	% Deviation from Optimum Moisture Content	Normal Stress Loads				
Test Pit #2	5-9	Grab	97	2.5% below	25, 50, 100 PSI	26.4°	905.2	27.0°	540.7
Test Pit #3	3-5	Grab	85	2.5% below	1, 2, 4 KSF	29.9°	157.0	30.5°	108.0

Notes: Test performed by ASTM D-3080
Ft BGS feet below ground surface
PSF = pounds per square foot
PSI = pounds per square inch
KSF = kips per square foot

TABLE 9
Triaxial Shear Test

Sample Location	Sample Depth (Ft BGS)	Sample Type	Laboratory Test Sample	Stress Condition at Maximum Deviator Stress (PSF)							
				σ_3	σ_1	σ'_3	σ'_1	c	$\theta_{undrained}$	c'	$\theta_{drained}$
NWE-09	17-19	UD	A	11,520	20,827	3,273	12,580	0	16.7	0	36.0
			B	5,760	9,160	1,138	4,538	0	13.2	0	36.8
			C	2,880	5,257	1,037	3,414	0	17.0	0	32.3
NWE-14	17-19	UD	A	11,520	18,181	3,970	10,631	0	13.0	0	27.1
			B	5,760	9,416	2,736	6,392	0	13.9	0	23.6
			C	2,880	4,980	1,238	3,338	0	15.5	0	27.3

Notes: Test performed by ASTM D-4767
ft BGS = feet below ground surface
psf = pounds per square foot
UD=Undisturbed

TABLE 10
Permeability Test Results

Sample Location	Sample Depth (Ft BGS)	Sample Type	USCS	Initial Moisture Content (%)	Initial Wet Density (PCF)	Initial Dry Density (PCF)	Permeability (cm/sec)
NWE-7	17-19	UD	CL	10.8	101.1	91.3	5.2×10^{-3}
NWE-12	14-16	UD	CL	11.2	100.3	90.1	2.1×10^{-3}
Test Pit #1	2-4	Remolded	CL	15.4	131.3	113.8	2.5×10^{-8}
Test Pit #2	5-9	Remolded	CL	14.4	135.3	118.2	6.8×10^{-8}
Test Pit #3	5-10	Remolded	CL*	14.2	133.0	116.4	1.1×10^{-7}
Test Pit #4	2-6	Remolded	SC/SM	13.5	130.9	115.3	2.8×10^{-7}
Test Pit #5	2-6	Remolded	CL/ML*	14.4	133.5	116.7	1.3×10^{-7}

Notes: Permeability test performed by ASTM D-5084, Method D

Ft BGS = Feet below ground surface
UD=Undisturbed sample
USCS = Unified Soil Classification System
PCF = pounds per cubic foot
cm/sec = centimeters per second
* = USCS based on visual description

TABLE 11

Soil Water Characteristic Curve

Location	Depth (Ft BGS)	Type	Van Genuchten Parameters			θ_r	θ_s	Wilting Point	Field Capacity
			alpha	n	m				
Test Pit #4	6-12	Remolded	0.01	1.22482	0.18355	0.0	0.377	0.122	0.284
Test Pit #5	6-10	Remolded	0.006	1.24000	0.19355	0.0	0.408	0.144	0.313

Notes: Test performed by ASTM D-6836
Ft BGS - Feet below ground surface
van Genuchten parameters in centimeters

TABLE 12
Agricultural Parameters Results

Sample Location	Sample Depth (Ft BGS)	Sample Type	Moisture Content (%)	Soil pH	Sodium Adsorption Ratio	Specific Conductance (umhos/cm)	Total Organic Carbon (g/Kg)
Test Pit #3	3-5	Cover Material	8.9	9.1	ND	390	ND
Test Pit #4	2-6	Cover Material	8.3	9.1	ND	330	ND
	6-12	Cover Material	11.3	9.1	2.5	400	ND
Test Pit #5	6-10	Cover Material	11.5	9.3	4.2	550	ND

Notes: Sodium adsorption ratio by USDA Method 20B
Specific conductance by Method SW-846 9050A
Ft BGS=feet below ground surface
umhos/cm= micromhos per centimeter

TABLE 13
Cation Exchange Capacity Results

Sample Location	Sample Depth (Ft BGS)	Sample Type	Moisture Content (%)	Cation Exchange Capacity (meq/100 gram)
NWE-4	14-17	Liner Material	6.9	8.9
NWE-8	14-18	Liner Material	7.7	9.9
NWE-12	9-14	Liner Material	12.6	15.0
NWE-17	9-14	Liner Material	12.3	14.0
NWE-4	17-19	Subgrade	23.2	11.0
NWE-8	19-24	Subgrade	9.1	10.0
NWE-12	14-19	Subgrade	11.5	10.0
NWE-17	16-18	Subgrade	10.1	12.0
Test Pit #1	2-4	Liner Material	13.6	17.0
Test Pit #2	5-9	Liner Material	12.5	15.0

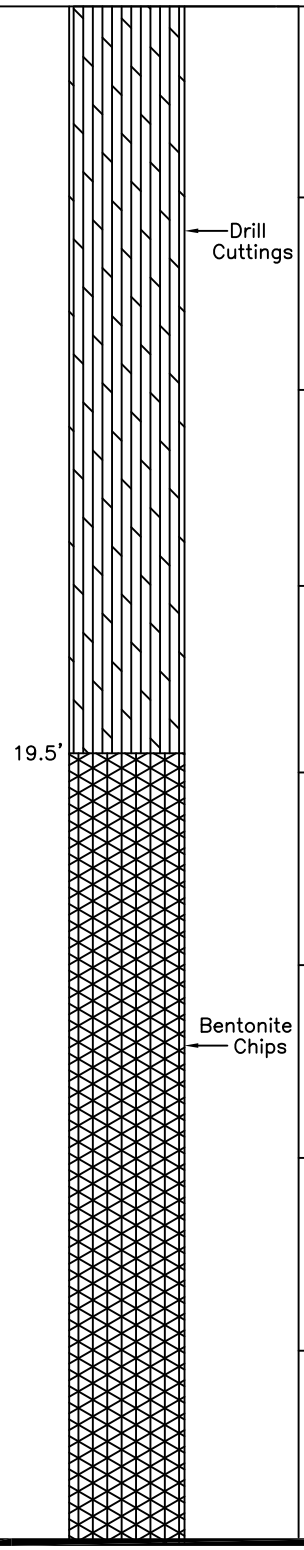
Notes: Cation Exchange Capacity performed by Method SW-846 9081
Ft BGS=feet below ground surface
meq/100 gram = milliequivalents per 100 grams of dry soil

APPENDIX C

BORING LOGS

PIEZOMETER & WELL INSTALLATION RECORDS

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5140.2'						
0	TOPSOIL: SOFT, brown (10YR 5/4), clayey SILT with roots, moist	CL/ ML					
1.5	Stiff, brown (10YR 5/4), clayey SILT with very fine–grained sand, damp	CL			48"	NO	
5					32"	NO	
8.0	Stiff, brown (10YR 5/4), silty CLAY, damp						
9.0	Firm, brown (10YR 6/6), silt with very fine–grained SAND, minor clay, damp	SM			36"	NO	
10							
13.0	Dense, grayish–orange to brown, silty fine–grained SAND, with fine gravel, damp				60"	NO	
15							
20					54"	NO	
23.0	Dense to very dense, gray (5YR 7/2), silty very fine–grained SAND, damp				6"		
25					6"		50/5
					40"	NO	
30					10"		50/6
					46"	NO	
35	TOP OF LARAMIE FM				6"		50/6
36.0	Hard, light brown (10YR 6/2), weathered SILTSTONE, laminated, friable, damp	CL			36"	NO	
39.0							
40	See page 2 for description				10"		50/4



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

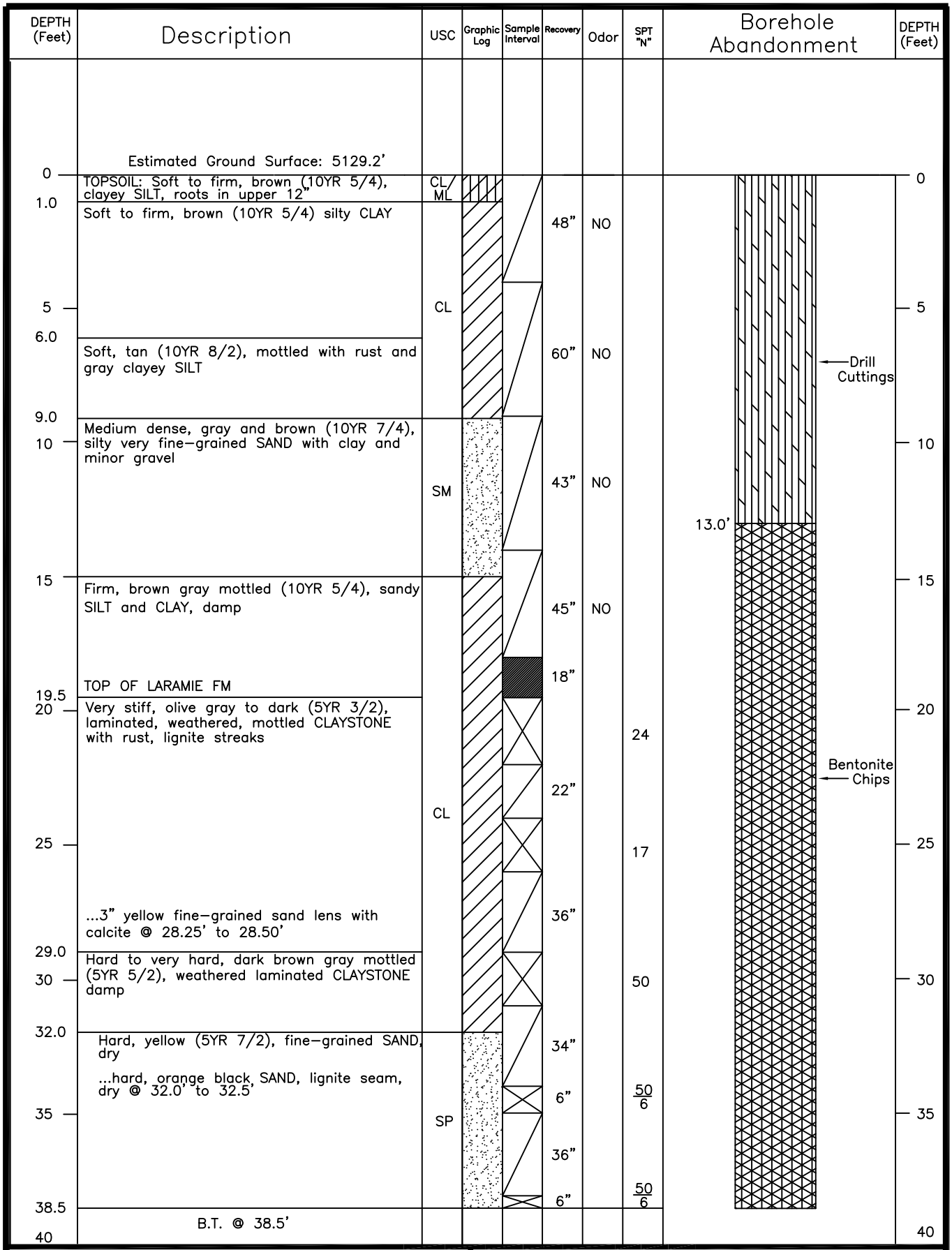
Location NWE–01
Coordinates: N 458654, E 2185896
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By CRS
Installation Date February 10, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
40	Very dense, brown gray (5YR 6/4), very fine–grained silty SAND, with hard weathered SILTSTONE fragments	SM			50"	NO	50/4	Bentonite Chips	40
45	B.T. @ 44.5'								45
50									50
55									55
60									60
65									65
70									70
75									75
80									80

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–01
Coordinates: N 458654, E 2185896
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By CRS
Installation Date February 10, 2016



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-02
Coordinates: N 458736, E 2186344
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 10, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5121.3'						
0	TOPSOIL: Firm, brown (10YR 5/4), silty CLAY with roots, damp	CL/ ML					
1.0	Firm, brown (10YR 5/4), clayey SILT				48"	NO	
5					60"	NO	
10		CL			58"	NO	
12.5	Firm, brown (10YR 5/4), SILT with clay, minor fine to coarse grained sand, damp						
15					36"	NO	
19.0							
20	Very dense, brown (10YR 5/4) to tan (10YR 7/4), silty very fine-grained SAND with some fine gravel, damp	SM			15"	NO	50/5
					36"		
25					6"		50/6
27.0	TOP OF LARAMIE FM						
	Hard, tan (10YR 7/4), very fine sandy SILT, friable layers, damp				36"		
30		CL			3"		50/3
					36"		
35	...weathered shale layer with rust-color mottling from 34.5' to 34.75'						50/6
37.0	B.T. @ 37.0'						
40							

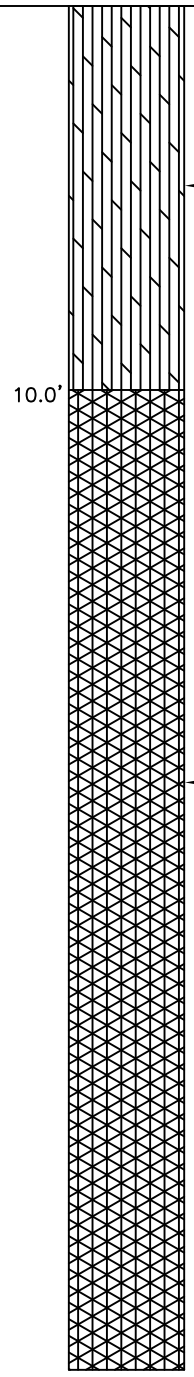
Borehole Abandonment	DEPTH (Feet)
	0
	5
Drill Cuttings	10
12.0'	15
	20
Bentonite Chips	25
	30
	35
	40

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-03
Coordinates: N 459156, E 2186401
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 16, 2016

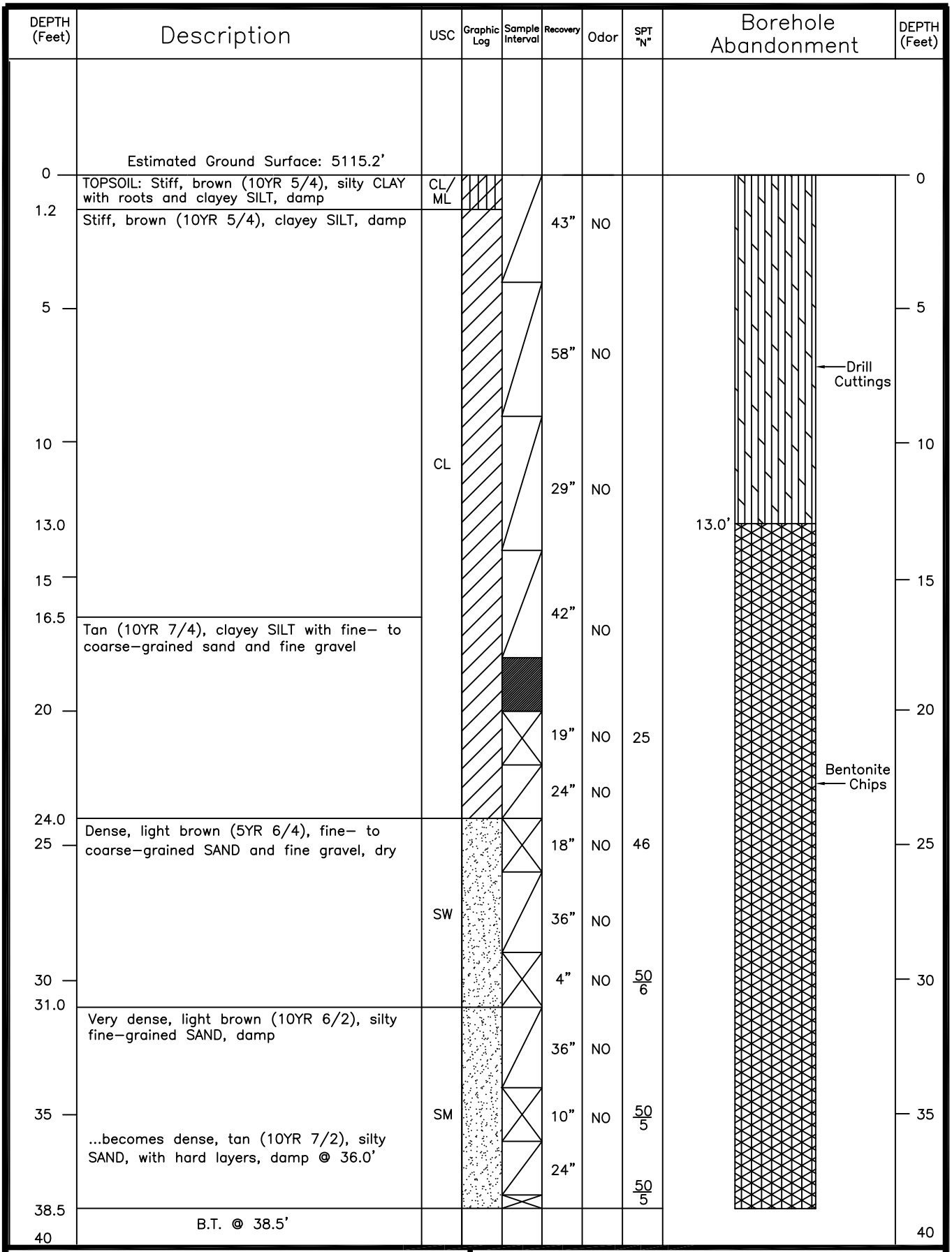
DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5118.5'						
0	TOPSOIL: Soft, brown (10YR 5/4), clayey SILT with roots, moist						
1.2	Medium dense, light brown, very fine–grained sandy SILT, damp	CL			46"	NO	
5					60"	NO	
10					60"	NO	
13.0	Soft, tan, SILT and silty SAND with laminations, damp	SM					
15	Soft, orange gray, clayey SILT	CL			36"	NO	
	TOP OF LARAMIE FM				8"		
17.0	Hard to very hard, tan (10YR 7/4) with rust–color staining, laminated weathered CLAYSTONE				16"		
20					6"	NO	50/4
					48"		
23.0	Purple and gray, silty CLAY with rust–color staining				12"		50/6
25							
26.5	Very dense, tan (10YR 7/4), silty, very fine–grained SAND, damp	SM			48"		
30					10"		50/5
31.0	Very hard, brown gray (10YR 6/2), very fine–grained sandy CLAY, damp	CL			44"		
35					16"		50/5
35.5	B.T. @ 35.5'						
40							



SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–04
Coordinates: N 458734, E 2186900
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 11, 2016

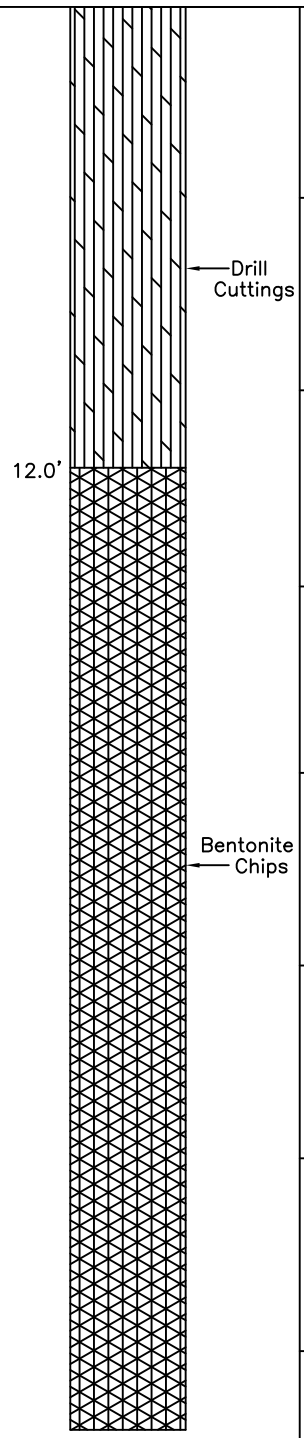


SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–05
Coordinates: N 459253, E 2186916
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 16, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5111.5'						
0	TOPSOIL: Firm, brown (10YR 5/4), silty CLAY and clayey SILT, with roots, damp	CL/ ML			42"	NO	
2.5	Stiff, brown (10YR 5/4), clayey SILT, damp	CL			58"	NO	
5							
10					43"	NO	
15					32"	NO	
15.5	Firm, brown (10YR 5/4), SILT with medium– to coarse–grained sand, damp						
20					12"	NO	8
23.0	Hard, tan (10YR 7/4), SILT with fine– to coarse–grained sand and fine gravel, gypsum, damp				32"		
25					10"		50/5
26.5	Very dense, tan (10YR 7/4), silty fine–grained SAND with hard layering, damp	SM			33"		
30					6"		50/6
	TOP OF LARAMIE FM				36"		
34.0	Very hard, brown (10YR 5/4), sandy SILT (SILTSTONE), dry	CL					50/5
35							
37.0	B.T. @ 37.0'						
40							



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–06

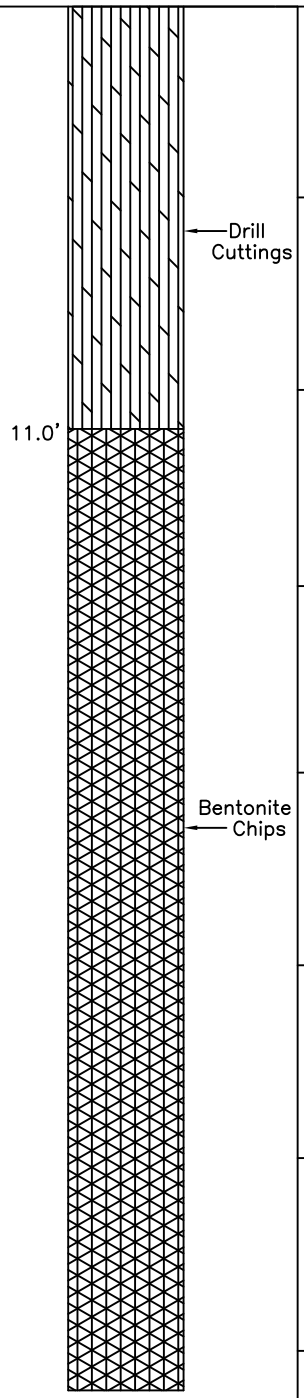
Coordinates: N 459676, E 2186916

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 17, 2016

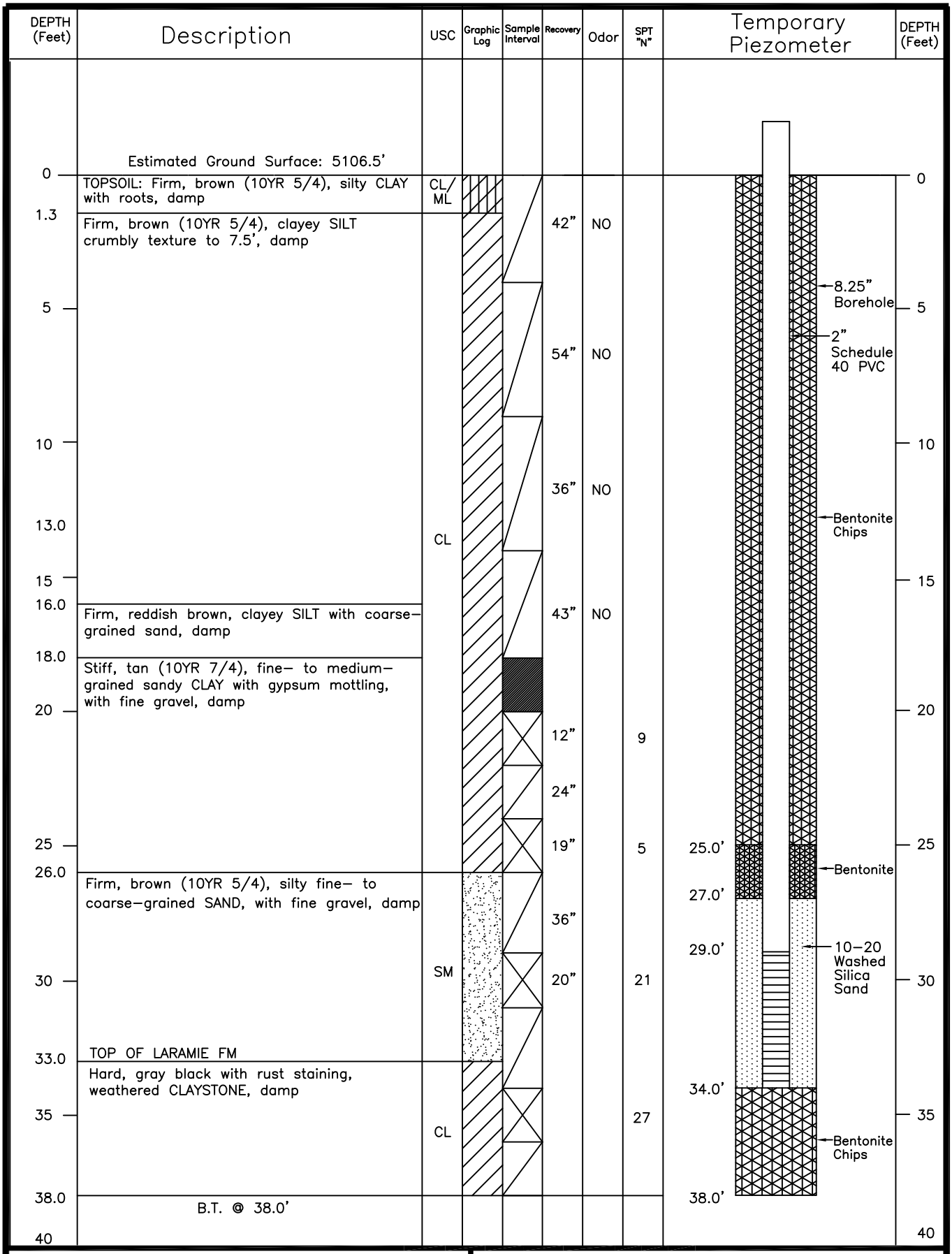
DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5111.1'						
0	TOPSOIL: Firm, brown (10YR 5/4), silty CLAY with roots, damp	CL/ML					
1.5	Soft to firm, brown (10YR 5/4), silty CLAY and clayey SILT, damp	CL			46"	NO	
5					58"	NO	
10							
11.0	Firm, brown (10YR 5/4), silty CLAY with fine gravel				36"	NO	
14.0	Firm to stiff, tan (10YR 7/4) and brown (10YR 5/4) fine- to coarse-grained sandy silty CLAY				36"	NO	
15							
20					13"	NO	21
					36"	NO	
25					15"	NO	39
26.0	Dense, brown (10YR 5/4), silty fine- to coarse-grained SAND, increasing gravel at 27.25", damp	SM			32"	NO	
29.0	Dense, red-brown (5YR 6/4), fine- to coarse-grained SAND with gravel, damp	SW			15"	NO	35
30					36"	NO	
35					24"	NO	41
36.0	B.T. @ 36.0'						
40							



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-07
Coordinates: N 458727, E 2187478
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 17, 2016



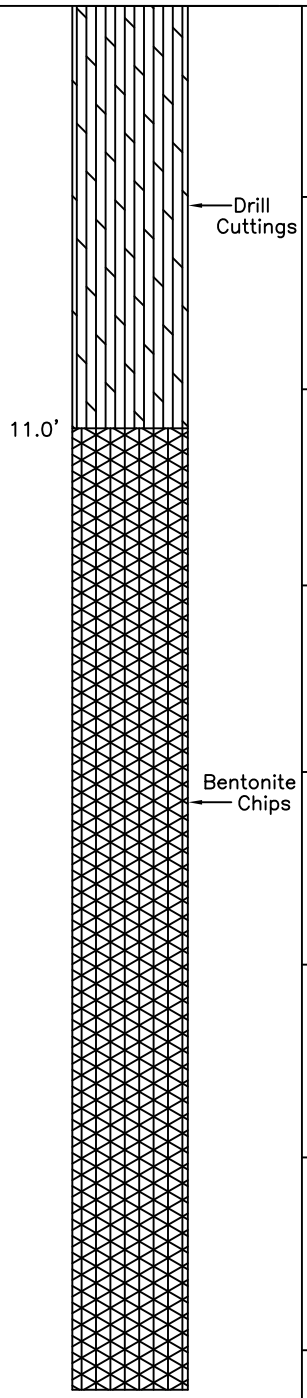
SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-08/TP-1
Coordinates: N 459243, E 2187478
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 17, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5102.0'						
0	TOPSOIL: Firm, brown, (10YR 5/4), silty CLAY with roots and clayey silt, damp	CL/ML					
1.0	Stiff, brown (10YR 5/4), silty CLAY, damp	CL			46"		
5					46"		
10	...increasing silt @ 10.0'				54"		
15					32"		
16.0	Firm, reddish-brown, clayey fine- to medium-grained SAND, damp	SC					
19.0	Stiff, light brown (10YR 6/6) clayey SILT with fine- to coarse-grained sand, damp	CL			18"		16
20					36"		
25					21"		13
26.0	Medium dense, reddish-brown (10YR 5/4), fine- to coarse-grained SAND with clay, damp	SW			36"		
30	Very stiff, reddish-brown (10YR 6/4), silty CLAY, damp	CL			18"		21
34.0					36"		
35	Dense, pink brown (10YR 6/4), fine- to coarse-grained SAND and gravel, dry	SW			8"		34
36.0	B.T. @ 36.0'						
40							

Borehole Abandonment



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-09
Coordinates: N 459862, E 2187488
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 17, 2016

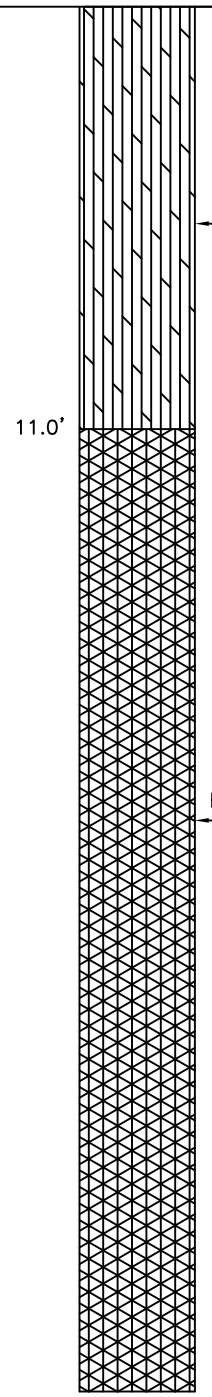
DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
	Estimated Ground Surface: 5105.4'								
0	TOPSOIL: Soft brown (10YR 5/4), silty CLAY with roots, moist	CL/ML							0
0.7	Firm, brown (10YR 5/4), clayey SILT, damp	CL			42"	NO			
5					52"	NO		← Drill Cuttings	5
9.0'									
10					50"	NO			10
13.0	Firm, brown (10YR 5/4), silty very fine–grained SAND, damp	SM			24"	NO			
15					14"	NO	11		15
19.0	Loose, fine to coarse SAND, damp				12"	NO			
20						NO	6	← Bentonite Chips	20
					36"	NO			
24.0	Firm, brown (10YR 5/4), silty fine– to coarse–grained SAND with fine gravel, damp				18"	NO	10		
25					36"	NO			25
30					16"	NO	15		30
30.5	Medium dense, brown (10YR 5/4) fine– to coarse–grained SAND with fine– to coarse (rounded) gravel	SW							
31.5					12"	NO			
	Dense, brown, silty fine– to coarse–grained SAND, damp	SM			16"	NO	32		
34.0	B.T. @ 34.0'								
35									35
40									40

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–10
Coordinates: N 458747, E 2187728
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 11, 2016

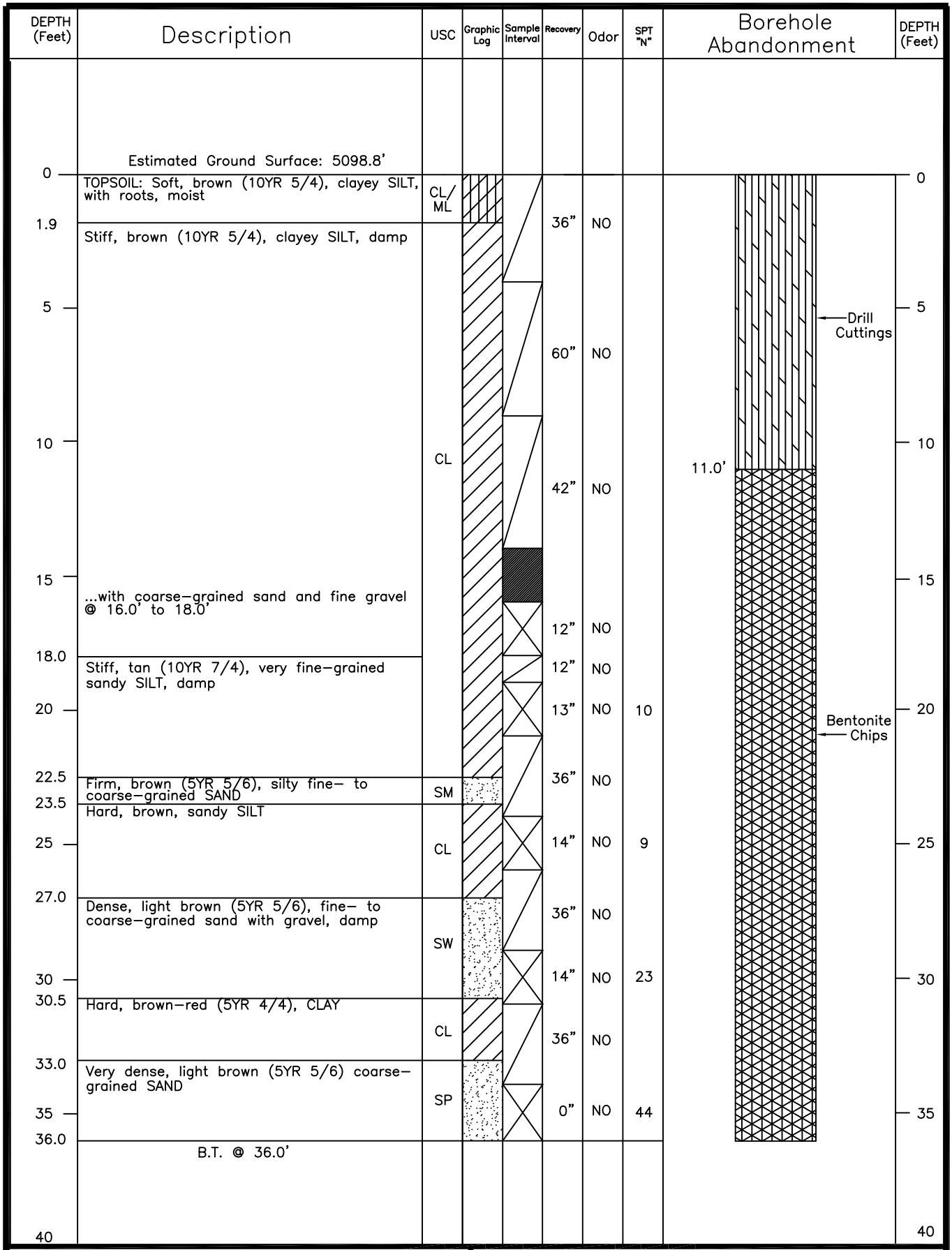
DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5101.8'						
0	TOPSOIL: Soft, brown (10YR 5/4), silty CLAY moist with roots, silt, damp	CL/ ML					
1.3	Stiff, brown (10YR 5/4), clayey SILT, with specks of gypsum, damp	CL			48"	NO	
5					46"	NO	
10					44"	NO	
15	...color change to tan (10YR 7/4) @ 16.5'				32"	NO	
19.0						NO	
20	Stiff, brown (10YR 5/4), very fine–grained sandy SILT, damp				10"	NO	10
					36"	NO	
25					12"	NO	9
28.0					36"	NO	
30	Firm, tan (10YR 7/4), silty fine– to coarse–grained SAND, damp	SM			12"	NO	23
32.0	TOP OF LARAMIE FM						
	Hard, brown, SILT and SILTSTONE with white gypsum nodules, dry	CL			36"	NO	
35					16"	NO	44
36.0	B.T. @ 36.0'						
40							



SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–11
Coordinates: N 459233, E 2187729
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 11, 2016



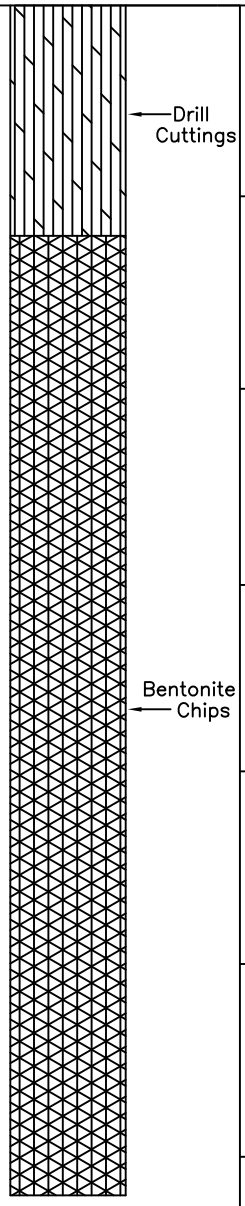
SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-12
Coordinates: N 459737, E 2187730
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 12, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5093.7'						
0	TOPSOIL: Soft, brown (10YR 5/4), clayey SILT, moist with roots (14") and firm brown silt with clay, damp	CL/ ML					
1.2	Stiff, brown (10YR 5/4), clayey SILT, damp	CL			36"	NO	
5					60"	NO	
10					58"	NO	
15						NO	
17.5	Firm, tan (10YR 7/4), clayey SILT, damp minor sand				14"	NO	9
					12"	NO	
20	...increase coarse sand and gravel @ 22.0'				12"	NO	8
23.0	Firm to dense, light brown (10YR 7/4), silty SAND, damp	SM			36"	NO	
25					13"	NO	23
					36"	NO	
28.5	TOP OF LARAMIE FM						
30	Hard, brown (10YR 7/4), cemented sandy SILT, damp	CL			10"	NO	59
31.0	B.T. @ 31.0'						
35							
40							

Borehole Abandonment



DEPTH (Feet): 0, 5, 10, 15, 20, 25, 30, 35, 40

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–13
Coordinates: N 458739, E 2188297
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 12, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5094.0'						
0	TOPSOIL: Soft, brown, (10YR 5/4), silty CLAY moist with roots, silt with clay, damp	CL/ ML					
1.3	Soft, brown (10YR 5/4), SILT with clay, damp				53"	NO	
5					26"	NO	
8.0	Firm, brown (10YR 5/4), silty CLAY, damp						
10					53"	NO	
13.0	Stiff, light brown (10YR 7/4) silty CLAY with fine–grained sand, gypsum mottling, damp	CL					
15					29"	NO	
20					10"	NO	8
					36"	NO	
25					11"	NO	20
25.5	Firm, fine– to coarse–grained silty SAND, damp						
26.0	Stiff, light brown (10YR 7/4), silty with coarse–grained SAND and fine gravel				36"	NO	
30		SM			18"	NO	15
					36"	NO	
33.0	Very dense, cemented fine– to coarse–grained SAND and GRAVEL with gypsum, damp						
34.0	TOP OF LARAMIE FM						
35	Very hard, sandy SILT, damp	CL			13"	NO	61
36.0	B.T. @ 36.0'						
40							

Borehole Abandonment

11.0'

Drill Cuttings

Bentonite Chips

DEPTH (Feet): 0, 5, 10, 15, 20, 25, 30, 35, 40

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

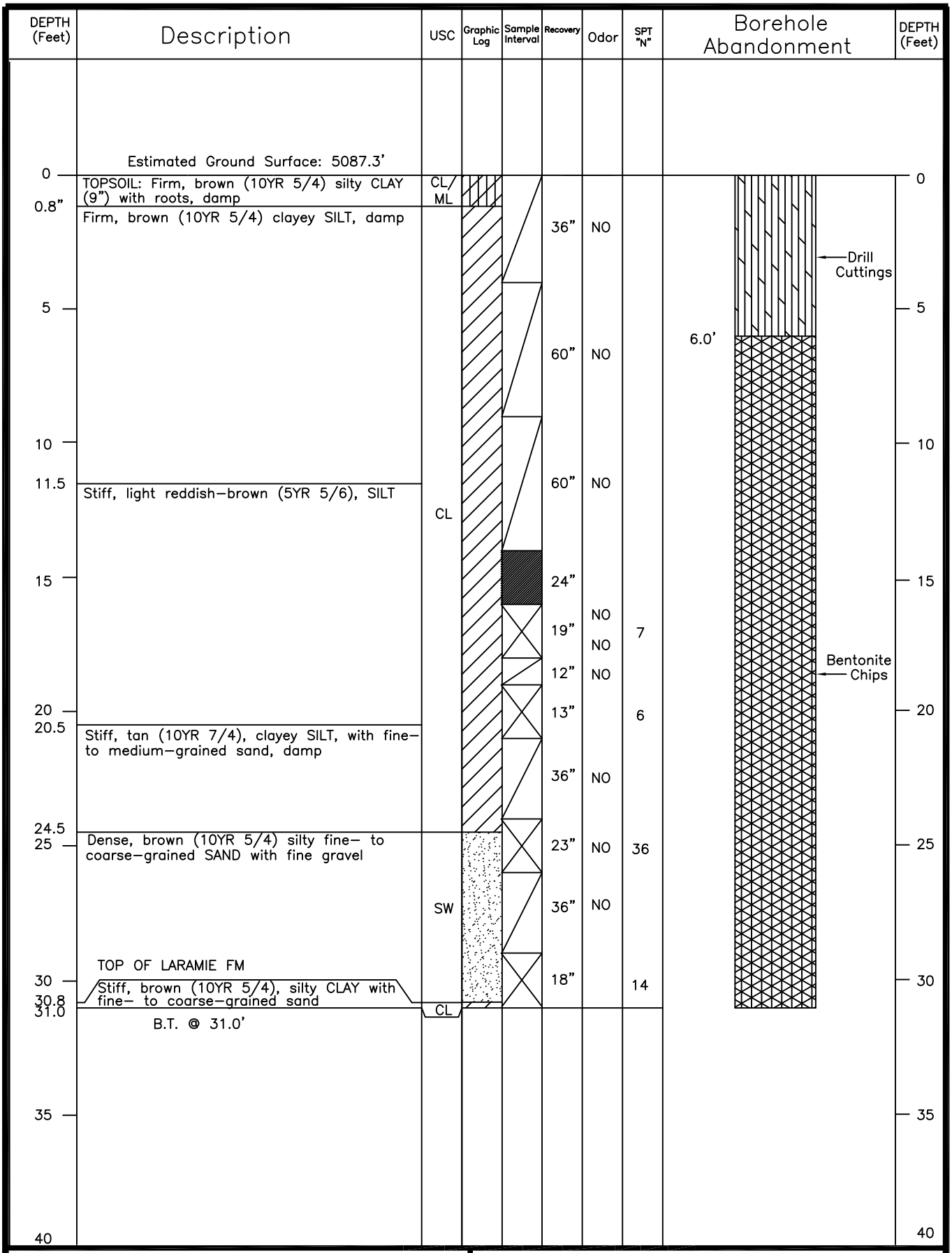
Location NWE–14

Coordinates: N 459231, E 2188298

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 12, 2016



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–15
Coordinates: N 459735, E 2188299
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 15, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
	Estimated Ground Surface: 5088.0'								
0	TOPSOIL: Soft, brown (10YR 5/4), silty CLAY with roots, damp	CL/ ML							0
1.8	Soft, brown (10YR 5/4), SILT, damp				42"	NO		←Drill Cuttings	
5									5
					58"	NO		6.0'	
8.0	Firm, brown (10YR 5/4), clayey SILT, blocky structure with fine–grained sand, damp								
10									10
					48"	NO			
15		CL			24"				15
					10"		17	←Bentonite Chips	
					12"				
20					8"		20		20
					36"	NO			
23.8	Firm, tan (10YR 8/2), SILT, gypsum cementing and mottling, with minor gravel, damp								
25					1"	NO	24		25
					36"				
29.0	Soft, tan (10YR 7/4), SILT with minor clay, gypsum mottling and coarse–grained sand, damp								
30					11"		7		30
31.0	B.T. @ 31.0'								
35									35
40									40

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–16
Coordinates: N 458737, E 2188820
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By CRS
Installation Date February 15, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
	Estimated Ground Surface: 5083.9'								
0	TOPSOIL: Firm to stiff, brown (10YR 5/4), silty CLAY with roots, damp	CL/ ML							0
1.0	Stiff, brown (10YR 5/4), silty CLAY and clayey SILT				42"	NO			
5					53"	NO		6.0'	5
10		CL			52"	NO			10
15									15
16.0	Stiff, brown (10YR 5/4), clayey SILT, damp				18"	NO	6		
					12"				
20	...sandier from 21.0' to 23.0'				16"	NO	5		20
					36"	NO			
23.0	Loose, brown (10YR 5/4), silty fine- to coarse-grained SAND with fine gravel, damp	SW							
24.0	Stiff, brown (10YR 5/4), clayey SILT with fine- to coarse-grained silty sand lenses and fine gravel, damp				19"		5		
25		CL			36"				25
30					19"		14		30
30.5	Firm, brown (10YR 5/4), silty fine- to coarse-grained SAND, damp	SM							
32.0	B.T. @ 32.0'								
35									35
40									40

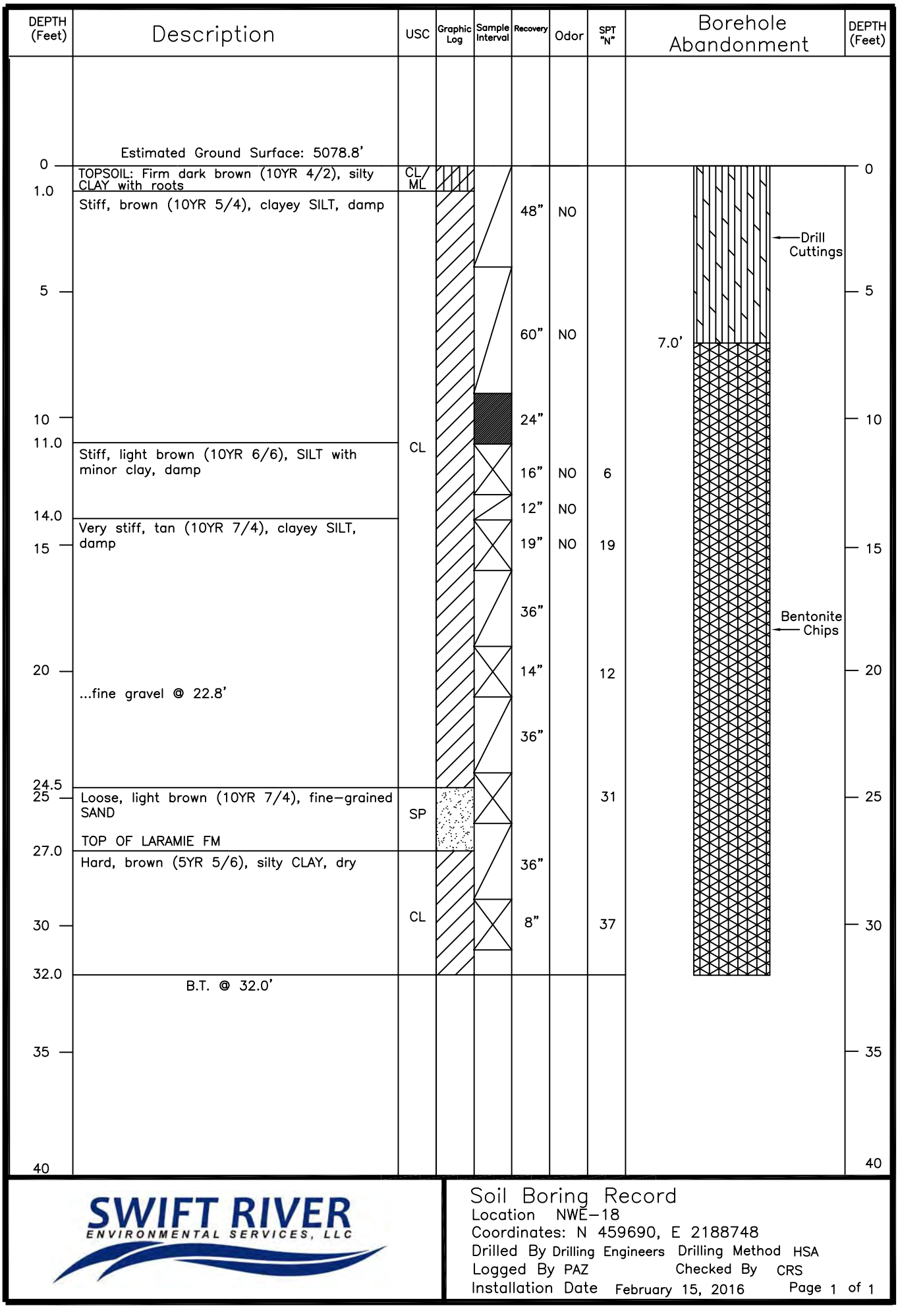
Drill Cuttings

Bentonite Chips

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-17
Coordinates: N 459235, E 2188821
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By CRS
Installation Date February 15, 2016



SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-18
Coordinates: N 459690, E 2188748
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By CRS
Installation Date February 15, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
	Estimated Ground Surface: 5081.3'								
0	TOPSOIL: Firm, brown (10YR 5/4), silty CLAY with roots, damp	CL/ ML							0
1.5	Soft, brown (10YR 5/4), clayey SILT with fine-grained sand				43"	NO			
5					33"	NO		6.0'	5
10									10
11.0	Firm, brown (10YR 5/4), clayey SILT and silty CLAY, damp				10"	NO	6		
					12"	NO			
15		CL			11"	NO	7		15
					36"				
20					19"		8		20
					36"				
25					12"		7		25
27.0	Soft, brown, sandy SILT, with coarse sand and fine gravel, damp				36"				
30							9		30
31.0	B.T. @ 31.0'								
35									35
40									40

Drill Cuttings

Bentonite Chips

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

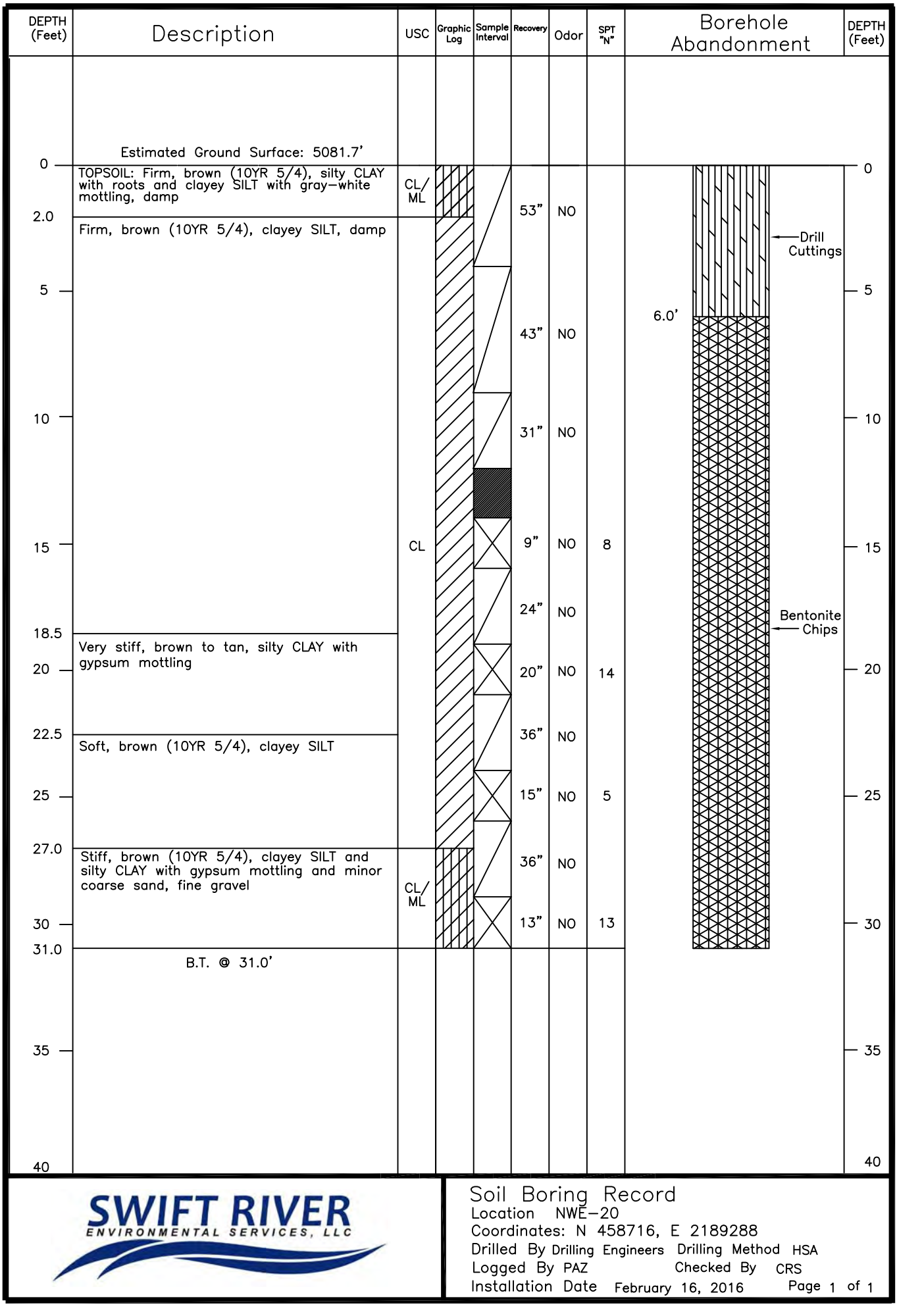
Location NWE-19

Coordinates: N 458225, E 2189329

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By CRS

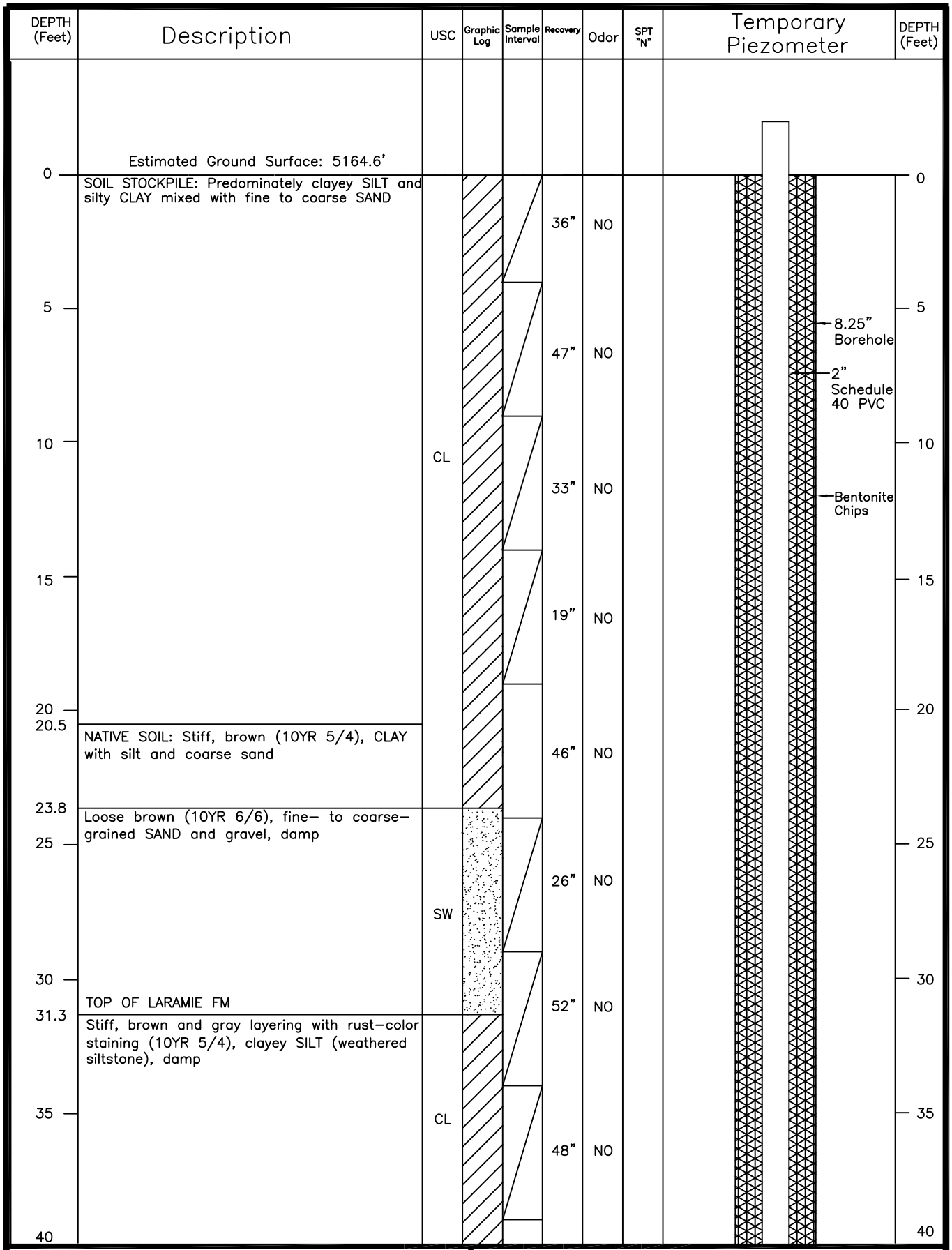
Installation Date February 16, 2016



SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–20
Coordinates: N 458716, E 2189288
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By CRS
Installation Date February 16, 2016

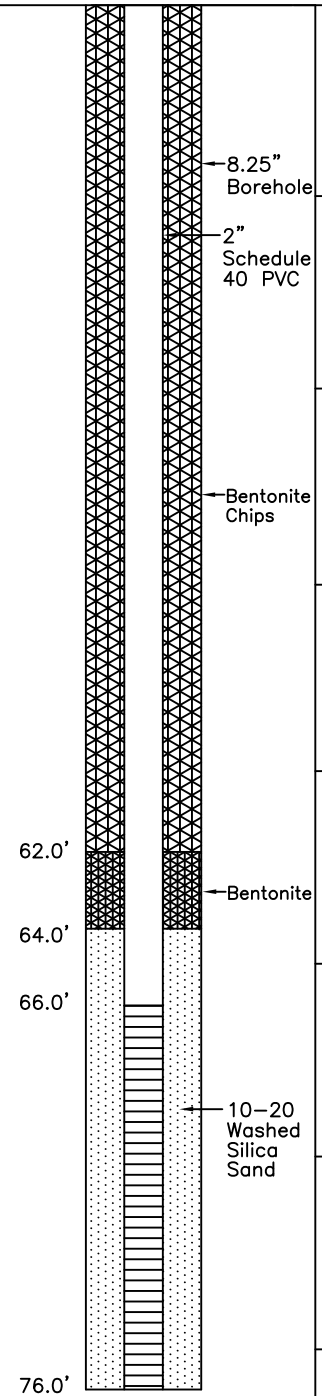


SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-21/TP-2
Coordinates: N 458214, E 2186343
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 18, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
40	(See 31.3' – 40.0')	CL			43"	NO	
45					43"	NO	
47.0	Hard to very hard, brown gray (10YR 5/4) and black (N3) layering, silty CLAYSTONE, thinly laminated, damp						
50					58"	NO	
55					24"	NO	
					~8"		
60	...lignite @ 59.5' to 60.5'				12"	NO	50/2"
					36"	NO	
65					24"		66
	...firm, brown–block rust–color mottled clay and lignite @ 67.25'				36"	NO	
67.8	Very dense, tan (10YR 7/4) silty fine–grained SAND	SM			5"	NO	50/2"
70							
75					5"	NO	50/2"
76.0	B.T. @ 76.0'						
80							



DEPTH (Feet): 40, 45, 50, 55, 60, 65, 70, 75, 80

Temporary Piezometer

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–21/TP–2

Coordinates: N 458214, E 2186343

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 18, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
	Estimated Ground Surface: 5150.6'								
0	SOIL STOCKPILE: Predominately silty fine to coarse SAND mixed with clayey silt	CL			47"	NO			0
5					60"	NO			5
10					18"	NO			10
15					43"	NO			15
20					60"	NO		Drill Cuttings	20
25					60"	NO			25
30					60"	NO			30
35					48"	NO			35
40									40

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE-22A
Coordinates: N 458225, E 2187829
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 18, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Borehole Abandonment	DEPTH (Feet)
40	SOIL STOCKPILE	CL			45"				40
44.0									
45	NATIVE SOIL: Dense, light brown (10YR 7/4), silty, fine–grained SAND, damp	SM			51"			Drill Cuttings	45
50					58"				50
	...stiff reddish brown silty CLAY layer @ 52.25'								
55					55"			55.0'	55
58.0	TOP OF LARAMIE FM								
	Stiff to hard, light brown (10YR 7/4) weathered SILTSTONE, damp with rust–color staining	CL			3"		50/4"		
60					4"				60
					48"				
64.0									
65	Very hard, tan and brown–gray (10YR 8/2 & 10YR 7/4) weathered silty CLAYSTONE with rust–color mottling				17"		81/11"		65
					36"			Bentonite Chips	
	...black coal seam, dry @ 67.0' to 68.0'								
69.0									
70	Very dense, light brown (10YR 7/4) weakly cemented, silty fine–grained SANDSTONE, damp	SM			11"		71/11"		70
					36"				
75					5"		50/5"		75
76.0									
	Very hard, brown, weakly cemented sandy SILTSTONE, weathered, damp	CL			36"				
	Silty CLAYSTONE, damp @ 80.0'						50/5"		
80	B.T. @ 80.0'								80

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location NWE–22A
Coordinates: N 458225, E 2187829
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 18, 2016

Industrial Compliance Inc.
1746 Cole Blvd., Bldg. 21 #300
Golden, CO 80401

JOB NO	CLIENT	LOCATION
2-3397	Waste Services	N. Weld Co.

DRILLING METHOD: CME-55

BORING NO. PZ-19

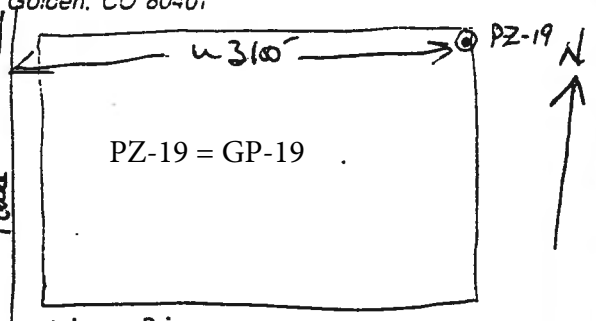
SHEET 1 OF 2

SAMPLING METHOD: 6" Hollow Stem Auger split spoon (SS)

DRILLING: START TIME 8:45 DATE 5/8/91; FINISH TIME 10:00 DATE 5/8/91

WATER LEVEL	dry @ 35.42' bgs			
TIME	10:00			
DATE	5/8			
CASING DEPTH	35'			

Location Diagram



DATUM ELEVATION

SURFACE CONDITIONS: [12' south of NE corner, 1' west of east fence line]

DRILLING CONTR. Drilling Engineering, Inc., Monty

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	OVA Reading	DEPTH IN FEET	SOIL GRAPH	
						1	CL	clay, v. silty, sandy (v.f.g.), dry, l. brown, Calcareous ($CaCO_3$)
						2		
						3		
						4	CL	clay, sandy to v. sandy (v.f.g.), silty, dry, l. brown, $CaCO_3$
SS				11/12		5		
						6		
						7		
						8		
						9	SC	sand, v. clayey, silty, (v.f.g.), dry, l. brown, $CaCO_3$
SS				8/12		10		
						11		
						12		
						13		
						14	SM/SC	sand (v.f.g.), v. silty, clayey, dry, l. brown, very calcareous
SS				7/12		15		
						16		
						17		
						18		
						19	SC	sand (v.f.g.-f.g.), v. silty, clayey, dry, l. brown, $CaCO_3$
SS				11/12		20		

BY Mike Unger CHK'D BY _____ DATE 5/8/91

Industrial Compliance Inc.
1746 Cole Blvd., Bldg. 21 #300
Golden, CO 80401

see diagram on page 1

N

JOB NO	CLIENT	LOCATION
2-3397	Waste Services	N. Weld Co.

DRILLING METHOD: CME-55, 6" H.S. Augers
BORING NO. PZ-19
SHEET 2 OF 2
SAMPLING METHOD: split spoon

		DRILLING START	DRILLING FINISH
WATER LEVEL	dry @ 35.42' bgs	TIME 8:45	TIME 10:00
TIME	10:00		
DATE	5/8	DATE 5/8/91	DATE 5/8/91
CASING DEPTH	35'		

DRILLING CONTR. Williams Engineers, Jim, Marty

Location Diagram

DATUM ELEVATION

SURFACE CONDITIONS:

SAMPLER TYPE	INCHES DRIVEN / INCHES RECOVERED	DEPTH OF CASING	SAMPLE NO. / SAMPLE DEPTH	BLOWS/FT. SAMPLER	OVA Reading	DEPTH IN FEET	SOIL GRAPH	
						21	SC	sand, v. clayey, silty, dry, l. brown, calcareous ($CaCO_3$) (v.f.g. - c.g.)
						22		
						23		
						24	SP	sand, v.f.g - c.g., clayey, silty, l. brown, sli. moist to med. moist, $CaCO_3$, some thin (1") clay lenses, brown, med. moist to moist
SS				13/12		25		
						26		
						27		
						28		
						29	SP	sand, v.f.g - c.g., clayey, silty, l. brown, med. moist, $CaCO_3$, some thin (1") clay lenses, brown, med. moist to moist
SS				20/12		30		
						31		
						32		
						33		
						34	SP	sand, v.f.g - m.g., clayey, silty, brown to yellow, iron stained, med. moist, occasional thin (1"-2") clay lense
SS				26/12		35		35' T.D.
						36		
						37		hand 1" PVC, slotted, 7'-35'
						38		cement : 0-2.6'
						39		bentonite (hole plug) : 2.6-5.1'
						40		sand & gravel : 5.1-35'

BY Mike Unger CHK'D BY
DATE 5/8/91

APPENDIX D

GEOTECHNICAL LABORATORY TESTING RESULTS

SOIL PROPERTIES

Moisture Content

Grain Size Distribution

Atterberg Limits

Unified Soil Classification

Moisture Content Determinations

ASTM D 2216

CLIENT:	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	LOCATION	--
PROJECT NO.	S152047		

BORING NO.	NWE-1	NWE-3	NWE-4	NWE-5
DEPTH	20' (19-24')	25' (24-29')	10' (9-14')	10' (9-14')
SAMPLE NO.	--	--	--	--
DATE SAMPLED	--	--	--	--
DATE TESTED	3/7/2016 DPM	3/7/2016 DPM	3/7/2016 DPM	3/7/2016 DPM
SOIL DESCRIPTION	--	--	--	--
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	220.86	305.94	228.54	294.67
Wt. of Dry Soil & Dish (gms)	205.13	289.61	208.79	259.17
Net Loss of Moisture (gms)	15.73	16.33	19.75	35.50
Wt. of Dish (gms)	14.20	14.36	14.25	14.47
Wt. of Dry Soil (gms)	190.93	275.25	194.54	244.70
Moisture Content (%)	8.2	5.9	10.2	14.5

BORING NO.	NWE-6	NWE-7	NWE-13	NWE-14
DEPTH	10' (9-14')	15' (14-17')	10' (9-14')	10' (9-14')
SAMPLE NO.	--	--	--	--
DATE SAMPLED	--	--	--	--
DATE TESTED	3/7/2016 DPM	3/7/2016 DPM	3/7/2016 DPM	3/7/2016 DPM
SOIL DESCRIPTION	--	--	--	--
MOISTURE DETERMINATIONS				
Wt. of Wet Soil & Dish (gms)	393.96	340.87	321.68	295.39
Wt. of Dry Soil & Dish (gms)	347.24	308.19	285.66	263.44
Net Loss of Moisture (gms)	46.72	32.68	36.02	31.95
Wt. of Dish (gms)	14.20	14.44	14.32	14.39
Wt. of Dry Soil (gms)	333.04	293.75	271.34	249.05
Moisture Content (%)	14.0	11.1	13.3	12.8

BORING NO.	NWE-20
DEPTH	10' (9-12')
SAMPLE NO.	--
DATE SAMPLED	--
DATE TESTED	3/7/2016 DPM
SOIL DESCRIPTION	--
MOISTURE DETERMINATIONS	
Wt. of Wet Soil & Dish (gms)	384.85
Wt. of Dry Soil & Dish (gms)	338.94
Net Loss of Moisture (gms)	45.91
Wt. of Dish (gms)	14.34
Wt. of Dry Soil (gms)	324.60
Moisture Content (%)	14.1

Data entry by: NN Date: 3/8/2016

Checked by: CAL Date: 3/8/16

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-1		
Job Number:	2952-1	Depth:	20' (19-24')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	100.23
Weight of Dry Soil & Pan (g):	98.04
Weight of Water (g):	2.18
Weight of Pan (g):	3.11
Weight of Dry Soil (g):	94.94
Moisture (%):	2.3

General Sample Data

Total Wet Weight of Sample (g):	823.32
Total Dry Weight of Sample (g):	804.85
Calculated Weight Plus #200 (g):	624.23
Moisture of Total Sample (%):	2.3
Percent Retained #200 Sieve (%):	77.6

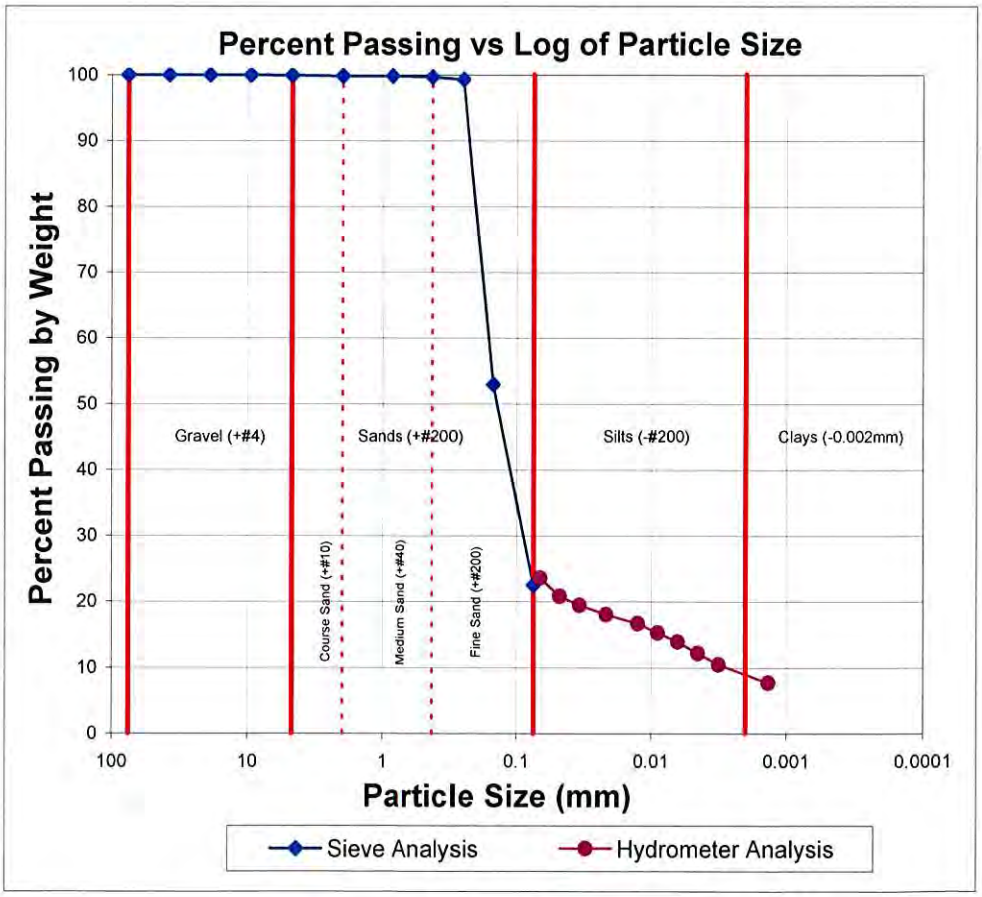
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.23	0.00	0.23	0.23	100.0
#10	**2.000**	1.09	0.00	1.09	1.09	99.8
73.689g split out of -#10 material.						
#20	**0.850**	3.14	3.13	0.00	0.04	99.8
#40	**0.425**	3.16	3.09	0.08	0.85	99.7
#60	**0.250**	3.45	3.11	0.34	3.74	99.3
#100	**0.150**	36.60	3.13	33.47	373.34	52.9
#200	**0.075**	25.06	3.10	21.96	244.94	22.4

Plus Split Data

Original Weight of +#10 (g): 1.52
Calculated Weight of +#10 (g): 1.32

Minus Split Data

Original Weight of -#10 (g): 821.80
Calculated Dry Weight of -#10 (g): 803.53



USCS Classification ASTM D 2487

Atterberg Classification: NP
Group Symbol: SM

Course-Grained Soils

Percent Gravels (%): 0.03
Percent Sands (%): 77.53
Percent Fines (%): 22.44

USCS Classification

Silty Sand

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_1.xls	Date:	3/14/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-1		
Job Number:	2952-1	Depth:	20' (19-24')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/8/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	823.32
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	804.85
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	73.689
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	72.033
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	72.178

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
0.5	21.0	17.0	23.0	0.0132	12.85	0.0668	23.6	189.83	23.6
1	19.0	15.0	23.0	0.0132	13.18	0.0478	20.8	167.49	20.8
2	18.0	14.0	23.0	0.0132	13.34	0.0340	19.4	156.33	19.4
5	17.0	13.0	23.0	0.0132	13.51	0.0216	18.0	145.16	18.0
15	16.0	12.0	23.0	0.0132	13.67	0.0126	16.6	133.99	16.6
30	15.0	11.0	23.1	0.0132	13.83	0.0089	15.3	122.83	15.3
60	14.0	10.0	23.2	0.0132	14.00	0.0064	13.9	111.66	13.9
120	12.8	8.8	23.3	0.0132	14.20	0.0045	12.1	97.70	12.1
250	11.5	7.5	23.4	0.0132	14.41	0.0032	10.4	83.75	10.4
1440	9.5	5.5	22.8	0.0133	14.74	0.0013	7.6	61.41	7.6

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_1.xls	Date:	3/14/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-3		
Job Number:	2952-1	Depth:	25' (24-29')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	50.64
Weight of Dry Soil & Pan (g):	49.87
Weight of Water (g):	0.77
Weight of Pan (g):	3.15
Weight of Dry Soil (g):	46.72
Moisture (%):	1.7

General Sample Data

Total Wet Weight of Sample (g):	962.45
Total Dry Weight of Sample (g):	946.76
Calculated Weight Plus #200 (g):	618.94
Moisture of Total Sample (%):	1.7
Percent Retained #200 Sieve (%):	65.4

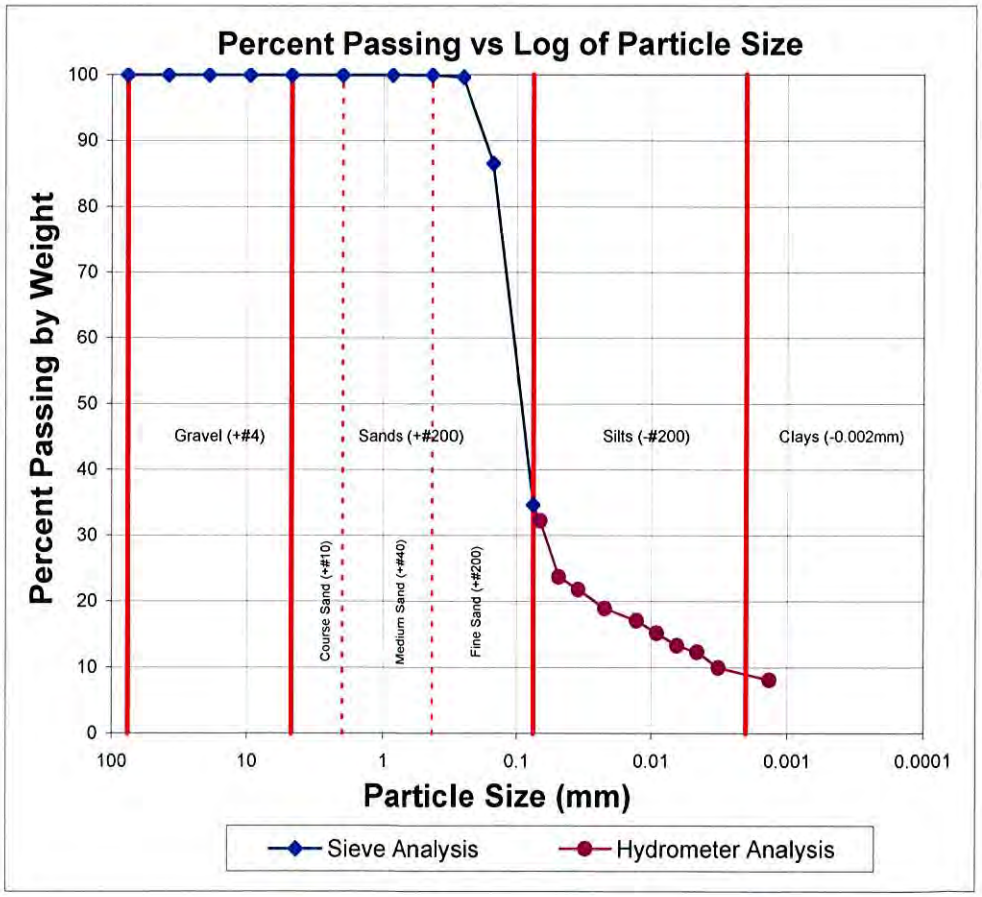
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
53.655g split out of -#10 material.						
#20	**0.850**	3.11	3.11	0.01	0.09	100.0
#40	**0.425**	3.11	3.10	0.01	0.18	100.0
#60	**0.250**	3.40	3.22	0.18	3.26	99.6
#100	**0.150**	10.03	3.12	6.91	123.97	86.5
#200	**0.075**	30.63	3.24	27.40	491.44	34.6

Plus Split Data

Original Weight of +#10 (g): 7.19
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 955.26
Calculated Dry Weight of -#10 (g): 946.76



USCS Classification ASTM D 2487

Atterberg Classification: NP
Group Symbol: SM

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 65.37
Percent Fines (%): 34.63

USCS Classification

Silty Sand

Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_hydrometer-ASTM-D422-R3_8.xls

Checked By: KR
Date: 3/16/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-3		
Job Number:	2952-1	Depth:	25' (24-29')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/8/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	962.45
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	946.76
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	53.655
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	52.781
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	52.781

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
0.5	21.0	17.0	23.0	0.0132	12.85	0.0668	32.3	305.36	32.3
1	16.5	12.5	23.0	0.0132	13.59	0.0485	23.7	224.53	23.7
2	15.5	11.5	23.0	0.0132	13.75	0.0345	21.8	206.56	21.8
5	14.0	10.0	23.0	0.0132	14.00	0.0220	19.0	179.62	19.0
15	13.0	9.0	23.0	0.0132	14.16	0.0128	17.1	161.66	17.1
30	12.0	8.0	23.0	0.0132	14.33	0.0091	15.2	143.70	15.2
60	11.0	7.0	23.1	0.0132	14.49	0.0065	13.3	125.74	13.3
120	10.5	6.5	23.1	0.0132	14.57	0.0046	12.3	116.75	12.3
250	9.3	5.3	23.3	0.0132	14.78	0.0032	10.0	94.30	10.0
1471	8.3	4.3	22.8	0.0133	14.94	0.0013	8.1	76.34	8.1

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	KR
File Name:	2952_1_hydrometer-ASTM-D422-R3_8.xls	Date:	3/16/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-4		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	55.63
Weight of Dry Soil & Pan (g):	54.42
Weight of Water (g):	1.21
Weight of Pan (g):	3.08
Weight of Dry Soil (g):	51.34
Moisture (%):	2.4

General Sample Data

Total Wet Weight of Sample (g):	585.65
Total Dry Weight of Sample (g):	572.28
Calculated Weight Plus #200 (g):	219.62
Moisture of Total Sample (%):	2.3
Percent Retained #200 Sieve (%):	38.4

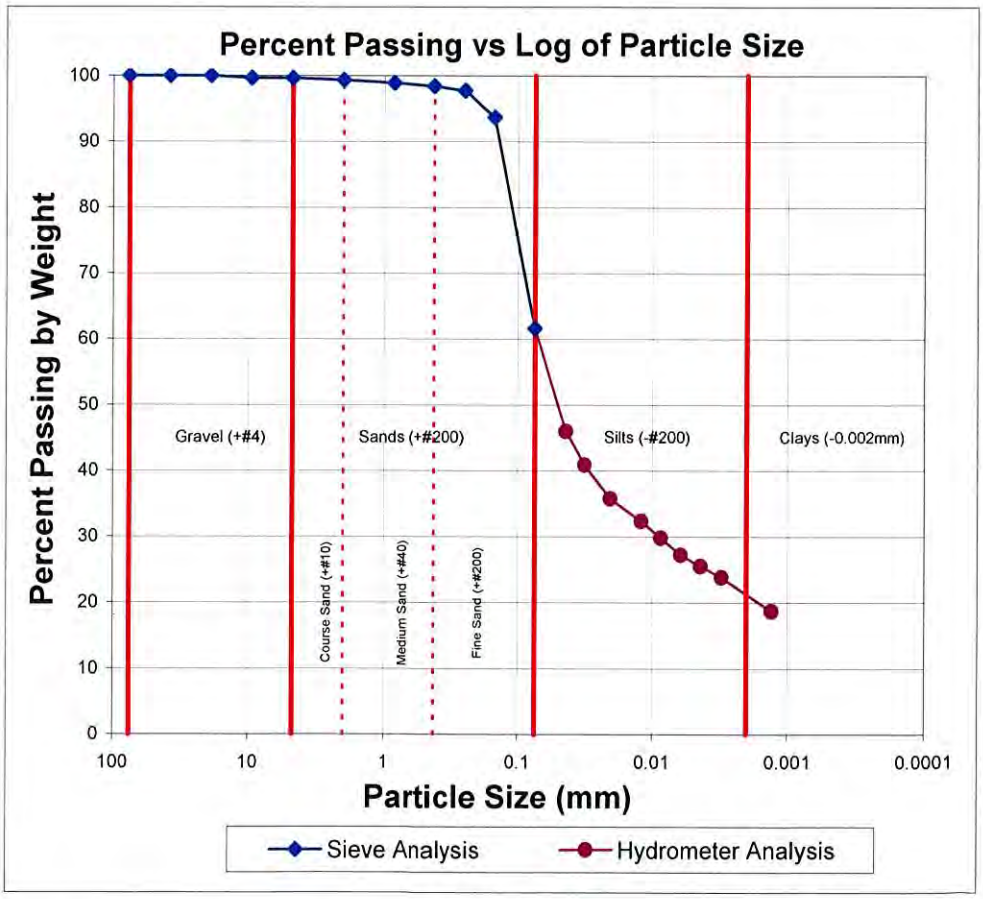
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	1.93	0.00	1.93	1.93	99.7
#4	**4.750**	0.00	0.00	0.00	0.00	99.7
#10	**2.000**	1.59	0.00	1.59	1.59	99.4
59.84g split out of -#10 material.						
#20	**0.850**	3.40	3.12	0.28	2.73	98.9
#40	**0.425**	3.37	3.08	0.29	2.82	98.4
#60	**0.250**	3.59	3.19	0.41	3.97	97.7
#100	**0.150**	5.48	3.11	2.37	23.08	93.7
#200	**0.075**	22.09	3.22	18.86	183.50	61.6

Plus Split Data

Original Weight of +#10 (g): 4.02
Calculated Weight of +#10 (g): 3.52

Minus Split Data

Original Weight of -#10 (g): 581.63
Calculated Dry Weight of -#10 (g): 568.76



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.34
Percent Sands (%): 38.04
Percent Fines (%): 61.62

USCS Classification

Sandy Lean Clay

Data Entered By:	NN	Checked By:	CKP
Date:	3/14/2016	Date:	3/14/16
File Name:	2952_1_hydrometer-ASTM-D422-R3_3.xls		

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-4		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/8/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	585.65
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	572.28
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	59.840
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	58.466
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	58.818

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	31.0	27.0	23.1	0.0132	11.21	0.0441	46.0	263.06	46.0
2	28.0	24.0	23.1	0.0132	11.70	0.0319	40.9	233.83	40.9
5	25.0	21.0	23.1	0.0132	12.19	0.0206	35.8	204.60	35.8
15	23.0	19.0	23.1	0.0132	12.52	0.0120	32.3	185.11	32.3
30	21.5	17.5	23.1	0.0132	12.77	0.0086	29.8	170.50	29.8
60	20.0	16.0	23.1	0.0132	13.01	0.0061	27.2	155.89	27.2
120	19.0	15.0	23.2	0.0132	13.18	0.0044	25.5	146.14	25.5
250	18.0	14.0	23.3	0.0132	13.34	0.0030	23.8	136.40	23.8
1440	15.0	11.0	22.7	0.0133	13.83	0.0013	18.7	107.17	18.7

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_3.xls	Date:	3/14/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-5		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	42.14
Weight of Dry Soil & Pan (g):	41.11
Weight of Water (g):	1.03
Weight of Pan (g):	3.07
Weight of Dry Soil (g):	38.04
Moisture (%):	2.7

General Sample Data

Total Wet Weight of Sample (g):	730.12
Total Dry Weight of Sample (g):	711.02
Calculated Weight Plus #200 (g):	152.48
Moisture of Total Sample (%):	2.7
Percent Retained #200 Sieve (%):	21.4

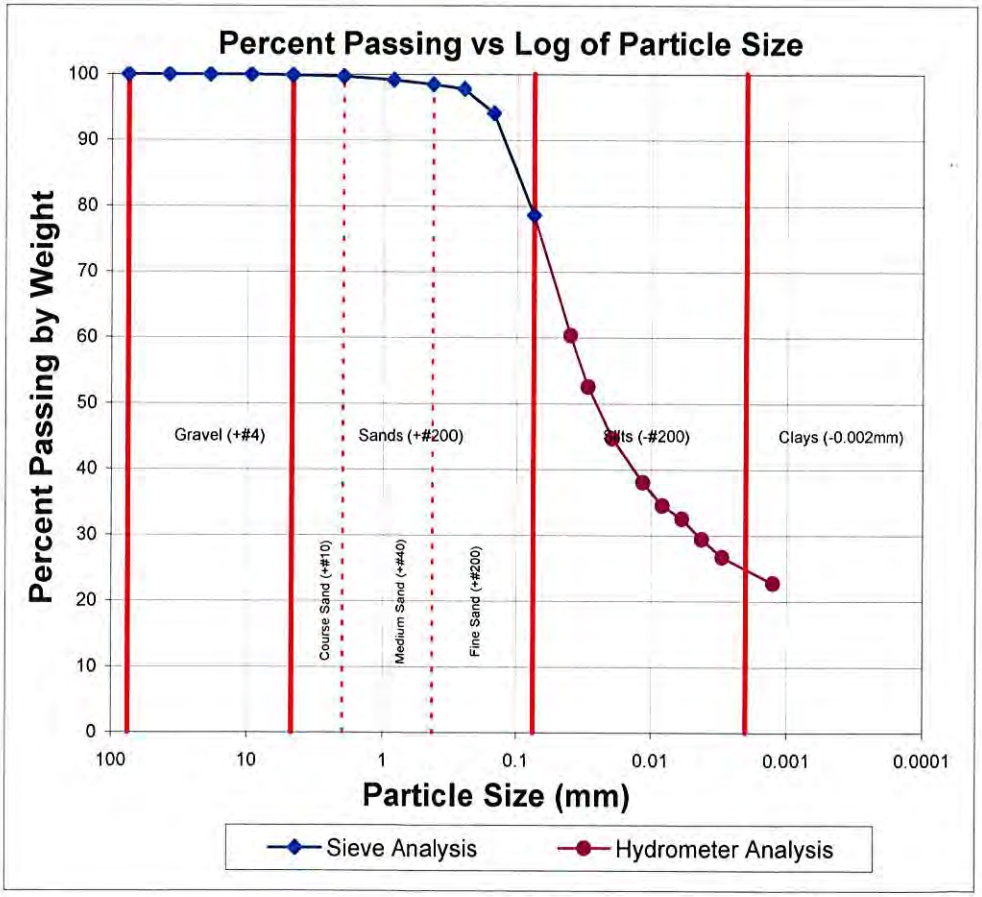
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.63	0.00	0.63	0.63	99.9
#10	**2.000**	1.33	0.00	1.33	1.33	99.7
65.435g split out of -#10 material.						
#20	**0.850**	3.50	3.14	0.37	4.08	99.2
#40	**0.425**	3.53	3.11	0.41	4.61	98.5
#60	**0.250**	3.53	3.05	0.48	5.33	97.8
#100	**0.150**	5.37	3.02	2.36	26.22	94.1
#200	**0.075**	13.10	3.19	9.91	110.28	78.6

Plus Split Data

Original Weight of +#10 (g): 2.17
Calculated Weight of +#10 (g): 1.96

Minus Split Data

Original Weight of -#10 (g): 727.95
Calculated Dry Weight of -#10 (g): 709.06



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.09
Percent Sands (%): 21.36
Percent Fines (%): 78.56

USCS Classification

Lean Clay With Sand

Data Entered By:	NN	Checked By:	CKP
Date:	3/14/2016	Date:	3/14/16
File Name:	2952_1_hydrometer-ASTM-D422-R3_0.xls		

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-5		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	730.12
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	711.02
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	65.435
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	63.718
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	63.910

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	43.0	38.5	23.1	0.0132	9.24	0.0400	60.3	428.91	60.3
2	38.0	33.5	23.1	0.0132	10.06	0.0295	52.5	373.21	52.5
5	33.0	28.5	23.1	0.0132	10.88	0.0194	44.7	317.50	44.7
15	28.8	24.3	23.1	0.0132	11.58	0.0116	38.0	270.16	38.0
30	26.5	22.0	23.2	0.0132	11.95	0.0083	34.5	245.09	34.5
60	25.3	20.8	23.3	0.0132	12.15	0.0059	32.5	231.17	32.5
120	23.3	18.8	23.4	0.0132	12.48	0.0042	29.4	208.88	29.4
250	21.5	17.0	23.5	0.0132	12.77	0.0030	26.6	189.39	26.6
1440	19.0	14.5	23.4	0.0132	13.18	0.0013	22.7	161.54	22.7

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_0.xls	Date:	3/14/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-6		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/11/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	50.12
Weight of Dry Soil & Pan (g):	48.63
Weight of Water (g):	1.49
Weight of Pan (g):	3.11
Weight of Dry Soil (g):	45.52
Moisture (%):	3.3

General Sample Data

Total Wet Weight of Sample (g):	1,062.99
Total Dry Weight of Sample (g):	1,029.26
Calculated Weight Plus #200 (g):	140.54
Moisture of Total Sample (%):	3.3
Percent Retained #200 Sieve (%):	13.7

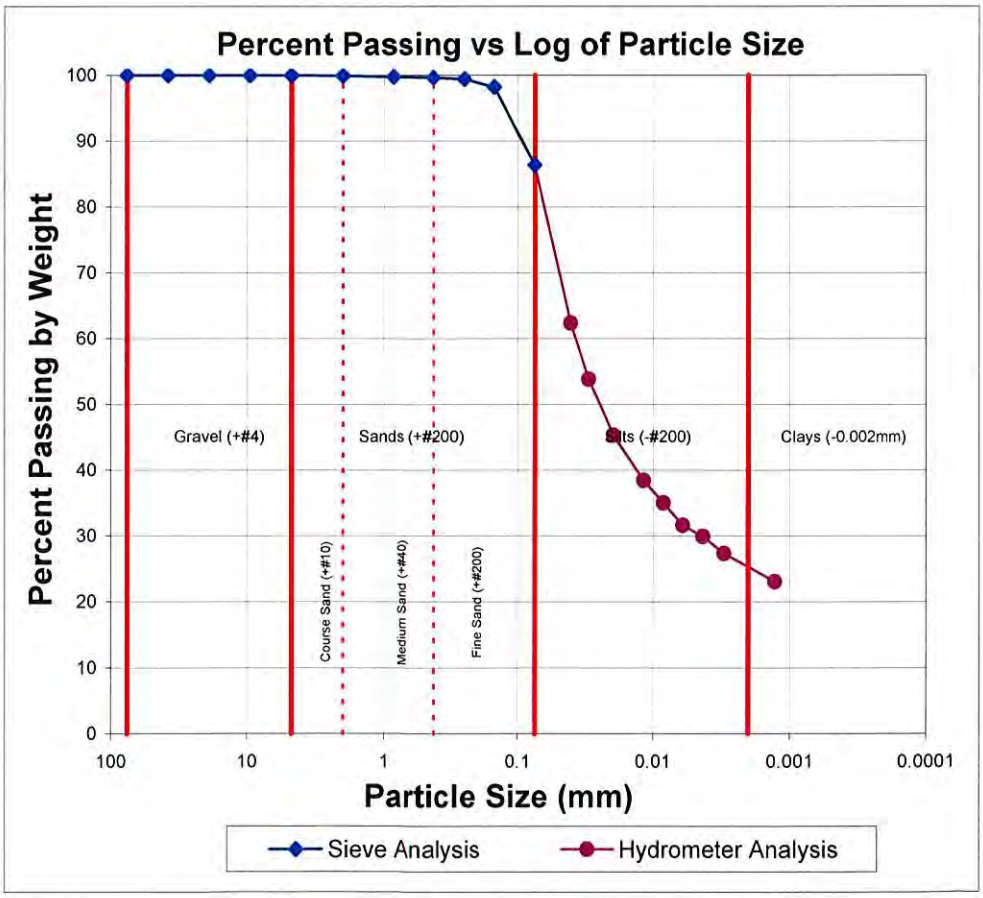
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.32	0.00	0.32	0.32	100.0
60.531g split out of -#10 material.						
#20	**0.850**	3.23	3.12	0.12	2.02	99.8
#40	**0.425**	3.21	3.12	0.09	1.60	99.6
#60	**0.250**	3.24	3.13	0.11	1.93	99.4
#100	**0.150**	3.93	3.20	0.73	12.80	98.2
#200	**0.075**	10.13	3.18	6.94	121.87	86.3

Plus Split Data

Original Weight of +#10 (g): 0.87
Calculated Weight of +#10 (g): 0.32

Minus Split Data

Original Weight of -#10 (g): 1,062.12
Calculated Dry Weight of -#10 (g): 1,028.94



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 13.65
Percent Fines (%): 86.35

USCS Classification

Lean Clay

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_11.xls	Date:	3/17/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-6		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	1,062.99
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	1,029.26
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	60.531
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	58.610
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	58.610

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	41.0	36.5	23.5	0.0132	9.57	0.0407	62.4	641.86	62.4
2	36.0	31.5	23.5	0.0132	10.39	0.0300	53.8	553.93	53.8
5	31.0	26.5	23.5	0.0132	11.21	0.0197	45.3	466.01	45.3
15	27.0	22.5	23.4	0.0132	11.87	0.0117	38.4	395.67	38.4
30	25.0	20.5	23.5	0.0132	12.19	0.0084	35.0	360.50	35.0
60	23.0	18.5	23.5	0.0132	12.52	0.0060	31.6	325.33	31.6
120	22.0	17.5	23.5	0.0132	12.69	0.0043	29.9	307.74	29.9
250	20.5	16.0	23.5	0.0132	12.93	0.0030	27.3	281.36	27.3
1440	18.0	13.5	23.3	0.0132	13.34	0.0013	23.1	237.40	23.1

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_11.xls	Date:	3/17/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-7		
Job Number:	2952-1	Depth:	15' (14-17')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/11/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	63.22
Weight of Dry Soil & Pan (g):	62.23
Weight of Water (g):	0.99
Weight of Pan (g):	3.09
Weight of Dry Soil (g):	59.14
Moisture (%):	1.7

General Sample Data

Total Wet Weight of Sample (g):	890.34
Total Dry Weight of Sample (g):	875.98
Calculated Weight Plus #200 (g):	416.02
Moisture of Total Sample (%):	1.6
Percent Retained #200 Sieve (%):	47.5

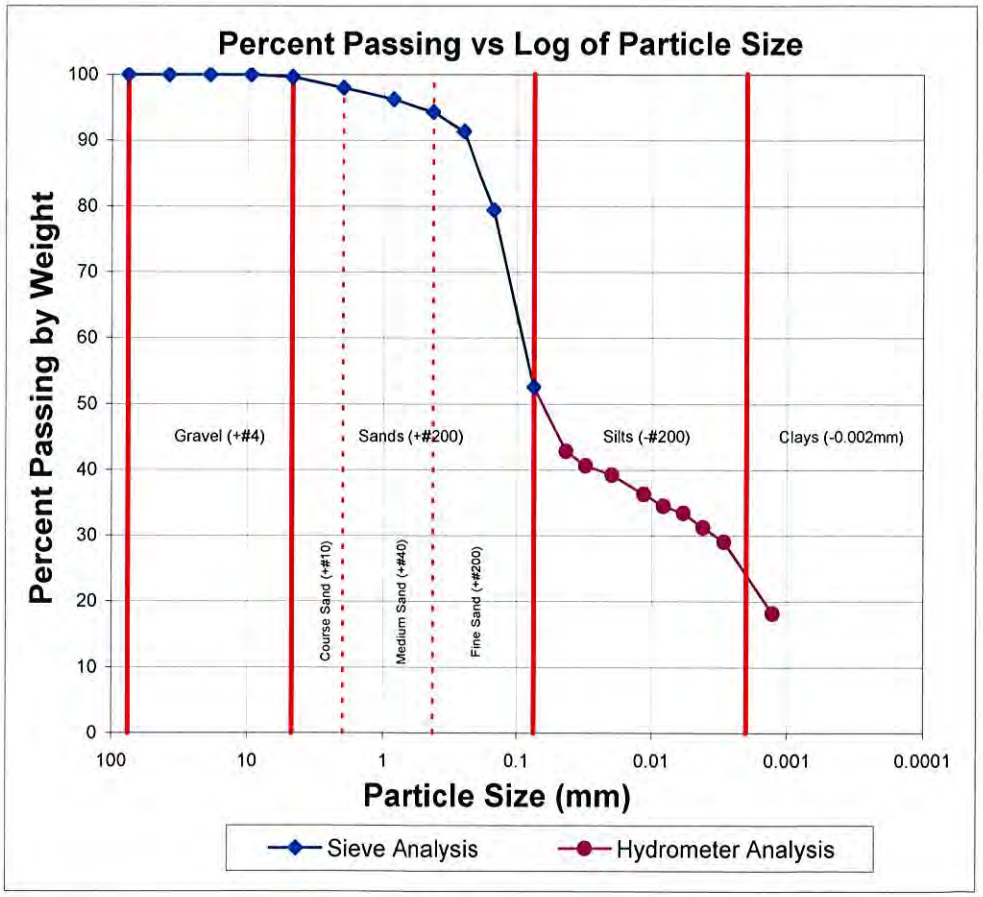
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	3.19	0.00	3.19	3.19	99.6
#10	**2.000**	14.18	0.00	14.18	14.18	98.0
68.819g split out of -#10 material.						
#20	**0.850**	4.38	3.17	1.21	15.34	96.3
#40	**0.425**	4.48	3.11	1.36	17.26	94.3
#60	**0.250**	5.20	3.15	2.05	26.00	91.3
#100	**0.150**	11.46	3.20	8.26	104.77	79.4
#200	**0.075**	21.69	3.14	18.55	235.28	52.5

Plus Split Data

Original Weight of +#10 (g):	19.70
Calculated Weight of +#10 (g):	17.37

Minus Split Data

Original Weight of -#10 (g):	870.64
Calculated Dry Weight of -#10 (g):	858.61



USCS Classification ASTM D 2487

Atterberg Classification:	CL
Group Symbol:	CL

Course-Grained Soils

Percent Gravels (%):	0.36
Percent Sands (%):	47.13
Percent Fines (%):	52.51

USCS Classification

Sandy Lean Clay

Data Entered By:	NN	Checked By:	CKP
Date:	3/14/2016	Date:	3/14/16
File Name:	2952_1_hydrometer-ASTM-D422-R3_2.xls		

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-7		
Job Number:	2952-1	Depth:	15' (14-17')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	890.34
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	875.98
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	68.819
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	67.687
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	69.068

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	34.0	29.5	23.3	0.0132	10.72	0.0431	42.8	374.65	42.8
2	32.5	28.0	23.3	0.0132	10.96	0.0308	40.6	355.60	40.6
5	31.5	27.0	23.3	0.0132	11.13	0.0196	39.1	342.90	39.1
15	29.5	25.0	23.3	0.0132	11.46	0.0115	36.2	317.50	36.2
30	28.3	23.8	23.3	0.0132	11.66	0.0082	34.4	301.63	34.4
60	27.5	23.0	23.3	0.0132	11.78	0.0058	33.3	292.10	33.3
120	26.0	21.5	23.4	0.0132	12.03	0.0042	31.2	273.05	31.2
250	24.5	20.0	23.4	0.0132	12.28	0.0029	29.0	254.00	29.0
1440	17.0	12.5	23.2	0.0132	13.51	0.0013	18.1	158.75	18.1

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_2.xls	Date:	3/14/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-7		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	66.84
Weight of Dry Soil & Pan (g):	63.70
Weight of Water (g):	3.14
Weight of Pan (g):	6.97
Weight of Dry Soil (g):	56.73
Moisture (%):	5.5

General Sample Data

Total Wet Weight of Sample (g):	964.35
Total Dry Weight of Sample (g):	914.64
Calculated Weight Plus #200 (g):	364.63
Moisture of Total Sample (%):	5.4
Percent Retained #200 Sieve (%):	39.9

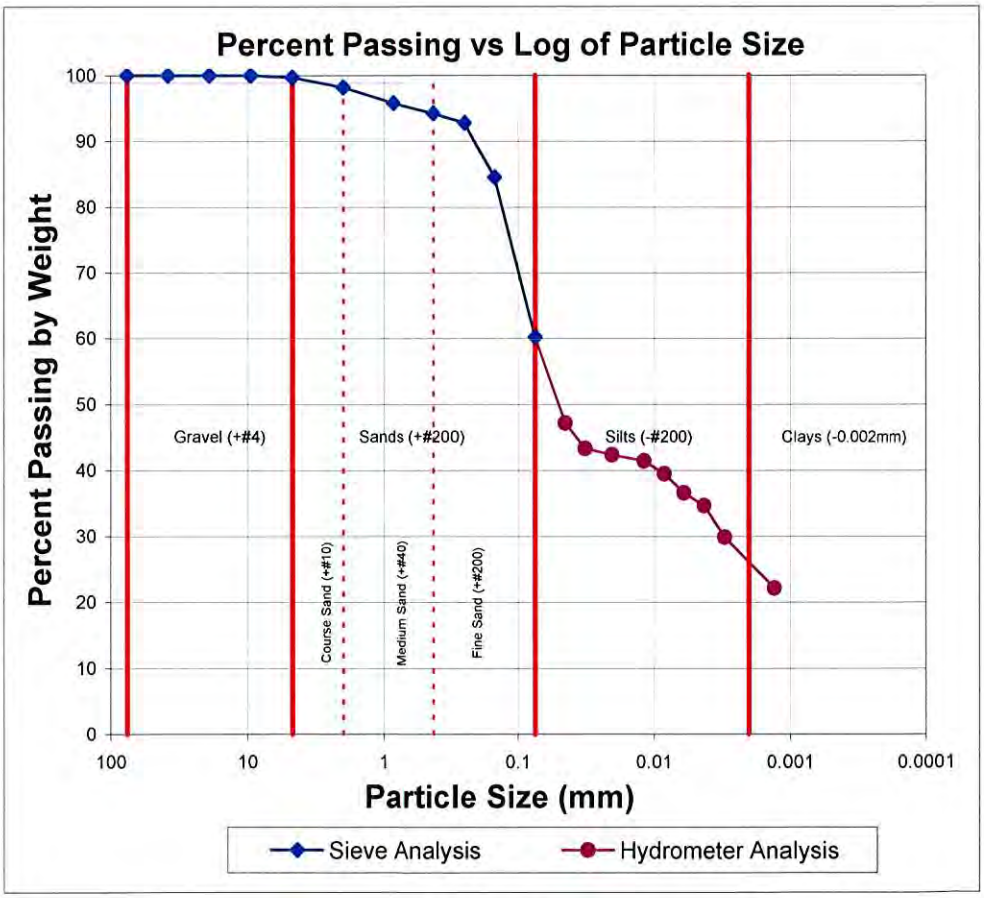
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	2.76	0.00	2.76	2.76	99.7
#10	**2.000**	13.83	0.00	13.83	13.83	98.2
53.91g split out of -#10 material.						
#20	**0.850**	4.37	3.15	1.23	21.59	95.8
#40	**0.425**	3.96	3.11	0.84	14.79	94.2
#60	**0.250**	3.97	3.20	0.77	13.50	92.7
#100	**0.150**	7.42	3.15	4.28	75.21	84.5
#200	**0.075**	15.81	3.13	12.68	222.96	60.1

Plus Split Data

Original Weight of +#10 (g): 17.91
Calculated Weight of +#10 (g): 16.59

Minus Split Data

Original Weight of -#10 (g): 946.44
Calculated Dry Weight of -#10 (g): 898.06



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.30
Percent Sands (%): 39.56
Percent Fines (%): 60.13

USCS Classification

Sandy Lean Clay

Data Entered By: NN
Date: 4/7/2016
File Name: 2952_2_hydrometer-ASTM-D422-R3_3.xls

Checked By: CM
Date: 4/11/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-7		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	964.35
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	914.64
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	53.910
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	51.083
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	52.019

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	28.5	24.5	23.3	0.0132	11.62	0.0449	47.2	431.37	47.2
2	26.5	22.5	23.3	0.0132	11.95	0.0322	43.3	396.15	43.3
5	26.0	22.0	23.3	0.0132	12.03	0.0204	42.3	387.35	42.3
15	25.5	21.5	23.3	0.0132	12.11	0.0118	41.4	378.55	41.4
30	24.5	20.5	23.4	0.0132	12.28	0.0084	39.5	360.94	39.5
60	23.0	19.0	23.4	0.0132	12.52	0.0060	36.6	334.53	36.6
120	22.0	18.0	23.6	0.0132	12.69	0.0043	34.6	316.92	34.6
250	19.5	15.5	23.6	0.0132	13.10	0.0030	29.8	272.91	29.8
1440	15.5	11.5	22.8	0.0133	13.75	0.0013	22.1	202.48	22.1

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CM
File Name:	2952_2_hydrometer-ASTM-D422-R3_3.xls	Date:	4/11/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-8		
Job Number:	2952-1	Depth:	18-20'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/11/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	69.13
Weight of Dry Soil & Pan (g):	67.58
Weight of Water (g):	1.55
Weight of Pan (g):	3.13
Weight of Dry Soil (g):	64.45
Moisture (%):	2.4

General Sample Data

Total Wet Weight of Sample (g):	681.67
Total Dry Weight of Sample (g):	665.74
Calculated Weight Plus #200 (g):	294.11
Moisture of Total Sample (%):	2.4
Percent Retained #200 Sieve (%):	44.2

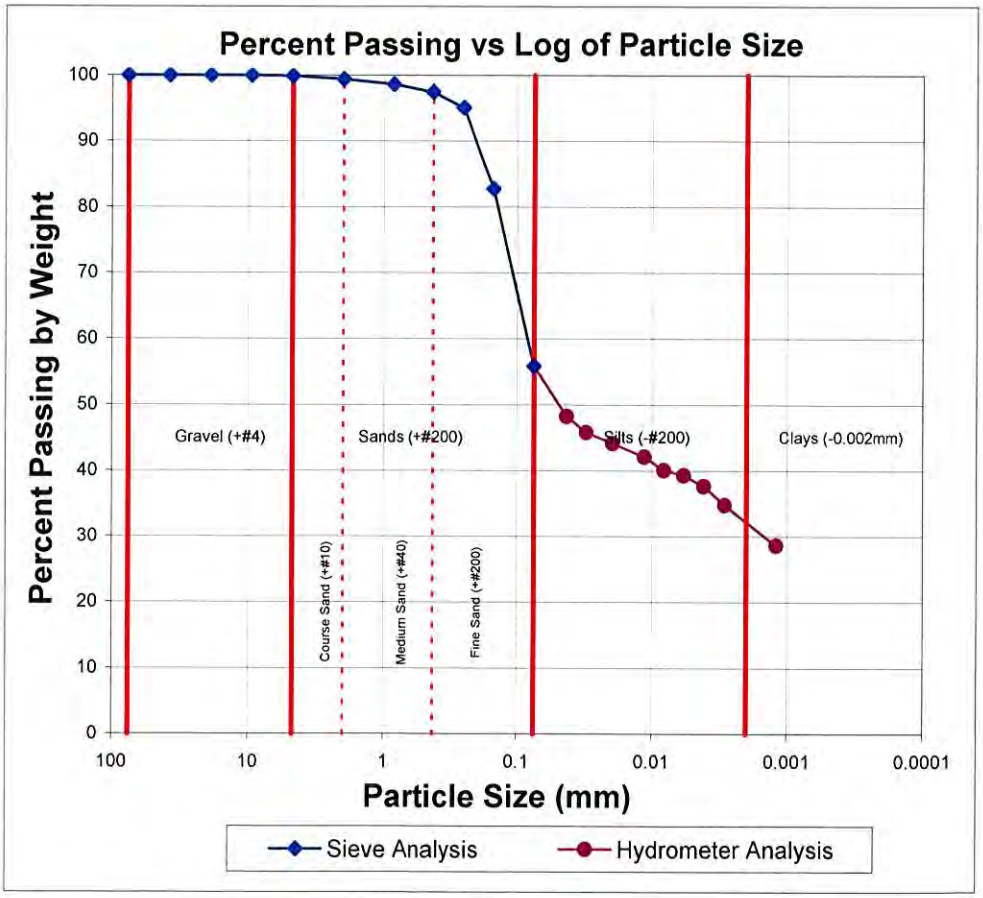
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.58	0.00	0.58	0.58	99.9
#10	**2.000**	3.23	0.00	3.23	3.23	99.4
62.34g split out of -#10 material.						
#20	**0.850**	3.59	3.10	0.49	5.33	98.6
#40	**0.425**	3.89	3.14	0.75	8.20	97.4
#60	**0.250**	4.67	3.22	1.44	15.70	95.0
#100	**0.150**	10.77	3.21	7.56	82.20	82.7
#200	**0.075**	19.64	3.19	16.45	178.87	55.8

Plus Split Data

Original Weight of +#10 (g): 5.08
Calculated Weight of +#10 (g): 3.81

Minus Split Data

Original Weight of -#10 (g): 676.59
Calculated Dry Weight of -#10 (g): 661.93



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.09
Percent Sands (%): 44.09
Percent Fines (%): 55.82

USCS Classification

Sandy Lean Clay

Data Entered By:	NN	Checked By:	CKP
Date:	3/14/2016	Date:	3/14/16
File Name:	2952_1_hydrometer-ASTM-D422-R3_9.xls		

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-8		
Job Number:	2952-1	Depth:	18-20'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	681.67
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	665.74
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	62.340
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	60.875
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	61.242

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	34.0	29.5	23.3	0.0132	10.72	0.0431	48.2	321.12	48.2
2	32.5	28.0	23.3	0.0132	10.96	0.0308	45.8	304.79	45.8
5	31.5	27.0	23.3	0.0132	11.13	0.0196	44.1	293.90	44.1
15	30.3	25.8	23.3	0.0132	11.33	0.0114	42.1	280.30	42.1
30	29.0	24.5	23.4	0.0132	11.54	0.0082	40.1	266.69	40.1
60	28.5	24.0	23.4	0.0132	11.62	0.0058	39.2	261.25	39.2
120	27.5	23.0	23.4	0.0132	11.78	0.0041	37.6	250.36	37.6
250	25.8	21.3	23.4	0.0132	12.07	0.0029	34.7	231.31	34.7
1536	22.0	17.5	23.2	0.0132	12.69	0.0012	28.6	190.49	28.6

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_9.xls	Date:	3/15/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-9		
Job Number:	2952-1	Depth:	17-19'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/14/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	98.07
Weight of Dry Soil & Pan (g):	97.27
Weight of Water (g):	0.80
Weight of Pan (g):	6.88
Weight of Dry Soil (g):	90.39
Moisture (%):	0.9

General Sample Data

Total Wet Weight of Sample (g):	775.08
Total Dry Weight of Sample (g):	768.54
Calculated Weight Plus #200 (g):	476.82
Moisture of Total Sample (%):	0.9
Percent Retained #200 Sieve (%):	62.0

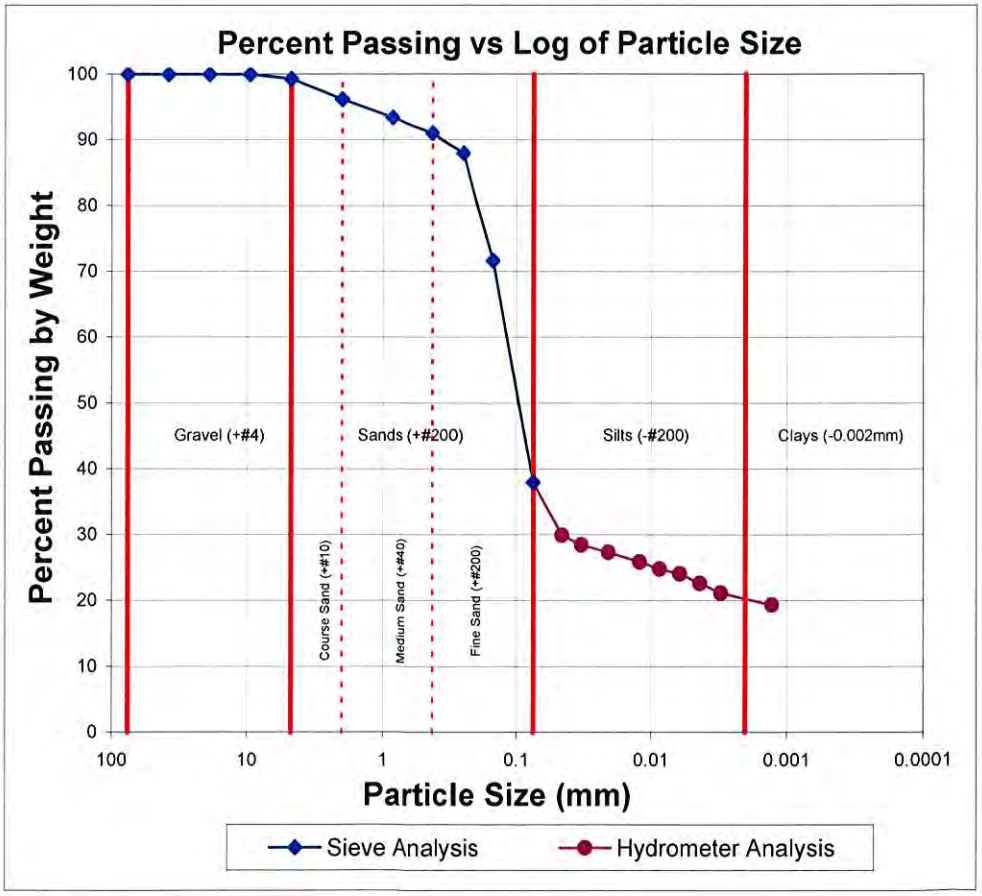
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	5.26	0.00	5.26	5.26	99.3
#10	**2.000**	23.84	0.00	23.84	23.84	96.2
66.647g split out of -#10 material.						
#20	**0.850**	4.96	3.04	1.92	21.48	93.4
#40	**0.425**	4.78	3.10	1.68	18.85	91.0
#60	**0.250**	5.19	3.11	2.09	23.35	87.9
#100	**0.150**	14.31	3.10	11.21	125.47	71.6
#200	**0.075**	26.22	3.12	23.10	258.57	38.0

Plus Split Data

Original Weight of +#10 (g):	30.70
Calculated Weight of +#10 (g):	29.10

Minus Split Data

Original Weight of -#10 (g):	744.38
Calculated Dry Weight of -#10 (g):	739.44



USCS Classification ASTM D 2487

Atterberg Classification:	CL
Group Symbol:	SC

Course-Grained Soils

Percent Gravels (%):	0.68
Percent Sands (%):	61.36
Percent Fines (%):	37.96

USCS Classification

Clayey Sand

Data Entered By:	NN		
Date:	3/15/2016	Checked By:	BDP
File Name:	2952_1_hydrometer-ASTM-D422-R3_12.xls	Date:	3/16/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-9		
Job Number:	2952-1	Depth:	17-19'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	775.08
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	768.54
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	66.647
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	66.062
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	68.672

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	25.0	20.5	23.3	0.0132	12.19	0.0460	29.9	229.74	29.9
2	24.0	19.5	23.3	0.0132	12.36	0.0327	28.4	218.53	28.4
5	23.3	18.8	23.3	0.0132	12.48	0.0208	27.3	210.13	27.3
15	22.3	17.8	23.4	0.0132	12.65	0.0121	25.9	198.92	25.9
30	21.5	17.0	23.4	0.0132	12.77	0.0086	24.8	190.51	24.8
60	21.0	16.5	23.4	0.0132	12.85	0.0061	24.1	184.91	24.1
120	20.0	15.5	23.4	0.0132	13.01	0.0043	22.6	173.70	22.6
250	19.0	14.5	23.4	0.0132	13.18	0.0030	21.1	162.50	21.1
1440	17.8	13.3	23.3	0.0132	13.38	0.0013	19.3	148.49	19.3

Data Entered By:	NN		
Date:	3/15/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_12.xls	Date:	3/16/16

ATT
ADVANCED TECHNOLOGY

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-12		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	109.09
Weight of Dry Soil & Pan (g):	107.13
Weight of Water (g):	1.97
Weight of Pan (g):	6.91
Weight of Dry Soil (g):	100.21
Moisture (%):	2.0

General Sample Data

Total Wet Weight of Sample (g):	793.17
Total Dry Weight of Sample (g):	778.43
Calculated Weight Plus #200 (g):	334.16
Moisture of Total Sample (%):	1.9
Percent Retained #200 Sieve (%):	42.9

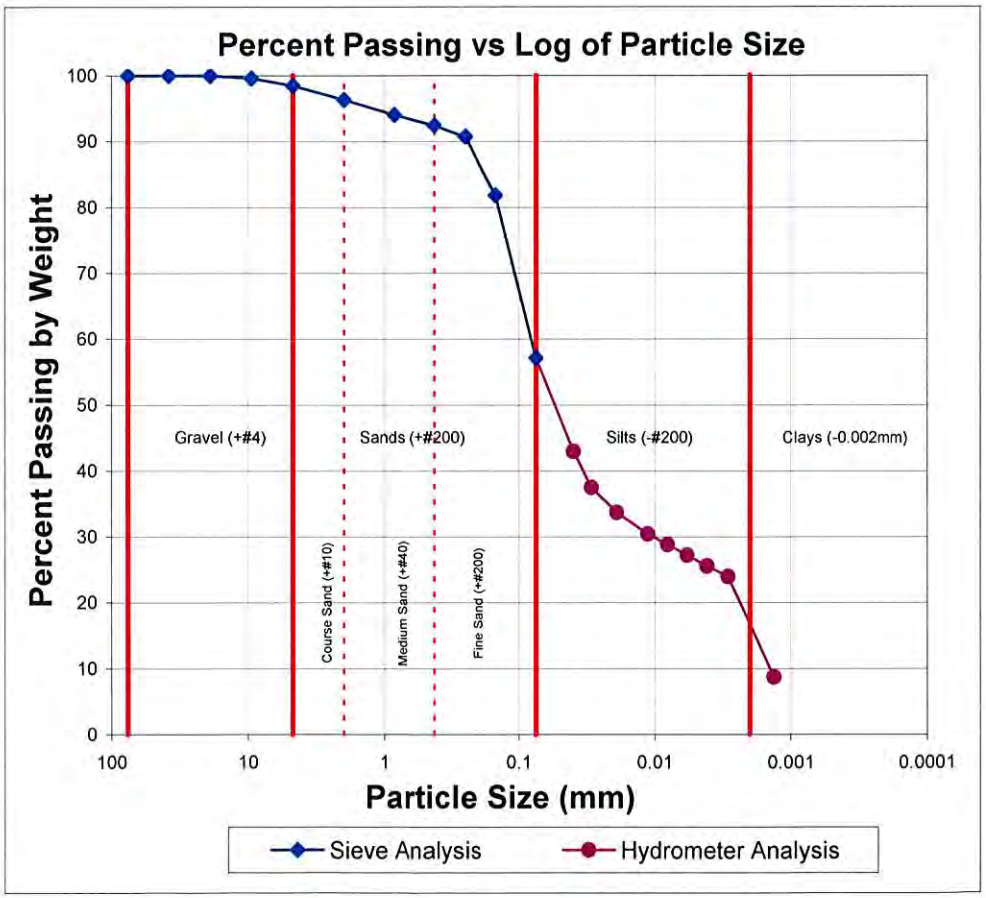
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	2.94	0.00	2.94	2.94	99.6
#4	**4.750**	8.66	0.00	8.66	8.66	98.5
#10	**2.000**	16.73	0.00	16.73	16.73	96.4
90.603g split out of -#10 material.						
#20	**0.850**	5.23	3.10	2.13	17.96	94.1
#40	**0.425**	4.61	3.10	1.50	12.69	92.4
#60	**0.250**	4.69	3.09	1.61	13.58	90.7
#100	**0.150**	11.31	3.10	8.20	69.25	81.8
#200	**0.075**	26.00	3.22	22.79	192.36	57.1

Plus Split Data

Original Weight of +#10 (g): 30.92
Calculated Weight of +#10 (g): 28.33

Minus Split Data

Original Weight of -#10 (g): 762.25
Calculated Dry Weight of -#10 (g): 750.10



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 1.49
Percent Sands (%): 41.44
Percent Fines (%): 57.07

USCS Classification

Sandy Lean Clay

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CAL
File Name:	2952_2_hydrometer-ASTM-D422-R3_4.xls	Date:	4-07-16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-12		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	793.17
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	778.43
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	90.603
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	88.857
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	92.175

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	43.5	39.5	23.5	0.0132	9.16	0.0399	42.9	334.04	42.9
2	38.5	34.5	23.5	0.0132	9.98	0.0294	37.5	291.75	37.5
5	35.0	31.0	23.5	0.0132	10.55	0.0191	33.7	262.16	33.7
15	32.0	28.0	23.4	0.0132	11.05	0.0113	30.4	236.79	30.4
30	30.5	26.5	23.5	0.0132	11.29	0.0081	28.8	224.10	28.8
60	29.0	25.0	23.6	0.0132	11.54	0.0058	27.2	211.42	27.2
120	27.5	23.5	23.7	0.0132	11.78	0.0041	25.5	198.73	25.5
250	26.0	22.0	23.7	0.0132	12.03	0.0029	23.9	186.05	23.9
1440	12.0	8.0	22.6	0.0133	14.33	0.0013	8.7	67.65	8.7

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CHL
File Name:	2952_2_hydrometer-ASTM-D422-R3_4.xls	Date:	4/9/16

ATT
ADVANCED TERRACTION

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-13		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	71.71
Weight of Dry Soil & Pan (g):	70.04
Weight of Water (g):	1.66
Weight of Pan (g):	3.09
Weight of Dry Soil (g):	66.95
Moisture (%):	2.5

General Sample Data

Total Wet Weight of Sample (g):	58.24
Total Dry Weight of Sample (g):	56.83
Calculated Weight Plus #200 (g):	8.99
Moisture of Total Sample (%):	2.5
Percent Retained #200 Sieve (%):	15.8

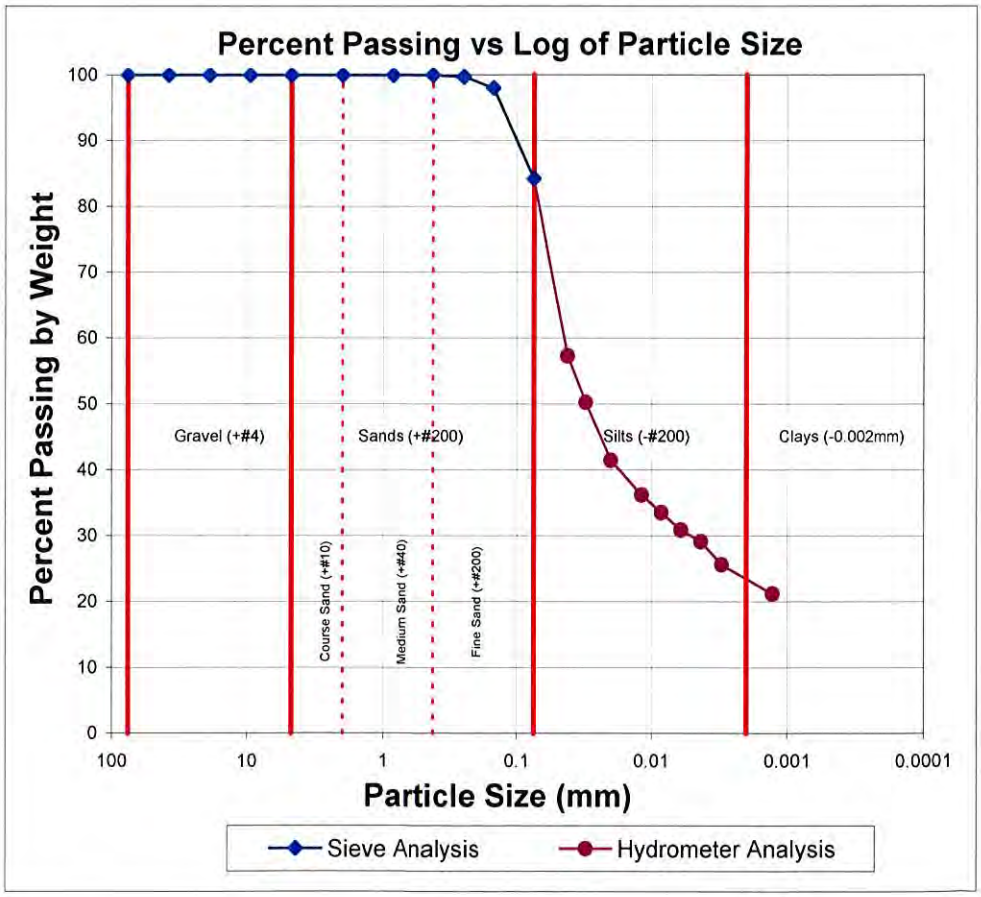
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
58.242g split out of -#10 material.						
#20	**0.850**	3.21	3.21	0.00	0.00	100.0
#40	**0.425**	3.27	3.24	0.03	0.03	99.9
#60	**0.250**	3.36	3.22	0.14	0.14	99.7
#100	**0.150**	4.18	3.23	0.96	0.96	98.0
#200	**0.075**	11.08	3.22	7.86	7.86	84.2

Plus Split Data

Original Weight of +#10 (g): 0.00
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 58.24
Calculated Dry Weight of -#10 (g): 56.83



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 15.82
Percent Fines (%): 84.18

USCS Classification

Lean Clay With Sand

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_5.xls	Date:	3/14/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-13		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	58.24
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	56.83
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	58.242
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	56.829
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	56.829

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	37.0	32.5	23.3	0.0132	10.23	0.0421	57.3	32.54	57.3
2	33.0	28.5	23.3	0.0132	10.88	0.0307	50.2	28.54	50.2
5	28.0	23.5	23.3	0.0132	11.70	0.0201	41.4	23.53	41.4
15	25.0	20.5	23.2	0.0132	12.19	0.0119	36.1	20.53	36.1
30	23.5	19.0	23.3	0.0132	12.44	0.0085	33.5	19.03	33.5
60	22.0	17.5	23.4	0.0132	12.69	0.0061	30.8	17.52	30.8
120	21.0	16.5	23.4	0.0132	12.85	0.0043	29.1	16.52	29.1
250	19.0	14.5	23.5	0.0132	13.18	0.0030	25.6	14.52	25.6
1440	16.5	12.0	23.4	0.0132	13.59	0.0013	21.1	12.02	21.1

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_5.xls	Date:	3/14/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-14		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	27.85
Weight of Dry Soil & Pan (g):	27.32
Weight of Water (g):	0.53
Weight of Pan (g):	3.13
Weight of Dry Soil (g):	24.18
Moisture (%):	2.2

General Sample Data

Total Wet Weight of Sample (g):	713.81
Total Dry Weight of Sample (g):	698.45
Calculated Weight Plus #200 (g):	142.83
Moisture of Total Sample (%):	2.2
Percent Retained #200 Sieve (%):	20.4

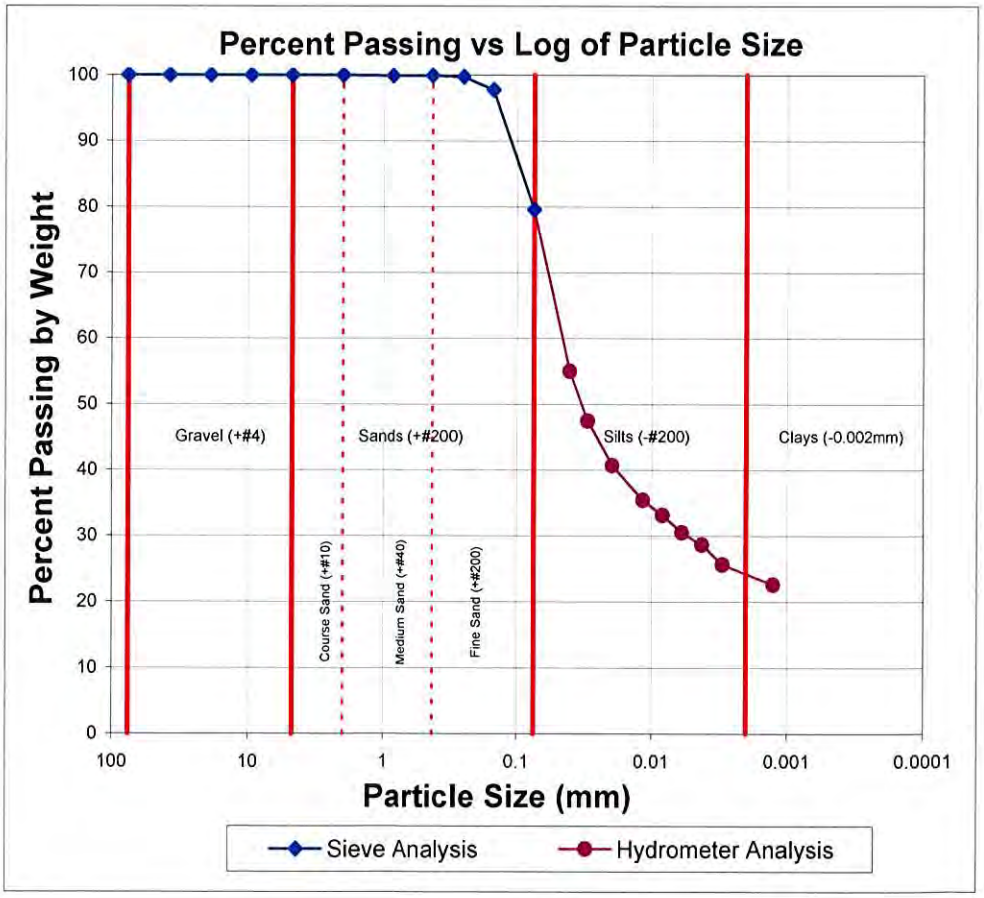
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.07	0.00	0.07	0.07	100.0
67.927g split out of -#10 material.						
#20	**0.850**	3.14	3.09	0.04	0.45	99.9
#40	**0.425**	3.11	3.08	0.03	0.27	99.9
#60	**0.250**	3.34	3.22	0.12	1.24	99.7
#100	**0.150**	4.57	3.23	1.34	14.08	97.7
#200	**0.075**	15.17	3.11	12.06	126.72	79.6

Plus Split Data

Original Weight of +#10 (g): 0.09
Calculated Weight of +#10 (g): 0.07

Minus Split Data

Original Weight of -#10 (g): 713.72
Calculated Dry Weight of -#10 (g): 698.38



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 20.45
Percent Fines (%): 79.55

USCS Classification

Lean Clay With Sand

Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_hydrometer-ASTM-D422-R3_4.xls

Checked By: CKP
Date: 3/14/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-14		
Job Number:	2952-1	Depth:	10' (9-14')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	713.81
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	698.45
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	67.927
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	66.465
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	66.465

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	41.0	36.5	23.3	0.0132	9.57	0.0407	55.0	384.08	55.0
2	36.0	31.5	23.3	0.0132	10.39	0.0300	47.5	331.47	47.5
5	31.5	27.0	23.3	0.0132	11.13	0.0196	40.7	284.12	40.7
15	28.0	23.5	23.3	0.0132	11.70	0.0116	35.4	247.29	35.4
30	26.5	22.0	23.3	0.0132	11.95	0.0083	33.1	231.50	33.1
60	24.8	20.3	23.4	0.0132	12.24	0.0059	30.5	213.09	30.5
120	23.5	19.0	23.4	0.0132	12.44	0.0042	28.6	199.93	28.6
250	21.5	17.0	23.4	0.0132	12.77	0.0030	25.6	178.89	25.6
1440	19.5	15.0	23.2	0.0132	13.10	0.0013	22.6	157.84	22.6

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_4.xls	Date:	3/14/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-14		
Job Number:	2952-1	Depth:	17-19'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	91.86
Weight of Dry Soil & Pan (g):	88.40
Weight of Water (g):	3.46
Weight of Pan (g):	6.57
Weight of Dry Soil (g):	81.83
Moisture (%):	4.2

General Sample Data

Total Wet Weight of Sample (g):	781.68
Total Dry Weight of Sample (g):	750.13
Calculated Weight Plus #200 (g):	227.11
Moisture of Total Sample (%):	4.2
Percent Retained #200 Sieve (%):	30.3

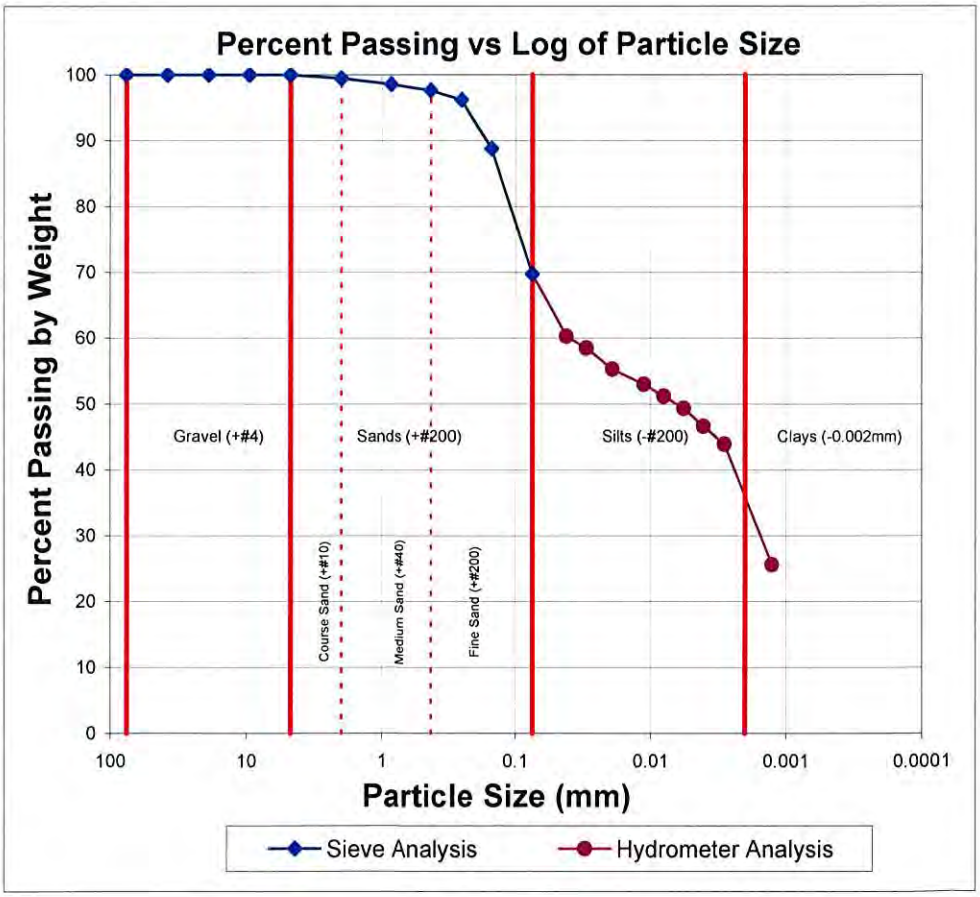
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	3.91	0.00	3.91	3.91	99.5
56.871g split out of -#10 material.						
#20	**0.850**	3.65	3.15	0.50	6.87	98.6
#40	**0.425**	3.71	3.20	0.51	7.03	97.6
#60	**0.250**	3.88	3.06	0.82	11.21	96.1
#100	**0.150**	7.18	3.14	4.04	55.27	88.8
#200	**0.075**	13.59	3.15	10.44	142.83	69.7

Plus Split Data

Original Weight of +#10 (g): 4.35
Calculated Weight of +#10 (g): 3.91

Minus Split Data

Original Weight of -#10 (g): 777.33
Calculated Dry Weight of -#10 (g): 746.22



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 30.28
Percent Fines (%): 69.72

USCS Classification

Sandy Lean Clay

Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_hydrometer-ASTM-D422-R3_7.xls

Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-14		
Job Number:	2952-1	Depth:	17-19'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/8/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	781.68
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	750.13
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	56.871
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	54.564
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	54.838

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	37.0	33.0	23.0	0.0132	10.23	0.0421	60.3	452.02	60.3
2	36.0	32.0	23.0	0.0132	10.39	0.0300	58.4	438.32	58.4
5	34.3	30.3	23.0	0.0132	10.68	0.0192	55.2	414.35	55.2
15	33.0	29.0	23.0	0.0132	10.88	0.0112	53.0	397.23	53.0
30	32.0	28.0	23.0	0.0132	11.05	0.0080	51.1	383.53	51.1
60	31.0	27.0	23.1	0.0132	11.21	0.0057	49.3	369.84	49.3
120	29.5	25.5	23.2	0.0132	11.46	0.0041	46.6	349.29	46.6
250	28.0	24.0	23.3	0.0132	11.70	0.0028	43.8	328.74	43.8
1482	18.0	14.0	22.8	0.0133	13.34	0.0013	25.6	191.77	25.6

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	CKP
File Name:	2952_1_hydrometer-ASTM-D422-R3_7.xls	Date:	3/14/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-16		
Job Number:	2952-1	Depth:	14-16'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	57.21
Weight of Dry Soil & Pan (g):	55.67
Weight of Water (g):	1.54
Weight of Pan (g):	3.11
Weight of Dry Soil (g):	52.56
Moisture (%):	2.9

General Sample Data

Total Wet Weight of Sample (g):	64.08
Total Dry Weight of Sample (g):	62.26
Calculated Weight Plus #200 (g):	15.27
Moisture of Total Sample (%):	2.9
Percent Retained #200 Sieve (%):	24.5

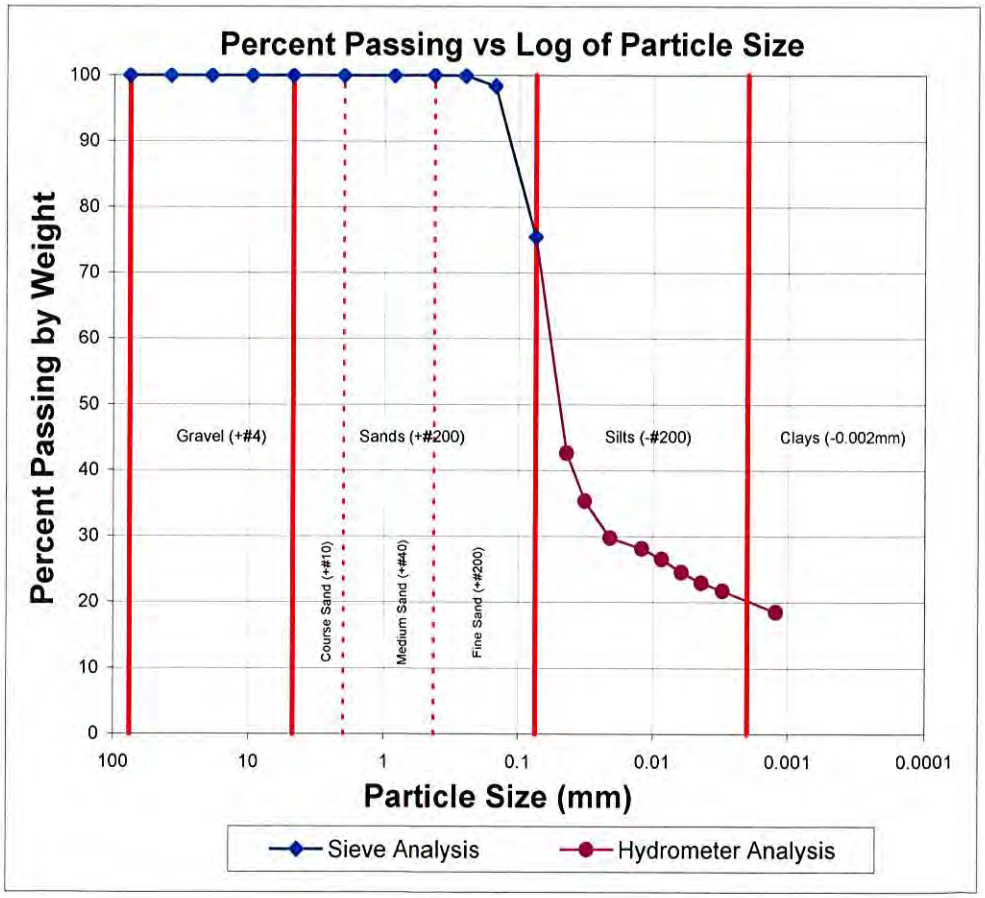
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
64.082g split out of -#10 material.						
#20	**0.850**	3.11	3.11	0.00	0.00	100.0
#40	**0.425**	3.11	3.11	0.00	0.00	100.0
#60	**0.250**	3.28	3.23	0.05	0.05	99.9
#100	**0.150**	4.10	3.12	0.99	0.99	98.3
#200	**0.075**	17.33	3.09	14.23	14.23	75.5

Plus Split Data

Original Weight of +#10 (g): 0.00
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 64.08
Calculated Dry Weight of -#10 (g): 62.26



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 24.53
Percent Fines (%): 75.47

USCS Classification

Lean Clay With Sand

Data Entered By:	NN	Checked By:	BDF
Date:	3/14/2016	Date:	3/15/16
File Name:	2952_1_hydrometer-ASTM-D422-R3_10.xls		

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-16		
Job Number:	2952-1	Depth:	14-16'		
Project:	North Weld Landfill Expansion	Sample Number:	UD		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/9/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	64.08
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	62.26
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	64.082
Deflocculant Correction:	4.5	Dry Weight of Sub-Sample (g):	62.257
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	62.257

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	31.0	26.5	23.4	0.0132	11.21	0.0441	42.6	26.54	42.6
2	26.5	22.0	23.4	0.0132	11.95	0.0322	35.4	22.03	35.4
5	23.0	18.5	23.4	0.0132	12.52	0.0208	29.8	18.53	29.8
15	22.0	17.5	23.4	0.0132	12.69	0.0121	28.1	17.52	28.1
30	21.0	16.5	23.4	0.0132	12.85	0.0086	26.5	16.52	26.5
60	19.8	15.3	23.4	0.0132	13.06	0.0061	24.5	15.27	24.5
120	18.8	14.3	23.5	0.0132	13.22	0.0044	22.9	14.27	22.9
250	18.0	13.5	23.4	0.0132	13.34	0.0030	21.7	13.52	21.7
1578	16.0	11.5	23.2	0.0132	13.67	0.0012	18.5	11.52	18.5

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_10.xls	Date:	3/15/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-20		
Job Number:	2952-1	Depth:	10' (9-12')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Wash Date:	3/10/2016	Wash Technician:	DPM

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	67.68
Weight of Dry Soil & Pan (g):	65.58
Weight of Water (g):	2.11
Weight of Pan (g):	3.11
Weight of Dry Soil (g):	62.46
Moisture (%):	3.4

General Sample Data

Total Wet Weight of Sample (g):	56.19
Total Dry Weight of Sample (g):	54.36
Calculated Weight Plus #200 (g):	10.78
Moisture of Total Sample (%):	3.4
Percent Retained #200 Sieve (%):	19.8

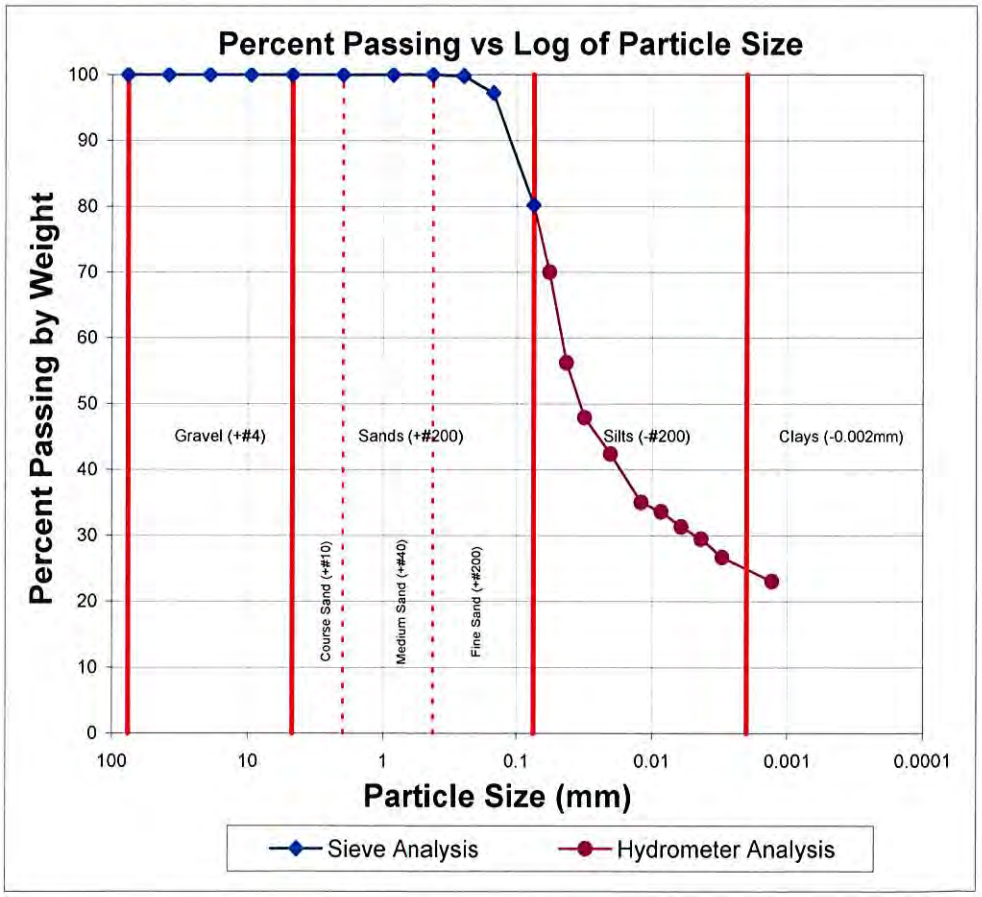
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
56.191g split out of -#10 material.						
#20	**0.850**	3.20	3.20	0.00	0.00	100.0
#40	**0.425**	3.11	3.09	0.02	0.02	100.0
#60	**0.250**	3.25	3.13	0.12	0.12	99.7
#100	**0.150**	4.61	3.21	1.40	1.40	97.2
#200	**0.075**	12.51	3.27	9.24	9.24	80.2

Plus Split Data

Original Weight of +#10 (g): 0.00
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 56.19
Calculated Dry Weight of -#10 (g): 54.36



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 19.83
Percent Fines (%): 80.17

USCS Classification

Lean Clay With Sand

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_6.xls	Date:	3/16/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	NWE-20		
Job Number:	2952-1	Depth:	10' (9-12')		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047	Test Date:	3/8/2016	Technician:	DPM

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	56.19
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	54.36
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	56.191
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	54.357
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	54.357

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
0.5	42.0	38.0	23.1	0.0132	9.41	0.0571	70.0	38.05	70.0
1	34.5	30.5	23.1	0.0132	10.64	0.0430	56.2	30.54	56.2
2	30.0	26.0	23.1	0.0132	11.37	0.0314	47.9	26.04	47.9
5	27.0	23.0	23.1	0.0132	11.87	0.0203	42.4	23.03	42.4
15	23.0	19.0	23.1	0.0132	12.52	0.0120	35.0	19.03	35.0
30	22.3	18.3	23.2	0.0132	12.65	0.0086	33.6	18.27	33.6
60	21.0	17.0	23.3	0.0132	12.85	0.0061	31.3	17.02	31.3
120	20.0	16.0	23.3	0.0132	13.01	0.0043	29.5	16.02	29.5
250	18.5	14.5	23.4	0.0132	13.26	0.0030	26.7	14.52	26.7
1440	16.5	12.5	22.8	0.0133	13.59	0.0013	23.0	12.52	23.0

Data Entered By:	NN		
Date:	3/14/2016	Checked By:	BDF
File Name:	2952_1_hydrometer-ASTM-D422-R3_6.xls	Date:	3/16/16

ATT
ADVANCED

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #1		
Job Number:	2952-2	Depth:	2-4' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	101.78
Weight of Dry Soil & Pan (g):	96.24
Weight of Water (g):	5.54
Weight of Pan (g):	6.60
Weight of Dry Soil (g):	89.64
Moisture (%):	6.2

General Sample Data

Total Wet Weight of Sample (g):	643.56
Total Dry Weight of Sample (g):	606.34
Calculated Weight Plus #200 (g):	115.35
Moisture of Total Sample (%):	6.1
Percent Retained #200 Sieve (%):	19.0

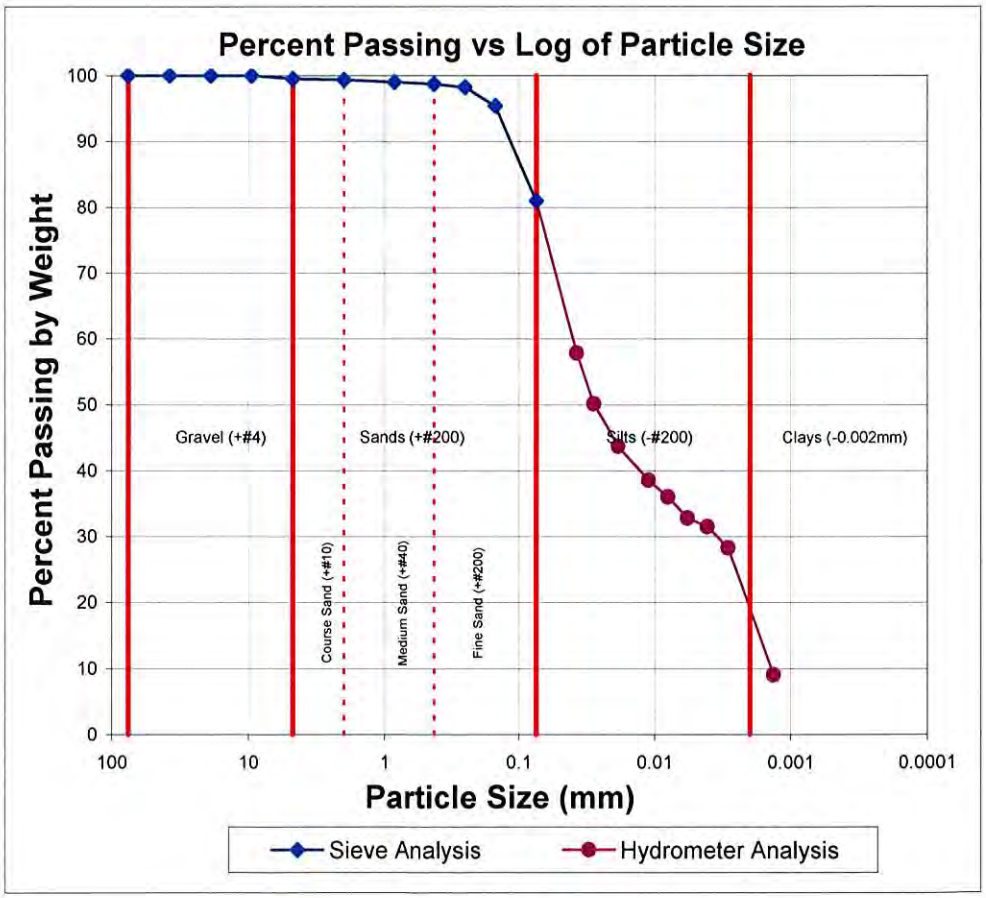
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	2.90	0.00	2.90	2.90	99.5
#10	**2.000**	0.87	0.00	0.87	0.87	99.4
82.253g split out of -#10 material.						
#20	**0.850**	3.40	3.13	0.27	2.11	99.0
#40	**0.425**	3.39	3.12	0.27	2.07	98.7
#60	**0.250**	3.48	3.11	0.38	2.92	98.2
#100	**0.150**	5.29	3.10	2.19	17.06	95.4
#200	**0.075**	14.43	3.19	11.24	87.43	81.0

Plus Split Data

Original Weight of +#10 (g): 4.06
Calculated Weight of +#10 (g): 3.77

Minus Split Data

Original Weight of -#10 (g): 639.50
Calculated Dry Weight of -#10 (g): 602.57



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.48
Percent Sands (%): 18.55
Percent Fines (%): 80.98

USCS Classification

Lean Clay With Sand

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CAC
File Name:	2952_2_hydrometer-ASTM-D422-R3_5.xls	Date:	4-7-16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #1		
Job Number:	2952-2	Depth:	2-4' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	643.56
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	606.34
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	82.253
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	77.467
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	77.935

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	49.0	45.0	23.0	0.0132	8.26	0.0378	57.8	350.58	57.8
2	43.0	39.0	23.0	0.0132	9.24	0.0283	50.1	303.84	50.1
5	38.0	34.0	23.0	0.0132	10.06	0.0187	43.7	264.88	43.7
15	34.0	30.0	23.1	0.0132	10.72	0.0111	38.5	233.72	38.5
30	32.0	28.0	23.1	0.0132	11.05	0.0080	36.0	218.14	36.0
60	29.5	25.5	23.4	0.0132	11.46	0.0058	32.8	198.66	32.8
120	28.5	24.5	23.6	0.0132	11.62	0.0041	31.5	190.87	31.5
250	26.0	22.0	23.7	0.0132	12.03	0.0029	28.3	171.39	28.3
1440	11.0	7.0	22.5	0.0133	14.49	0.0013	9.0	54.53	9.0

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CdL
File Name:	2952_2_hydrometer-ASTM-D422-R3_5.xls	Date:	4-7-16

ATT
ADVANCED TERRACE STONE

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #2		
Job Number:	2952-2	Depth:	5-9'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	101.09
Weight of Dry Soil & Pan (g):	97.20
Weight of Water (g):	3.89
Weight of Pan (g):	6.90
Weight of Dry Soil (g):	90.30
Moisture (%):	4.3

General Sample Data

Total Wet Weight of Sample (g):	739.60
Total Dry Weight of Sample (g):	709.08
Calculated Weight Plus #200 (g):	128.76
Moisture of Total Sample (%):	4.3
Percent Retained #200 Sieve (%):	18.2

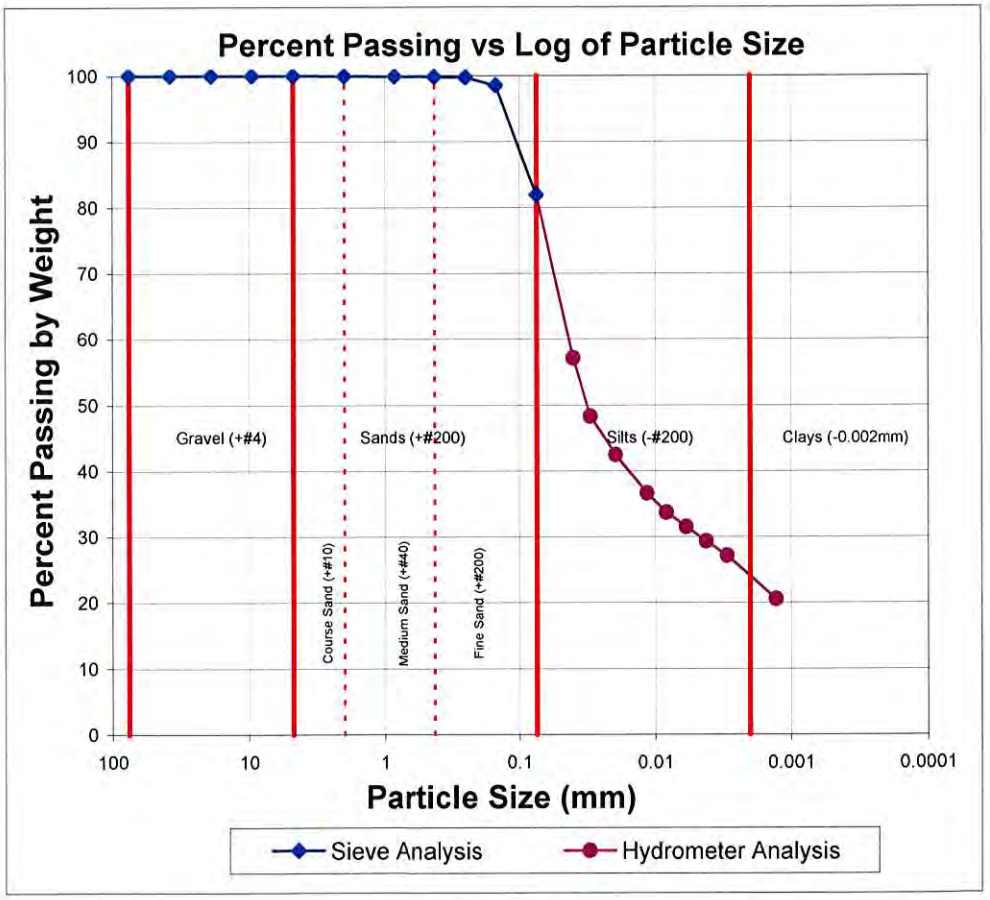
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.39	0.00	0.39	0.39	99.9
71.3g split out of -#10 material.						
#20	**0.850**	3.18	3.15	0.03	0.29	99.9
#40	**0.425**	3.28	3.23	0.05	0.53	99.8
#60	**0.250**	3.20	3.11	0.09	0.91	99.7
#100	**0.150**	3.94	3.10	0.84	8.70	98.5
#200	**0.075**	14.50	3.12	11.38	117.94	81.8

Plus Split Data

Original Weight of +#10 (g): 0.43
Calculated Weight of +#10 (g): 0.39

Minus Split Data

Original Weight of -#10 (g): 739.17
Calculated Dry Weight of -#10 (g): 708.69



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 18.16
Percent Fines (%): 81.84

USCS Classification

Lean Clay With Sand

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CAL
File Name:	2952_2_hydrometer-ASTM-D422-R3_6.xls	Date:	4/11/16

ATT
ADVANCED TREATMENT

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #2		
Job Number:	2952-2	Depth:	5-9'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	739.60
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	709.08
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	71.300
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	68.356
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	68.425

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	43.0	39.0	22.9	0.0133	9.24	0.0405	57.1	404.70	57.1
2	37.0	33.0	22.9	0.0133	10.23	0.0301	48.3	342.44	48.3
5	33.0	29.0	22.9	0.0133	10.88	0.0197	42.4	300.93	42.4
15	29.0	25.0	23.0	0.0132	11.54	0.0116	36.6	259.43	36.6
30	27.0	23.0	23.1	0.0132	11.87	0.0083	33.7	238.67	33.7
60	25.5	21.5	23.2	0.0132	12.11	0.0059	31.5	223.11	31.5
120	24.0	20.0	23.5	0.0132	12.36	0.0042	29.3	207.54	29.3
250	22.5	18.5	23.7	0.0132	12.60	0.0030	27.1	191.97	27.1
1440	18.0	14.0	22.5	0.0133	13.34	0.0013	20.5	145.28	20.5

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CH
File Name:	2952_2_hydrometer-ASTM-D422-R3_6.xls	Date:	4/11/16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #3		
Job Number:	2952-2	Depth:	3-5' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	116.76
Weight of Dry Soil & Pan (g):	112.43
Weight of Water (g):	4.33
Weight of Pan (g):	7.04
Weight of Dry Soil (g):	105.40
Moisture (%):	4.1

General Sample Data

Total Wet Weight of Sample (g):	838.75
Total Dry Weight of Sample (g):	805.65
Calculated Weight Plus #200 (g):	375.97
Moisture of Total Sample (%):	4.1
Percent Retained #200 Sieve (%):	46.7

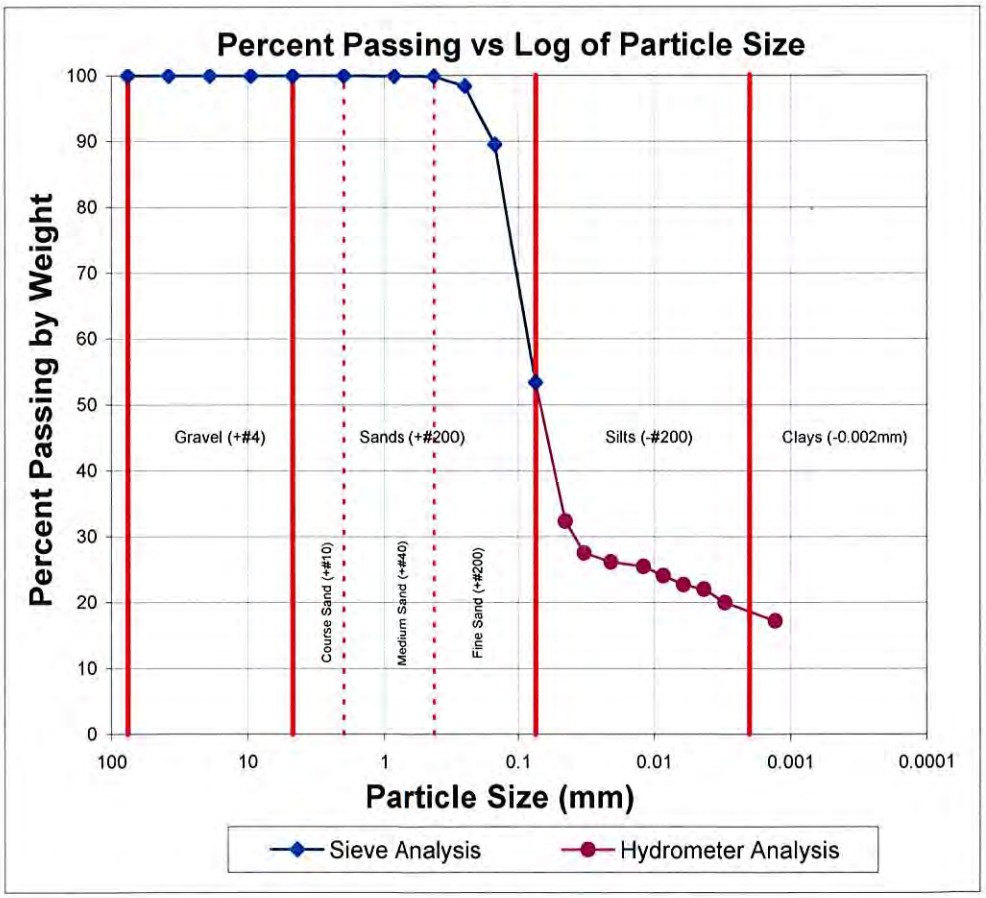
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
75.911g split out of -#10 material.						
#20	**0.850**	3.22	3.19	0.03	0.29	100.0
#40	**0.425**	3.19	3.11	0.08	0.89	99.9
#60	**0.250**	4.24	3.13	1.11	12.23	98.3
#100	**0.150**	9.57	3.13	6.45	71.23	89.5
#200	**0.075**	29.46	3.10	26.37	291.32	53.3

Plus Split Data

Original Weight of +#10 (g): 0.00
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 838.75
Calculated Dry Weight of -#10 (g): 805.65



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 46.67
Percent Fines (%): 53.33

USCS Classification

Sandy Lean Clay

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CJC
File Name:	2952_2_hydrometer-ASTM-D422-R3_2.xls	Date:	4/07/2016

ATT
ADVANCED TERRA SYSTEMS

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #3		
Job Number:	2952-2	Depth:	3-5' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	838.75
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	805.65
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	75.911
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	72.915
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	72.915

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	27.5	23.5	23.2	0.0132	11.78	0.0452	32.3	260.01	32.3
2	24.0	20.0	23.2	0.0132	12.36	0.0327	27.5	221.28	27.5
5	23.0	19.0	23.2	0.0132	12.52	0.0208	26.1	210.22	26.1
15	22.5	18.5	23.2	0.0132	12.60	0.0121	25.4	204.69	25.4
30	21.5	17.5	23.3	0.0132	12.77	0.0086	24.0	193.62	24.0
60	20.5	16.5	23.4	0.0132	12.93	0.0061	22.7	182.56	22.7
120	20.0	16.0	23.7	0.0132	13.01	0.0043	22.0	177.03	22.0
250	18.5	14.5	23.7	0.0132	13.26	0.0030	19.9	160.43	19.9
1440	16.5	12.5	22.5	0.0133	13.59	0.0013	17.2	138.30	17.2

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	
File Name:	2952_2_hydrometer-ASTM-D422-R3_2.xls	Date:	4/07/2016

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #4		
Job Number:	2952-2	Depth:	2-6' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	129.20
Weight of Dry Soil & Pan (g):	124.26
Weight of Water (g):	4.95
Weight of Pan (g):	7.05
Weight of Dry Soil (g):	117.20
Moisture (%):	4.2

General Sample Data

Total Wet Weight of Sample (g):	1,024.90
Total Dry Weight of Sample (g):	983.39
Calculated Weight Plus #200 (g):	725.63
Moisture of Total Sample (%):	4.2
Percent Retained #200 Sieve (%):	73.8

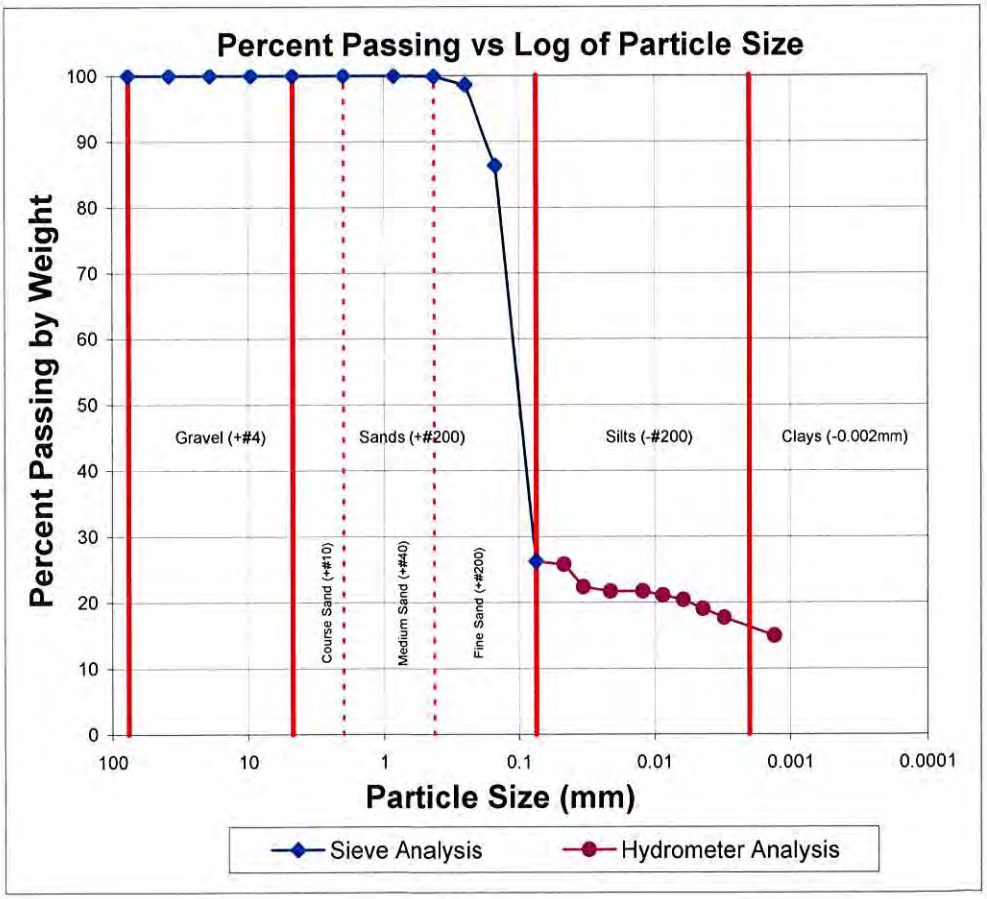
Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
76.958g split out of -#10 material.						
#20	**0.850**	3.07	3.06	0.01	0.11	100.0
#40	**0.425**	3.26	3.17	0.09	1.20	99.9
#60	**0.250**	4.07	3.11	0.96	12.80	98.6
#100	**0.150**	12.11	3.08	9.03	120.26	86.3
#200	**0.075**	47.58	3.18	44.40	591.26	26.2

Plus Split Data

Original Weight of +#10 (g): 0.00
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 1,024.90
Calculated Dry Weight of -#10 (g): 983.39



USCS Classification ASTM D 2487

Atterberg Classification: CL-ML
Group Symbol: SC-SM

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 73.79
Percent Fines (%): 26.21

USCS Classification

Silty, Clayey Sand

Data Entered By:	NN	Checked By:	CAL
Date:	4/7/2016	Date:	4-07-16
File Name:	2952_2_hydrometer-ASTM-D422-R3_0.xls		

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	Test Pit #4		
Job Number:	2952-2	Depth:	2-6' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	1,024.90
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	983.39
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	76.958
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	73.841
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	73.841

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	23.0	19.0	23.2	0.0132	12.52	0.0466	25.8	253.38	25.8
2	20.5	16.5	23.2	0.0132	12.93	0.0335	22.4	220.04	22.4
5	20.0	16.0	23.2	0.0132	13.01	0.0212	21.7	213.37	21.7
15	20.0	16.0	23.3	0.0132	13.01	0.0123	21.7	213.37	21.7
30	19.5	15.5	23.4	0.0132	13.10	0.0087	21.0	206.71	21.0
60	19.0	15.0	23.5	0.0132	13.18	0.0062	20.3	200.04	20.3
120	18.0	14.0	23.7	0.0132	13.34	0.0044	19.0	186.70	19.0
250	17.0	13.0	23.6	0.0132	13.51	0.0031	17.6	173.37	17.6
1440	15.0	11.0	22.7	0.0133	13.83	0.0013	14.9	146.69	14.9

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CH
File Name:	2952_2_hydrometer-ASTM-D422-R3_0.xls	Date:	4-7-16

ATT
ADVANCED TERRA TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	TP-4		
Job Number:	2952-2	Depth:	2-6' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Wash Date:	4/6/2016	Wash Technician:	BDF

Grain Size Data

Hygroscopic Moisture of Fines

Weight of Wet Soil & Pan (g):	181.97
Weight of Dry Soil & Pan (g):	178.13
Weight of Water (g):	3.84
Weight of Pan (g):	7.00
Weight of Dry Soil (g):	171.13
Moisture (%):	2.2

General Sample Data

Total Wet Weight of Sample (g):	1,831.50
Total Dry Weight of Sample (g):	1,791.30
Calculated Weight Plus #200 (g):	784.80
Moisture of Total Sample (%):	2.2
Percent Retained #200 Sieve (%):	43.8

Sieve Number	Sieve Size (mm)	Weight of Retained Soil & Pan (g)	Weight of Pan (g)	Weight of Retained Soil (g)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
3"	**76.2**	0.00	0.00	0.00	0.00	100.0
1.5"	**38.10**	0.00	0.00	0.00	0.00	100.0
3/4"	**19.05**	0.00	0.00	0.00	0.00	100.0
3/8"	**9.525**	0.00	0.00	0.00	0.00	100.0
#4	**4.750**	0.00	0.00	0.00	0.00	100.0
#10	**2.000**	0.00	0.00	0.00	0.00	100.0
95.839g split out of -#10 material.						
#20	**0.850**	3.17	3.16	0.01	0.17	100.0
#40	**0.425**	3.24	3.16	0.08	1.51	99.9
#60	**0.250**	3.90	3.22	0.68	12.96	99.2
#100	**0.150**	9.85	3.13	6.72	128.36	92.0
#200	**0.075**	36.71	3.13	33.58	641.80	56.2

Plus Split Data

Original Weight of +#10 (g): 0.00
Calculated Weight of +#10 (g): 0.00

Minus Split Data

Original Weight of -#10 (g): 1,831.50
Calculated Dry Weight of -#10 (g): 1,791.30

USCS Classification ASTM D 2487

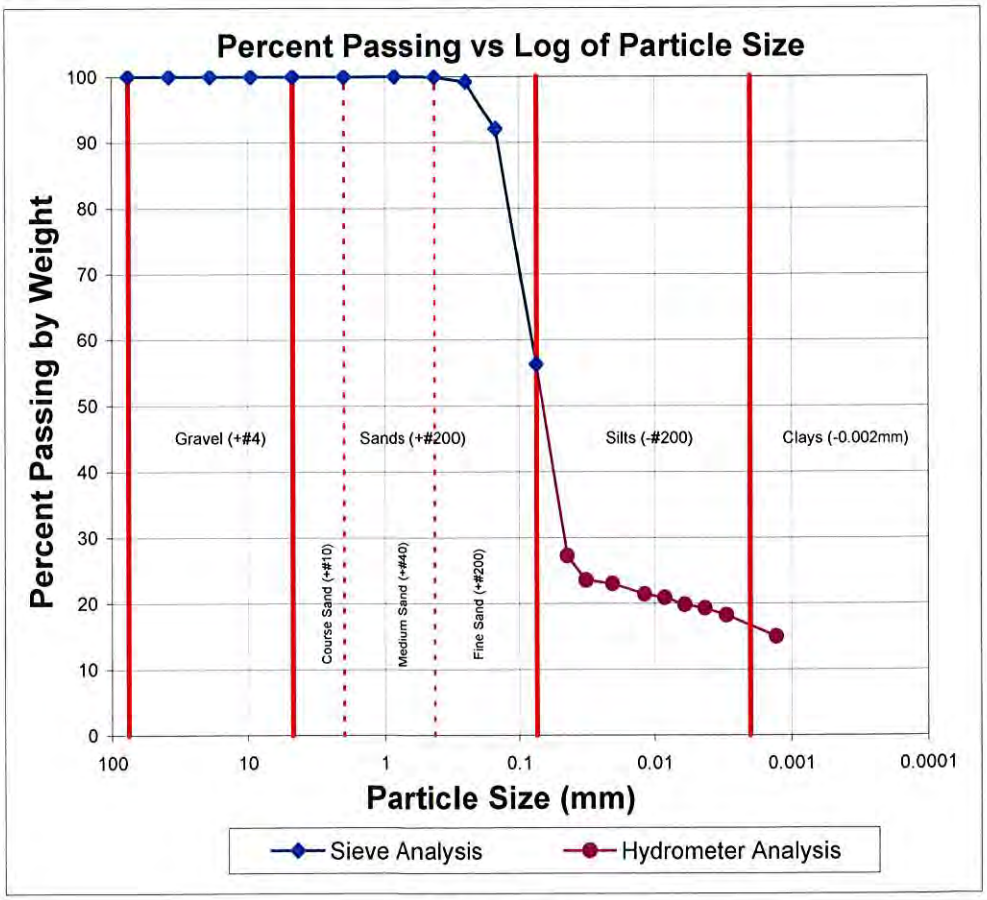
Atterberg Classification: CL-ML
Group Symbol: CL-ML

Course-Grained Soils

Percent Gravels (%): 0.00
Percent Sands (%): 43.81
Percent Fines (%): 56.19

USCS Classification

Sandy Silty Clay



Data Entered By: NN
Date: 4/7/2016
File Name: 2952_2_hydrometer-ASTM-D422-R3_1.xls

Checked By: CM
Date: 4/11/16

ATT
ADVANCED TERRACE TESTING

Particle Size Analysis of Soils
ASTM D 422

Client:	Swift River Environmental Services	Boring Number:	TP-4		
Job Number:	2952-2	Depth:	2-6' bgs		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/5/2016	Technician:	BDF

Hydrometer Data

Test Configuration

Hydrometer Type:	152H	Total Wet Weight of Sample (g):	1,831.50
Specific Gravity:	2.65	Total Dry Weight of Sample (g):	1,791.30
Deflocculant:	Sodium Hexametaphosphate	Wet Weight of Sub-Sample (g):	95.839
Deflocculant Correction:	4.0	Dry Weight of Sub-Sample (g):	93.736
Specific Gravity Correction Factor	1.00	Corrected Dry Weight of Sub-Sample - W(g):	93.736

Elapsed Time (min)	Hydrometer Reading	Corrected Hydrometer Reading	Temperature (°C)	Temperature Coefficient (K)	Effective Depth (L)	Grain Diameter (mm)	Percent in Suspension (%)	Calculated Weight of Retained Soil (g)	Percent Passing by Weight (%)
0	-	-	-	-	-	-	-	-	-
1	29.5	25.5	23.0	0.0132	11.46	0.0446	27.2	487.97	27.2
2	26.0	22.0	23.0	0.0132	12.03	0.0323	23.5	421.00	23.5
5	25.5	21.5	23.0	0.0132	12.11	0.0205	23.0	411.43	23.0
15	24.0	20.0	23.0	0.0132	12.36	0.0120	21.4	382.72	21.4
30	23.5	19.5	23.1	0.0132	12.44	0.0085	20.8	373.16	20.8
60	22.5	18.5	23.3	0.0132	12.60	0.0060	19.8	354.02	19.8
120	22.0	18.0	23.5	0.0132	12.69	0.0043	19.2	344.45	19.2
250	21.0	17.0	23.7	0.0132	12.85	0.0030	18.2	325.32	18.2
1440	18.0	14.0	22.5	0.0133	13.34	0.0013	15.0	267.91	15.0

Data Entered By:	NN		
Date:	4/7/2016	Checked By:	CH
File Name:	2952_2_hydrometer-ASTM-D422-R3_1.xls	Date:	4/11/16

ATT
ADVANCED

Atterberg Limits Test
ASTM D 4318

Client:	Swift River Environmental Services	Boring Number:	NWE-1
Job Number:	2952-1	Depth:	20' (19-24')
Project:	North Weld Landfill Expansion	Sample Number:	--
Location:	--	Test Date:	3/10/2016
Project Number:	S152047	Technician:	CAL
		Sampled Date:	--
		Sampled By:	--
		Method:	Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

Non-Plastic

Liquid Limits

Non-Plastic

Atterberg Classification NP

Data Entered By: NN Date: 3/10/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_5.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client:	Swift River Environmental Services	Boring Number:	NWE-3
Job Number:	2952-1	Depth:	25' (24-29')
Project:	North Weld Landfill Expansion	Sample Number:	--
Location:	--	Test Date:	3/8/2016
Project Number:	S152047	Technician:	NN
		Sampled Date:	--
		Sampled By:	--
		Method:	Method A

Test Configuration

Liquid Limits Device: 0966
Material Size of Fines: -#40

Plastic Limits

Non-Plastic

Liquid Limits

Non-Plastic

Atterberg Classification NP

Data Entered By: NN Date: 3/8/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_0.xls

Data Checked By: KR
Date: 3/15/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-4
Depth: 10' (9-14')
Sample Number: --
Test Date: 3/9/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

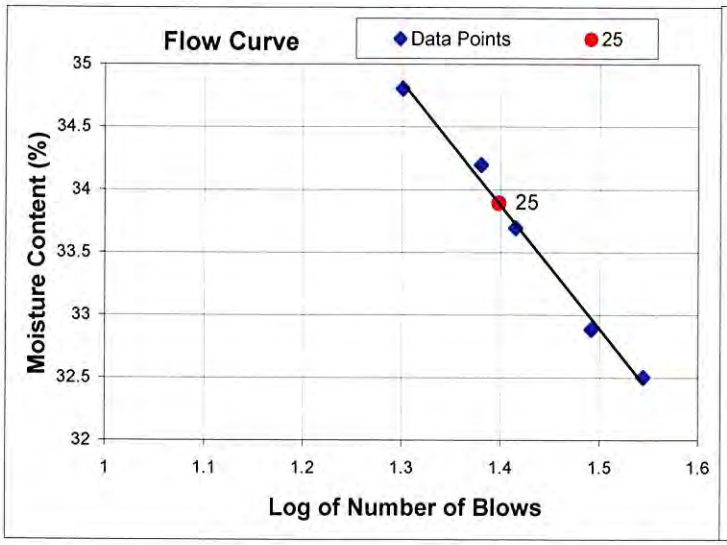
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.491	6.871	6.589
Weight of Dry Soil & Pan (g):	5.812	6.175	5.926
Weight of Water (g):	0.679	0.696	0.663
Weight of Pan (g):	1.103	1.136	1.054
Moisture Content (%):	14.4	13.8	13.6

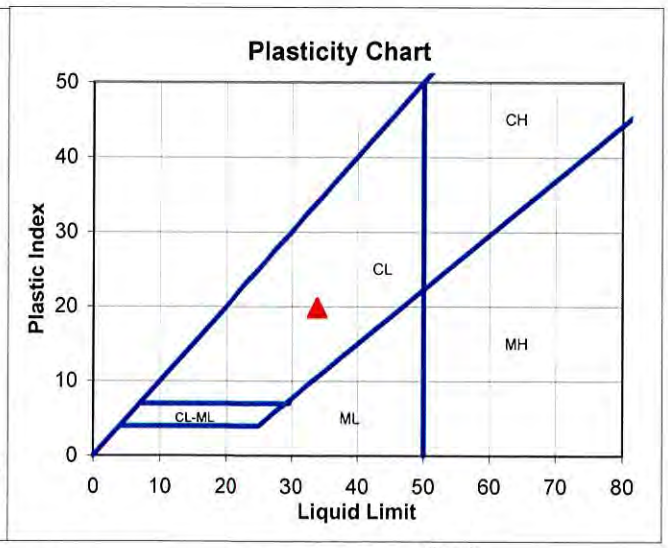
Average: 13.9%
Standard Deviation: 0.4%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	35	31	24	26	20
Weight of Wet Soil & Pan (g):	9.321	8.763	8.597	9.878	9.725
Weight of Dry Soil & Pan (g):	7.313	6.879	6.693	7.671	7.506
Weight of Water (g):	2.008	1.884	1.904	2.207	2.219
Weight of Pan (g):	1.135	1.150	1.125	1.121	1.130
Moisture Content (%):	32.5	32.9	34.2	33.7	34.8

Plastic Limit: 14
Liquid Limit: 34
Plastic Index: 20
Atterberg Classification CL





Data Entered By: NN Date: 3/10/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_3.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-5
Depth: 10' (9-14')
Sample Number: --
Test Date: 3/10/2016
Technician: cal
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

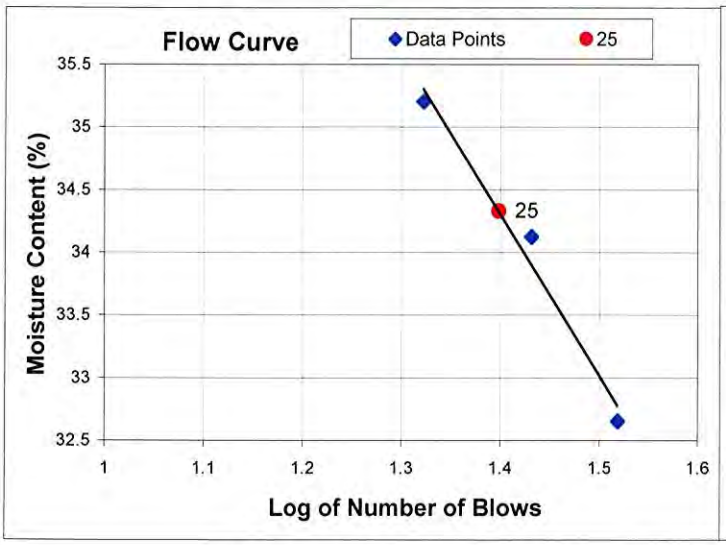
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.525	6.650	6.634
Weight of Dry Soil & Pan (g):	5.892	6.019	6.008
Weight of Water (g):	0.633	0.631	0.626
Weight of Pan (g):	1.099	1.093	1.148
Moisture Content (%):	13.2	12.8	12.9

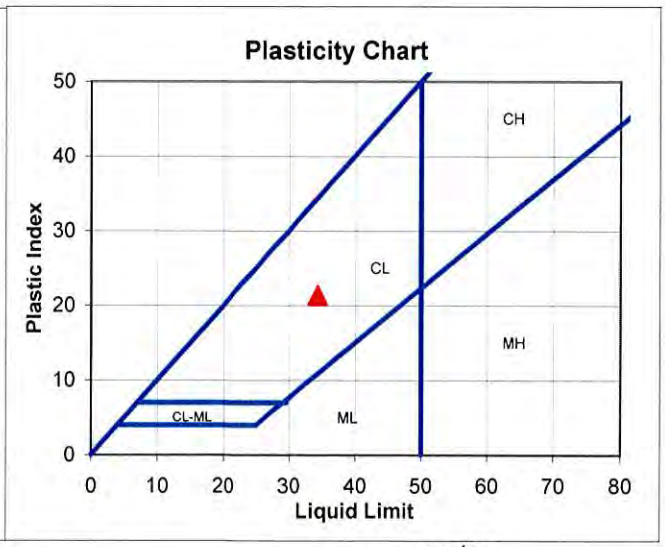
Average: 13.0%
Standard Deviation: 0.2%

Liquid Limits

	Sample 1	Sample 2	Sample 3
Number of Blows:	33	27	21
Weight of Wet Soil & Pan (g):	8.351	9.338	9.836
Weight of Dry Soil & Pan (g):	6.578	7.209	7.559
Weight of Water (g):	1.773	2.129	2.277
Weight of Pan (g):	1.148	0.970	1.091
Moisture Content (%):	32.7	34.1	35.2

Plastic Limit: 13
Liquid Limit: 34
Plastic Index: 21
Atterberg Classification CL





Data Entered By: cal
Date: 3/11/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_6.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-6
Depth: 10' (9-14')
Sample Number: --
Test Date: 3/11/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

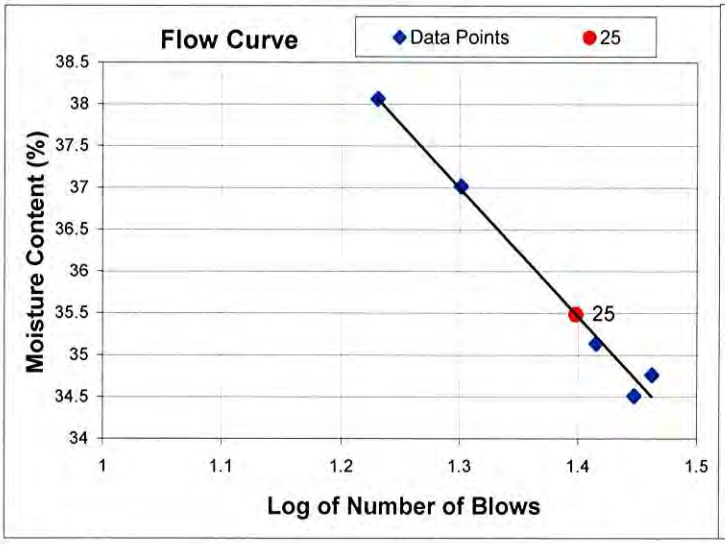
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.545	6.289	6.165
Weight of Dry Soil & Pan (g):	5.878	5.662	5.539
Weight of Water (g):	0.667	0.627	0.626
Weight of Pan (g):	1.126	1.150	1.107
Moisture Content (%):	14.0	13.9	14.1

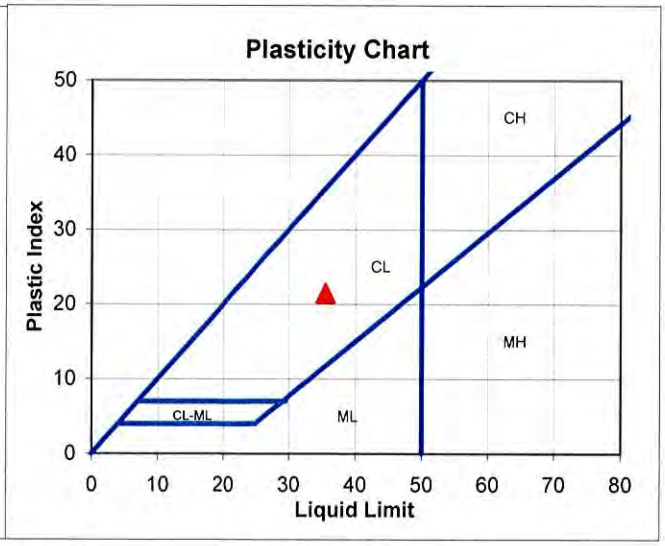
Average: 14.0%
Standard Deviation: 0.1%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	28	29	26	20	17
Weight of Wet Soil & Pan (g):	8.642	9.999	10.970	8.630	8.464
Weight of Dry Soil & Pan (g):	6.719	7.711	8.415	6.608	6.443
Weight of Water (g):	1.923	2.288	2.555	2.022	2.021
Weight of Pan (g):	1.147	1.129	1.144	1.146	1.134
Moisture Content (%):	34.5	34.8	35.1	37.0	38.1

Plastic Limit: 14
Liquid Limit: 35
Plastic Index: 21
Atterberg Classification CL





Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_10.xls

Data Checked By: BDF
Date: 3/16/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-7
Depth: 15' (14-17')
Sample Number: --
Test Date: 3/9/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

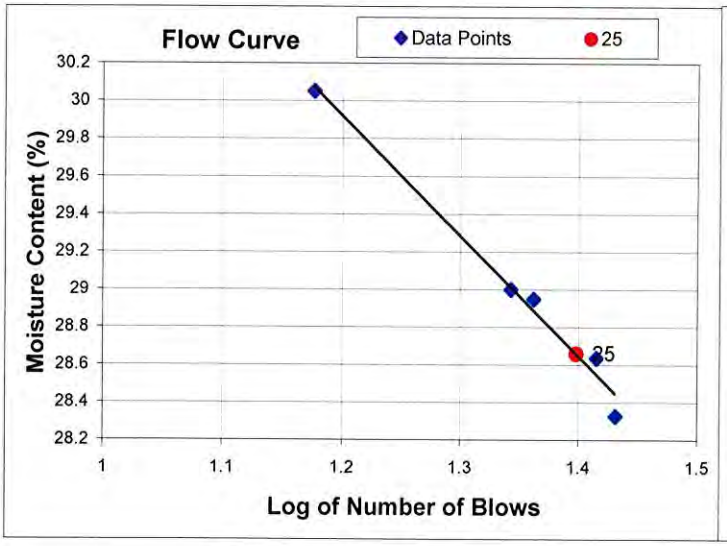
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	7.399	7.554	6.977
Weight of Dry Soil & Pan (g):	6.731	6.884	6.346
Weight of Water (g):	0.668	0.670	0.631
Weight of Pan (g):	1.139	1.100	1.092
Moisture Content (%):	11.9	11.6	12.0

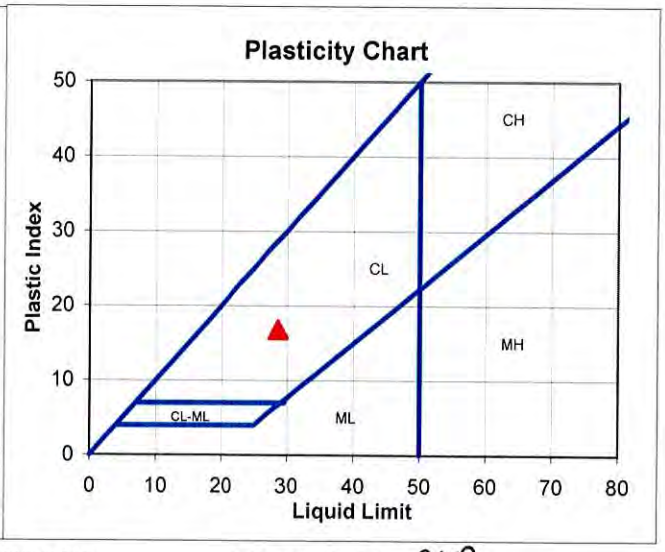
Average: 11.8%
Standard Deviation: 0.2%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	15	22	27	23	26
Weight of Wet Soil & Pan (g):	9.938	9.336	9.202	8.567	10.449
Weight of Dry Soil & Pan (g):	7.908	7.500	7.421	6.905	8.380
Weight of Water (g):	2.030	1.836	1.781	1.662	2.069
Weight of Pan (g):	1.153	1.169	1.134	1.164	1.155
Moisture Content (%):	30.1	29.0	28.3	28.9	28.6

Plastic Limit: 12
Liquid Limit: 29
Plastic Index: 17
Atterberg Classification CL





Data Entered By: NN
Date: 3/10/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_4.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: NWE-7
Depth: --
Sample Number: --
Test Date: 4/5/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

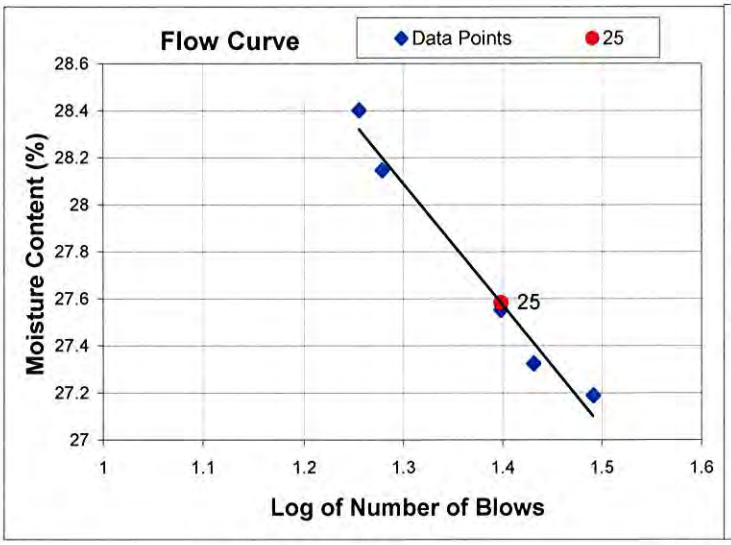
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	7.382	7.325	7.026
Weight of Dry Soil & Pan (g):	6.538	6.501	6.229
Weight of Water (g):	0.844	0.824	0.797
Weight of Pan (g):	1.106	1.134	1.077
Moisture Content (%):	15.5	15.4	15.5

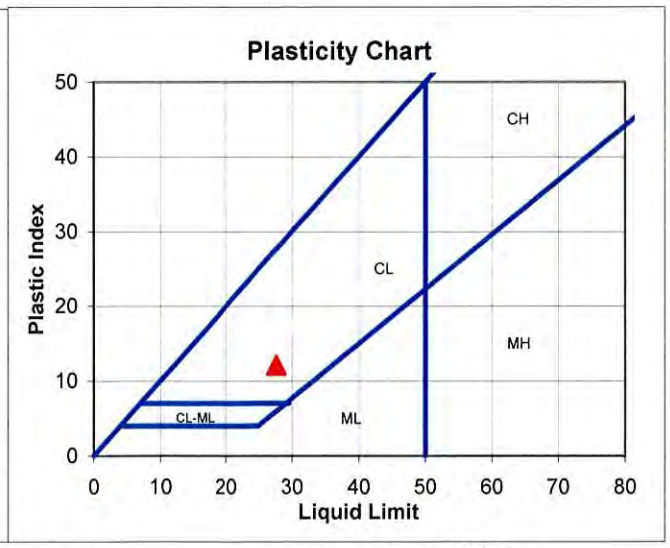
Average: 15.5%
Standard Deviation: 0.1%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	18	19	25	27	31
Weight of Wet Soil & Pan (g):	8.784	9.759	9.910	9.132	10.329
Weight of Dry Soil & Pan (g):	7.087	7.863	8.015	7.418	8.329
Weight of Water (g):	1.697	1.896	1.895	1.714	2.000
Weight of Pan (g):	1.112	1.127	1.137	1.145	0.973
Moisture Content (%):	28.4	28.1	27.6	27.3	27.2

Plastic Limit: 15
Liquid Limit: 28
Plastic Index: 13
Atterberg Classification CL





Data Entered By: CAL Date: 4/6/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_1.xls

Data Checked By: DJM
Date: 4/6/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-8
Depth: 18-20'
Sample Number: --
Test Date: 3/11/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1080
Material Size of Fines: -#40

Plastic Limits

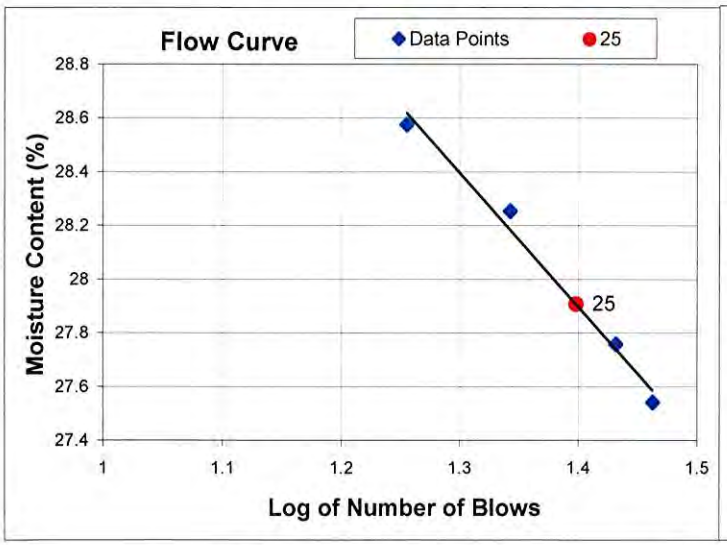
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	7.273	7.586	7.082
Weight of Dry Soil & Pan (g):	6.555	6.807	6.365
Weight of Water (g):	0.718	0.779	0.717
Weight of Pan (g):	1.146	1.131	1.117
Moisture Content (%):	13.3	13.7	13.7

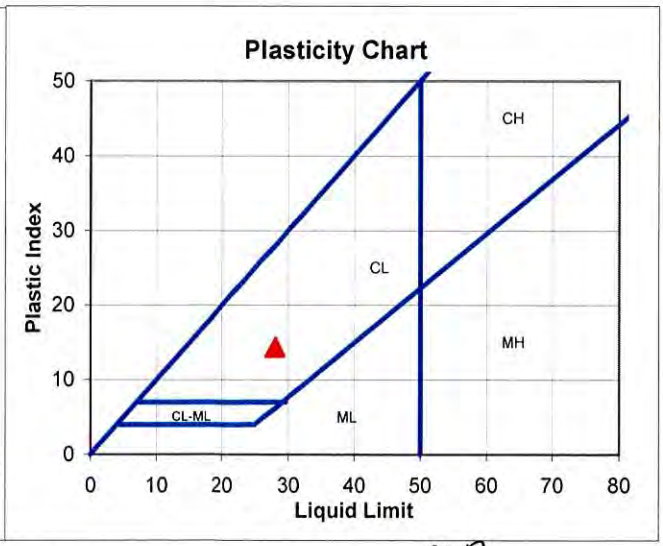
Average: 13.6%
Standard Deviation: 0.2%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4
Number of Blows:	18	22	27	29
Weight of Wet Soil & Pan (g):	10.433	9.840	9.472	8.784
Weight of Dry Soil & Pan (g):	8.367	7.919	7.648	7.123
Weight of Water (g):	2.066	1.921	1.824	1.661
Weight of Pan (g):	1.137	1.120	1.077	1.092
Moisture Content (%):	28.6	28.3	27.8	27.5

Plastic Limit: 14
Liquid Limit: 28
Plastic Index: 14
Atterberg Classification CL





Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_9.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-9
Depth: 17-19'
Sample Number: UD
Test Date: 3/8/2016
Technician: NN
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 0966
Material Size of Fines: -#40

Plastic Limits

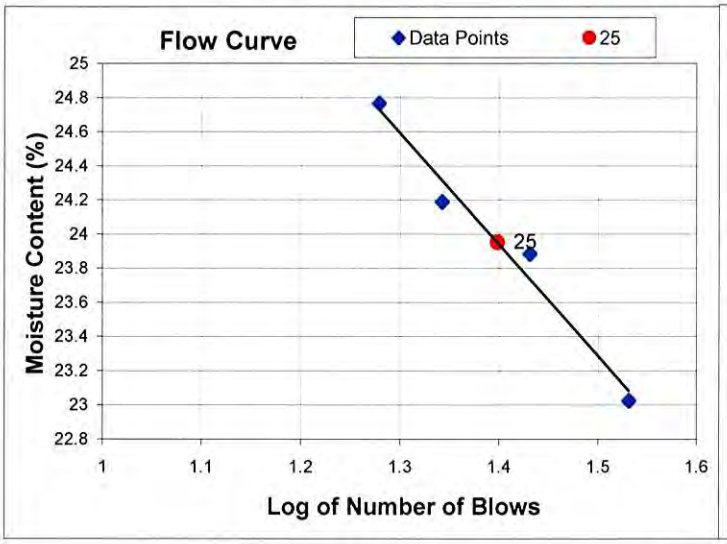
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	9.573	6.907	6.524
Weight of Dry Soil & Pan (g):	8.651	6.303	5.985
Weight of Water (g):	0.922	0.604	0.539
Weight of Pan (g):	1.141	1.161	1.095
Moisture Content (%):	12.3	11.7	11.0

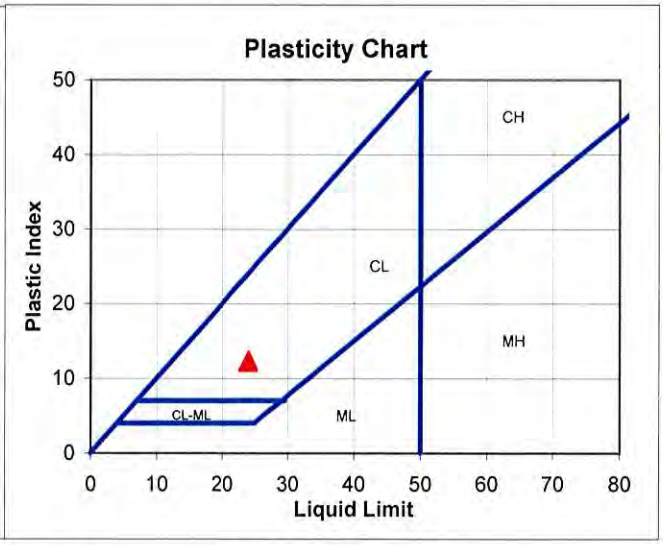
Average: 11.7%
Standard Deviation: 0.6%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4
Number of Blows:	34	19	22	27
Weight of Wet Soil & Pan (g):	18.471	15.273	15.822	14.845
Weight of Dry Soil & Pan (g):	15.218	12.474	12.964	12.193
Weight of Water (g):	3.253	2.799	2.858	2.652
Weight of Pan (g):	1.089	1.172	1.148	1.089
Moisture Content (%):	23.0	24.8	24.2	23.9

Plastic Limit: 12
Liquid Limit: 24
Plastic Index: 12
Atterberg Classification CL





Data Entered By: NN Date: 3/9/2016 Data Checked By: CK
File Name: 2952_1_atterberg-ASTMD-4318-R8_2.xls Date: 3/9/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: NWE-12
Depth: --
Sample Number: --
Test Date: 4/5/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

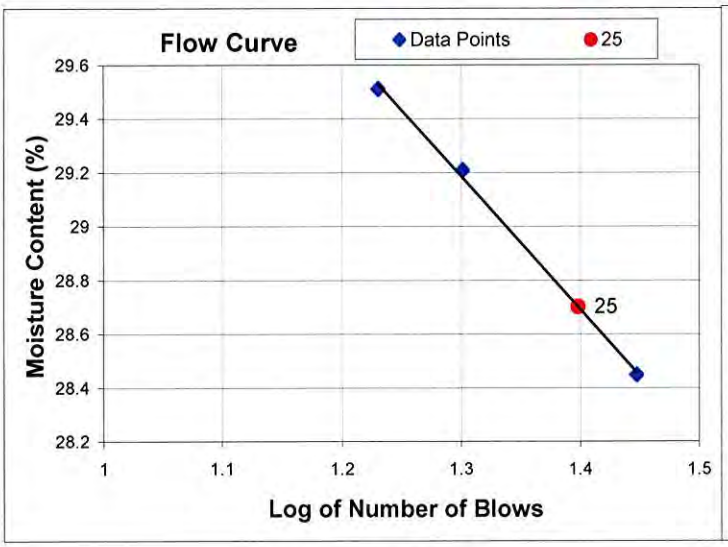
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.979	7.169	6.950
Weight of Dry Soil & Pan (g):	6.343	6.486	6.305
Weight of Water (g):	0.636	0.683	0.645
Weight of Pan (g):	1.092	1.090	1.102
Moisture Content (%):	12.1	12.7	12.4

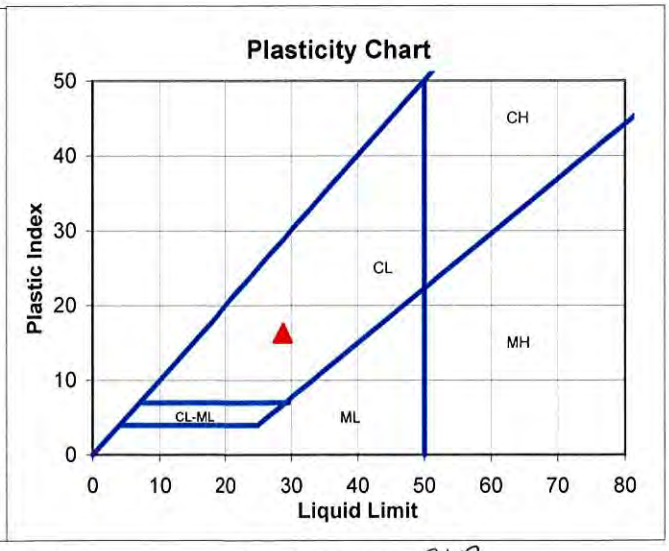
Average: 12.4%
Standard Deviation: 0.3%

Liquid Limits

	Sample 1	Sample 2	Sample 3
Number of Blows:	17	20	28
Weight of Wet Soil & Pan (g):	8.917	10.527	10.726
Weight of Dry Soil & Pan (g):	7.147	8.405	8.602
Weight of Water (g):	1.770	2.122	2.124
Weight of Pan (g):	1.149	1.140	1.136
Moisture Content (%):	29.5	29.2	28.4

Plastic Limit: 12
Liquid Limit: 29
Plastic Index: 17
Atterberg Classification CL





Data Entered By: CAL Date: 4/6/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_2.xls

Data Checked By: CKP
Date: 4/6/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-13
Depth: 10' (9-14')
Sample Number: --
Test Date: 3/10/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

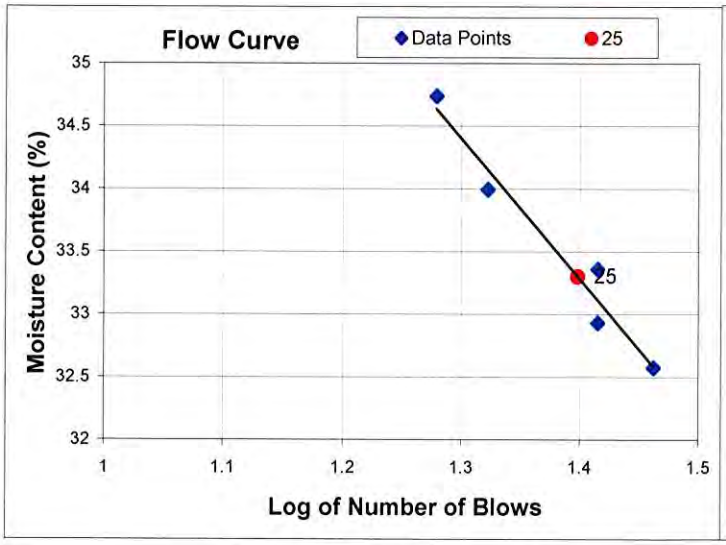
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.720	6.926	6.580
Weight of Dry Soil & Pan (g):	6.035	6.196	5.889
Weight of Water (g):	0.685	0.730	0.691
Weight of Pan (g):	1.136	1.088	1.156
Moisture Content (%):	14.0	14.3	14.6

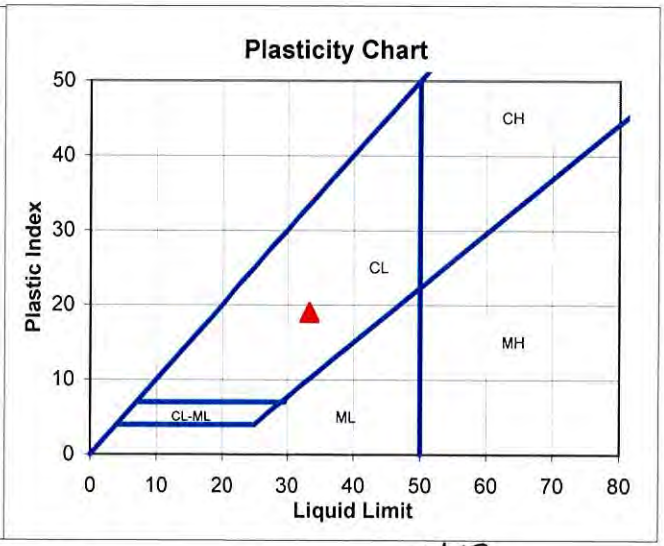
Average: 14.3%
Standard Deviation: 0.3%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	26	29	26	21	19
Weight of Wet Soil & Pan (g):	9.967	8.746	9.922	10.483	10.120
Weight of Dry Soil & Pan (g):	7.778	6.876	7.722	8.113	7.807
Weight of Water (g):	2.189	1.870	2.200	2.370	2.313
Weight of Pan (g):	1.131	1.135	1.127	1.141	1.149
Moisture Content (%):	32.9	32.6	33.4	34.0	34.7

Plastic Limit: 14
Liquid Limit: 33
Plastic Index: 19
Atterberg Classification CL





Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_7.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-14
Depth: 10' (9-14')
Sample Number: --
Test Date: 3/11/2016
Technician: BDF
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1080
Material Size of Fines: -#40

Plastic Limits

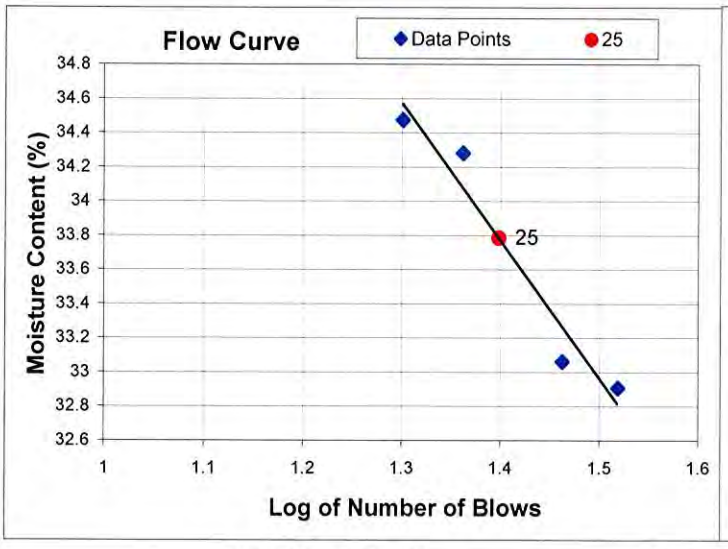
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.436	6.482	6.563
Weight of Dry Soil & Pan (g):	5.801	5.826	5.894
Weight of Water (g):	0.635	0.656	0.669
Weight of Pan (g):	1.117	1.135	1.149
Moisture Content (%):	13.6	14.0	14.1

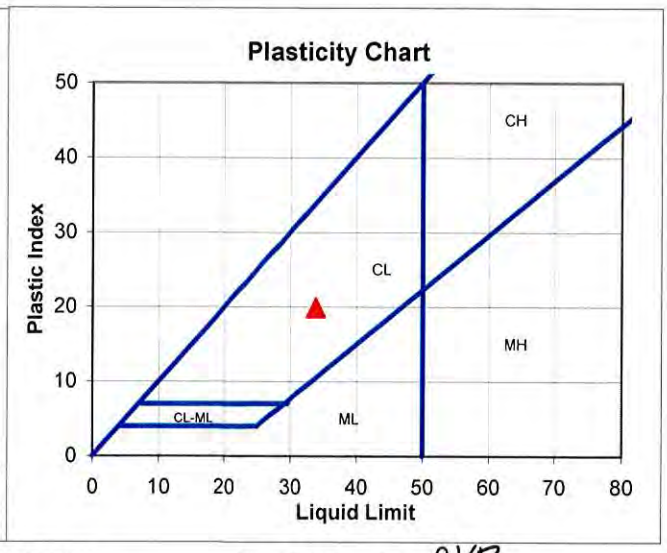
Average: 13.9%
Standard Deviation: 0.3%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4
Number of Blows:	20	33	29	23
Weight of Wet Soil & Pan (g):	10.391	11.364	10.317	10.779
Weight of Dry Soil & Pan (g):	8.012	8.833	8.037	8.316
Weight of Water (g):	2.379	2.531	2.280	2.463
Weight of Pan (g):	1.111	1.142	1.141	1.131
Moisture Content (%):	34.5	32.9	33.1	34.3

Plastic Limit: 14
Liquid Limit: 34
Plastic Index: 20
Atterberg Classification CL





Data Entered By: NN
Date: 3/14/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_12.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-14
Depth: 17-19'
Sample Number: UD
Test Date: 3/10/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

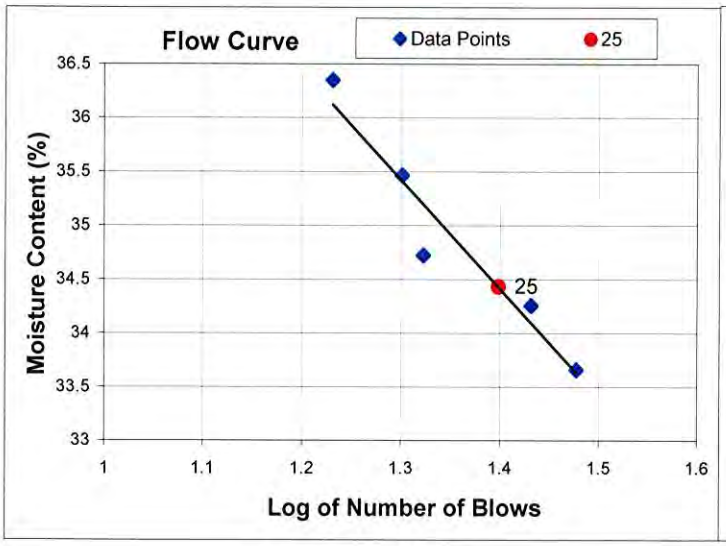
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	7.402	7.436	7.529
Weight of Dry Soil & Pan (g):	6.565	6.590	6.679
Weight of Water (g):	0.837	0.846	0.850
Weight of Pan (g):	1.136	1.137	1.094
Moisture Content (%):	15.4	15.5	15.2

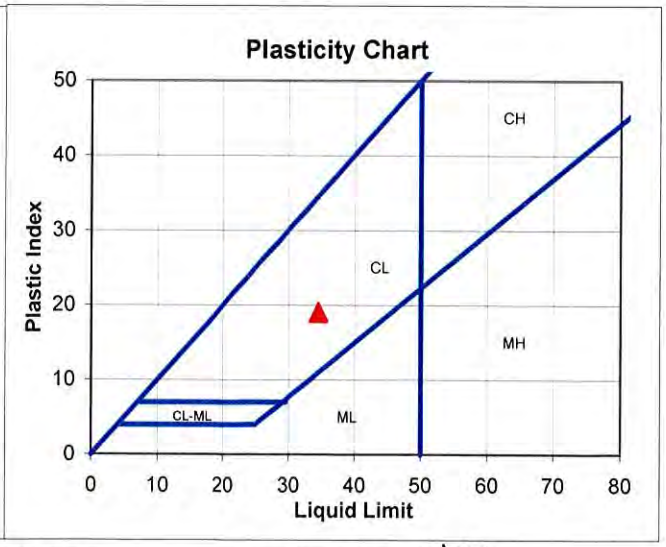
Average: 15.4%
Standard Deviation: 0.2%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	30	27	21	20	17
Weight of Wet Soil & Pan (g):	9.702	7.737	8.779	9.705	9.725
Weight of Dry Soil & Pan (g):	7.546	6.046	6.804	7.463	7.435
Weight of Water (g):	2.156	1.691	1.975	2.242	2.290
Weight of Pan (g):	1.141	1.110	1.116	1.141	1.135
Moisture Content (%):	33.7	34.3	34.7	35.5	36.3

Plastic Limit: 15
Liquid Limit: 34
Plastic Index: 19
Atterberg Classification CL





Data Entered By: NN Date: 3/14/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_8.xls

Data Checked By: CKP
Date: 3/14/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-16
Depth: 14-16'
Sample Number: UD
Test Date: 3/10/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

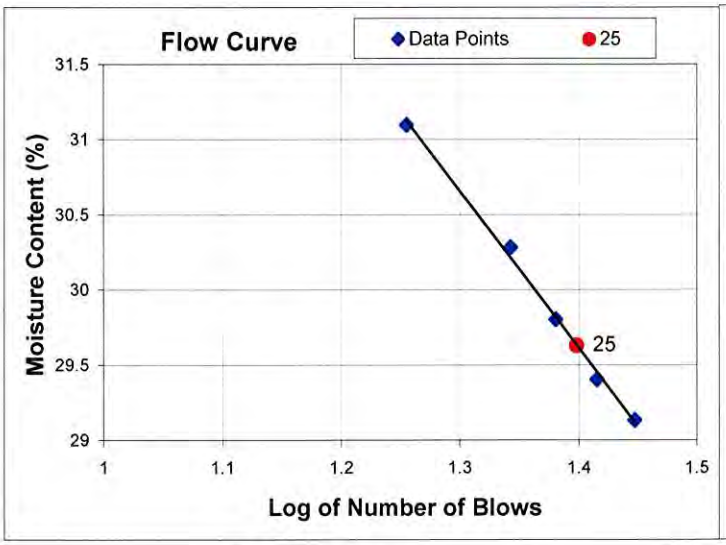
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.497	6.475	6.666
Weight of Dry Soil & Pan (g):	5.769	5.763	5.944
Weight of Water (g):	0.728	0.712	0.722
Weight of Pan (g):	1.084	1.145	1.150
Moisture Content (%):	15.5	15.4	15.1

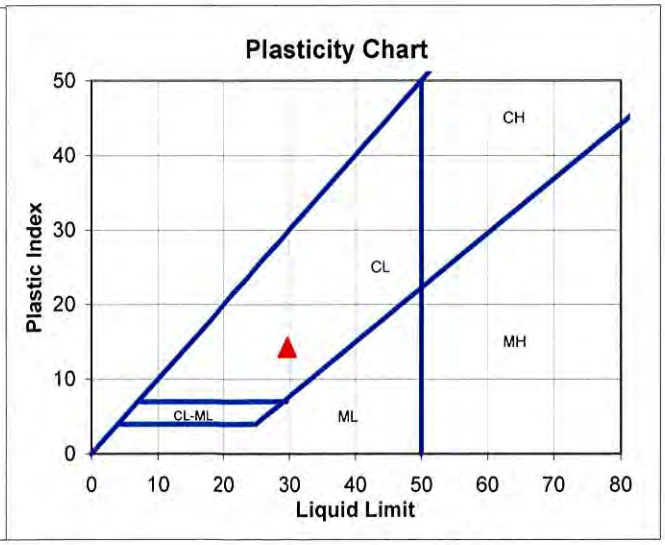
Average: 15.3%
Standard Deviation: 0.2%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	26	28	24	22	18
Weight of Wet Soil & Pan (g):	10.665	10.531	8.771	9.559	9.535
Weight of Dry Soil & Pan (g):	8.501	8.398	7.028	7.603	7.544
Weight of Water (g):	2.164	2.133	1.743	1.956	1.991
Weight of Pan (g):	1.142	1.077	1.180	1.144	1.142
Moisture Content (%):	29.4	29.1	29.8	30.3	31.1

Plastic Limit: 15
Liquid Limit: 30
Plastic Index: 15
Atterberg Classification CL





Data Entered By: NN Date: 3/14/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_11.xls

Data Checked By: BDF
Date: 3/16/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-1
Project: North Weld Landfill Expansion
Location: --
Project Number: S152047

Boring Number: NWE-20
Depth: 10' (9-12')
Sample Number: --
Test Date: 3/8/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

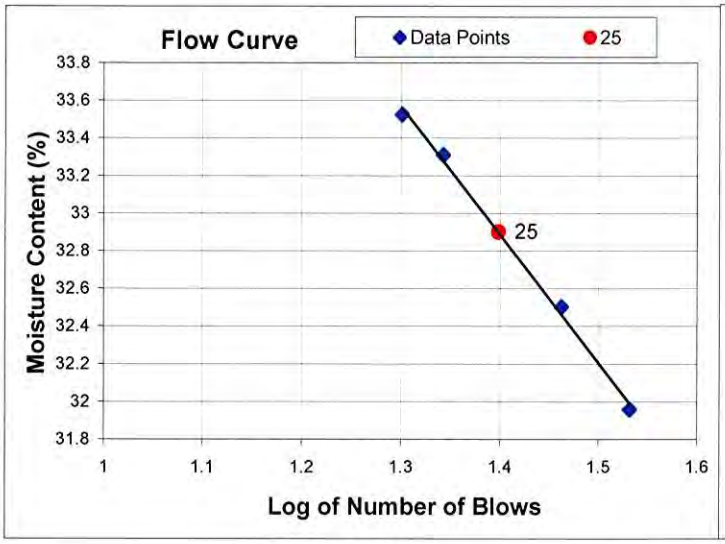
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.539	6.456	6.532
Weight of Dry Soil & Pan (g):	5.907	5.838	5.906
Weight of Water (g):	0.632	0.618	0.626
Weight of Pan (g):	1.124	1.144	1.088
Moisture Content (%):	13.2	13.2	13.0

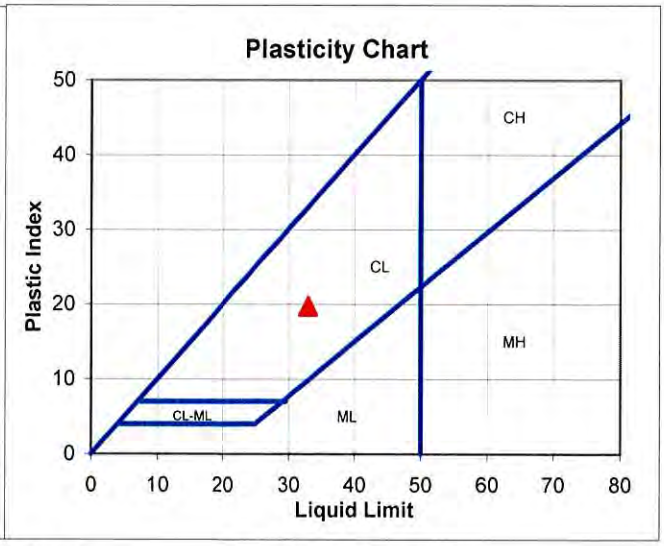
Average: 13.1%
Standard Deviation: 0.1%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4
Number of Blows:	34	29	22	20
Weight of Wet Soil & Pan (g):	9.563	8.053	9.830	9.367
Weight of Dry Soil & Pan (g):	7.526	6.360	7.657	7.312
Weight of Water (g):	2.037	1.693	2.173	2.055
Weight of Pan (g):	1.152	1.151	1.133	1.182
Moisture Content (%):	32.0	32.5	33.3	33.5

Plastic Limit: 13
Liquid Limit: 33
Plastic Index: 20
Atterberg Classification CL





Data Entered By: NN Date: 3/9/2016
File Name: 2952_1_atterberg-ASTMD-4318-R8_1.xls

Data Checked By: cac
Date: 3/9/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: Test Pit #1
Depth: 2-4' bgs
Sample Number: --
Test Date: 4/5/2016
Technician: NN
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 0966
Material Size of Fines: -#40

Plastic Limits

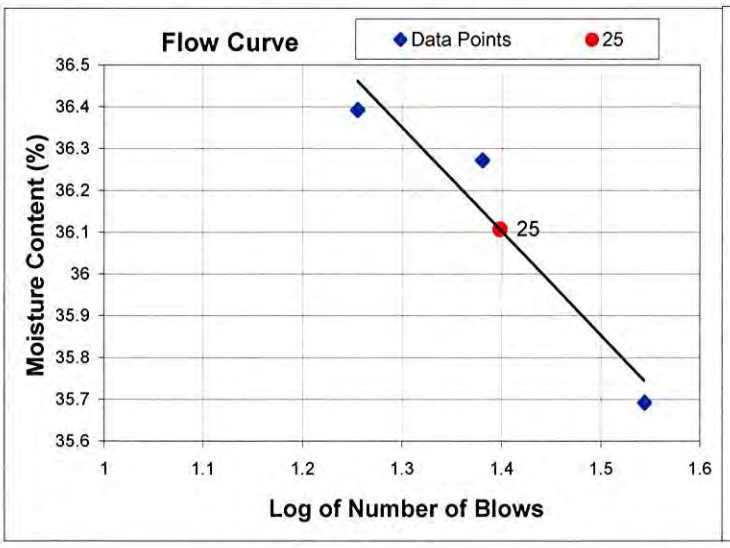
	Sample 1	Sample 2
Weight of Wet Soil & Pan (g):	6.728	6.901
Weight of Dry Soil & Pan (g):	6.051	6.199
Weight of Water (g):	0.677	0.702
Weight of Pan (g):	1.135	1.141
Moisture Content (%):	13.8	13.9

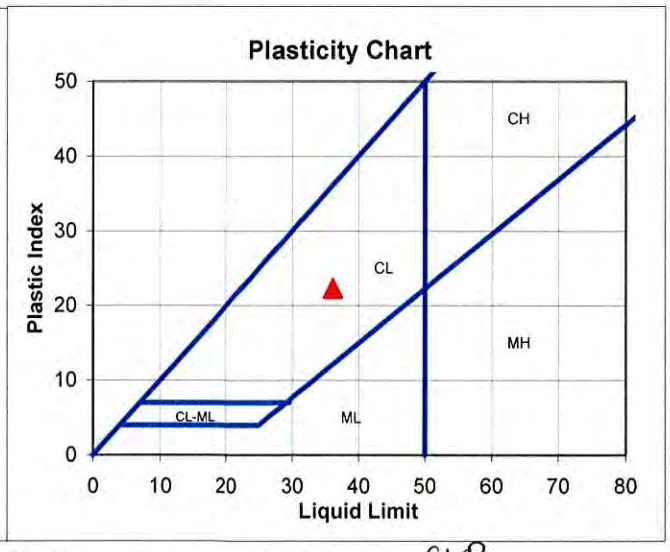
Average: 13.8%
Standard Deviation: 0.1%

Liquid Limits

	Sample 1	Sample 2	Sample 3
Number of Blows:	18	24	35
Weight of Wet Soil & Pan (g):	14.408	12.482	12.948
Weight of Dry Soil & Pan (g):	10.871	9.466	9.840
Weight of Water (g):	3.537	3.016	3.108
Weight of Pan (g):	1.152	1.151	1.132
Moisture Content (%):	36.4	36.3	35.7

Plastic Limit: 14
Liquid Limit: 36
Plastic Index: 22
Atterberg Classification CL





Data Entered By: CAL Date: 4/6/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_3.xls

Data Checked By: CKP
Date: 4/6/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: Test Pit #2
Depth: 5-9'
Sample Number: --
Test Date: 4/6/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

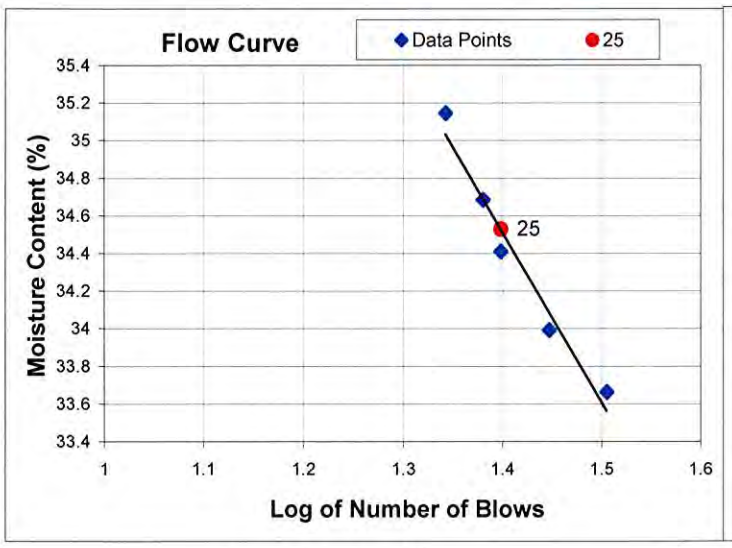
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.758	6.311	6.123
Weight of Dry Soil & Pan (g):	6.087	5.705	5.532
Weight of Water (g):	0.671	0.606	0.591
Weight of Pan (g):	1.151	1.132	1.137
Moisture Content (%):	13.6	13.3	13.4

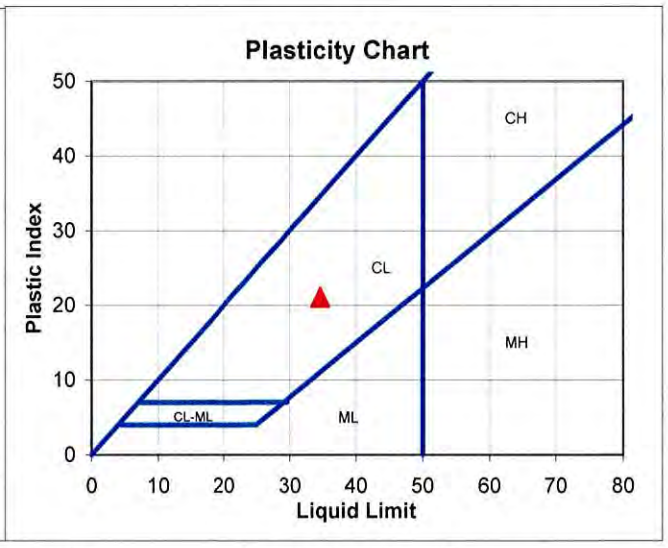
Average: 13.4%
Standard Deviation: 0.2%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	32	28	25	24	22
Weight of Wet Soil & Pan (g):	9.036	10.088	10.552	9.380	9.830
Weight of Dry Soil & Pan (g):	7.049	7.817	8.146	7.234	7.568
Weight of Water (g):	1.987	2.271	2.406	2.146	2.262
Weight of Pan (g):	1.146	1.136	1.154	1.047	1.132
Moisture Content (%):	33.7	34.0	34.4	34.7	35.1

Plastic Limit: 13
Liquid Limit: 35
Plastic Index: 22
Atterberg Classification CL





Data Entered By: NN Date: 4/7/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_4.xls

Data Checked By: CAL
Date: 4/7/2016

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: Test Pit #3
Depth: 3-5' bgs
Sample Number: --
Test Date: 4/6/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

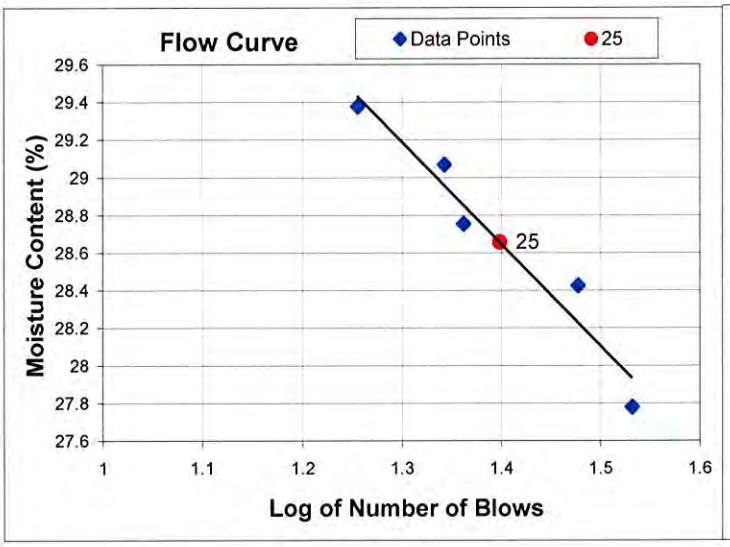
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	7.383	7.746	6.668
Weight of Dry Soil & Pan (g):	6.533	6.815	5.913
Weight of Water (g):	0.850	0.931	0.755
Weight of Pan (g):	1.132	1.125	1.073
Moisture Content (%):	15.7	16.4	15.6

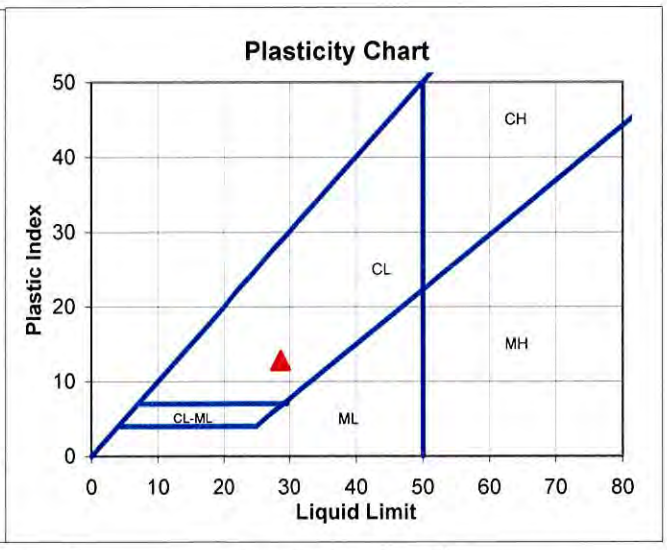
Average: 15.9%
Standard Deviation: 0.4%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	34	18	22	23	30
Weight of Wet Soil & Pan (g):	11.334	9.917	10.468	10.810	10.283
Weight of Dry Soil & Pan (g):	9.107	7.915	8.356	8.638	8.256
Weight of Water (g):	2.227	2.002	2.112	2.172	2.027
Weight of Pan (g):	1.090	1.100	1.090	1.084	1.125
Moisture Content (%):	27.8	29.4	29.1	28.8	28.4

Plastic Limit: 16
Liquid Limit: 29
Plastic Index: 13
Atterberg Classification CL





Data Entered By: NN Date: 4/7/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_5.xls

Data Checked By: CAL
Date: 4/7/2016

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: Test Pit #4
Depth: 2-6' bgs
Sample Number: --
Test Date: 4/4/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

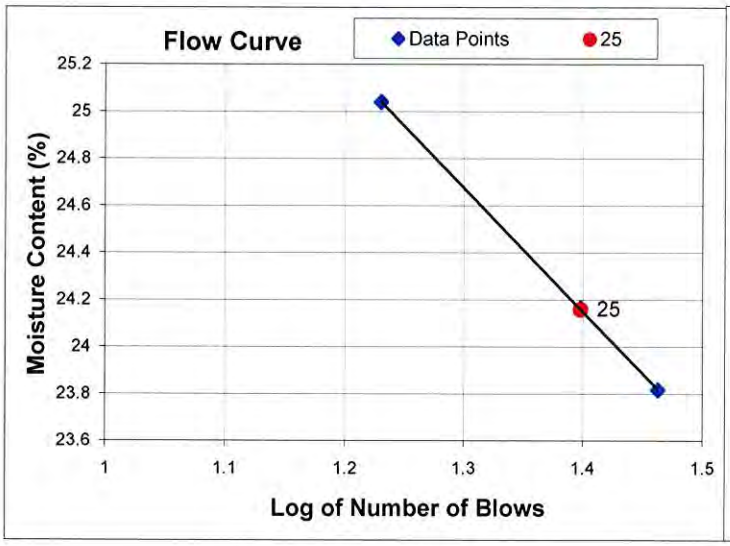
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.314	6.795	7.219
Weight of Dry Soil & Pan (g):	5.461	5.871	6.222
Weight of Water (g):	0.853	0.924	0.997
Weight of Pan (g):	1.129	1.145	1.152
Moisture Content (%):	19.7	19.6	19.7

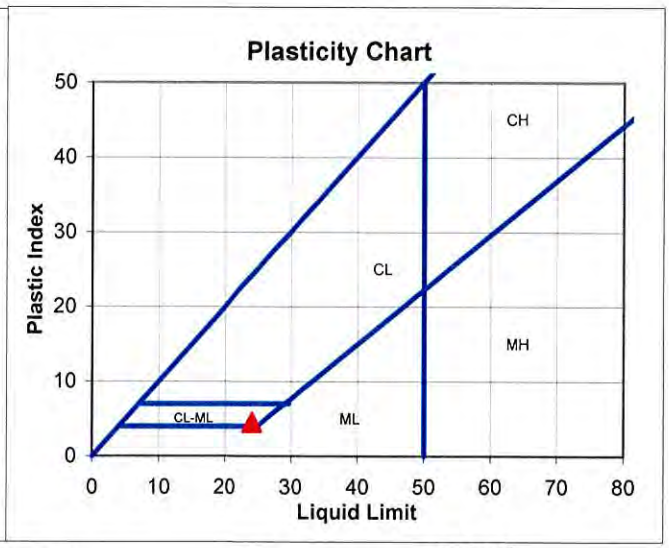
Average: 19.6%
Standard Deviation: 0.1%

Liquid Limits

	Sample 1	Sample 2	Sample 3
Number of Blows:	25	29	17
Weight of Wet Soil & Pan (g):	13.212	10.886	13.336
Weight of Dry Soil & Pan (g):	10.864	9.011	10.890
Weight of Water (g):	2.348	1.875	2.446
Weight of Pan (g):	1.147	1.138	1.121
Moisture Content (%):	24.2	23.8	25.0

Plastic Limit: 20
Liquid Limit: 24
Plastic Index: 4
Atterberg Classification CL-ML





Data Entered By: NN
Date: 4/5/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_0.xls

Data Checked By: DPM
Date: 4/6/16

ATT
ADVANCED TERRA TESTING

Atterberg Limits Test
ASTM D 4318

Client: Swift River Environmental Services
Job Number: 2952-2
Project: North Weld Landfill Expansion
Location: --
Project Number: 152047

Boring Number: TP-4
Depth: 2-6' bgs
Sample Number: --
Test Date: 04/07/2016
Technician: CAL
Sampled Date: --
Sampled By: --
Method: Method A

Test Configuration

Liquid Limits Device: 1075
Material Size of Fines: -#40

Plastic Limits

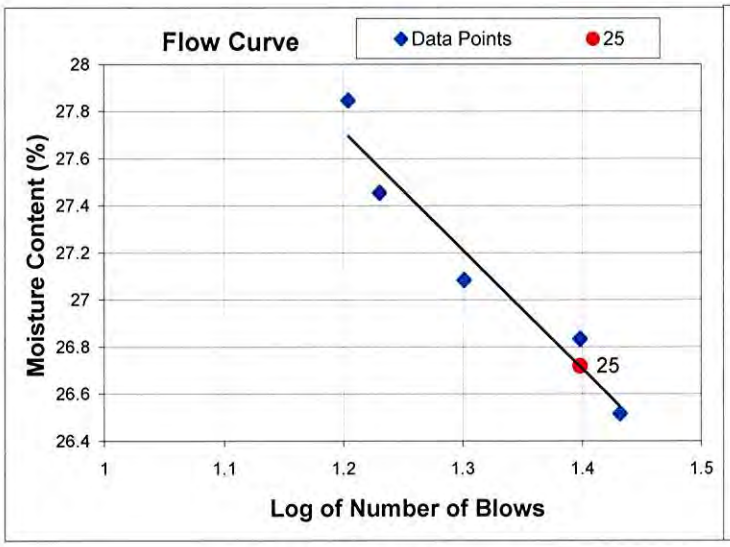
	Sample 1	Sample 2	Sample 3
Weight of Wet Soil & Pan (g):	6.200	8.644	9.294
Weight of Dry Soil & Pan (g):	5.347	7.356	7.924
Weight of Water (g):	0.853	1.288	1.370
Weight of Pan (g):	1.094	1.135	1.115
Moisture Content (%):	20.1	20.7	20.1

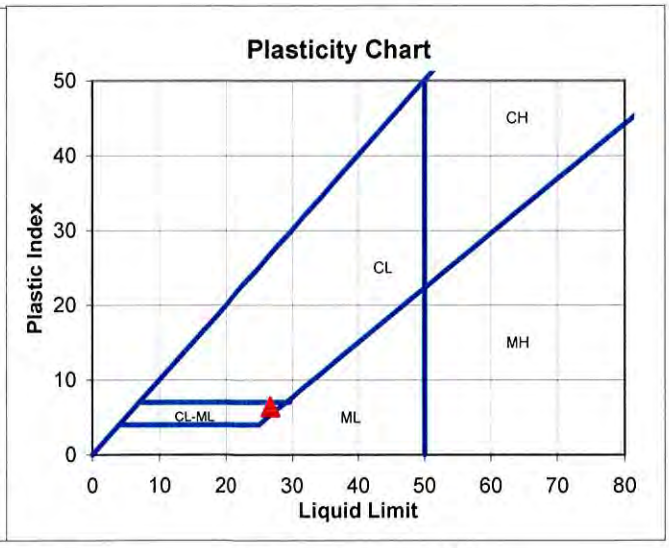
Average: 20.3%
Standard Deviation: 0.4%

Liquid Limits

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Number of Blows:	16	17	20	25	27
Weight of Wet Soil & Pan (g):	11.826	12.733	13.494	11.023	12.016
Weight of Dry Soil & Pan (g):	9.492	10.221	10.864	8.930	9.738
Weight of Water (g):	2.334	2.512	2.630	2.093	2.278
Weight of Pan (g):	1.110	1.071	1.153	1.130	1.147
Moisture Content (%):	27.8	27.5	27.1	26.8	26.5

Plastic Limit: 20
Liquid Limit: 27
Plastic Index: 7
Atterberg Classification CL-ML





Data Entered By: CKP Date: 4/8/2016
File Name: 2952_2_atterberg-ASTMD-4318-R8_6.xls

Data Checked By: CAL
Date: 4/11/16

ATT
ADVANCED TERRA TESTING

Compaction Testing

Proctor

ADVANCED TERRA TESTING

Compaction Test
ASTM D 1557 - A

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #1
Sampled by:	--	Depth:	2-4' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/4/2016

Initial conditions

Wet Wt. Pan and Soil (g):	326.33				Pf (% fines)	99.83%	
Dry Wt. Pan and Soil (g):	303.74				Pc (% course)	0.17%	
Wt. Water (g):	22.59				Use Correction?	No	
Dish Weight:	6.65				Layers	5	
Wet Wt. of Total Fines (lb):	29.37				Blows/Layer	25	
Dry Wt. of total fines (lb):	27.30						
Mdc (mass dry coarse) (lb):	0.047						
Wt of Moisture added (ml)	200	40	80	120	160		
Wt. of soil & dish (g)	325.97	322.32	473.31	430.36	437.93		
Dry wt. soil & dish (g)	280.07	295.39	426.94	382.40	382.37		
Net loss of moisture (g)	45.90	26.93	46.37	47.96	55.56		
Wt. of dish (g)	6.89	7.04	6.64	6.92	6.96		
Net wt. of dry soil (g)	273.18	288.35	420.30	375.48	375.41		
Moisture Content	16.8%	9.3%	11.0%	12.8%	14.8%		
Corrected Moisture Content							
Wt of soil & mold (lb)	13.77	13.48	13.68	13.85	13.86		
Wt. of mold (lb)	9.38	9.38	9.38	9.38	9.38		
Net wt. of wet soil (lb)	4.39	4.10	4.30	4.47	4.48		
Net wt of dry soil (lb)	3.76	3.75	3.87	3.96	3.90		
Dry Density, (pcf)	112.8	112.5	116.2	118.9	117.1		
Corrected Dry Density (pcf)							

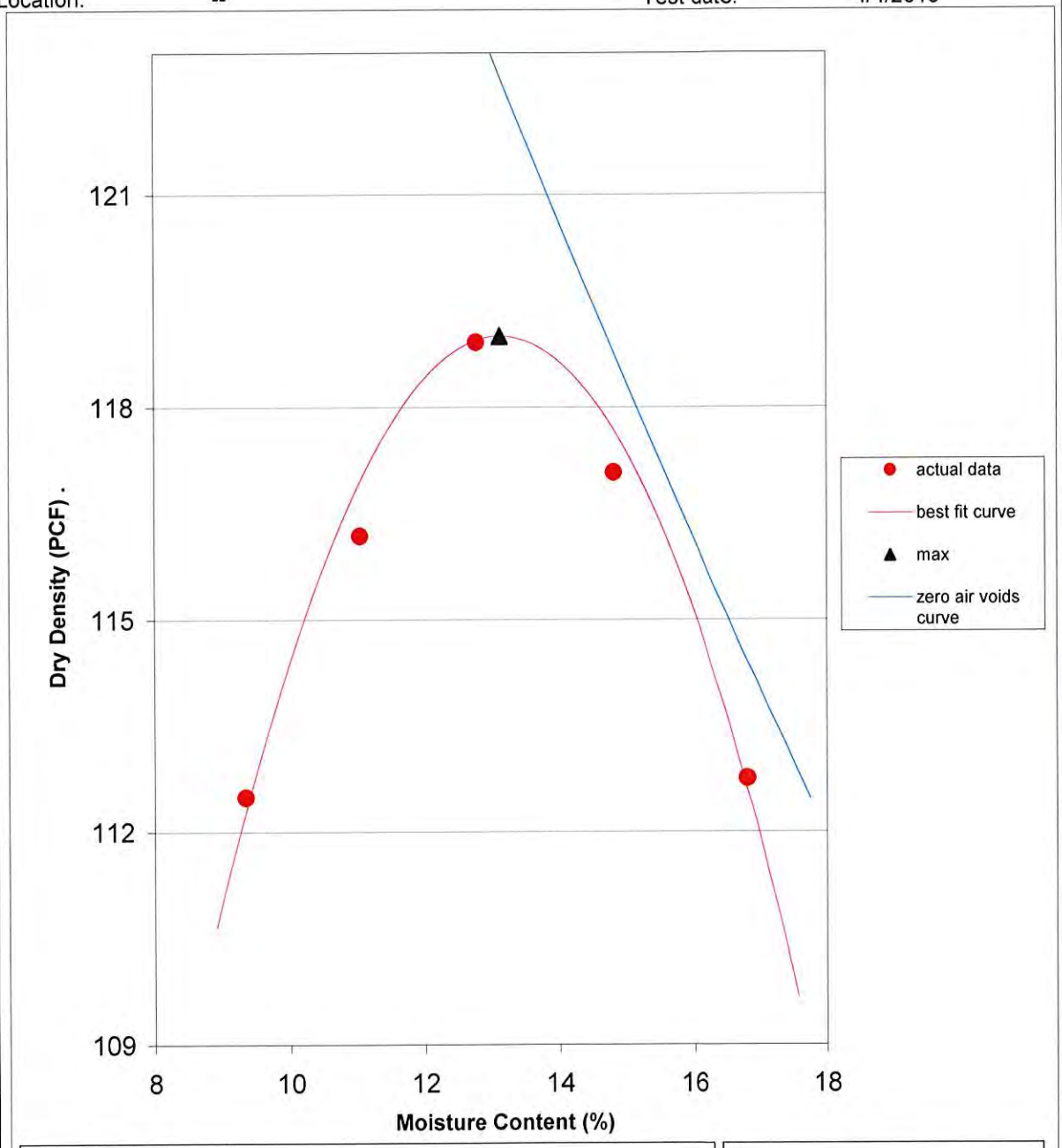
Data entry by:	NN	Date:	04/05/16
Data checked by:	CAL	Date:	04/05/16
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_1.xls		

Proctor Compaction Test

ASTM D 1557 - A

ADVANCED TERRA TESTING

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #1
Sampled by:	--	Depth:	2-4' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/4/2016



Optimum Moisture content: 13.1 Maximum dry density: 119.0

Zero air voids curve @ SG = 2.65

Data entry by:	NN	Date:	04/05/16
Data checked by:	CAL	Date:	04/05/16
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_1.xls		

ATT
ADVANCED TERRA TESTING

Compaction Test
ASTM D 1557 - A

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #2
Sampled by:	--	Depth:	5-9' bgs
Tested by:	CAL	Sample Id:	--
Location:	--	Test date:	4/1/2016

Initial conditions

Wet Wt. Pan and Soil (g):	151.94	Pf (% fines)	99.95%
Dry Wt. Pan and Soil (g):	141.62	Pc (% course)	0.05%
Wt. Water (g):	10.32	Use Correction?	No
Dish Weight:	6.6	Layers	5
Wet Wt. of Total Fines (lb):	30.41	Blows/Layer	25
Dry Wt. of total fines (lb):	28.25		
Mdc (mass dry coarse) (lb):	0.015		

Wt of Moisture added (ml)	160	120	80	40		
Wt. of soil & dish (g)	312.56	330.11	418.85	479.66		
Dry wt. soil & dish (g)	272.04	291.84	376.02	438.21		
Net loss of moisture (g)	40.52	38.27	42.83	41.45		
Wt. of dish (g)	6.68	6.94	7.00	6.68		
Net wt. of dry soil (g)	265.36	284.90	369.02	431.53		
Moisture Content	15.3%	13.4%	11.6%	9.6%		
Corrected Moisture Content						
Wt of soil & mold (lb)	13.87	13.96	13.92	13.68		
Wt. of mold (lb)	9.38	9.38	9.38	9.38		
Net wt. of wet soil (lb)	4.49	4.58	4.54	4.30		
Net wt of dry soil (lb)	3.90	4.04	4.07	3.92		
Dry Density, (pcf)	116.9	121.1	122.0	117.7		
Corrected Dry Density (pcf)						

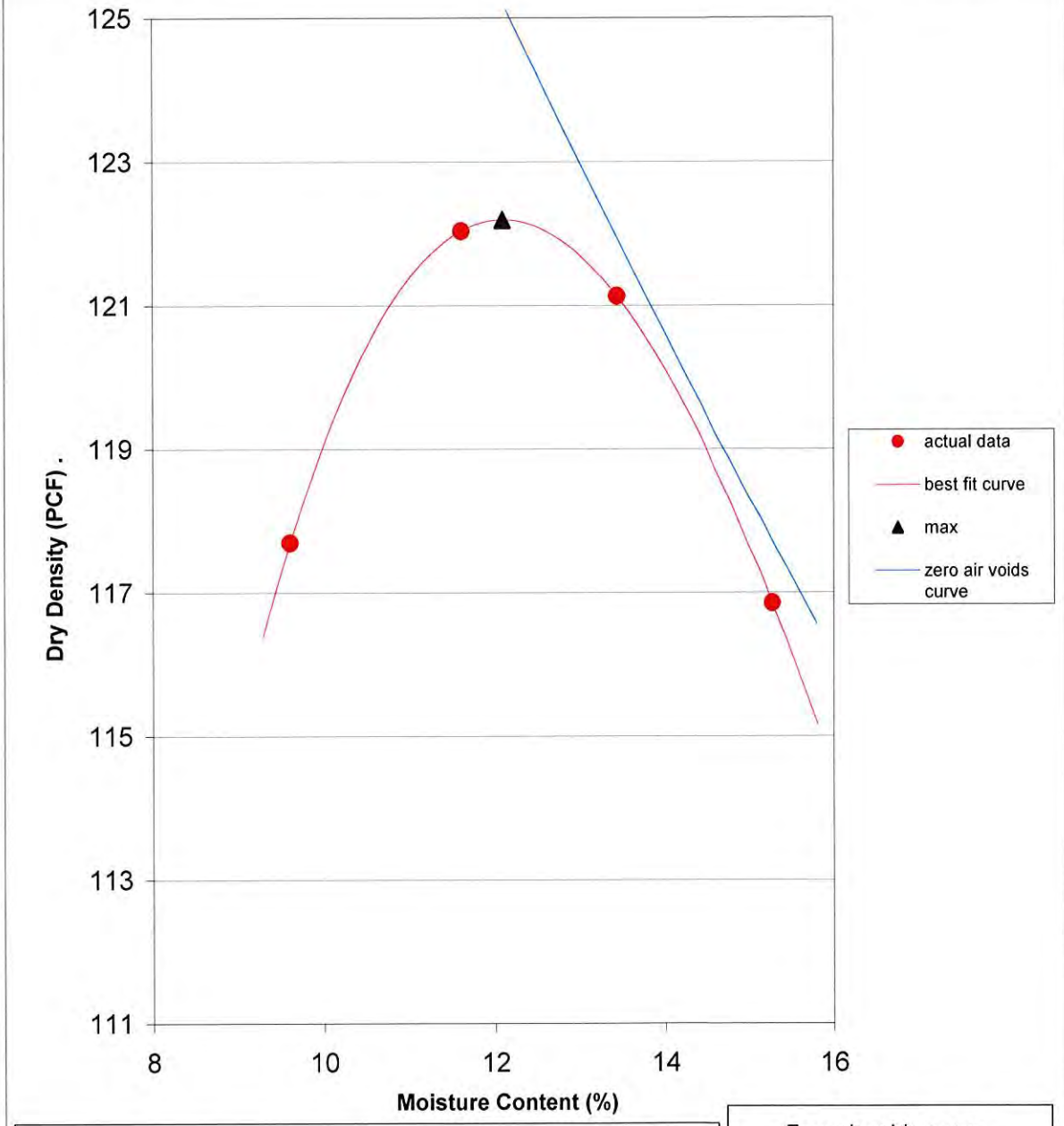
Data entry by:	BDF	Date:	04/04/16		
Data checked by:	KP	Date:	4/5/16		
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_0.xls				

Proctor Compaction Test

ASTM D 1557 - A

ADVANCED TERRA TESTING

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #2
Sampled by:	--	Depth:	5-9' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/1/2016



Optimum Moisture content: 12.1 Maximum dry density: 122.2

Zero air voids curve @ SG = 2.65

Data entry by:	CAL	Date:	04/04/16
Data checked by:	KR	Date:	4/5/16
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_0.xls		

ADVANCED TERRA TESTING

Compaction Test
ASTM D 1557 - A

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #3
Sampled by:	--	Depth:	3-5' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/4/2016

Initial conditions

Wet Wt. Pan and Soil (g):	281.87	Pf (% fines)	99.99%
Dry Wt. Pan and Soil (g):	268.36	Pc (% course)	0.01%
Wt. Water (g):	13.51	Use Correction?	No
Dish Weight:	6.58	Layers	5
Wet Wt. of Total Fines (lb):	35.94	Blows/Layer	25
Dry Wt. of total fines (lb):	34.18		
Mdc (mass dry coarse) (lb):	0.002		

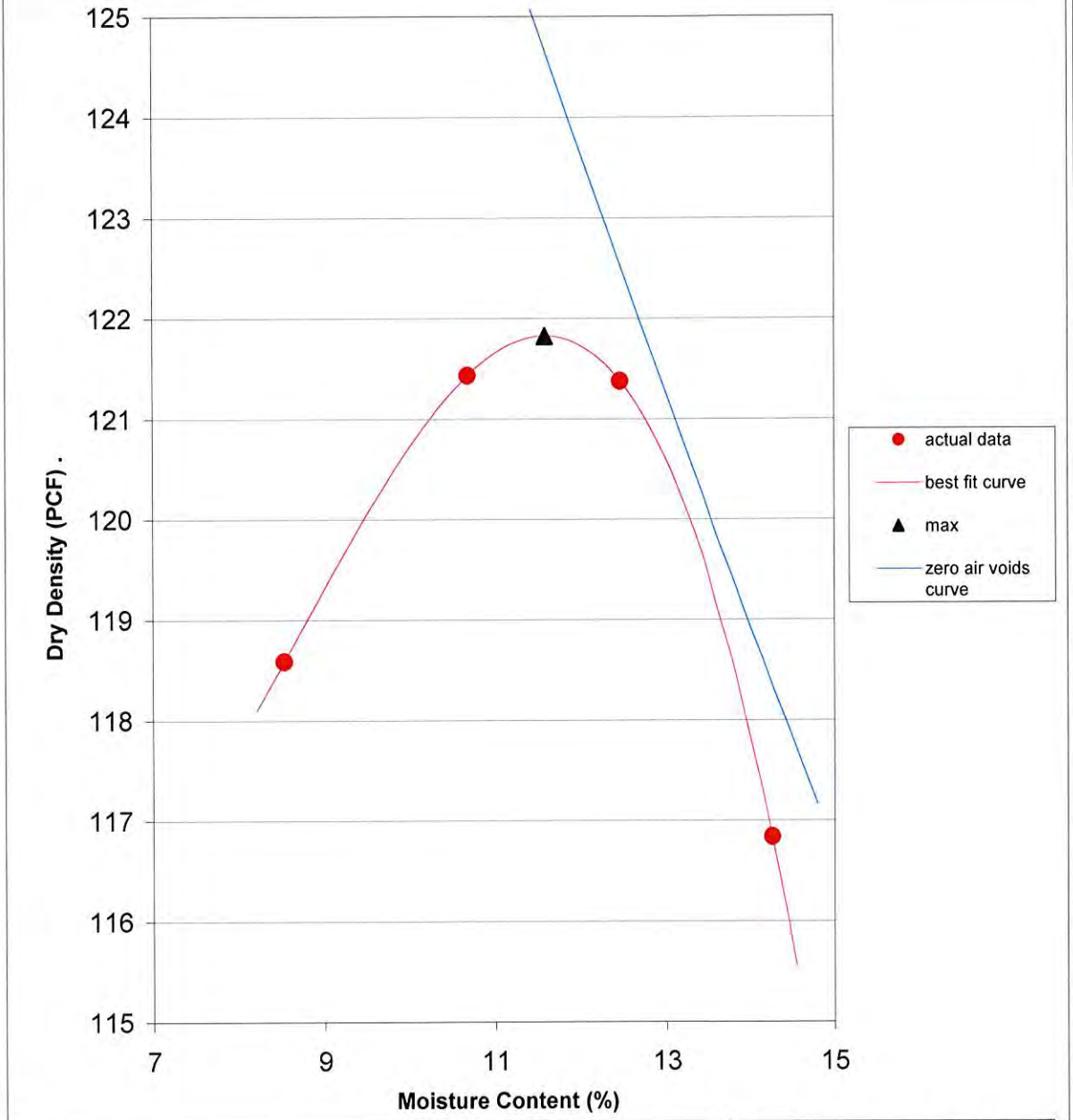
Wt of Moisture added (ml)	160	120	200	80		
Wt. of soil & dish (g)	422.99	383.28	312.83	427.56		
Dry wt. soil & dish (g)	376.91	346.97	274.62	394.49		
Net loss of moisture (g)	46.08	36.31	38.21	33.07		
Wt. of dish (g)	7.12	6.98	6.66	6.62		
Net wt. of dry soil (g)	369.79	339.99	267.96	387.87		
Moisture Content	12.5%	10.7%	14.3%	8.5%		
Corrected Moisture Content						
Wt of soil & mold (lb)	13.93	13.86	13.83	13.67		
Wt. of mold (lb)	9.38	9.38	9.38	9.38		
Net wt. of wet soil (lb)	4.55	4.48	4.45	4.29		
Net wt of dry soil (lb)	4.05	4.05	3.89	3.95		
Dry Density, (pcf)	121.4	121.4	116.8	118.6		
Corrected Dry Density (pcf)						

Data entry by:	NN	Date:	04/05/16		
Data checked by:	CAL	Date:	04/05/16		
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_2.xls				

Proctor Compaction Test

ASTM D 1557 - A

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #3
Sampled by:	--	Depth:	3-5' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/4/2016



Optimum Moisture content: 11.6 Maximum dry density: 121.8	Zero air voids curve @ SG = 2.6

Data entry by:	NN	Date:	04/05/16
Data checked by:	CAL	Date:	04/05/16
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_2.xls		

ADVANCED TERRA TESTING

Compaction Test
ASTM D 1557 - A

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #4
Sampled by:	--	Depth:	2-6' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/5/2016

Initial conditions

Wet Wt. Pan and Soil (g):	266.14			Pf (% fines)	100.00%	
Dry Wt. Pan and Soil (g):	260.29			Pc (% course)	0.00%	
Wt. Water (g):	5.85			Use Correction?	No	
Dish Weight:	6.6			Layers	5	
Wet Wt. of Total Fines (lb):	25.00			Blows/Layer	25	
Dry Wt. of total fines (lb):	24.44					
Mdc (mass dry coarse) (lb):	0					
Wt of Moisture added (ml)	160	200	280	320	240	
Wt. of soil & dish (g)	347.67	422.82	371.21	310.72	410.80	
Dry wt. soil & dish (g)	317.94	380.96	324.27	267.50	364.45	
Net loss of moisture (g)	29.73	41.86	46.94	43.22	46.35	
Wt. of dish (g)	6.94	6.92	6.58	6.92	6.64	
Net wt. of dry soil (g)	311.00	374.04	317.69	260.58	357.81	
Moisture Content	9.6%	11.2%	14.8%	16.6%	13.0%	
Corrected Moisture Content						
Wt of soil & mold (lb)	13.70	13.84	13.74	13.62	13.84	
Wt. of mold (lb)	9.38	9.38	9.38	9.38	9.38	
Net wt. of wet soil (lb)	4.32	4.46	4.36	4.24	4.46	
Net wt of dry soil (lb)	3.94	4.01	3.80	3.64	3.95	
Dry Density, (pcf)	118.3	120.3	114.0	109.1	118.5	
Corrected Dry Density (pcf)						

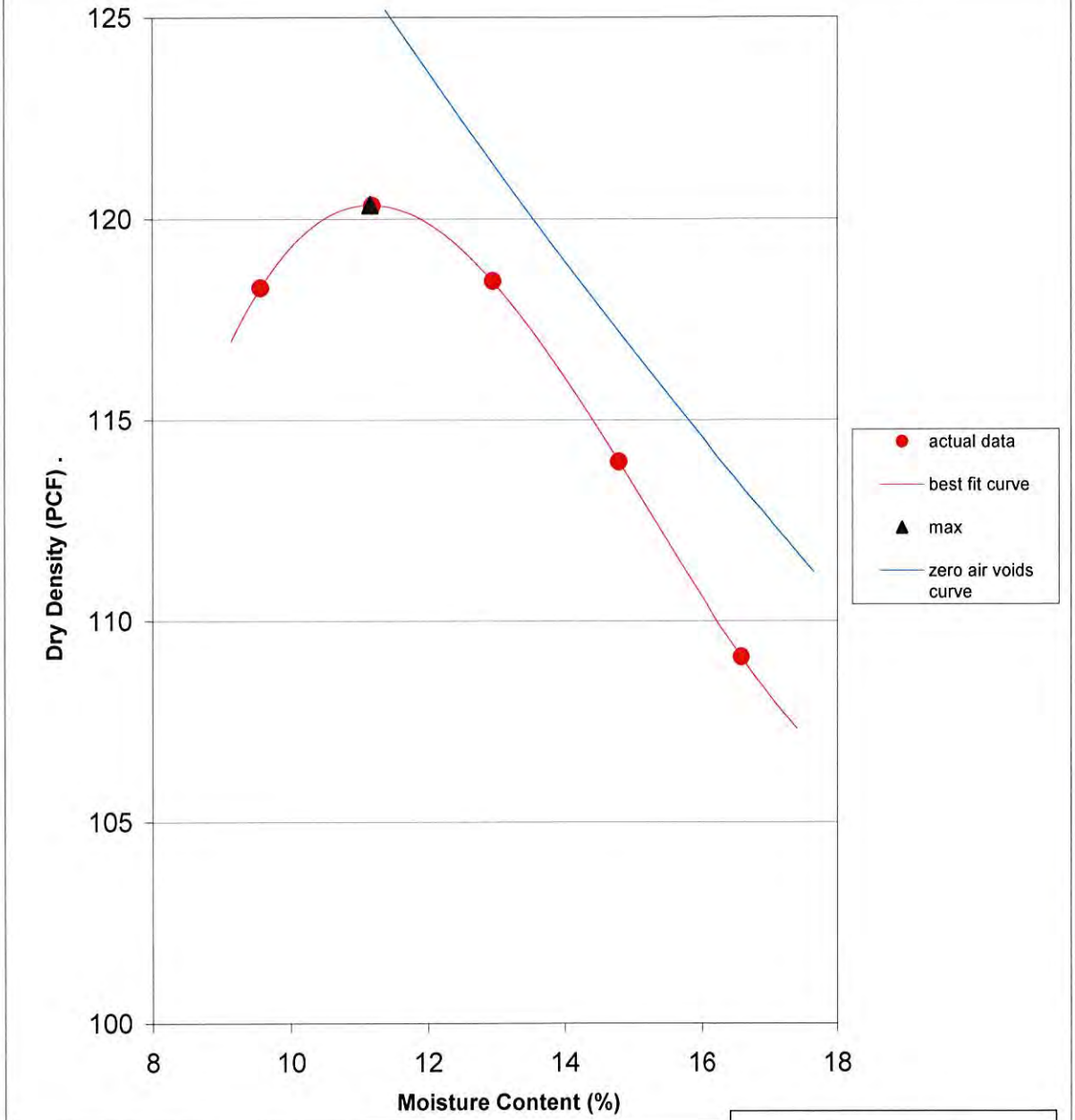
Data entry by:	CAL	Date:	04/06/16
Data checked by:	DPM	Date:	4/6/16
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_4.xls		

Proctor Compaction Test

ASTM D 1557 - A

ADVANCED TERRA TESTING

Client:	Swift River Environmental Services	Job number:	2952-2
Project Number:	152047		
Project:	North Weld Landfill Expansion	Boring:	Test Pit #4
Sampled by:	--	Depth:	2-6' bgs
Tested by:	BDF	Sample Id:	--
Location:	--	Test date:	4/5/2016



Optimum Moisture content: 11.2 Maximum dry density: 120.3

Zero air voids curve @ SG = 2.6

Data entry by:	CAL	Date:	04/06/16
Data checked by:	DPM	Date:	4/6/16
Filename	2952_2_Proctor_ASTMD1557_ASTMD698_R2_4.xls		

Consolidation Testing

One-Dimensional

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/09/2016 DPM
LOCATION	--	TEST FINISHED	03/18/2016 DPM
BORING NO.	NWE-8	CONSOLIDOMETER	ATT-17
DEPTH	18-20'	SAMPLE DESCR.	--
SAMPLE NO.	UD		
		INITIAL HT.(in)	1.000
SAMPLE DIA.(in)	2.410	FINAL HT.(in)	0.839

MOISTURE/DENSITY DATA

	BEFORE TEST	AFTER TEST		BEFORE TEST	AFTER TEST
Wt. Soil & Ring(s) (g)	171.91	178.24	Wt. Wet Soil & Pan (g)	132.04	138.37
Wt. Ring(s) (g)	43.07	43.07	Wt. Dry Soil & Pan (g)	119.00	119.00
Wt. Soil (g)	128.84	135.17	Wt. Lost Moisture (g)	13.04	19.37
Wet Density (pcf)	107.6	134.5	Wt. of Pan Only (g)	3.20	3.20
Moisture Content (%)	11.3	16.7	Wt. of Dry Soil (g)	115.80	115.80
Dry Density (pcf)	96.7	115.2	Saturation (%)	42.0	101.7

	LOAD (psf)	CONSOL. (IN)	LOG p	CONSOL. (IN/IN)	DEFL. (IN/IN)	VOID RATIO (e)
	100	0.0000	2.000	0.0000	0.0000	0.711
Inundate	100	0.0018	2.000	0.0018	-0.0018	0.708
	200	0.0065	2.301	0.0065	-0.0065	0.700
	400	0.0103	2.602	0.0103	-0.0103	0.693
	800	0.0168	2.903	0.0168	-0.0168	0.682
	1600	0.0315	3.204	0.0315	-0.0315	0.657
	3200	0.0631	3.505	0.0631	-0.0631	0.603
	6400	0.1025	3.806	0.1025	-0.1025	0.535
	12800	0.1423	4.107	0.1423	-0.1423	0.467
	25600	0.1755	4.408	0.1755	-0.1755	0.411
	6400	0.1735	3.806	0.1735	-0.1735	0.414
	1600	0.1697	3.204	0.1697	-0.1697	0.420
	400	0.1657	2.602	0.1657	-0.1657	0.427
	100	0.1606	2.000	0.1606	-0.1606	0.436

Init. Ht. Solids (cm)	1.485	Sp. Gr. (g/cc)	2.650
Init. Ht. Voids (cm)	1.055		
Init. Void Ratio	0.711		

Data entry by: NN Date: 03/21/2016

Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_0.xls

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT Swift River Environmental Services JOB NO. 2952-1

PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/09/2016 DPM
LOCATION	--	TEST FINISHED	03/18/2016 DPM
BORING NO.	NWE-8	CONSOLIDOMETER	ATT-17
DEPTH	18-20'	SAMPLE DESCR.	--
SAMPLE NO.	UD		

TIME READING DATA

100 wet psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0000	0.0000	0.7108
0.1	0.32	0.0001	0.0001	0.7106
0.3	0.50	0.0003	0.0003	0.7102
0.5	0.71	0.0006	0.0006	0.7097
1.0	1.00	0.0010	0.0010	0.7091
2.0	1.41	0.0012	0.0012	0.7087
4.0	2.00	0.0014	0.0014	0.7084
9.0	3.00	0.0015	0.0015	0.7082
16.0	4.00	0.0016	0.0016	0.7080
30.0	5.48	0.0017	0.0017	0.7079
60.0	7.75	0.0018	0.0018	0.7077
120.0	10.95	0.0018	0.0018	0.7077

200 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0018	0.0018	0.7077
0.1	0.32	0.0044	0.0041	0.7037
0.3	0.50	0.0047	0.0044	0.7032
0.5	0.71	0.0050	0.0047	0.7027
1.0	1.00	0.0052	0.0049	0.7024
2.0	1.41	0.0054	0.0051	0.7020
4.0	2.00	0.0056	0.0053	0.7017
9.0	3.00	0.0058	0.0055	0.7014
16.0	4.00	0.0060	0.0057	0.7010
30.0	5.48	0.0061	0.0058	0.7008
60.0	7.75	0.0063	0.0060	0.7005
120.0	10.95	0.0065	0.0062	0.7002
240.0	15.49	0.0067	0.0064	0.6998
360.0	18.97	0.0068	0.0065	0.6996

400 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0068	0.0065	0.6996
0.1	0.32	0.0092	0.0083	0.6966
0.3	0.50	0.0095	0.0086	0.6960
0.5	0.71	0.0097	0.0088	0.6957
1.0	1.00	0.0099	0.0090	0.6954
2.0	1.41	0.0100	0.0091	0.6952
4.0	2.00	0.0102	0.0093	0.6949
9.0	3.00	0.0104	0.0095	0.6945
16.0	4.00	0.0106	0.0097	0.6942
30.0	5.48	0.0107	0.0098	0.6940
60.0	7.75	0.0109	0.0100	0.6937
120.0	10.95	0.0112	0.0103	0.6931

800 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0112	0.0103	0.6931
0.1	0.32	0.0153	0.0136	0.6875
0.3	0.50	0.0158	0.0141	0.6866
0.5	0.71	0.0161	0.0144	0.6861
1.0	1.00	0.0164	0.0147	0.6856
2.0	1.41	0.0168	0.0151	0.6849
4.0	2.00	0.0171	0.0154	0.6844
9.0	3.00	0.0174	0.0157	0.6839
16.0	4.00	0.0177	0.0160	0.6834
30.0	5.48	0.0179	0.0162	0.6830
65.0	8.06	0.0182	0.0165	0.6825
120.0	10.95	0.0185	0.0168	0.6820

Data entry by: NN Date: 03/21/2016

Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_0.xls

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT Swift River Environmental Services JOB NO. 2952-1

PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/09/2016 DPM
LOCATION	--	TEST FINISHED	03/18/2016 DPM
BORING NO.	NWE-8	CONSOLIDOMETER	ATT-17
DEPTH	18-20'	SAMPLE DESCR.	--
SAMPLE NO.	UD		

TIME READING DATA

1600 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0185	0.0168	0.6820
0.1	0.32	0.0260	0.0233	0.6709
0.3	0.50	0.0272	0.0245	0.6688
0.5	0.71	0.0280	0.0253	0.6675
1.0	1.00	0.0288	0.0261	0.6661
2.0	1.41	0.0295	0.0268	0.6649
4.0	2.00	0.0302	0.0275	0.6637
9.0	3.00	0.0311	0.0284	0.6622
16.0	4.00	0.0316	0.0289	0.6613
30.0	5.48	0.0322	0.0295	0.6603
60.0	7.75	0.0327	0.0300	0.6594
120.0	10.95	0.0332	0.0305	0.6586
240.0	15.49	0.0335	0.0308	0.6581
1214.0	34.84	0.0342	0.0315	0.6569

3200 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0342	0.0315	0.6569
0.1	0.32	0.0501	0.0458	0.6324
0.3	0.50	0.0530	0.0487	0.6274
0.5	0.71	0.0548	0.0505	0.6244
1.0	1.00	0.0564	0.0521	0.6216
2.0	1.41	0.0579	0.0536	0.6191
4.0	2.00	0.0593	0.0550	0.6167
9.0	3.00	0.0609	0.0566	0.6139
20.0	4.47	0.0621	0.0578	0.6119
30.0	5.48	0.0628	0.0585	0.6107
60.0	7.75	0.0638	0.0595	0.6090
120.0	10.95	0.0646	0.0603	0.6076
240.0	15.49	0.0654	0.0611	0.6062
480.0	21.91	0.0658	0.0615	0.6055
1465.0	38.28	0.0666	0.0623	0.6042

6400 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0674	0.0631	0.6028
0.1	0.32	0.0890	0.0831	0.5686
0.3	0.50	0.0927	0.0868	0.5623
0.5	0.71	0.0951	0.0892	0.5582
1.0	1.00	0.0974	0.0915	0.5542
2.0	1.41	0.0996	0.0937	0.5505
4.0	2.00	0.1012	0.0953	0.5477
9.0	3.00	0.1030	0.0971	0.5446
16.0	4.00	0.1040	0.0981	0.5429
30.0	5.48	0.1050	0.0991	0.5412
60.0	7.75	0.1059	0.1000	0.5397
120.0	10.95	0.1067	0.1008	0.5383
240.0	15.49	0.1073	0.1014	0.5373
480.0	21.91	0.1078	0.1019	0.5364
1440.0	37.95	0.1084	0.1025	0.5354

12800 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.1084	0.1025	0.5354
0.1	0.32	0.1348	0.1266	0.4942
0.3	0.50	0.1379	0.1297	0.4889
0.5	0.71	0.1397	0.1315	0.4858
1.0	1.00	0.1412	0.1330	0.4832
2.0	1.41	0.1426	0.1344	0.4808
4.0	2.00	0.1439	0.1357	0.4786
9.0	3.00	0.1452	0.1370	0.4764
16.0	4.00	0.1461	0.1379	0.4748
30.0	5.48	0.1470	0.1388	0.4733
60.0	7.75	0.1479	0.1397	0.4718
120.0	10.95	0.1486	0.1404	0.4706
240.0	15.49	0.1493	0.1411	0.4694
480.0	21.91	0.1499	0.1417	0.4683
1526.0	39.06	0.1505	0.1423	0.4673

Data entry by: NN Date: 03/21/2016

Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_0.xls

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT Swift River Environmental Services JOB NO. 2952-1

PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/09/2016 DPM
LOCATION	--	TEST FINISHED	03/18/2016 DPM
BORING NO.	NWE-8	CONSOLIDOMETER	ATT-17
DEPTH	18-20'	SAMPLE DESCR.	--
SAMPLE NO.	UD		

TIME READING DATA

25600 psf Load

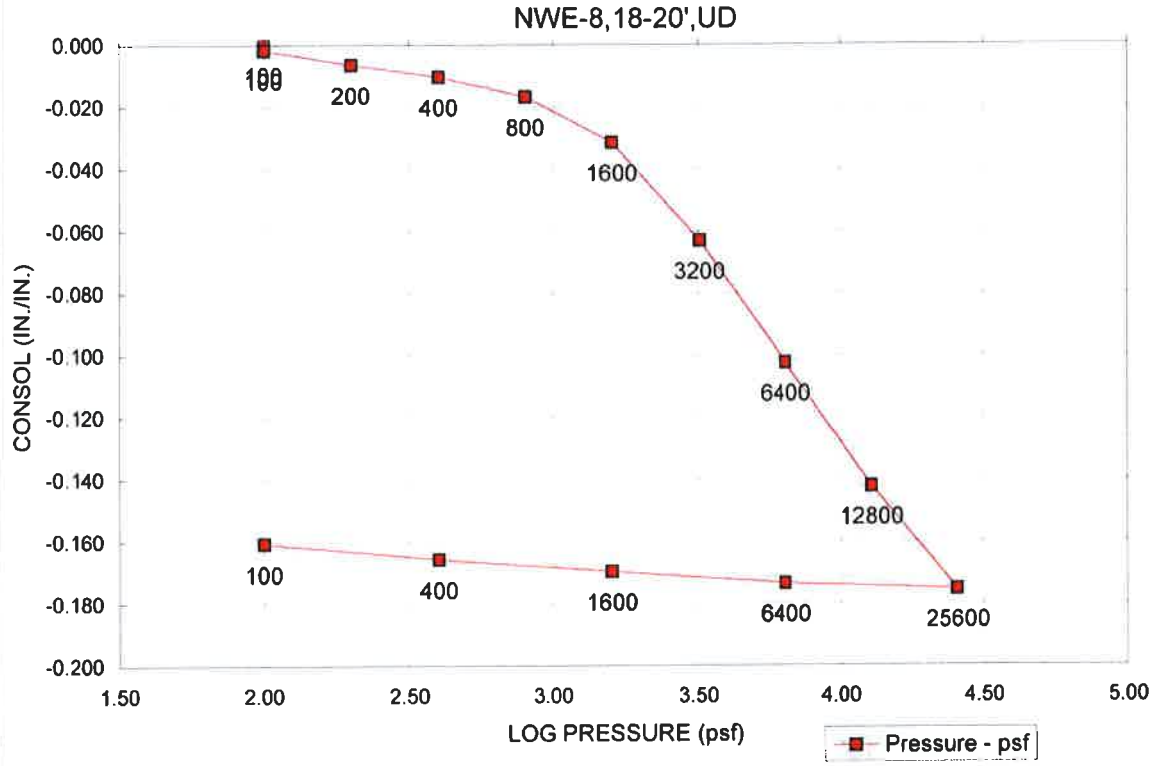
Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.1505	0.1423	0.4673
0.1	0.32	0.1726	0.1619	0.4338
0.3	0.50	0.1750	0.1643	0.4297
0.5	0.71	0.1764	0.1657	0.4273
1.0	1.00	0.1778	0.1671	0.4249
2.0	1.41	0.1789	0.1682	0.4230
6.0	2.45	0.1806	0.1699	0.4201
9.0	3.00	0.1811	0.1704	0.4192
16.0	4.00	0.1819	0.1712	0.4179
30.0	5.48	0.1827	0.1720	0.4165
65.0	8.06	0.1836	0.1729	0.4150
120.0	10.95	0.1841	0.1734	0.4141
240.0	15.49	0.1848	0.1741	0.4129
480.0	21.91	0.1854	0.1747	0.4119
1440.0	37.95	0.1862	0.1755	0.4105

Data entry by: NN Date: 03/21/2016

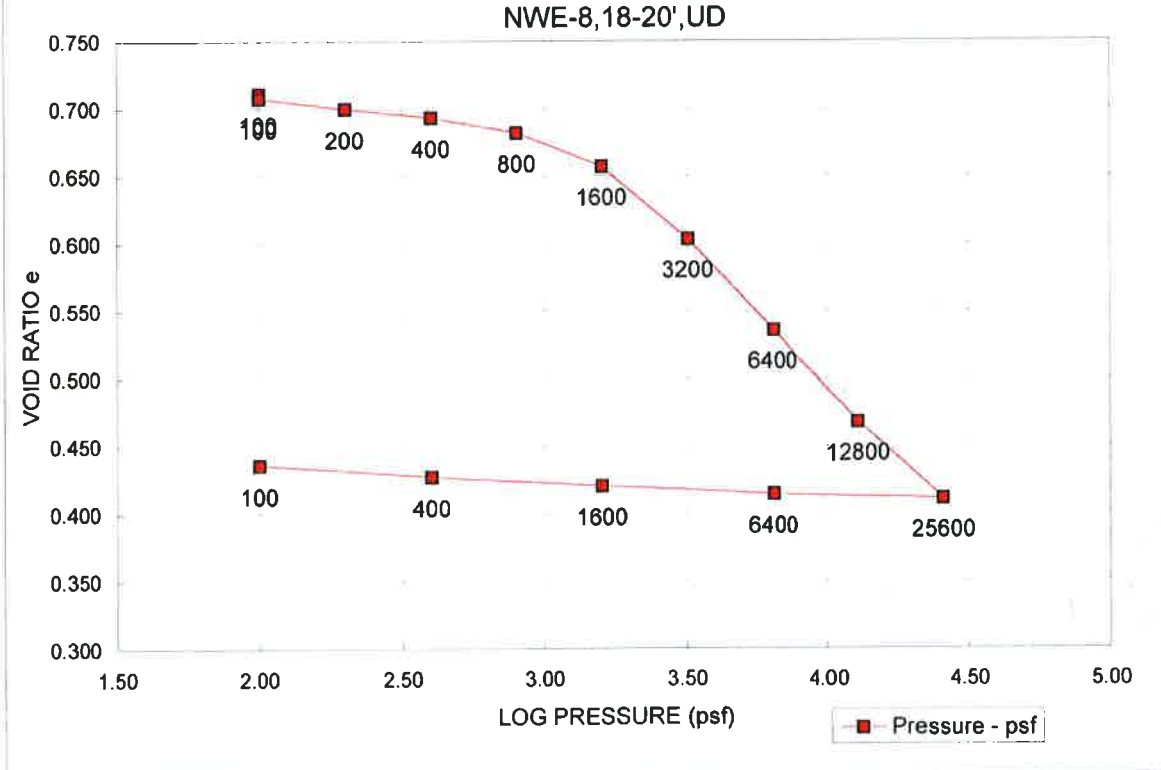
Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_0.xls

CONSOLIDATION TEST DATA

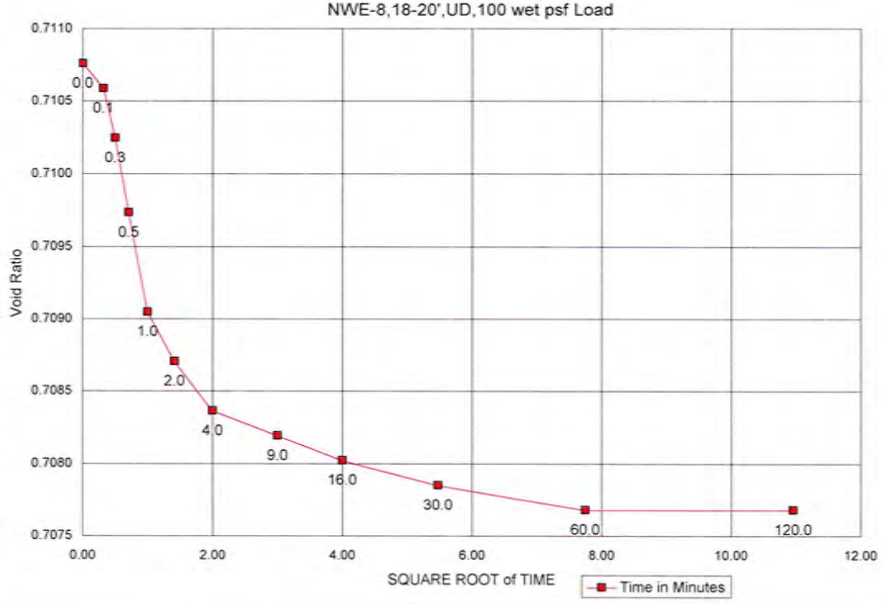


CONSOLIDATION TEST DATA



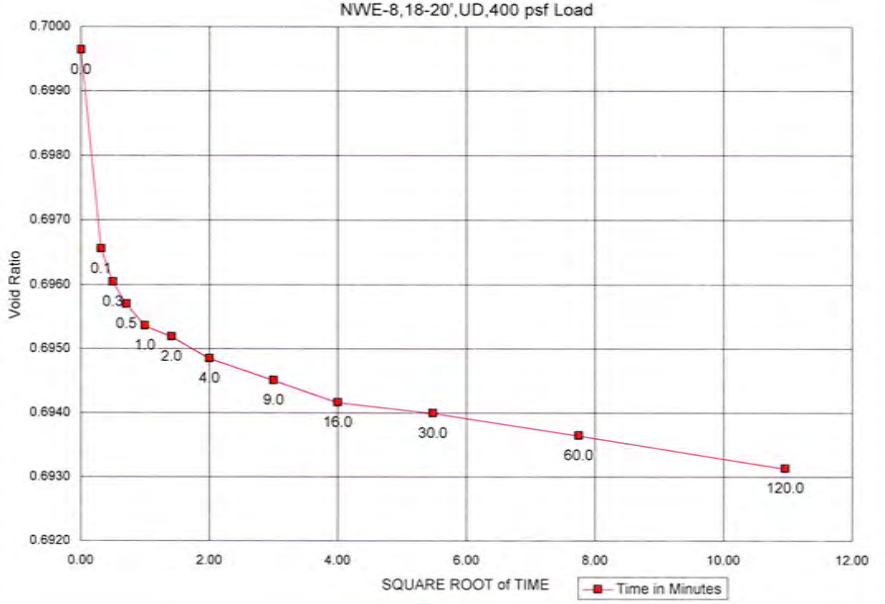
TIME READING DATA

NWE-8,18-20',UD,100 wet psf Load



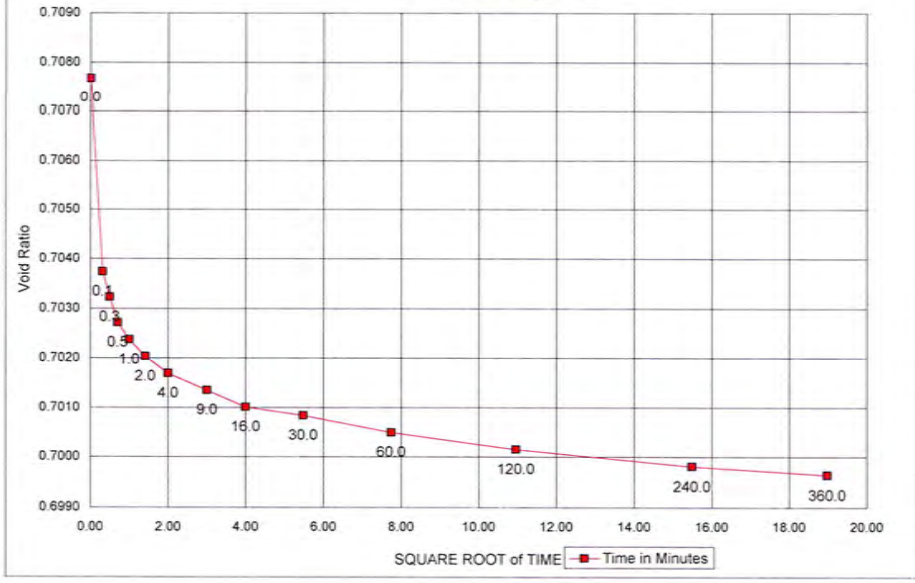
TIME READING DATA

NWE-8,18-20',UD,400 psf Load



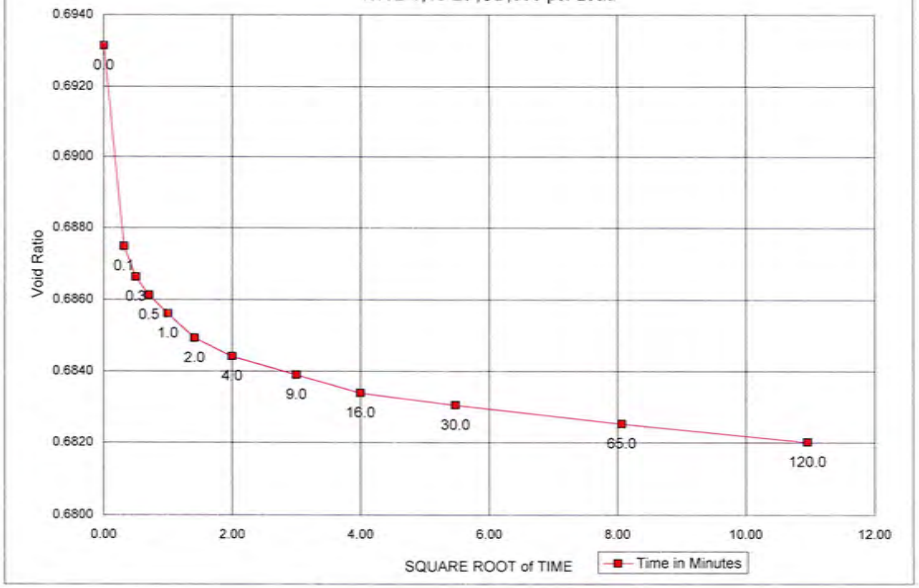
TIME READING DATA

NWE-8,18-20',UD,200 psf Load



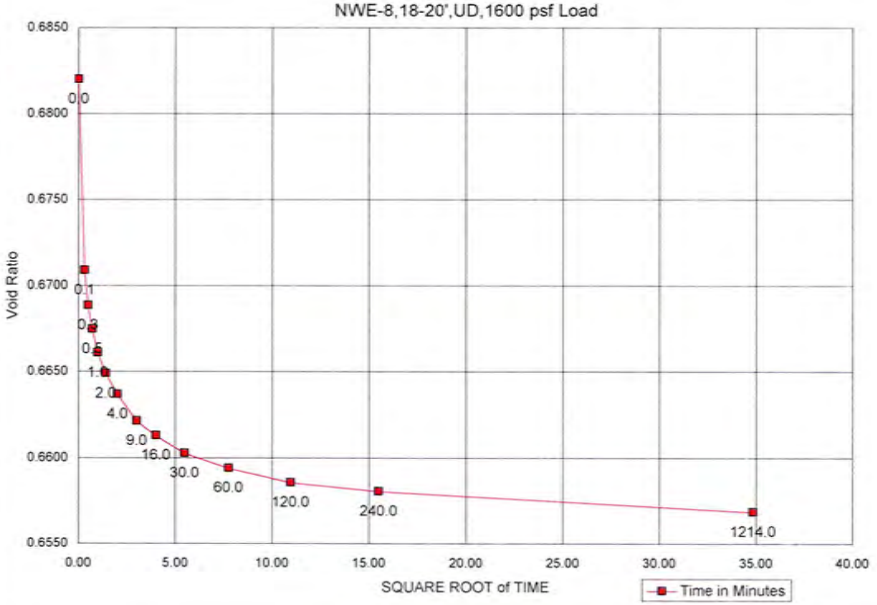
TIME READING DATA

NWE-8,18-20',UD,800 psf Load



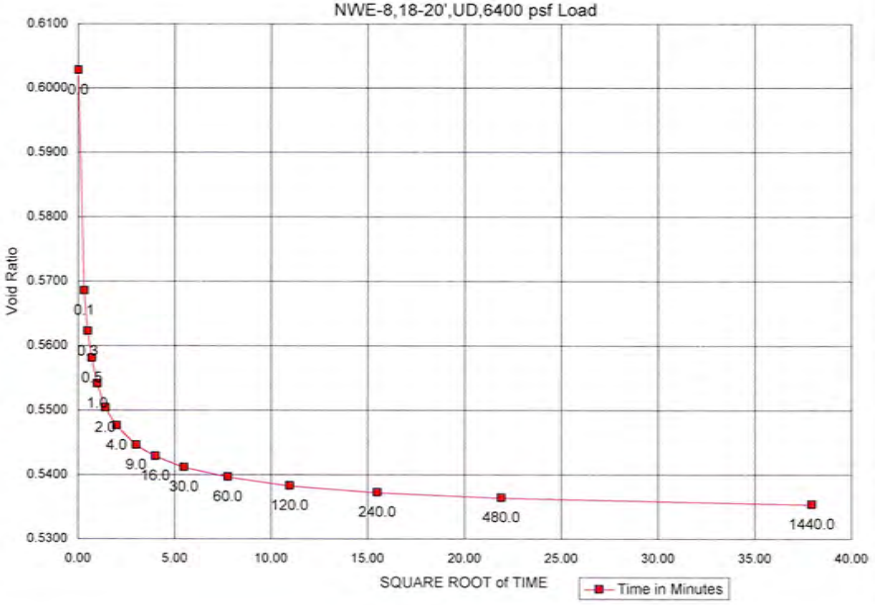
TIME READING DATA

NWE-8,18-20',UD,1600 psf Load



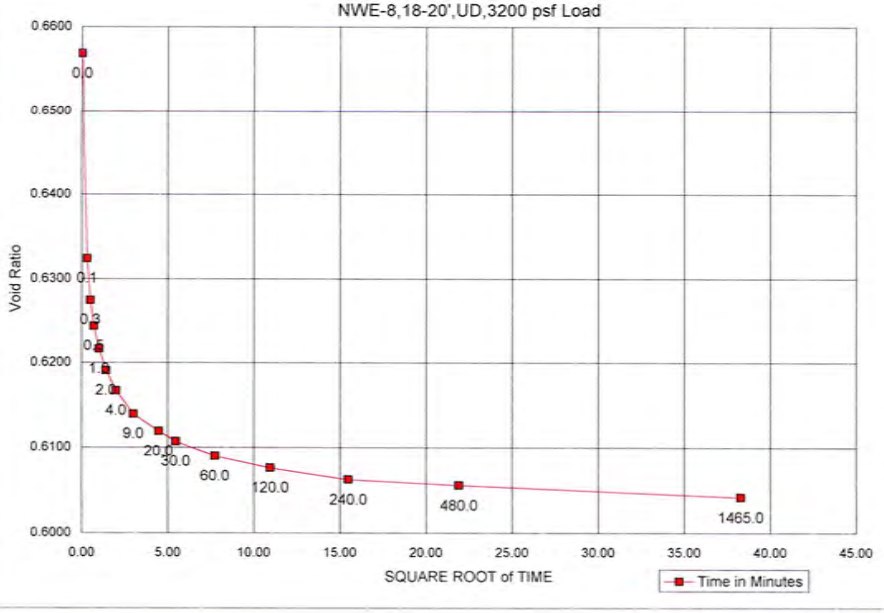
TIME READING DATA

NWE-8,18-20',UD,6400 psf Load



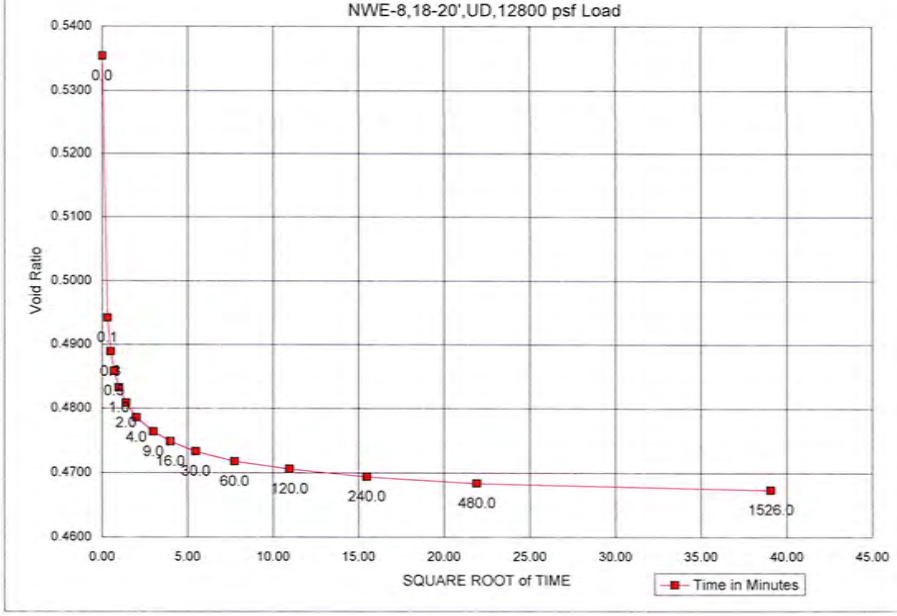
TIME READING DATA

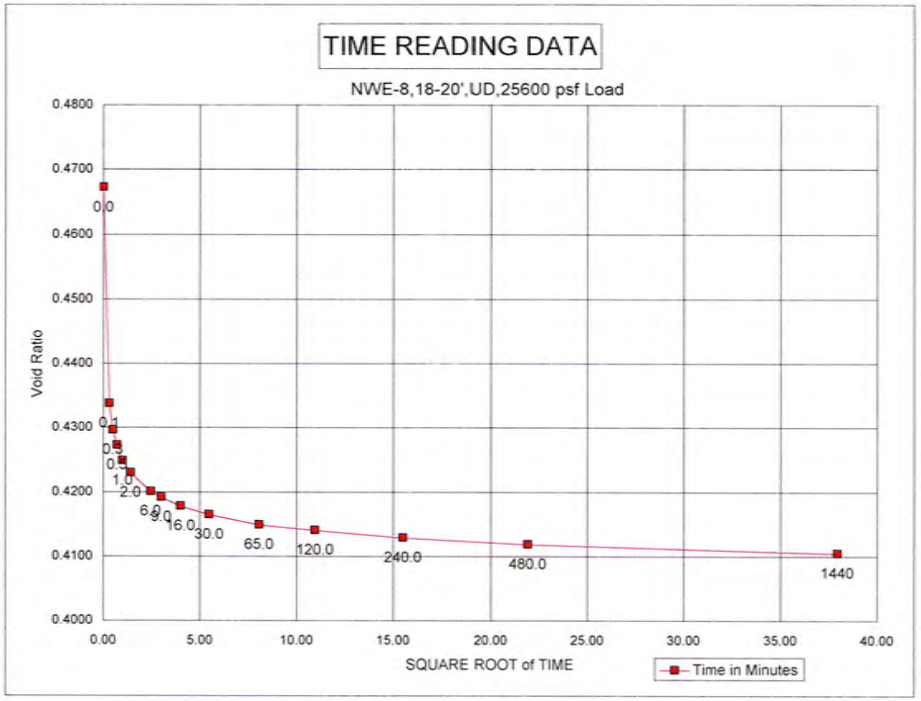
NWE-8,18-20',UD,3200 psf Load



TIME READING DATA

NWE-8,18-20',UD,12800 psf Load




TIME READING DATA
NWE-8,18-20',UD,25600 psf Load
Void Ratio
0.4800
0.4700
0.4600
0.4500
0.4400
0.4300
0.4200
0.4100
0.4000
0.0
0.1
0.5
1.0
2.0
6.0
9.0
16.0
30.0
65.0
120.0
240.0
480.0
1440
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
SQUARE ROOT of TIME
Time in Minutes

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/11/2016 DPM
LOCATION	--	TEST FINISHED	03/24/2016 CAL
BORING NO.	NWE-16	CONSOLIDOMETER	ATT-15
DEPTH	14-16'	SAMPLE DESCR.	--
SAMPLE NO.	UD		
		INITIAL HT.(in)	1.000
SAMPLE DIA.(in)	2.410	FINAL HT.(in)	0.802

MOISTURE/DENSITY DATA

	BEFORE TEST	AFTER TEST		BEFORE TEST	AFTER TEST
Wt. Soil & Ring(s) (g)	149.69	163.35	Wt. Wet Soil & Pan (g)	111.96	125.62
Wt. Ring(s) (g)	40.97	40.97	Wt. Dry Soil & Pan (g)	104.86	104.86
Wt. Soil (g)	108.72	122.38	Wt. Lost Moisture (g)	7.10	20.77
Wet Density (pcf)	90.8	127.4	Wt. of Pan Only (g)	3.24	3.24
Moisture Content (%)	7.0	20.4	Wt. of Dry Soil (g)	101.62	101.62
Dry Density (pcf)	84.9	105.8	Saturation (%)	19.5	96.1

	LOAD (psf)	CONSOL. (IN)	LOG p	CONSOL. (IN/IN)	DEFL. (IN/IN)	VOID RATIO (e)
	100	0.0000	2.000	0.0000	0.0000	0.950
Inundate	100	0.0089	2.000	0.0089	-0.0089	0.932
	200	0.0177	2.301	0.0177	-0.0177	0.915
	400	0.0375	2.602	0.0375	-0.0375	0.876
	800	0.0615	2.903	0.0615	-0.0615	0.830
	1600	0.0924	3.204	0.0924	-0.0924	0.769
	3200	0.1267	3.505	0.1267	-0.1267	0.703
	6400	0.1571	3.806	0.1571	-0.1571	0.643
	12800	0.1886	4.107	0.1886	-0.1886	0.582
	25600	0.2136	4.408	0.2136	-0.2136	0.533
	6400	0.2110	3.806	0.2110	-0.2110	0.538
	1600	0.2080	3.204	0.2080	-0.2080	0.544
	400	0.2040	2.602	0.2040	-0.2040	0.552
	100	0.1980	2.000	0.1980	-0.1980	0.564

Init. Ht. Solids (cm)	1.303	Sp. Gr. (g/cc)	2.650
Init. Ht. Voids (cm)	1.237		
Init. Void Ratio	0.950		

Data entry by: CAL Date: 03/25/2016

Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_1-cr.xls

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT Swift River Environmental Services

JOB NO. 2952-1

PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/11/2016 DPM
LOCATION	--	TEST FINISHED	03/24/2016 CAL
BORING NO.	NWE-16	CONSOLIDOMETER	ATT-15
DEPTH	14-16'	SAMPLE DESCR.	--
SAMPLE NO.	UD		

TIME READING DATA

100 Wet psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0000	0.0000	0.9495
0.1	0.32	0.0025	-0.0025	0.9447
0.3	0.50	0.0055	-0.0055	0.9388
0.5	0.71	0.0081	-0.0081	0.9337
1.0	1.00	0.0084	-0.0084	0.9332
2.0	1.41	0.0085	-0.0085	0.9330
4.0	2.00	0.0086	-0.0086	0.9328
9.0	3.00	0.0088	-0.0088	0.9324
16.0	4.00	0.0088	-0.0088	0.9324
30.0	5.48	0.0089	-0.0089	0.9322
60.0	7.75	0.0089	-0.0089	0.9322

200 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0089	0.0089	0.9322
0.1	0.32	0.0128	0.0124	0.9254
0.3	0.50	0.0137	0.0133	0.9236
0.5	0.71	0.0143	0.0139	0.9224
1.0	1.00	0.0148	0.0144	0.9215
2.0	1.41	0.0154	0.0150	0.9203
4.0	2.00	0.0160	0.0156	0.9191
9.0	3.00	0.0166	0.0162	0.9180
16.0	4.00	0.0169	0.0165	0.9174
30.0	5.48	0.0173	0.0169	0.9166
60.0	7.75	0.0177	0.0173	0.9158
120.0	10.95	0.0180	0.0176	0.9152
190.0	13.78	0.0181	0.0177	0.9150

400 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0181	0.0177	0.9150
0.1	0.32	0.0291	0.0282	0.8946
0.3	0.50	0.0303	0.0294	0.8922
0.5	0.71	0.0312	0.0303	0.8905
1.0	1.00	0.0320	0.0311	0.8889
2.0	1.41	0.0328	0.0319	0.8873
4.0	2.00	0.0336	0.0327	0.8858
9.0	3.00	0.0344	0.0335	0.8842
16.0	4.00	0.0349	0.0340	0.8833
30.0	5.48	0.0355	0.0346	0.8821
60.0	7.75	0.0362	0.0353	0.8807
125.0	11.18	0.0369	0.0360	0.8794
240.0	15.49	0.0372	0.0363	0.8788
1176.0	34.29	0.0379	0.0370	0.8774

800 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0384	0.0375	0.8764
0.1	0.32	0.0497	0.0481	0.8558
0.3	0.50	0.0515	0.0499	0.8523
0.5	0.71	0.0527	0.0511	0.8499
1.0	1.00	0.0545	0.0529	0.8464
2.0	1.41	0.0554	0.0538	0.8447
4.0	2.00	0.0563	0.0547	0.8429
9.0	3.00	0.0574	0.0558	0.8408
16.0	4.00	0.0581	0.0565	0.8394
30.0	5.48	0.0590	0.0574	0.8376
60.0	7.75	0.0599	0.0583	0.8359
120.0	10.95	0.0608	0.0592	0.8341
240.0	15.49	0.0616	0.0600	0.8326
480.0	21.91	0.0624	0.0608	0.8310
1394.0	37.34	0.0630	0.0614	0.8298

Data entry by: CAL Date: 03/25/2016

Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_1-cr.xls

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT Swift River Environmental Services JOB NO. 2952-1

PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/11/2016 DPM
LOCATION	--	TEST FINISHED	03/24/2016 CAL
BORING NO.	NWE-16	CONSOLIDOMETER	ATT-15
DEPTH	14-16'	SAMPLE DESCR.	--
SAMPLE NO.	UD		

TIME READING DATA

1600 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0631	0.0615	0.8296
0.1	0.32	0.0785	0.0760	0.8014
0.3	0.50	0.0805	0.0780	0.7975
0.5	0.71	0.0819	0.0794	0.7947
1.0	1.00	0.0833	0.0808	0.7920
2.0	1.41	0.0847	0.0822	0.7893
4.0	2.00	0.0860	0.0835	0.7868
9.0	3.00	0.0876	0.0851	0.7836
16.0	4.00	0.0887	0.0862	0.7815
30.0	5.48	0.0897	0.0872	0.7795
60.0	7.75	0.0909	0.0884	0.7772
120.0	10.95	0.0921	0.0896	0.7749
240.0	15.49	0.0930	0.0905	0.7731
480.0	21.91	0.0939	0.0914	0.7713
1549.0	39.36	0.0949	0.0924	0.7694

3200 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.0949	0.0924	0.7694
0.1	0.32	0.1127	0.1090	0.7370
0.3	0.50	0.1149	0.1112	0.7327
0.5	0.71	0.1166	0.1129	0.7294
1.0	1.00	0.1181	0.1144	0.7265
2.0	1.41	0.1196	0.1159	0.7236
4.0	2.00	0.1211	0.1174	0.7207
9.0	3.00	0.1226	0.1189	0.7177
16.0	4.00	0.1239	0.1202	0.7152
30.0	5.48	0.1250	0.1213	0.7131
66.0	8.12	0.1265	0.1228	0.7101
120.0	10.95	0.1274	0.1237	0.7084
240.0	15.49	0.1284	0.1247	0.7064
480.0	21.91	0.1293	0.1256	0.7047
1440.0	37.95	0.1304	0.1267	0.7025

6400 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.1304	0.1267	0.7025
0.1	0.32	0.1458	0.1409	0.6748
0.3	0.50	0.1484	0.1435	0.6698
0.5	0.71	0.1501	0.1452	0.6665
1.0	1.00	0.1516	0.1467	0.6635
2.0	1.41	0.1530	0.1481	0.6608
4.0	2.00	0.1544	0.1495	0.6581
9.0	3.00	0.1559	0.1510	0.6552
16.0	4.00	0.1569	0.1520	0.6532
30.0	5.48	0.1579	0.1530	0.6513
60.0	7.75	0.1590	0.1541	0.6491
120.0	10.95	0.1599	0.1550	0.6474
240.0	15.49	0.1607	0.1558	0.6458
480.0	21.91	0.1613	0.1564	0.6446
1440.0	37.95	0.1620	0.1571	0.6433

12800 psf Load

Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.1620	0.1571	0.6433
0.1	0.32	0.1818	0.1747	0.6090
0.3	0.50	0.1837	0.1766	0.6052
0.5	0.71	0.1850	0.1779	0.6027
1.0	1.00	0.1863	0.1792	0.6002
2.0	1.41	0.1874	0.1803	0.5980
4.0	2.00	0.1885	0.1814	0.5959
9.0	3.00	0.1898	0.1827	0.5934
16.0	4.00	0.1906	0.1835	0.5918
30.0	5.48	0.1914	0.1843	0.5902
60.0	7.75	0.1923	0.1852	0.5885
120.0	10.95	0.1931	0.1860	0.5869
240.0	15.49	0.1938	0.1867	0.5856
480.0	21.91	0.1944	0.1873	0.5844
1736.0	41.67	0.1953	0.1882	0.5826

Data entry by: CAL Date: 03/25/2016

Data checked by:_____ Date:_____

FileName: 2952_1_Consolidation-ASTMD2435-R0_1-cr.xls

CONSOLIDATION TEST

ASTM D2435 Method B

CLIENT Swift River Environmental Services

JOB NO. 2952-1

PROJECT NAME	North Weld Landfill Expansion	SAMPLED	-- --
PROJECT NO.	S152047	TEST STARTED	03/11/2016 DPM
LOCATION	--	TEST FINISHED	03/24/2016 CAL
BORING NO.	NWE-16	CONSOLIDOMETER	ATT-15
DEPTH	14-16'	SAMPLE DESCR.	--
SAMPLE NO.	UD		

TIME READING DATA

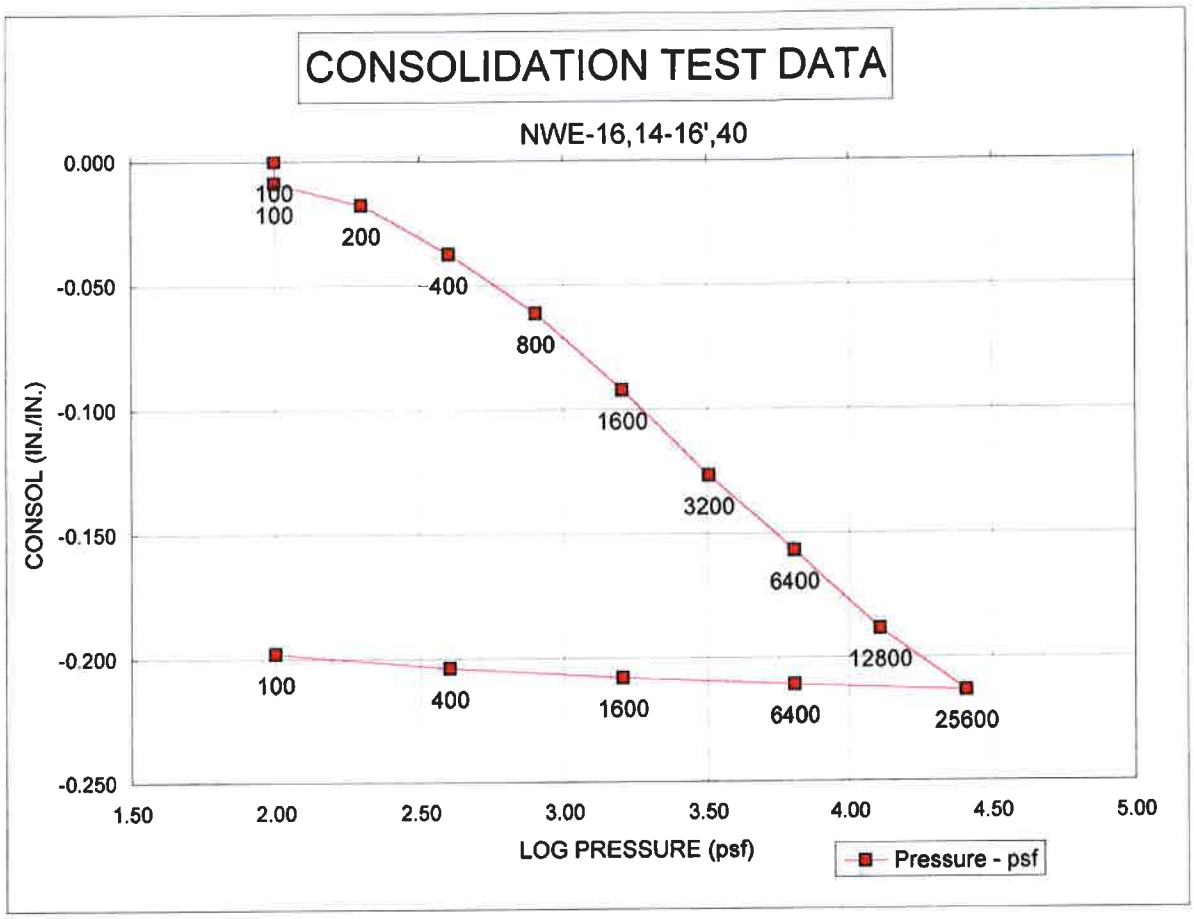
25600 psf Load

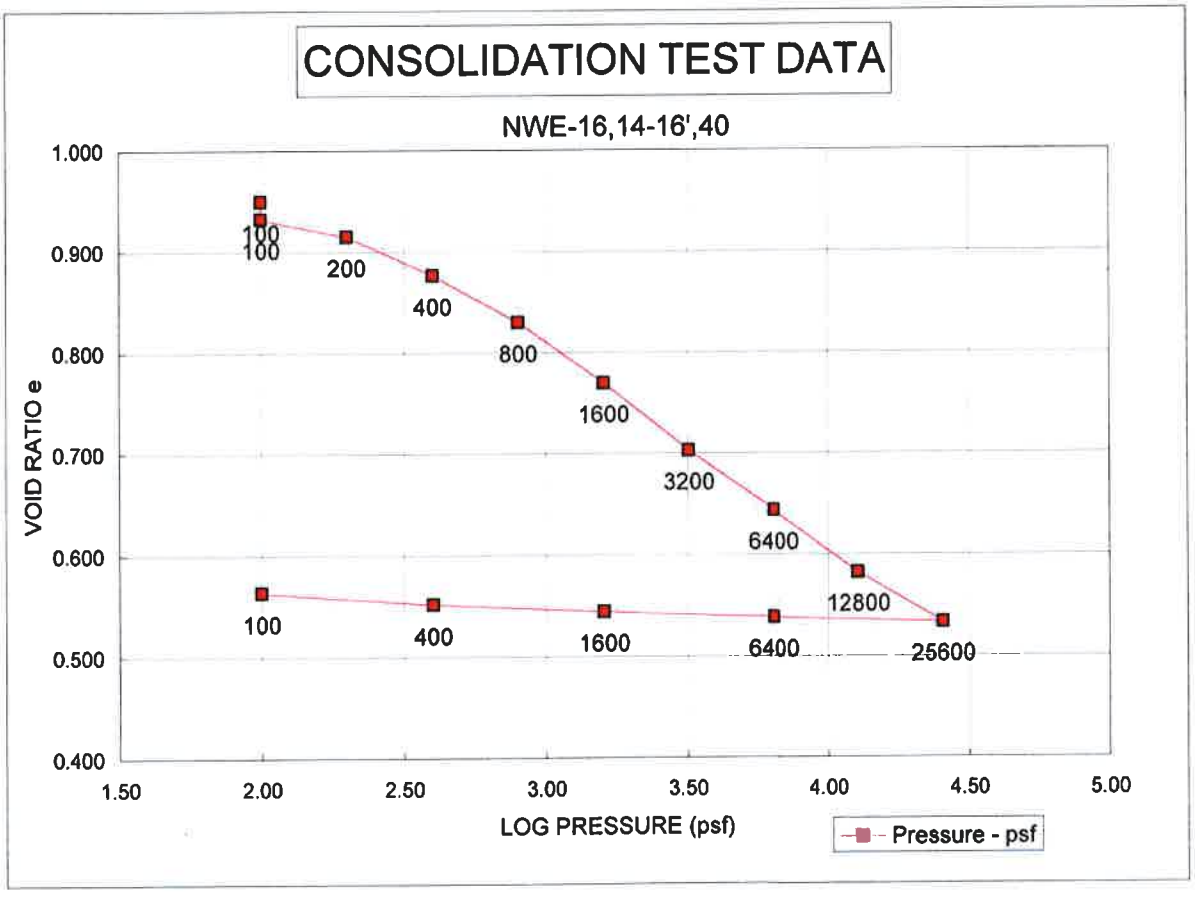
Elapsed Time (min)	SQRT Time (min)	Dial Reading (in)	Corrected Defl. (in)	VOID RATIO (e)
0.0	0.00	0.1957	0.1886	0.5819
0.1	0.32	0.2112	0.2016	0.5565
0.3	0.50	0.2128	0.2032	0.5534
0.5	0.71	0.2138	0.2042	0.5514
1.0	1.00	0.2148	0.2052	0.5495
2.0	1.41	0.2158	0.2062	0.5475
4.0	2.00	0.2168	0.2072	0.5456
9.0	3.00	0.2178	0.2082	0.5436
16.0	4.00	0.2186	0.2090	0.5421
30.0	5.48	0.2194	0.2098	0.5405
60.0	7.75	0.2202	0.2106	0.5390
120.0	10.95	0.2210	0.2114	0.5374
240.0	15.49	0.2217	0.2121	0.5360
480.0	21.91	0.2224	0.2128	0.5347
1500.0	38.73	0.2232	0.2136	0.5331

Data entry by: CAL Date: 03/25/2016

Data checked by:_____ Date:_____

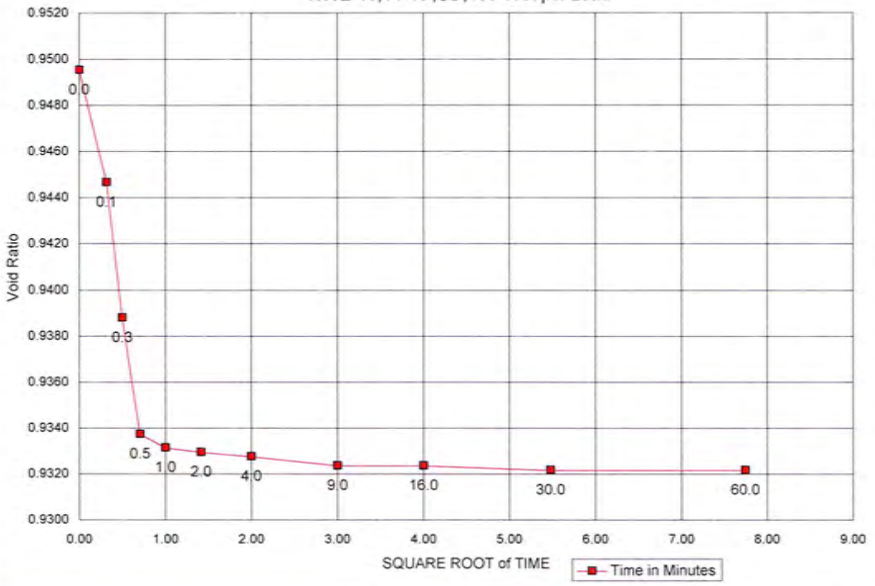
FileName: 2952_1_Consolidation-ASTMD2435-R0_1-cr.xls


CONSOLIDATION TEST DATA
NWE-16,14-16',40
CONSOL (IN./IN.)
0.000
-0.050
-0.100
-0.150
-0.200
-0.250
100
100
200
400
800
1600
3200
6400
12800
25600
100
400
1600
6400
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
LOG PRESSURE (psf)
Pressure - psf


CONSOLIDATION TEST DATA
NWE-16,14-16',40
VOID RATIO e
1.000
0.900
0.800
0.700
0.600
0.500
0.400
100
100
200
400
800
1600
3200
6400
12800
25600
100
400
1600
6400
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
LOG PRESSURE (psf)
Pressure - psf

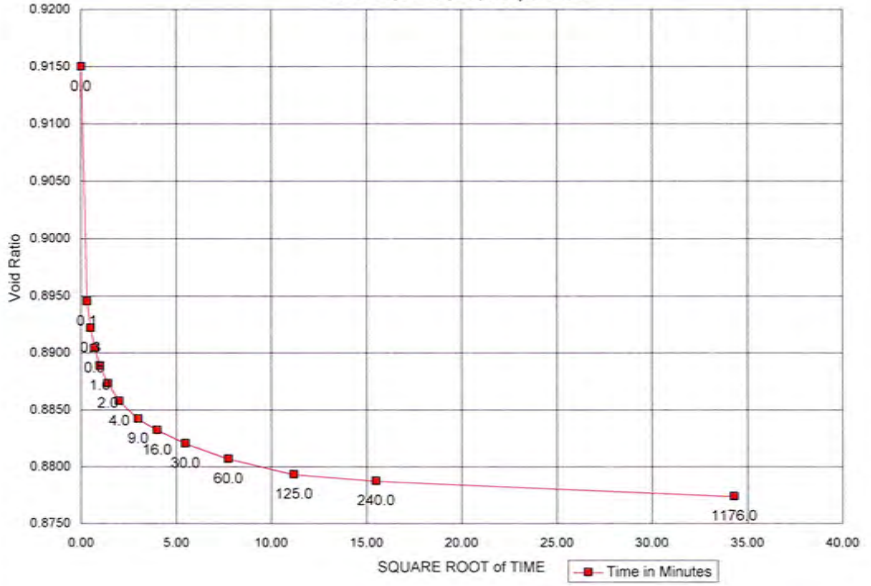
TIME READING DATA

NWE-16,14-16',UD,100 Wet psf Load



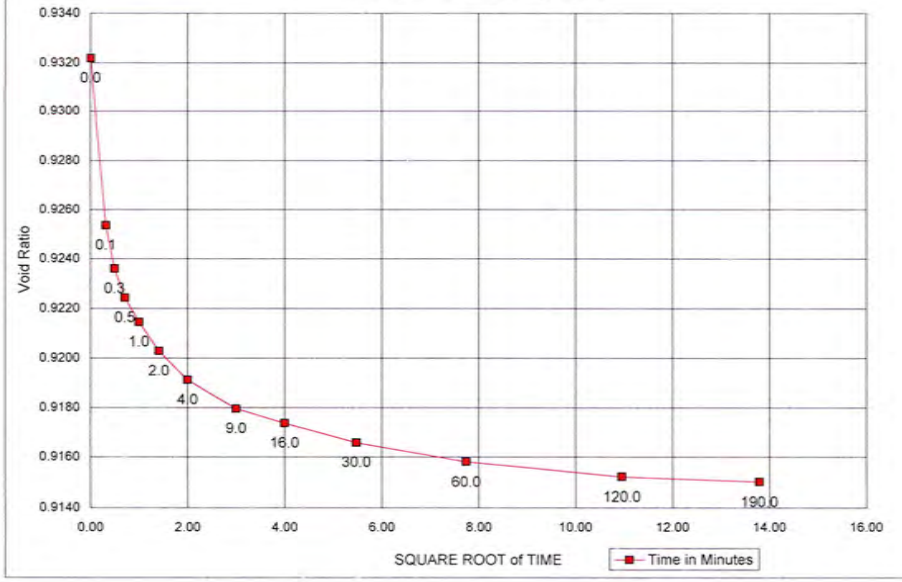
TIME READING DATA

NWE-16,14-16',UD,400 psf Load



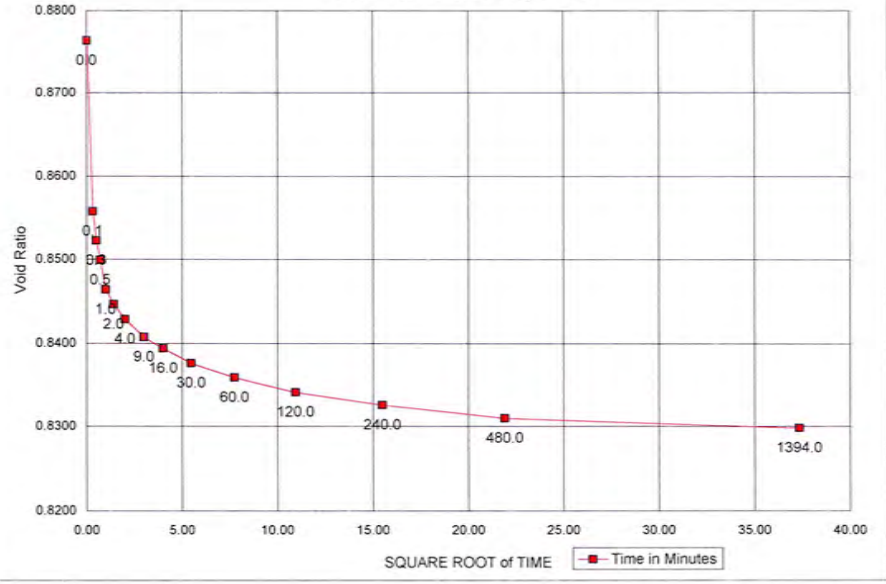
TIME READING DATA

NWE-16,14-16',UD,200 psf Load



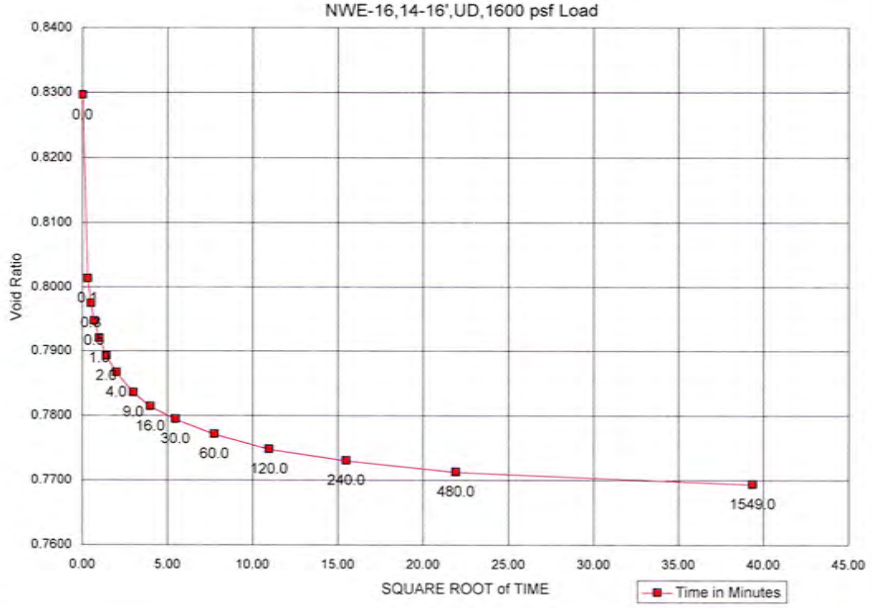
TIME READING DATA

NWE-16,14-16',UD,800 psf Load



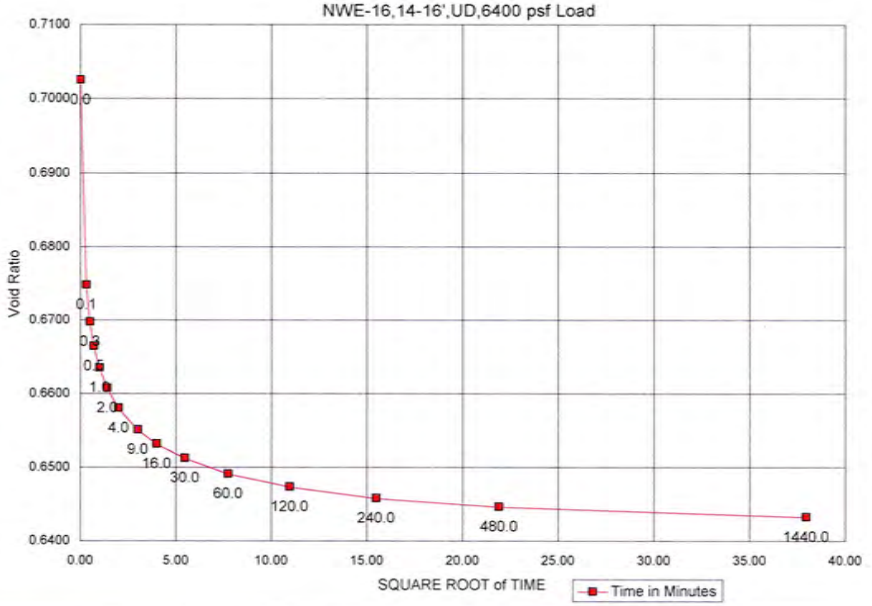
TIME READING DATA

NWE-16,14-16',UD,1600 psf Load



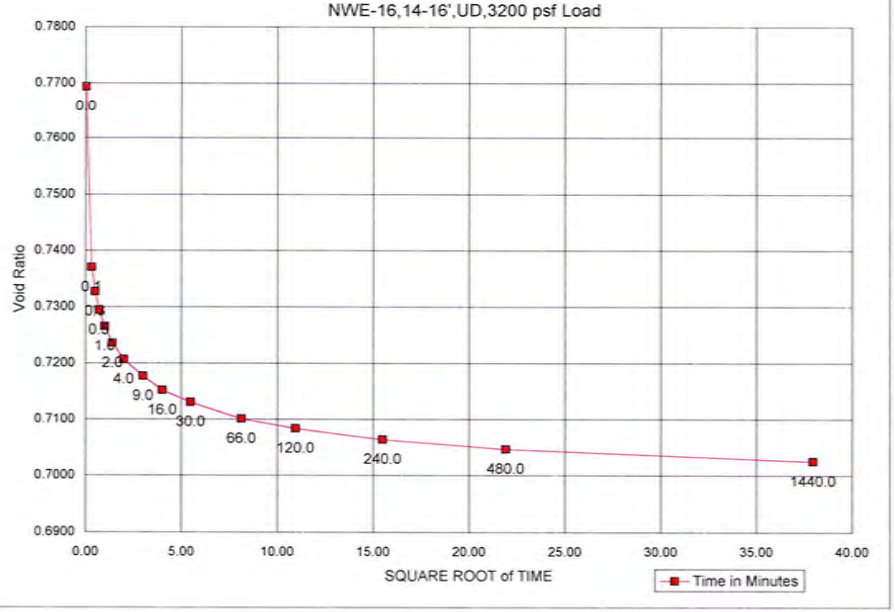
TIME READING DATA

NWE-16,14-16',UD,6400 psf Load



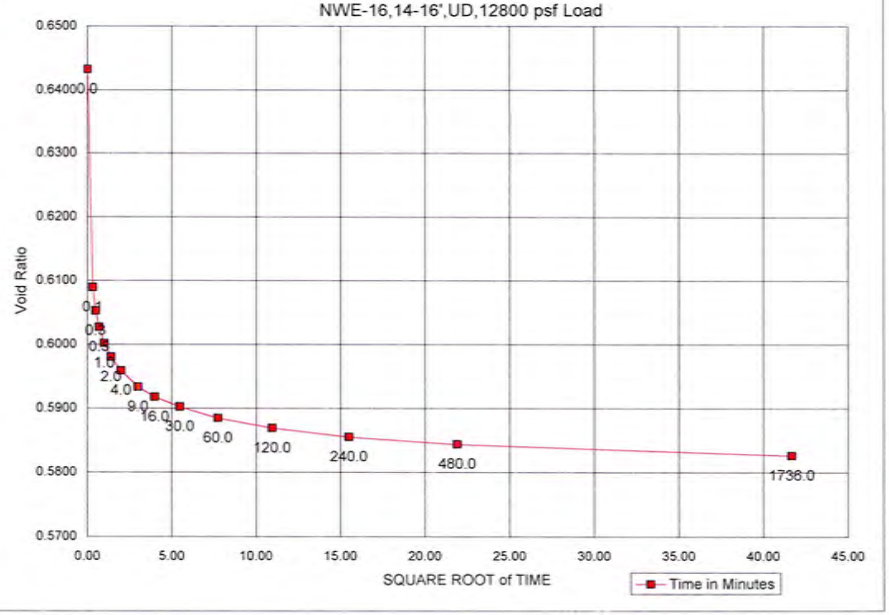
TIME READING DATA

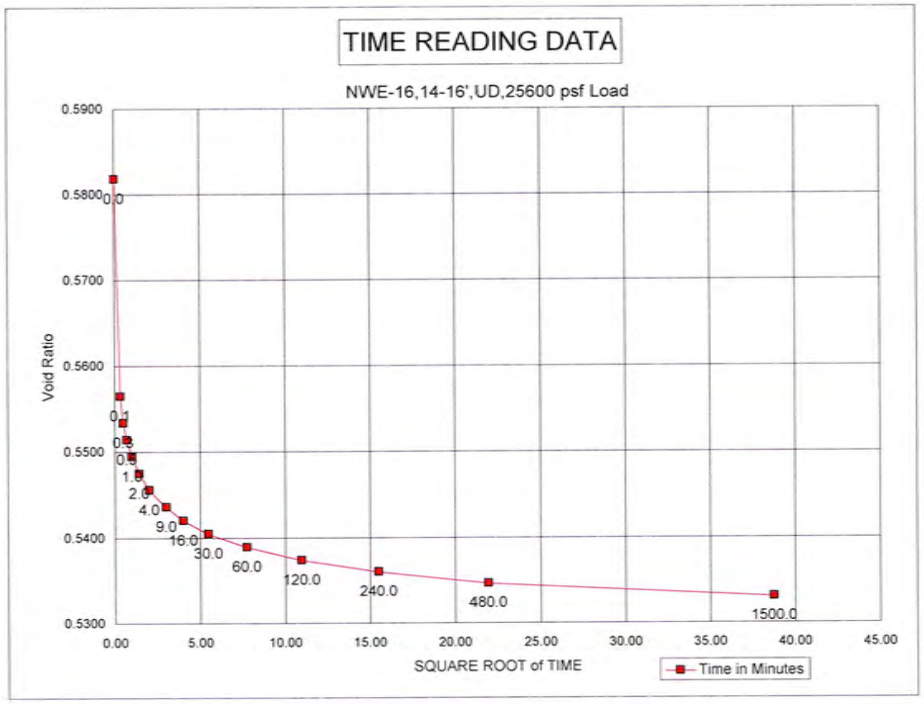
NWE-16,14-16',UD,3200 psf Load



TIME READING DATA

NWE-16,14-16',UD,12800 psf Load




TIME READING DATA
NWE-16,14-16',UD,25600 psf Load
Void Ratio
0.5900
0.5800
0.5700
0.5600
0.5500
0.5400
0.5300
0.0
0.1
0.5
1.0
2.0
4.0
9.0
16.0
30.0
60.0
120.0
240.0
480.0
1500.0
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
SQUARE ROOT of TIME
Time in Minutes

Shear Testing

Direct Shear

Triaxial Consolidated Undrained

Direct Shear

ASTM D3080

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: North Weld Landfill Expansion
Project Number: 152047
Project: --

Test Start Date: 04/08/16 By: BDF
Test Finish Date: 04/08/16 By: BDF

Raw Data Files: SRDSTP2A.DAT,
SRDSTP2B.DAT,
SRDSTP2C.DAT

Sample Information

Boring: TP-2
Depth: 5-9'
Sample Number: --
Sampled Date: --
Soil Description: --

Test Configuration

Continuous, Increasing, Deflection Control
Shear Rate (in./min.): 0.0030
Normal Stress Point A (psf): 14382
Normal Stress Point B (psf): 7191
Normal Stress Point C (psf): 3595

	Point A 14382 psf		Point B 7191 psf		Point C 3595 psf	
	Before	After	Before	After	Before	After
Wt. Wet Soil & Ring (g):	128.41	133.45	128.60	134.23	128.54	135.07
Wt of Ring (g):	27.92	27.92	28.01	28.01	27.97	27.97
Wt. Wet Soil (g):	100.49	105.53	100.59	106.23	100.56	107.09
Wt. Wet Soil & Pan (g):	107.23	112.27	108.97	114.61	108.78	115.31
Wt. Dry Soil & Pan(g):	98.29	98.29	100.10	100.10	100.01	100.01
Wt. Water (g):	8.94	13.98	8.87	14.51	8.77	15.30
Wt. of Pan (g):	6.74	6.74	8.38	8.38	8.21	8.21
Wt. of Dry Soil (g):	91.55	91.55	91.72	91.72	91.80	91.80
Percent Moisture:	9.76%	15.27%	9.67%	15.82%	9.55%	16.66%
Diameter (in):	1.938	1.938	1.938	1.938	1.938	1.938
Area (in²):	2.950	2.950	2.950	2.950	2.950	2.950
Height (in):	1.000	0.988	1.000	0.996	1.000	0.997
Volume (ft^3):	0.00171	0.00169	0.00171	0.00170	0.00171	0.00170
Wet Density (pcf):	129.78	137.92	129.91	137.78	129.87	138.70
Dry Density (pcf):	118.24	119.65	118.45	118.96	118.55	118.89

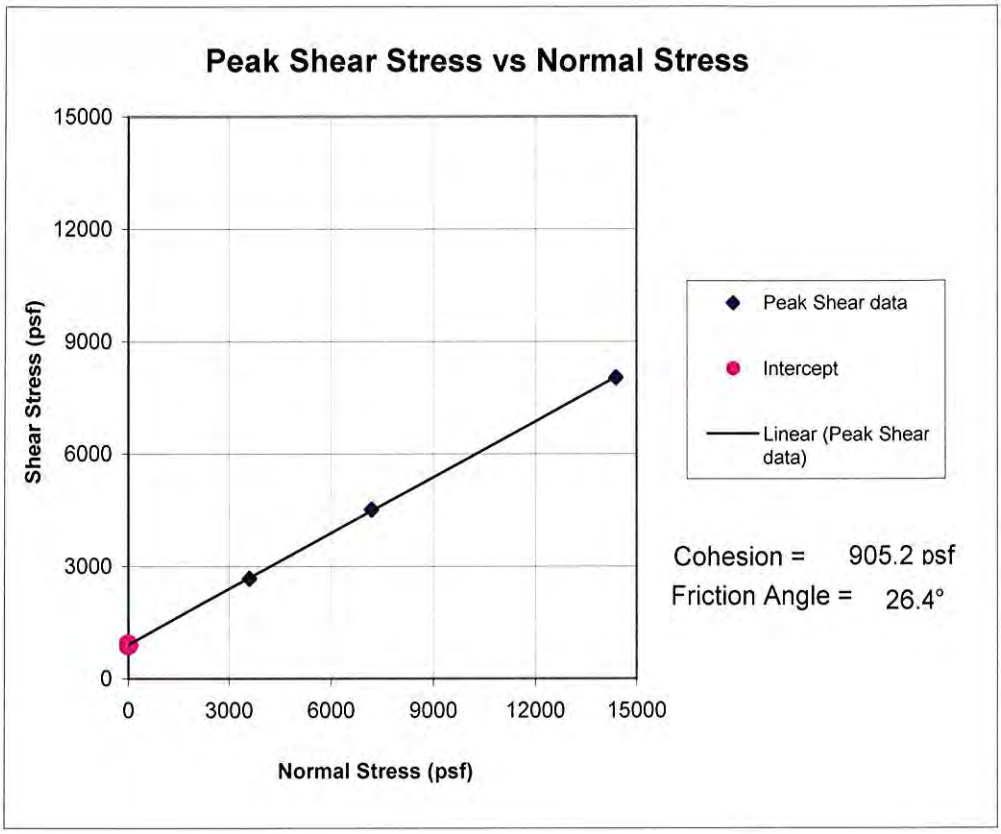
	Point A 14382 psf	Point B 7191 psf	Point C 3595 psf
Peak Strength (psf)	8037.0	4513.0	2667.0
Ultimate Strength(psf)	7795.0	4438.0	2219.0

	Peak	Ultimate
Friction Angle °	26.4	27.0
Cohesion (psf)	905.2	540.7

Data Entered By: NN
Entry Date: 04/11/16
File Name: 2952_2_directShear-ASTMD3080-R3_3.xls

Data Checked By BDF
Date 4/13/16

ATT
ADVANCED TERRA TESTING

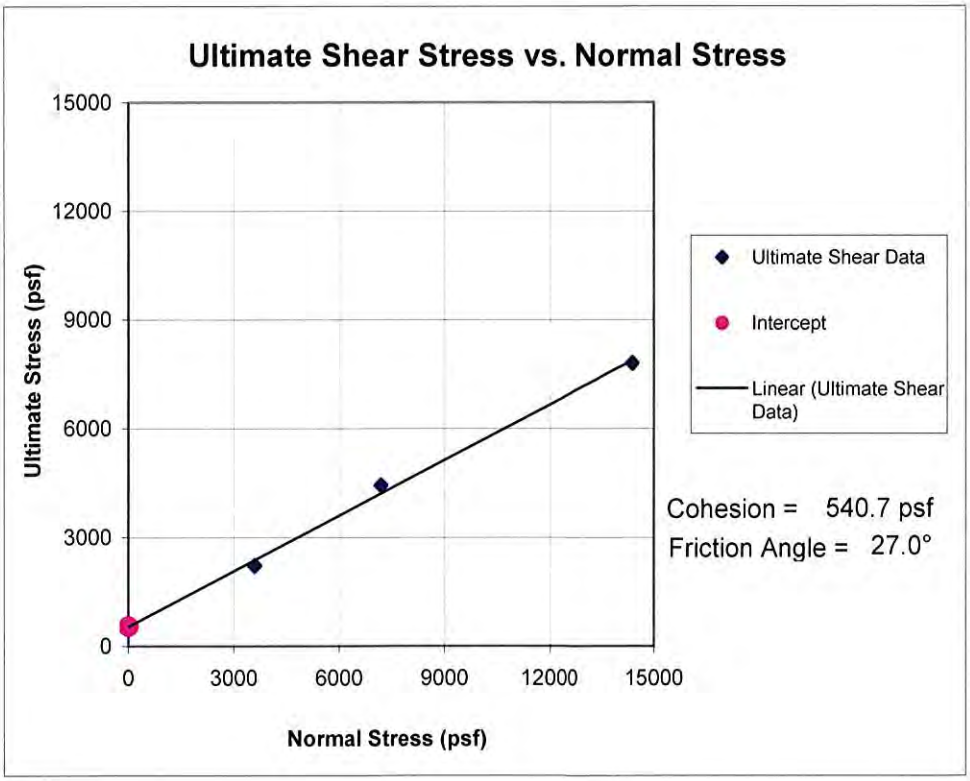


Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: North Weld Landfill Expansion
Project Number: 152047
Project: --

Sample Information

Boring: TP-2
Depth: 5-9'
Sample Number: --
Sampled Date: --
Soil Description: --



Data Entered By: NN
Entry Date: 04/11/16
File Name: 2952_2_directShear-ASTMD3080-R3_3.xls

Data Checked By BDF
Date 4/13/16

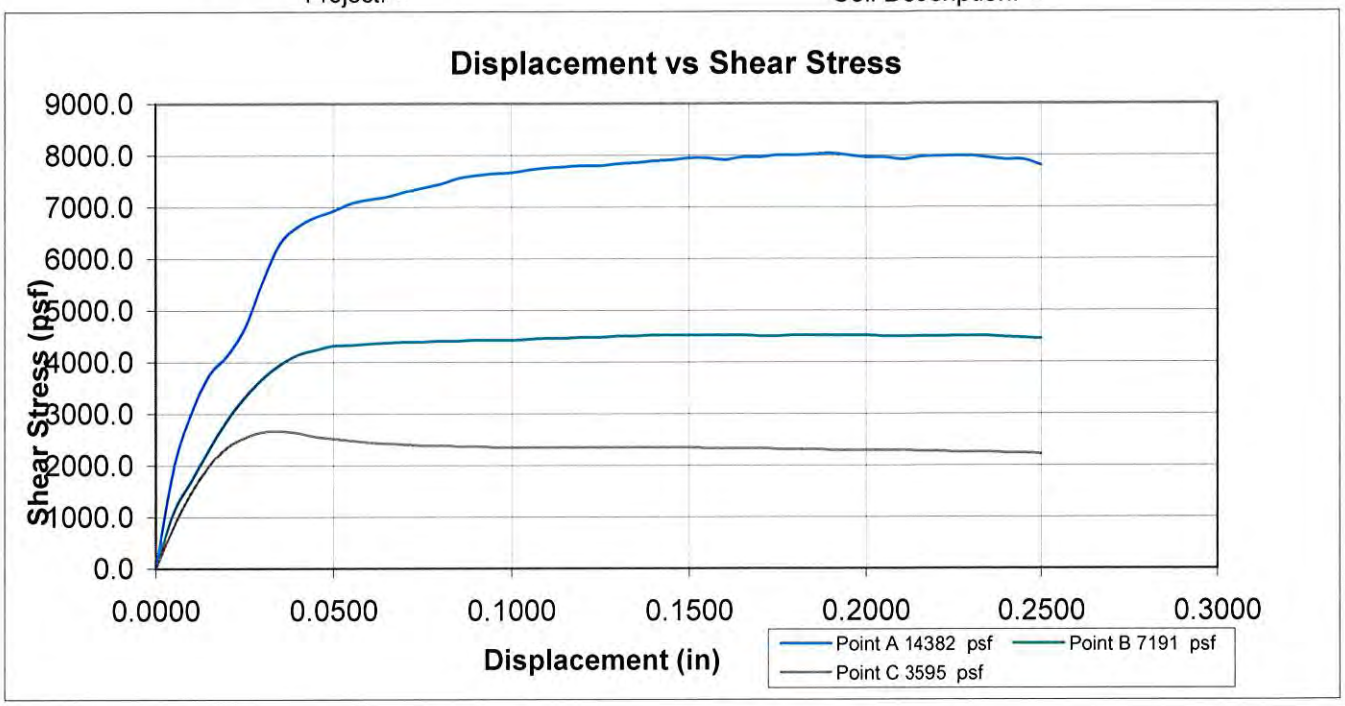
ATT
ADVANCED TERRA TESTING

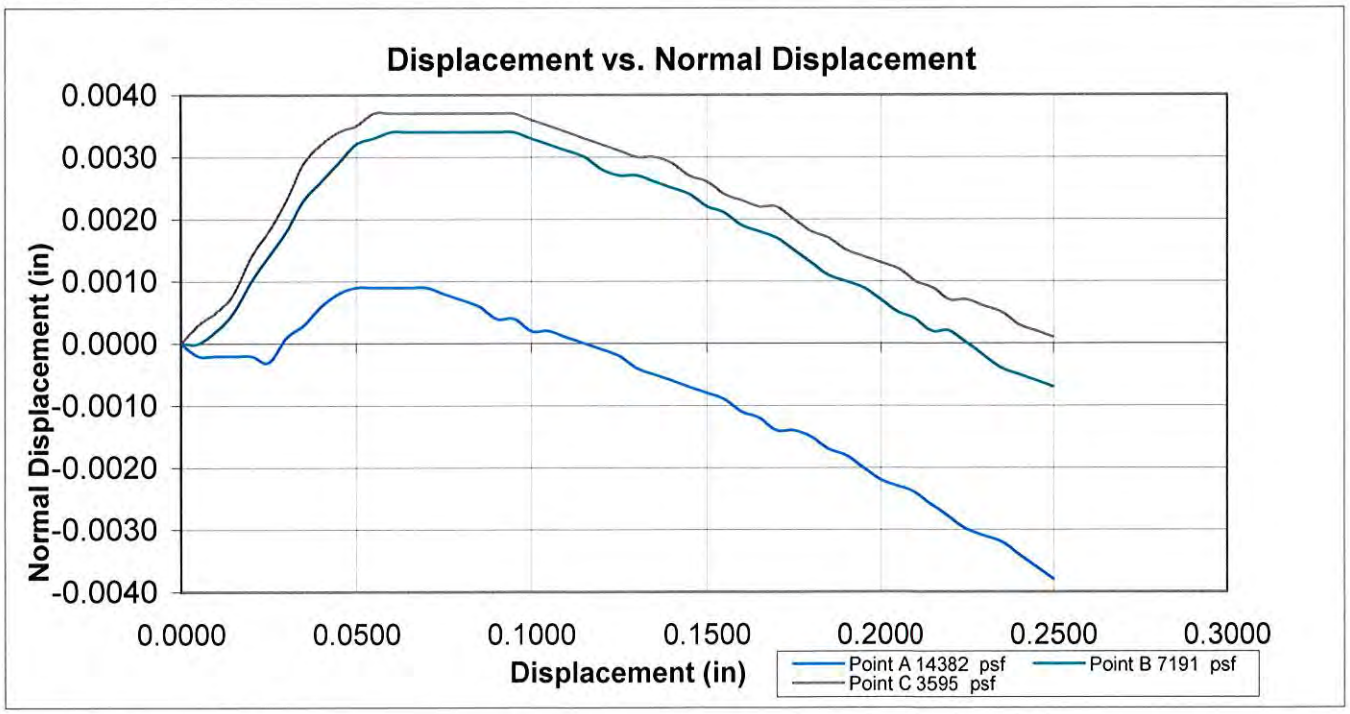
Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: North Weld Landfill Expansion
Project Number: 152047
Project: --

Sample Information

Boring: TP-2
Depth: 5-9'
Sample Number: --
Sampled Date: --
Soil Description: --





Data Entered By: NN
Entry Date: 04/11/16
File Name: 2952_2_directShear-ASTMD3080-R3_3.xls

Data Checked By BDF
Date 4/13/16

ATT
ADVANCED TERRA TESTING

Direct Shear

ASTM D 3080

Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: North Weld Landfill Expansion
Project Number: 152047

Sample Information

Boring: TP-2
Depth: 5-9'
Sample Number: --
Sampled Date: --
Soil Description: --

Raw Data

Point A 14382 psf			Point B 7191 psf			Point C 3595 psf		
Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)
0.0000	0.0	0.0000	0.0000	0.0	0.0000	0.0000	0.0	0.0000
0.0050	1921.0	-0.0002	0.0050	1082.0	0.0000	0.0050	802.0	0.0003
0.0100	3002.0	-0.0002	0.0100	1697.0	0.0002	0.0100	1473.0	0.0005
0.0150	3748.0	-0.0002	0.0150	2312.0	0.0005	0.0150	1995.0	0.0008
0.0200	4121.0	-0.0002	0.0200	2872.0	0.0010	0.0200	2350.0	0.0014
0.0250	4643.0	-0.0003	0.0250	3319.0	0.0014	0.0250	2536.0	0.0018
0.0300	5520.0	0.0001	0.0300	3674.0	0.0018	0.0300	2648.0	0.0023
0.0350	6284.0	0.0003	0.0350	3953.0	0.0023	0.0350	2667.0	0.0029
0.0400	6620.0	0.0006	0.0400	4140.0	0.0026	0.0400	2629.0	0.0032
0.0450	6806.0	0.0008	0.0450	4233.0	0.0029	0.0450	2555.0	0.0034
0.0500	6918.0	0.0009	0.0500	4308.0	0.0032	0.0500	2517.0	0.0035
0.0550	7068.0	0.0009	0.0550	4326.0	0.0033	0.0550	2480.0	0.0037
0.0600	7142.0	0.0009	0.0600	4345.0	0.0034	0.0600	2443.0	0.0037
0.0650	7198.0	0.0009	0.0650	4364.0	0.0034	0.0650	2424.0	0.0037
0.0700	7291.0	0.0009	0.0700	4382.0	0.0034	0.0700	2406.0	0.0037
0.0750	7366.0	0.0008	0.0750	4382.0	0.0034	0.0750	2387.0	0.0037
0.0800	7440.0	0.0007	0.0800	4401.0	0.0034	0.0800	2387.0	0.0037
0.0850	7552.0	0.0006	0.0850	4401.0	0.0034	0.0850	2368.0	0.0037
0.0900	7608.0	0.0004	0.0900	4420.0	0.0034	0.0900	2368.0	0.0037
0.0950	7646.0	0.0004	0.0950	4420.0	0.0034	0.0950	2350.0	0.0037
0.1000	7664.0	0.0002	0.1000	4420.0	0.0033	0.1000	2350.0	0.0036
0.1050	7720.0	0.0002	0.1050	4438.0	0.0032	0.1050	2350.0	0.0035
0.1100	7757.0	0.0001	0.1100	4457.0	0.0031	0.1100	2350.0	0.0034
0.1150	7776.0	0.0000	0.1150	4457.0	0.0030	0.1150	2350.0	0.0033
0.1200	7795.0	-0.0001	0.1200	4475.0	0.0028	0.1200	2350.0	0.0032
0.1250	7795.0	-0.0002	0.1250	4475.0	0.0027	0.1250	2350.0	0.0031
0.1300	7832.0	-0.0004	0.1300	4494.0	0.0027	0.1300	2350.0	0.0030
0.1350	7851.0	-0.0005	0.1350	4494.0	0.0026	0.1350	2350.0	0.0030
0.1400	7888.0	-0.0006	0.1400	4513.0	0.0025	0.1400	2350.0	0.0029
0.1450	7907.0	-0.0007	0.1450	4513.0	0.0024	0.1450	2350.0	0.0027
0.1500	7944.0	-0.0008	0.1500	4513.0	0.0022	0.1500	2350.0	0.0026
0.1550	7944.0	-0.0009	0.1550	4513.0	0.0021	0.1550	2331.0	0.0024
0.1600	7907.0	-0.0011	0.1600	4513.0	0.0019	0.1600	2331.0	0.0023
0.1650	7963.0	-0.0012	0.1650	4513.0	0.0018	0.1650	2331.0	0.0022
0.1700	7963.0	-0.0014	0.1700	4494.0	0.0017	0.1700	2331.0	0.0022
0.1750	8000.0	-0.0014	0.1750	4494.0	0.0015	0.1750	2312.0	0.0020
0.1800	8000.0	-0.0015	0.1800	4513.0	0.0013	0.1800	2312.0	0.0018
0.1850	8019.0	-0.0017	0.1850	4513.0	0.0011	0.1850	2312.0	0.0017
0.1900	8037.0	-0.0018	0.1900	4513.0	0.0010	0.1900	2294.0	0.0015

ATT
ADVANCED TERRA TESTING

Direct Shear
ASTM D 3080

Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: North Weld Landfill Expansion
Project Number: 152047

Sample Information

Boring: TP-2
Depth: 5-9'
Sample Number: --
Sampled Date: --
Soil Description: --

Raw Data

Point A 14382 psf			Point B 7191 psf			Point C 3595 psf		
Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)
0.1950	8000.0	-0.0020	0.1950	4513.0	0.0009	0.1950	2294.0	0.0014
0.2000	7963.0	-0.0022	0.2000	4513.0	0.0007	0.2000	2294.0	0.0013
0.2050	7963.0	-0.0023	0.2050	4494.0	0.0005	0.2050	2294.0	0.0012
0.2100	7925.0	-0.0024	0.2100	4494.0	0.0004	0.2100	2294.0	0.0010
0.2150	7963.0	-0.0026	0.2150	4494.0	0.0002	0.2150	2275.0	0.0009
0.2200	7981.0	-0.0028	0.2200	4494.0	0.0002	0.2200	2275.0	0.0007
0.2250	7981.0	-0.0030	0.2250	4494.0	0.0000	0.2250	2256.0	0.0007
0.2300	7981.0	-0.0031	0.2300	4494.0	-0.0002	0.2300	2256.0	0.0006
0.2350	7944.0	-0.0032	0.2350	4494.0	-0.0004	0.2350	2256.0	0.0005
0.2400	7907.0	-0.0034	0.2400	4475.0	-0.0005	0.2400	2238.0	0.0003
0.2450	7907.0	-0.0036	0.2450	4457.0	-0.0006	0.2450	2238.0	0.0002
0.2500	7795.0	-0.0038	0.2500	4438.0	-0.0007	0.2500	2219.0	0.0001

ATT
ADVANCED TERRA TESTING

Direct Shear

ASTM D3080

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: --
Project Number: 152047
Project: North Weld Landfill Expansion

Test Start Date: 04/07/2016 By: BDF
Test Finish Date: 04/07/2016 By: BDF

Raw Data Files: SRDSTP3A.DAT, SRDSTP3B.DAT, SRDSTP3C.DAT

Sample Information

Boring: TP-3
Depth: 3-5'
Sample Number: --
Sampled Date: --
Soil Description: --

Test Configuration

Continuous, Increasing, Deflection Control
Shear Rate (in./min.): 0.0080
Normal Stress Point A (psf): 4000
Normal Stress Point B (psf): 2000
Normal Stress Point C (psf): 1000

	Point A 4000 psf		Point B 2000 psf		Point C 1000 psf	
	Before	After	Before	After	Before	After
Wt. Wet Soil & Ring (g):	178.25	190.01	178.12	190.71	176.82	190.39
Wt of Ring (g):	43.15	43.15	42.91	42.91	41.73	41.73
Wt. Wet Soil (g):	135.10	146.85	135.20	147.80	135.09	148.66
Wt. Wet Soil & Pan (g):	141.78	153.53	141.67	154.26	141.87	155.44
Wt. Dry Soil & Pan(g):	130.66	130.66	130.67	130.67	130.84	130.84
Wt. Water (g):	11.12	22.88	11.00	23.59	11.03	24.60
Wt. of Pan (g):	6.68	6.68	6.47	6.47	6.78	6.78
Wt. of Dry Soil (g):	123.98	123.98	124.21	124.21	124.06	124.06
Percent Moisture:	8.97%	18.45%	8.85%	18.99%	8.89%	19.83%
Diameter (in):	2.410	2.410	2.410	2.410	2.410	2.410
Area (in²):	4.562	4.562	4.562	4.562	4.562	4.562
Height (in):	1.000	0.976	1.000	0.988	1.000	1.008
Volume (ft^3):	0.00264	0.00258	0.00264	0.00261	0.00264	0.00266
Wet Density (pcf):	112.83	125.71	112.91	124.98	112.82	123.13
Dry Density (pcf):	103.54	106.13	103.73	105.03	103.61	102.76

	Point A 4000 psf	Point B 2000 psf	Point C 1000 psf
Peak Strength (psf)	2460.0	1302.0	736.0
Ultimate Strength(psf)	2460.0	1302.0	687.0

	Peak	Ultimate
Friction Angle °	29.9	30.5
Cohesion (psf)	157.0	108.0

Data Entered By: CKP
Entry Date: 04/08/2016
File Name: 2952_2_directShear-ASTMD3080-R3_1.xls

Data Checked By CK
Date 4/11/16

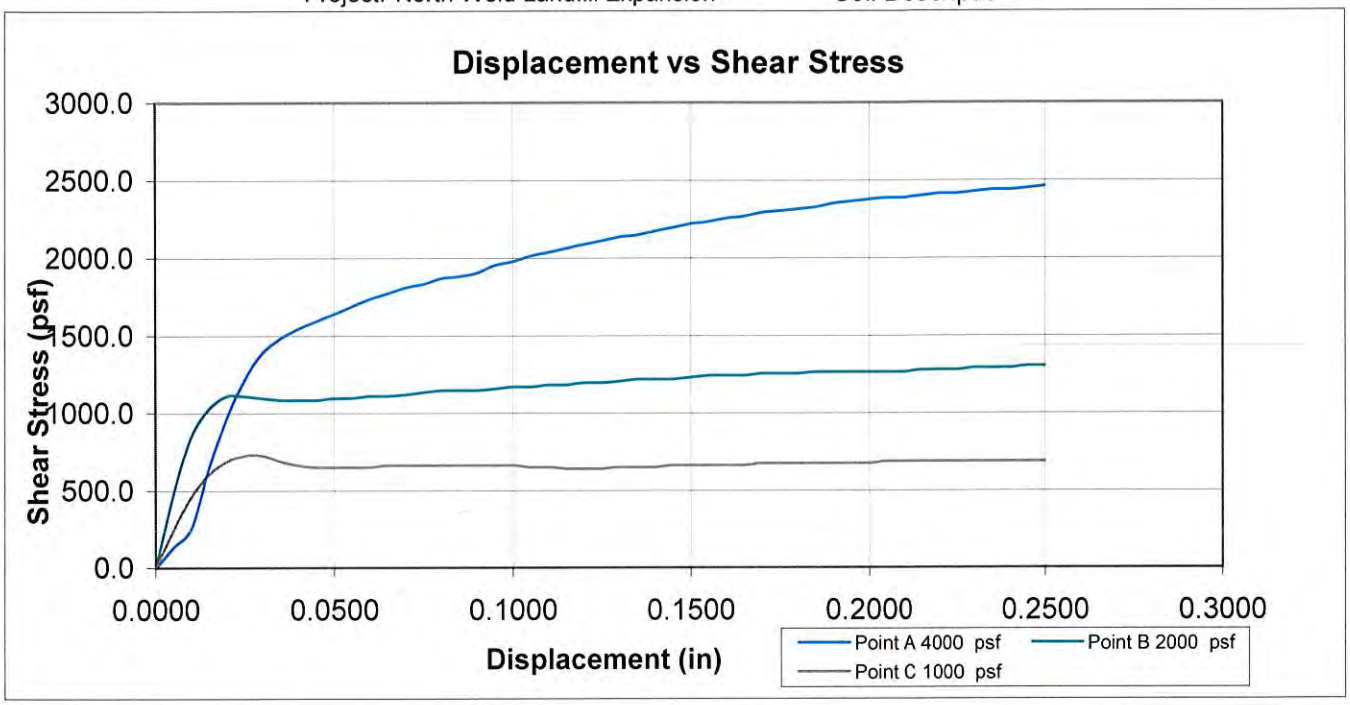
ATT
ADVANCED TERRA TESTING

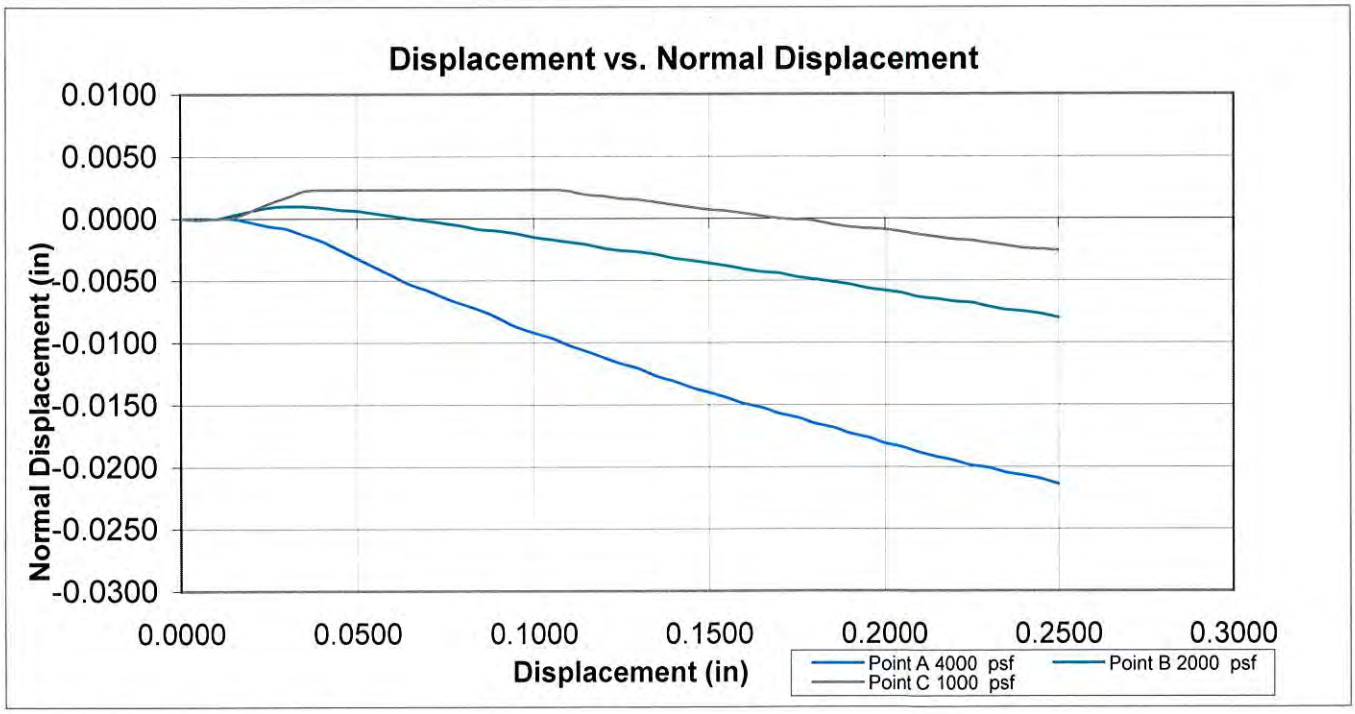
Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: --
Project Number: 152047
Project: North Weld Landfill Expansion

Sample Information

Boring: TP-3
Depth: 3-5'
Sample Number: --
Sampled Date: --
Soil Description: --

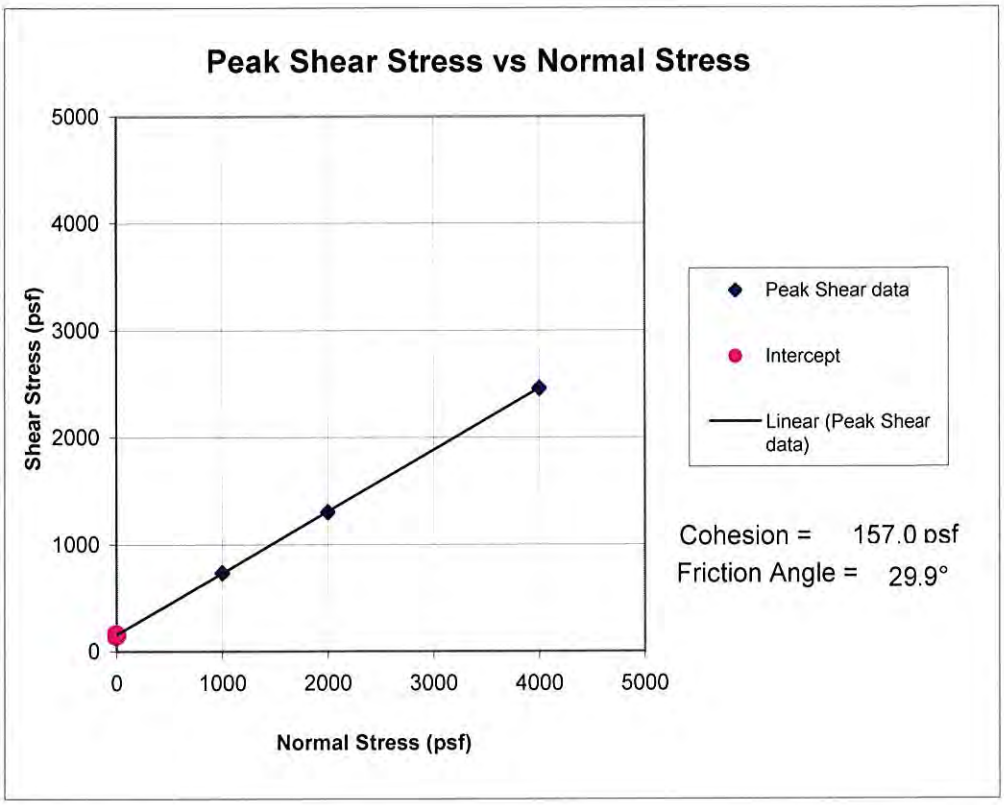




Data Entered By: CKP
Entry Date: 04/08/2016
File Name: 2952_2_directShear-ASTMD3080-R3_1.xls

Data Checked By ckc
Date 4/11/16

ATT
ADVANCED TERRA TESTING

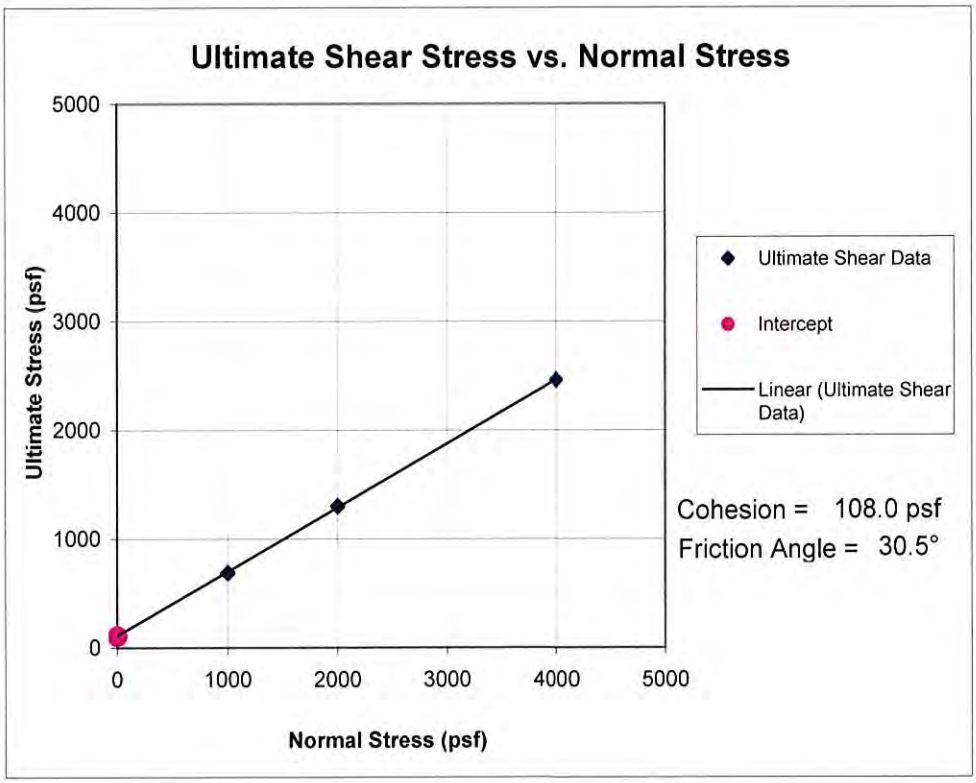


Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: --
Project Number: 152047
Project: North Weld Landfill Expansion

Sample Information

Boring: TP-3
Depth: 3-5'
Sample Number: --
Sampled Date: --
Soil Description: --



Data Entered By: CKP
Entry Date: 04/08/2016
File Name: 2952_2_directShear-ASTMD3080-R3_1.xls

Data Checked By CH
Date 4/11/16

ATT
ADVANCED TERRA TESTING

Direct Shear

ASTM D 3080

Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: --
Project Number: 152047

Sample Information

Boring: TP-3
Depth: 3-5'
Sample Number: --
Sampled Date: --
Soil Description: --

Raw Data

Point A 4000 psf			Point B 2000 psf			Point C 1000 psf		
Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)
0.0000	0.0	0.0000	0.0000	0.0	0.0000	0.0000	0.0	0.0000
0.0050	133.0	0.0000	0.0050	470.0	0.0000	0.0050	241.0	-0.0001
0.0100	253.0	0.0000	0.0100	844.0	0.0000	0.0100	458.0	0.0000
0.0150	639.0	0.0000	0.0150	1025.0	0.0003	0.0150	603.0	0.0001
0.0200	965.0	-0.0003	0.0200	1109.0	0.0006	0.0200	687.0	0.0006
0.0250	1218.0	-0.0006	0.0250	1109.0	0.0009	0.0248	736.0	0.0012
0.0300	1387.0	-0.0008	0.0300	1097.0	0.0010	0.0300	724.0	0.0017
0.0350	1483.0	-0.0013	0.0350	1085.0	0.0010	0.0350	687.0	0.0022
0.0400	1544.0	-0.0018	0.0400	1085.0	0.0009	0.0400	663.0	0.0023
0.0450	1592.0	-0.0025	0.0450	1085.0	0.0007	0.0450	651.0	0.0023
0.0500	1640.0	-0.0032	0.0500	1097.0	0.0006	0.0500	651.0	0.0023
0.0550	1688.0	-0.0039	0.0550	1097.0	0.0004	0.0550	651.0	0.0023
0.0600	1736.0	-0.0046	0.0600	1109.0	0.0002	0.0600	651.0	0.0023
0.0650	1773.0	-0.0053	0.0650	1109.0	0.0000	0.0650	663.0	0.0023
0.0700	1809.0	-0.0058	0.0700	1121.0	-0.0002	0.0700	663.0	0.0023
0.0750	1833.0	-0.0064	0.0750	1134.0	-0.0004	0.0750	663.0	0.0023
0.0800	1869.0	-0.0069	0.0800	1146.0	-0.0006	0.0800	663.0	0.0023
0.0850	1881.0	-0.0074	0.0850	1146.0	-0.0009	0.0850	663.0	0.0023
0.0900	1905.0	-0.0080	0.0900	1146.0	-0.0010	0.0900	663.0	0.0023
0.0950	1954.0	-0.0087	0.0950	1158.0	-0.0012	0.0950	663.0	0.0023
0.1000	1978.0	-0.0092	0.1000	1170.0	-0.0015	0.1000	663.0	0.0023
0.1050	2014.0	-0.0096	0.1050	1170.0	-0.0017	0.1050	651.0	0.0023
0.1100	2038.0	-0.0102	0.1100	1182.0	-0.0019	0.1100	651.0	0.0022
0.1150	2062.0	-0.0107	0.1150	1182.0	-0.0021	0.1150	639.0	0.0019
0.1200	2086.0	-0.0112	0.1200	1194.0	-0.0024	0.1200	639.0	0.0018
0.1250	2110.0	-0.0117	0.1250	1194.0	-0.0026	0.1250	639.0	0.0016
0.1300	2134.0	-0.0121	0.1300	1206.0	-0.0027	0.1300	651.0	0.0015
0.1350	2146.0	-0.0127	0.1350	1218.0	-0.0029	0.1350	651.0	0.0013
0.1400	2171.0	-0.0131	0.1400	1218.0	-0.0032	0.1400	651.0	0.0011
0.1450	2195.0	-0.0136	0.1450	1218.0	-0.0034	0.1450	663.0	0.0009
0.1500	2219.0	-0.0140	0.1500	1230.0	-0.0036	0.1500	663.0	0.0007
0.1550	2231.0	-0.0144	0.1550	1242.0	-0.0038	0.1550	663.0	0.0006
0.1600	2255.0	-0.0149	0.1600	1242.0	-0.0041	0.1600	663.0	0.0004
0.1650	2267.0	-0.0152	0.1650	1242.0	-0.0043	0.1650	663.0	0.0002
0.1700	2291.0	-0.0157	0.1700	1254.0	-0.0044	0.1700	675.0	0.0000
0.1750	2303.0	-0.0160	0.1750	1254.0	-0.0047	0.1750	675.0	-0.0001
0.1800	2315.0	-0.0165	0.1800	1254.0	-0.0049	0.1800	675.0	-0.0002
0.1850	2327.0	-0.0168	0.1850	1266.0	-0.0051	0.1850	675.0	-0.0005
0.1900	2351.0	-0.0173	0.1900	1266.0	-0.0053	0.1900	675.0	-0.0007

ATT
ADVANCED TERRA TESTING

Direct Shear

ASTM D 3080

Client Data

Client: Swift River Environmental Services
Job Number.: 2952-2
Location: --
Project Number: 152047

Sample Information

Boring: TP-3
Depth: 3-5'
Sample Number: --
Sampled Date: --
Soil Description: --

Raw Data

Point A 4000 psf			Point B 2000 psf			Point C 1000 psf		
Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)	Displacement (in)	Shear Stress (psf)	Vertical Displacement (in)
0.1950	2364.0	-0.0176	0.1950	1266.0	-0.0056	0.1950	675.0	-0.0008
0.2000	2376.0	-0.0181	0.2000	1266.0	-0.0058	0.2000	675.0	-0.0009
0.2050	2388.0	-0.0184	0.2050	1266.0	-0.0060	0.2050	687.0	-0.0011
0.2100	2388.0	-0.0188	0.2100	1266.0	-0.0063	0.2100	687.0	-0.0013
0.2150	2400.0	-0.0192	0.2150	1278.0	-0.0065	0.2150	687.0	-0.0015
0.2200	2412.0	-0.0195	0.2200	1278.0	-0.0067	0.2200	687.0	-0.0017
0.2250	2412.0	-0.0199	0.2250	1278.0	-0.0068	0.2250	687.0	-0.0018
0.2300	2424.0	-0.0201	0.2300	1290.0	-0.0071	0.2300	687.0	-0.0020
0.2350	2436.0	-0.0205	0.2350	1290.0	-0.0074	0.2350	687.0	-0.0022
0.2400	2436.0	-0.0207	0.2400	1290.0	-0.0075	0.2400	687.0	-0.0024
0.2450	2448.0	-0.0210	0.2450	1302.0	-0.0077	0.2450	687.0	-0.0025
0.2500	2460.0	-0.0214	0.2500	1302.0	-0.0080	0.2500	687.0	-0.0026

ATT
ADVANCED TERRA TESTING

Consolidated Undrained Triaxial Compression Test for Cohesive Soils
ASTM D 4767

Client	Swift River Environmental Services	Boring Number:	NWE-9
Job Number	2952-1	Depth:	17-19'
Project	North Weld Landfill Expansion	Sample Number:	Pt A, B, D
Location	--	Sampled Date:	--
Project Number	S152047	Sampled By:	--

Tested By: CAL

TEST TYPE TX/CUPP

σ_3 Confining Stresses (psf)	
SAMPLE A	11520
SAMPLE B	5760
SAMPLE C	2880

Peak Points	p' (psf)	q (psf)
SAMPLE A	7927	4654
SAMPLE B	2838	1700
SAMPLE C	2226	1189

Stress Condition at Maximum Deviator Stress (PSF)				
	σ3	σ1	σ'3	σ'1
SAMPLE A	11520	20827	3273	12580
SAMPLE B	5760	9160	1138	4538
SAMPLE C	2880	5257	1037	3414

SAMPLE A DATA

σ_3' (psf)	σ_1' (psf)	Deviator Stress $(\sigma_1-\sigma_3)$ (psf)	p' = $(\sigma_1'+\sigma_3')/2$ (psf)	q = $(\sigma_1-\sigma_3)/2$ (psf)
11520	11520	0	11520	0
11501	11839	338	11670	169
11382	12393	1011	11888	506
11208	12660	1452	11934	726
10987	12690	1703	11839	852
10776	12750	1974	11763	987
10583	12786	2203	11685	1102
10344	12817	2473	11581	1237
10096	13007	2911	11552	1456
9628	13247	3619	11438	1810
6110	12999	6889	9555	3445
4448	11736	7288	8092	3644
3741	11197	7456	7469	3728
3383	10910	7527	7147	3764
3007	10638	7631	6823	3816
2841	10512	7671	6677	3836
2822	10688	7866	6755	3933
2831	10907	8076	6869	4038
2831	11060	8229	6946	4115
2904	11331	8427	7118	4214
2942	11483	8541	7213	4271
3024	11751	8727	7388	4364
3089	12125	9036	7607	4518
3144	12287	9143	7716	4572
3200	12364	9164	7782	4582
3273	12580	9307	7927	4654

SAMPLE B DATA

σ_3' (psf)	σ_1' (psf)	Deviator Stress $(\sigma_1-\sigma_3)$ (psf)	p' = $(\sigma_1'+\sigma_3')/2$ (psf)	q = $(\sigma_1-\sigma_3)/2$ (psf)
5760	5760	0	5760	0
5458	6686	1228	6072	614
4867	7195	2328	6031	1164
4205	6951	2746	5578	1373
3643	6681	3038	5162	1519
3226	6409	3183	4818	1592
2894	6118	3224	4506	1612
2635	5898	3263	4267	1632
2390	5732	3342	4061	1671
2218	5451	3233	3835	1617
2074	5346	3272	3710	1636
1613	4744	3131	3179	1566
1397	4450	3053	2924	1527
1282	4296	3014	2789	1507
1181	4240	3059	2711	1530
1080	4028	2948	2554	1474
1080	4100	3020	2590	1510
1051	4176	3125	2614	1563
1051	4105	3054	2578	1527
1037	4191	3154	2614	1577
1022	4146	3124	2584	1562
1051	4291	3240	2671	1620
1080	4340	3260	2710	1630
1066	4288	3222	2677	1611
1094	4409	3315	2752	1658
1094	4407	3313	2751	1657
1138	4538	3400	2838	1700

SAMPLE C DATA

σ_3' (psf)	σ_1' (psf)	Deviator Stress $(\sigma_1-\sigma_3)$ (psf)	p' = $(\sigma_1'+\sigma_3')/2$ (psf)	q = $(\sigma_1-\sigma_3)/2$ (psf)
2880	2880	0	2880	0
2837	2979	142	2908	71
2779	3204	425	2992	213
2448	3651	1203	3050	602
2146	3701	1555	2924	778
1915	3680	1765	2798	883
1728	3703	1975	2716	988
1584	3628	2044	2606	1022
1454	3566	2112	2510	1056
1368	3548	2180	2458	1090
1282	3530	2248	2406	1124
1037	3414	2377	2226	1189
907	3203	2296	2055	1148
778	3061	2283	1920	1142
734	2937	2203	1836	1102
677	2789	2112	1733	1056
648	2671	2023	1660	1012
619	2621	2002	1620	1001
590	2503	1913	1547	957
590	2483	1893	1537	947
576	2384	1808	1480	904
562	2349	1787	1456	894
547	2315	1768	1431	884
533	2219	1686	1376	843
533	2200	1667	1367	834
504	2152	1648	1328	824
504	2072	1568	1288	784

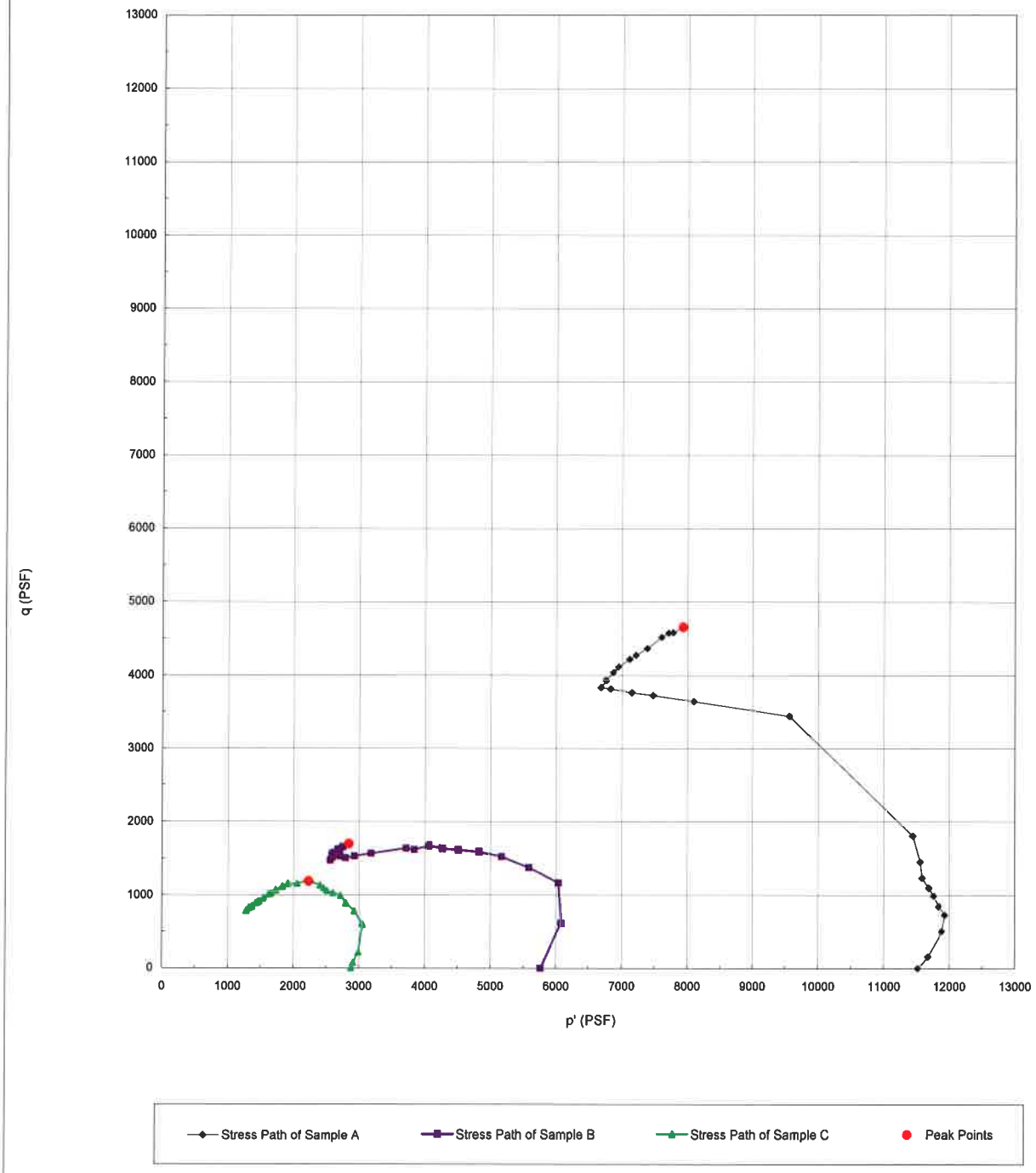
Data entry by: NN
Date: 3/21/16
FileName: 2952_1_PQPlots-ASTM-D4767-withmetric-R2_1 xls

Data checked by: [signature]
Date: 3-21-16

ATT ADVANCED

Effective Stress Path Analysis - p' q Plots

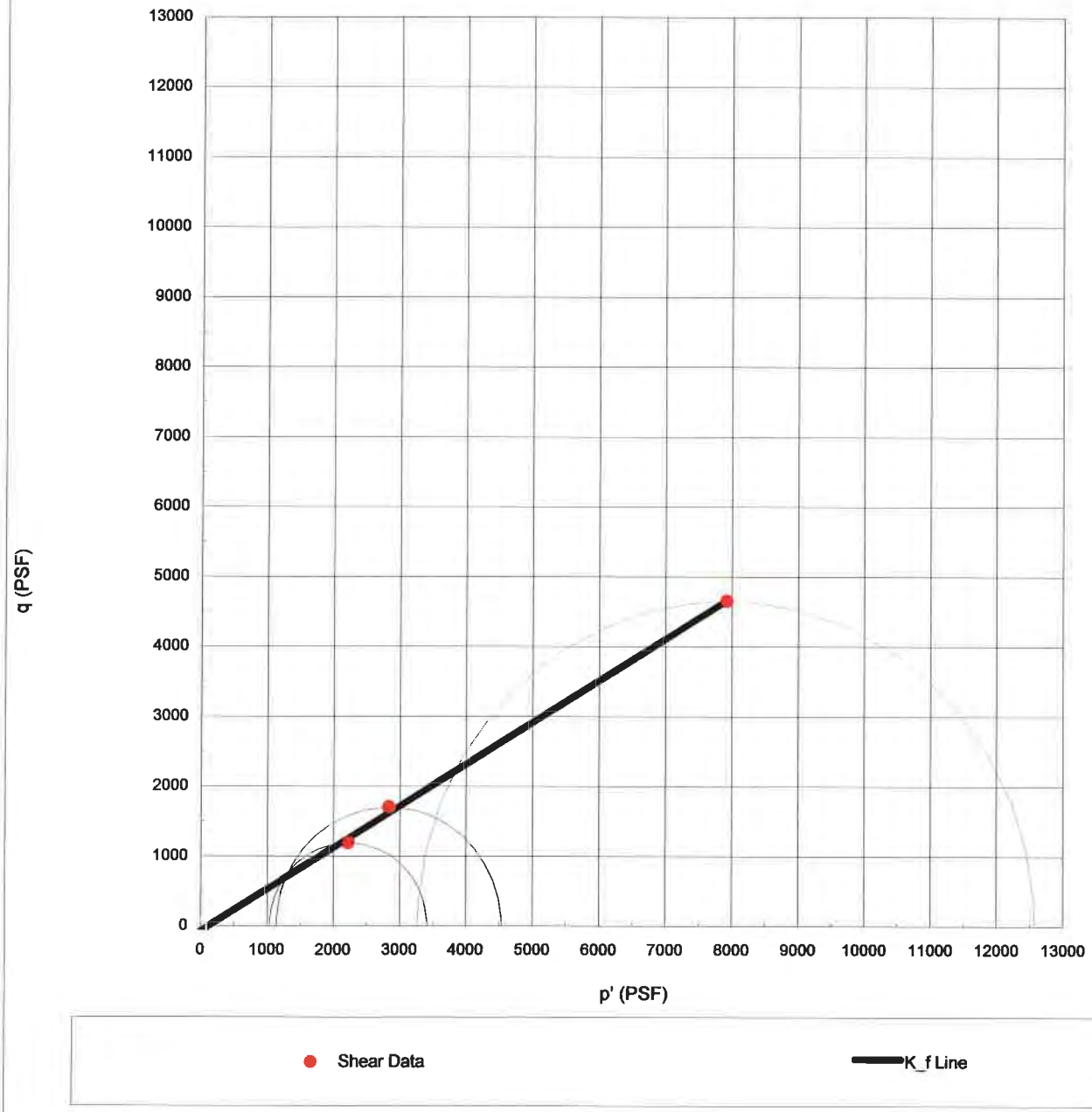
--,NWE-9,Pt. A, B, D,17-19'



NOTE 1: The peak points shown in the plot represent maximum values of q [(σ1-σ3)/2].

Effective Stress Path Analysis - p'-q Regression Plot at Maximum q

–,NWE-9,Pt. A, B, D,17-19'



Note: Peak points are plotted for visual verification only. Least squared regression analysis, yields a negative alpha (a) value; therefore no regression analysis has been provided.

NOTE 2: The line presented in the graph is the K_f line taken at Peak q values defined by the equation $q=a+p' \tan(\Psi)$ where a = the intercept on the q-axis in stress units and Ψ = the angle of the K_f line with respect to the horizontal in degrees.

NOTE 3: The K_f is NOT the Mohr-Coulomb failure envelope defined by the equation $\tau=c+\sigma \tan(\Phi)$. The equations $\sin(\Phi)=\tan(\Psi)$ and $c=a/\cos(\Phi)$ may be used to approximate values for Φ and c at the effective stress condition described in NOTE 1.

ATT
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ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/15/2016
BORING NO.	NWE-9	CELL NUMBER	22S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. A	CONF. PRES. (psf)	11520
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture (g)	758.64	788.85	
Wt. Wet Soil & Pan (g)	772.84	803.05	
Wt. Dry Soil & Pan (g)	688.61	688.61	
Wt. Lost Moisture (g)	84.23	114.44	
Wt. of Pan Only (g)	14.20	14.20	
Wt. of Dry Soil (g)	674.41	674.41	
Moisture Content %	12.5	17.0	
Wet Density (pcf)	123.3	138.2	
Dry Density (pcf)	109.6	118.1	
Init. Diameter (in)	2.416		
Init. Area (sq in)	4.584		
Init. Height (in)	5.112		
Vol. Bef. Consol. (cu ft)	0.01356		
Vol. After Consol. (cu ft)	0.01259		

Notes & Comments:

Data entry by: NN Date: 03/16/2016 Technician CAL

Data checked by: [signature] Date: 3/16/16

FileName: 2952_1_TX_CUpp_ASTMD_4767_R0_2.xls

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/15/2016
BORING NO.	NWE-9	CELL NUMBER	22S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. A	CONF. PRES. (psf)	11520
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

SATURATION DATA

Cell Pressure (psi)	Back Pressure (psi)	Burette Reading (cc)		Pore Pressure (psi)		Change	B
		Close	Open	Close	Open		
40.0	38.0	3.1	14.6				
50.0	48.0	18.1	19.7	38.1	45.2	7.1	0.71
60.0	58.0	21.1	22.0	48.2	56.4	8.2	0.82
70.0	68.0	23.2	24.0	58.2	66.5	8.3	0.83
80.0	78.0	24.8	24.6	68.0	76.9	8.9	0.89
90.0		27.4	27.5	77.8	87.4	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (min)	SQRT TIME (min)	Burette Reading (cc)	Volume Deflection (cc)
0.00	0.0	0.30	0.00
0.25	0.5	18.50	-18.20
0.5	0.7	19.40	-19.10
1	1.0	20.05	-19.75
2	1.4	20.50	-20.20
4	2.0	20.80	-20.50
9	3.0	21.20	-20.90
16	4.0	21.40	-21.10
30	5.5	21.80	-21.50
60	7.7	22.00	-21.70
120	11.0	22.30	-22.00
240	15.5	22.80	-22.50
360	19.0	23.10	-22.80
1440	37.9	25.40	-25.10

Initial Height (in)	5.112	Initial Vol. (cc)	384.108
Height Change (in)	0.107	Vol. Change (cc)	49.800
Ht. After Cons. (in)	5.005	Cell Exp. (cc)	22.153
Initial Area (sq in)	4.584	Net Change (cc)	27.647
Area After Cons. (sq in)	4.345	Cons. Vol. (cc)	356.462

ADVANCED TERRA TESTING

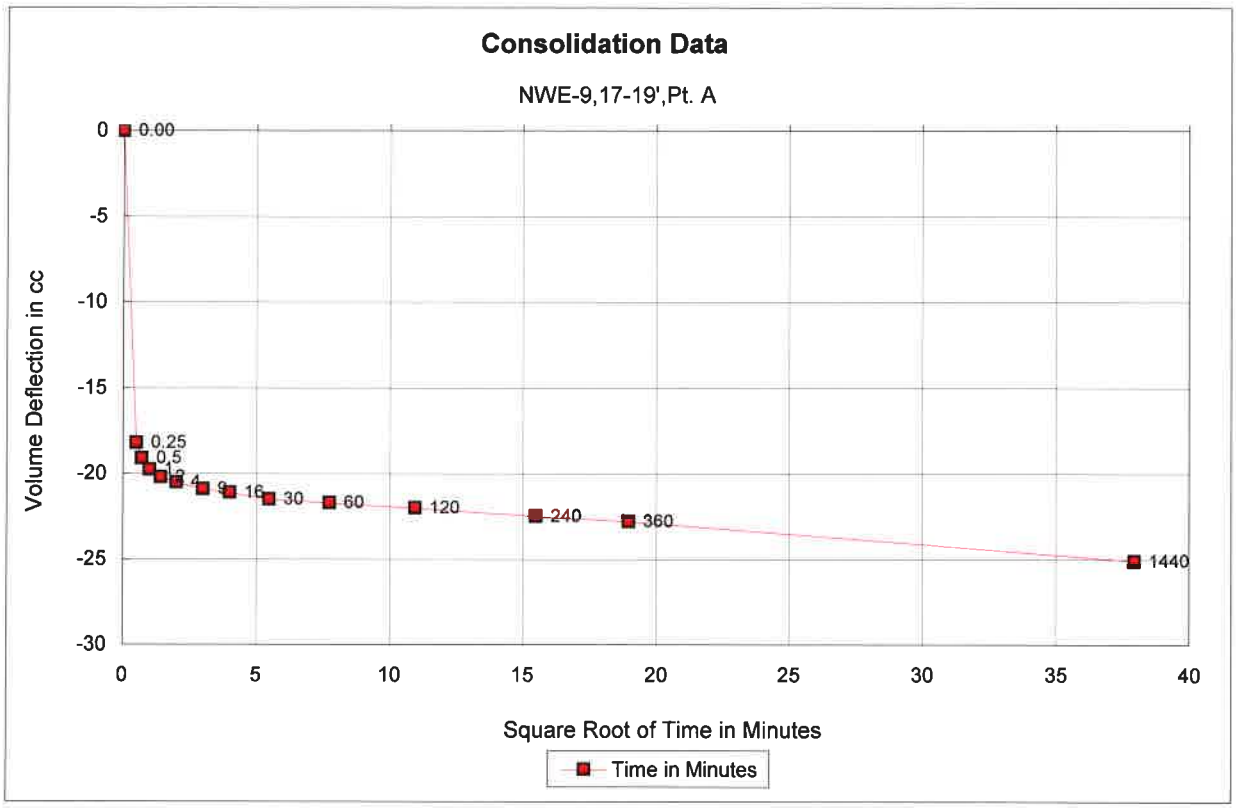
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D 4767

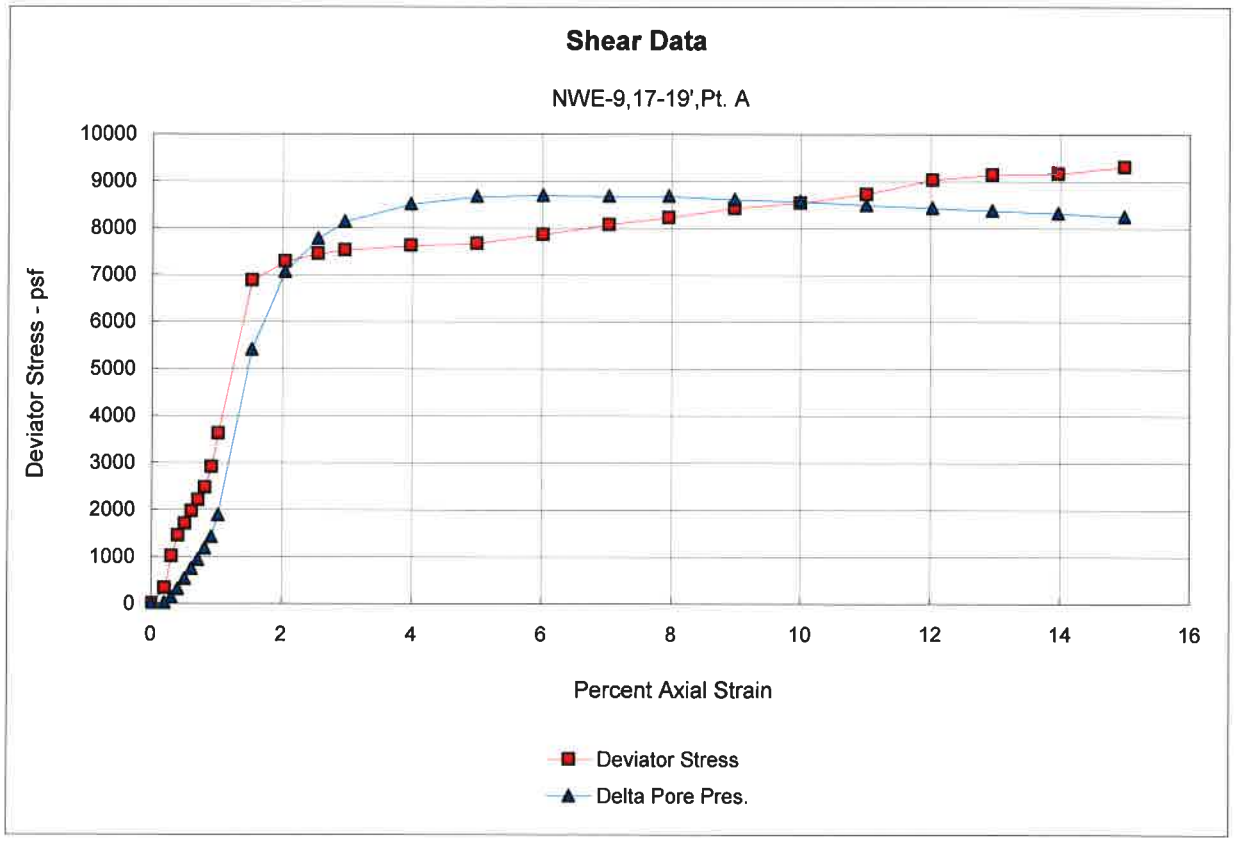
CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/15/2016
BORING NO.	NWE-9	CELL NUMBER	22S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. A	CONF. PRES. (psf)	11520
LOCATION	--		
SAMPLE TYPE	Shelby Tube		
Init. Ht. (in)	5.112	Init. Area (sq in)	4.584
Consol. Ht. (in)	5.005	Consol. Area (sq in)	4.345
Back Pres. (psi)	77.2	Strain Rate (in/min)	0.0081

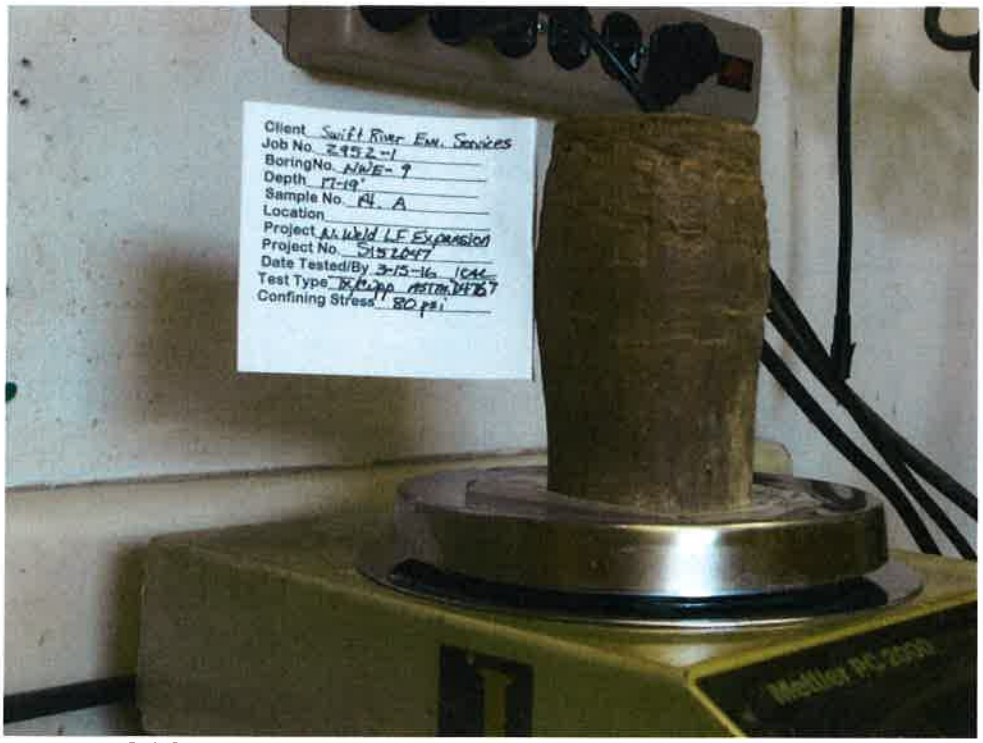
Axial Load (lbs.)	Axial Load (psf)	Delta Ht. (in)	Axial Strain (%)	Area Final (sq in)	Dev. Stress (psf)	Pore Pres. (psi)	Delta Pres. (psf)	Sigma 3' (psf)	Sigma 1' (psf)	Prin. Stress Ratio
0.0	0	0.000	0.00	4.345	0	77.2	0	11520	11520	1.00
10	338	0.010	0.20	4.354	337	77.3	19	11501	11839	1.03
31	1014	0.015	0.31	4.359	1011	78.2	138	11382	12393	1.09
44	1458	0.020	0.41	4.363	1452	79.4	312	11208	12660	1.13
52	1712	0.026	0.51	4.368	1703	80.9	533	10987	12690	1.16
60	1987	0.031	0.61	4.372	1975	82.4	744	10776	12750	1.18
67	2219	0.036	0.71	4.377	2203	83.7	937	10583	12786	1.21
75	2494	0.041	0.82	4.381	2474	85.4	1176	10344	12817	1.24
89	2938	0.046	0.92	4.386	2911	87.1	1424	10096	13007	1.29
110	3657	0.051	1.02	4.390	3619	90.4	1892	9628	13247	1.38
211	6996	0.077	1.53	4.413	6889	114.8	5410	6110	12999	2.13
225	7440	0.102	2.04	4.436	7288	126.3	7072	4448	11736	2.64
231	7651	0.128	2.55	4.459	7456	131.2	7779	3741	11197	2.99
234	7757	0.148	2.96	4.478	7527	133.7	8137	3383	10910	3.23
240	7947	0.199	3.98	4.525	7631	136.3	8513	3007	10638	3.54
244	8074	0.250	5.00	4.574	7670	137.5	8679	2841	10512	3.70
253	8370	0.301	6.02	4.624	7866	137.6	8698	2822	10688	3.79
262	8687	0.352	7.04	4.674	8076	137.6	8689	2831	10907	3.85
270	8940	0.398	7.96	4.721	8229	137.6	8689	2831	11060	3.91
279	9258	0.449	8.98	4.774	8427	137.0	8616	2904	11331	3.90
286	9490	0.500	9.99	4.828	8541	136.8	8578	2942	11483	3.90
296	9807	0.551	11.01	4.883	8727	136.2	8496	3024	11751	3.89
310	10272	0.602	12.03	4.940	9036	135.8	8431	3089	12125	3.93
317	10505	0.648	12.95	4.992	9144	135.4	8376	3144	12287	3.91
321	10652	0.699	13.97	5.051	9164	135.0	8320	3200	12364	3.86
330	10948	0.750	14.99	5.112	9307	134.5	8247	3273	12580	3.84

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
FOR COHESIVE SOILS
ASTM D4767







Q:\Client Data File\2952\1\PICTURE\DSCF6156.jpg

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	03/17/2016
BORING NO.	NWE-9	CELL NUMBER	7S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. B	CONF. PRES. (psf)	5760
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture (g)	688.94	749.16	
Wt. Wet Soil & Pan (g)	703.26	763.48	
Wt. Dry Soil & Pan (g)	637.36	637.36	
Wt. Lost Moisture (g)	65.90	126.12	
Wt. of Pan Only (g)	14.32	14.32	
Wt. of Dry Soil (g)	623.04	623.04	
Moisture Content %	10.6	20.2	
Wet Density (pcf)	113.6	132.0	
Dry Density (pcf)	102.7	109.8	
Init. Diameter (in)	2.404		
Init. Area (sq in)	4.539		
Init. Height (in)	5.090		
Vol. Bef. Consol. (cu ft)	0.01337		
Vol. After Consol. (cu ft)	0.01251		

Notes & Comments:

Data entry by: CKP Date: 03/21/2016 Technician CAL

Data checked by: [signature] Date: 3/21/16

FileName: 2952_1_TX_CUpp_ASTMD_4767_R0_4.xls

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	03/17/2016
BORING NO.	NWE-9	CELL NUMBER	7S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. B	CONF. PRES. (psf)	5760
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

SATURATION DATA

Cell Pressure (psi)	Back Pressure (psi)	Burette Reading (cc)		Pore Pressure (psi)		Change	B
		Close	Open	Close	Open		
40.0	38.0	4.9	16.5				
50.0	48.0	17.6	19.0	38.7	44.8	6.1	0.61
60.0	58.0	19.1	20.2	47.9	55.0	7.1	0.71
70.0	68.0	20.4	21.4	58.4	65.9	7.5	0.75
80.0	78.0	21.6	22.5	68.2	76.5	8.3	0.83
90.0	88.0	23.1	24.0	78.8	87.7	8.9	0.89
100.0	98 0	24.1	24.9	89.0	98.2	9.2	0.92
110.0	108.0	25.0	25.2	98.9	108.4	9.5	0.95

CONSOLIDATION DATA

Elapsed Time (min)	SQRT TIME (min)	Burette Reading (cc)	Volume Deflection (cc)
0.00	0.0	0.20	0.00
0.25	0.5	14.70	-14.50
0.5	0.7	15.25	-15.05
1	1.0	15.70	-15.50
2	1.4	16.30	-16.10
4	2.0	16.90	-16.70
9	3.0	17.50	-17.30
16	4.0	17.80	-17.60
30	5.5	18.15	-17.95
60	7.7	18.50	-18.30
120	11.0	18.80	-18.60
240	15.5	19.10	-18.90
374	19.3	19.30	-19.10
1440	37.9	19.90	-19.70

Initial Height (in)	5.090	Initial Vol. (cc)	378.665
Height Change (in)	0.100	Vol. Change (cc)	40.000
Ht. After Cons. (in)	4.990	Cell Exp. (cc)	15.772
Initial Area (sq in)	4.539	Net Change (cc)	24.228
Area After Cons. (sq in)	4.334	Cons. Vol. (cc)	354.438

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D 4767

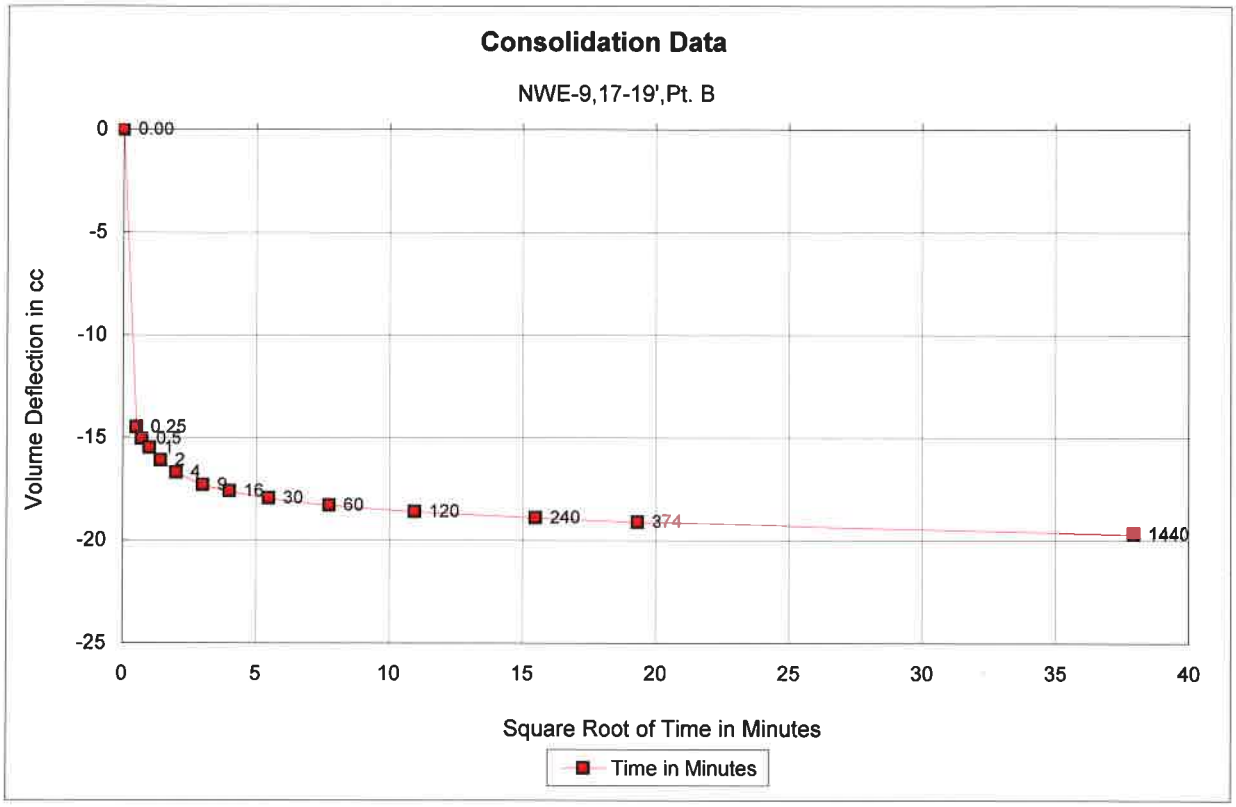
CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	03/17/2016
BORING NO.	NWE-9	CELL NUMBER	7S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. B	CONF. PRES. (psf)	5760
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

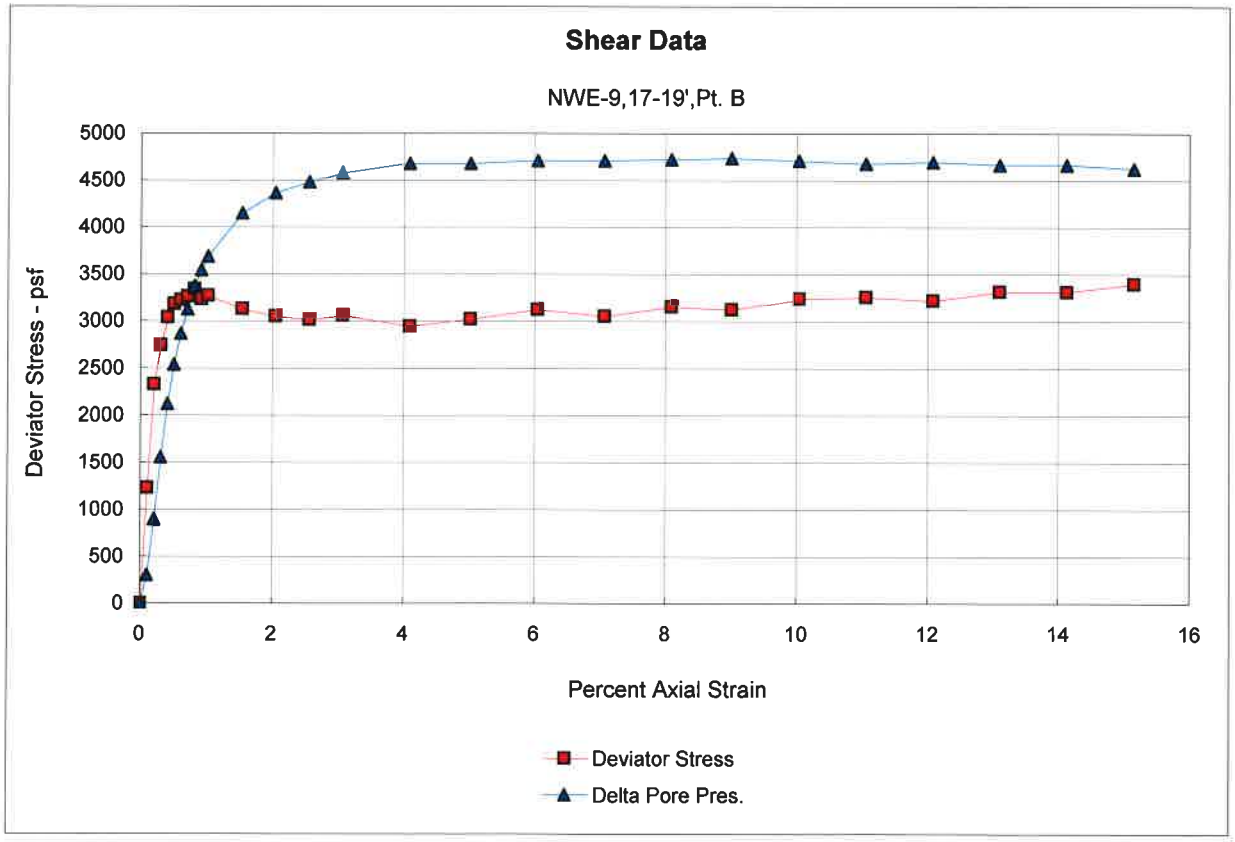
Init. Ht. (in)	5.090	Init. Area (sq in)	4.539
Consol. Ht. (in)	4.990	Consol. Area (sq in)	4.334
Back Pres. (psi)	97.1	Strain Rate (in/min)	0.0042

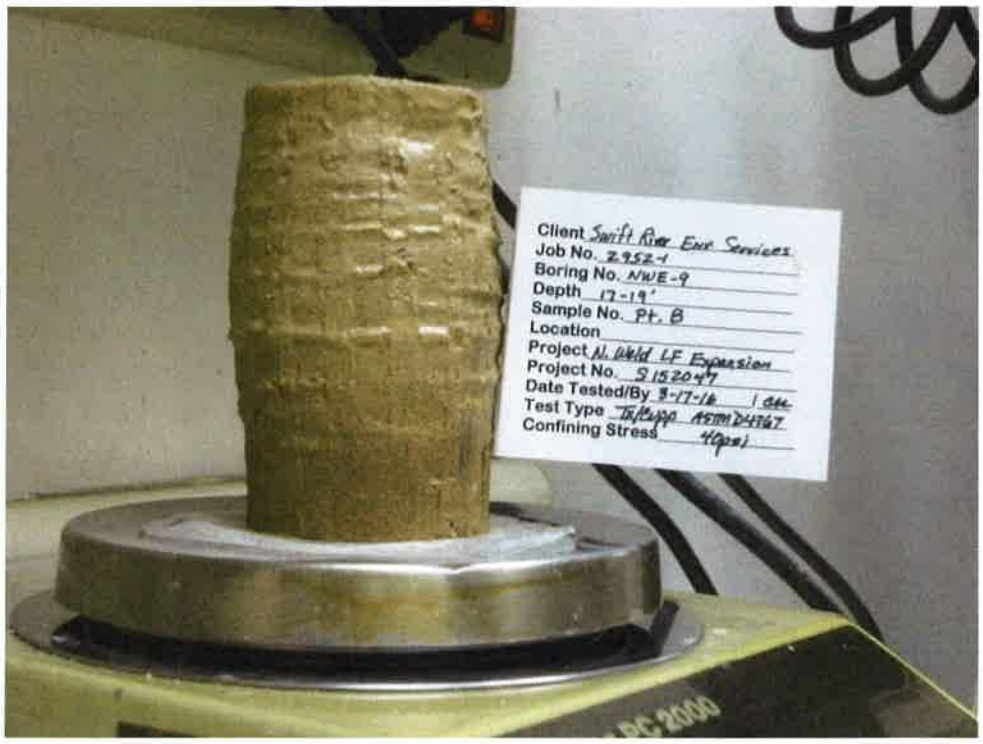
Axial Load (lbs.)	Axial Load (psf)	Delta Ht. (in)	Axial Strain (%)	Area Final (sq in)	Dev. Stress (psf)	Pore Pres. (psi)	Delta Pres. (psf)	Sigma 3' (psf)	Sigma 1' (psf)	Prin. Stress Ratio
0.0	0	0.000	0.00	4.334	0	97.1	0	5760	5760	1.00
37	1229	0.005	0.10	4.338	1228	99.2	302	5458	6686	1.23
70	2333	0.010	0.20	4.343	2328	103.3	893	4867	7195	1.48
83	2755	0.015	0.31	4.347	2746	107.9	1555	4205	6951	1.65
92	3050	0.020	0.41	4.352	3038	111.8	2117	3643	6681	1.83
96	3200	0.026	0.51	4.356	3183	114.7	2534	3226	6409	1.99
98	3243	0.031	0.61	4.360	3223	117.0	2866	2894	6118	2.11
99	3286	0.036	0.72	4.365	3263	118.8	3125	2635	5898	2.24
101	3369	0.041	0.82	4.369	3342	120.5	3370	2390	5732	2.40
98	3263	0.046	0.92	4.374	3233	121.7	3542	2218	5451	2.46
100	3306	0.051	1.02	4.378	3272	122.7	3686	2074	5346	2.58
96	3180	0.077	1.54	4.401	3131	125.9	4147	1613	4744	2.94
94	3117	0.102	2.05	4.424	3053	127.4	4363	1397	4450	3.19
93	3094	0.128	2.56	4.448	3014	128.2	4478	1282	4296	3.35
95	3157	0.153	3.07	4.471	3060	128.9	4579	1181	4240	3.59
93	3074	0.204	4.10	4.519	2948	129.6	4680	1080	4028	3.73
96	3180	0.250	5.02	4.563	3020	129.6	4680	1080	4100	3.80
100	3326	0.302	6.05	4.613	3125	129.8	4709	1051	4176	3.97
99	3286	0.353	7.07	4.663	3054	129.8	4709	1051	4105	3.91
103	3432	0.404	8.09	4.715	3155	129.9	4723	1037	4191	4.04
103	3432	0.450	9.01	4.763	3123	130.0	4738	1022	4146	4.05
108	3602	0.501	10.04	4.817	3240	129.8	4709	1051	4291	4.08
110	3665	0.552	11.06	4.873	3260	129.6	4680	1080	4340	4.02
110	3665	0.603	12.09	4.930	3222	129.7	4694	1066	4288	4.02
115	3815	0.654	13.11	4.987	3315	129.5	4666	1094	4409	4.03
116	3858	0.705	14.13	5.047	3313	129.5	4666	1094	4407	4.03
121	4007	0.756	15.15	5.108	3400	129.2	4622	1138	4538	3.99

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
FOR COHESIVE SOILS
ASTM D4767







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ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/19/2016
BORING NO.	NWE-9	CELL NUMBER	15S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. D	CONF. PRES. (psf)	2880
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture (g)	1046.05	1153.36
Wt. Wet Soil & Pan (g)	1060.21	1167.52
Wt. Dry Soil & Pan (g)	926.43	926.43
Wt. Lost Moisture (g)	133.78	241.09
Wt. of Pan Only (g)	14.16	14.16
Wt. of Dry Soil (g)	912.27	912.27
Moisture Content %	14.7	26.4
Wet Density (pcf)	106.7	124.9
Dry Density (pcf)	93.1	98.8
Init. Diameter (in)	2.845	
Init. Area (sq in)	6.357	
Init. Height (in)	5.875	
Vol. Bef. Consol. (cu ft)	0.02161	
Vol. After Consol. (cu ft)	0.02036	

Notes & Comments:

Data entry by: NN Date: 03/21/2016 Technician CAL

Data checked by: [illegible] Date: 3/21/16

FileName: 2952_1_TX_CUpp_ASTMD_4767_R0_5.xls

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/19/2016
BORING NO.	NWE-9	CELL NUMBER	15S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. D	CONF. PRES. (psf)	2880
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

SATURATION DATA

Cell Pressure (psi)	Back Pressure (psi)	Burette Reading (cc)		Pore Pressure (psi)		Change	B
		Close	Open	Close	Open		
40.0	38.0	8.1	30.8				
50.0	48.0	32.5	34.4	38.9	45.0	6.1	0.61
60.0	58.0	34.5	35.4	48.7	55.1	6.4	0.64
70.0	68.0	35.1	36.3	59.0	66.6	7.6	0.76
80.0	78.0	36.0	36.9	69.0	77.2	8.2	0.82
90.0	88.0	36.2	37.3	78.8	87.8	9.0	0.90
100.0	98.0	37.2	38.2	88.9	98.0	9.1	0.91
110.0	108.0	38.0	38.8	98.9	108.2	9.3	0.93
120.0		38.8	38.9	108.9	118.5	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (min)	SQRT TIME (min)	Burette Reading (cc)	Volume Deflection (cc)
0.00	0.0	0.40	0.00
0.25	0.5	12.10	-11.70
0.5	0.7	13.00	-12.60
1	1.0	14.05	-13.65
2	1.4	14.75	-14.35
4	2.0	15.30	-14.90
9	3.0	15.90	-15.50
16	4.0	16.20	-15.80
30	5.5	16.65	-16.25
60	7.7	17.05	-16.65
120	11.0	17.40	-17.00
240	15.5	17.75	-17.35
341	18.5	17.90	-17.50
1538	39.2	18.45	-18.05

Initial Height (in)	5.875	Initial Vol. (cc)	612.127
Height Change (in)	0.095	Vol. Change (cc)	49.100
Ht. After Cons. (in)	5.780	Cell Exp. (cc)	13.711
Initial Area (sq in)	6.357	Net Change (cc)	35.389
Area After Cons. (sq in)	6.088	Cons. Vol. (cc)	576.738

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D 4767

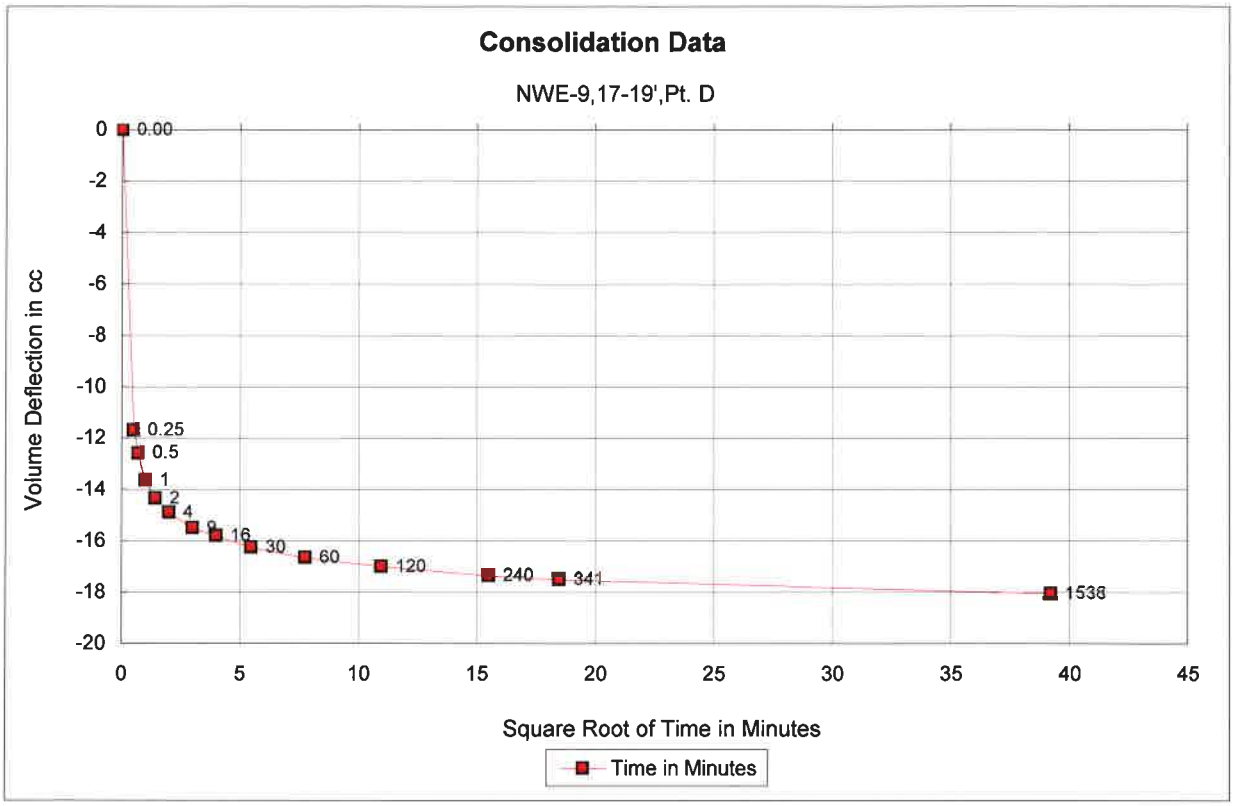
CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/19/2016
BORING NO.	NWE-9	CELL NUMBER	15S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. D	CONF. PRES. (psf)	2880
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

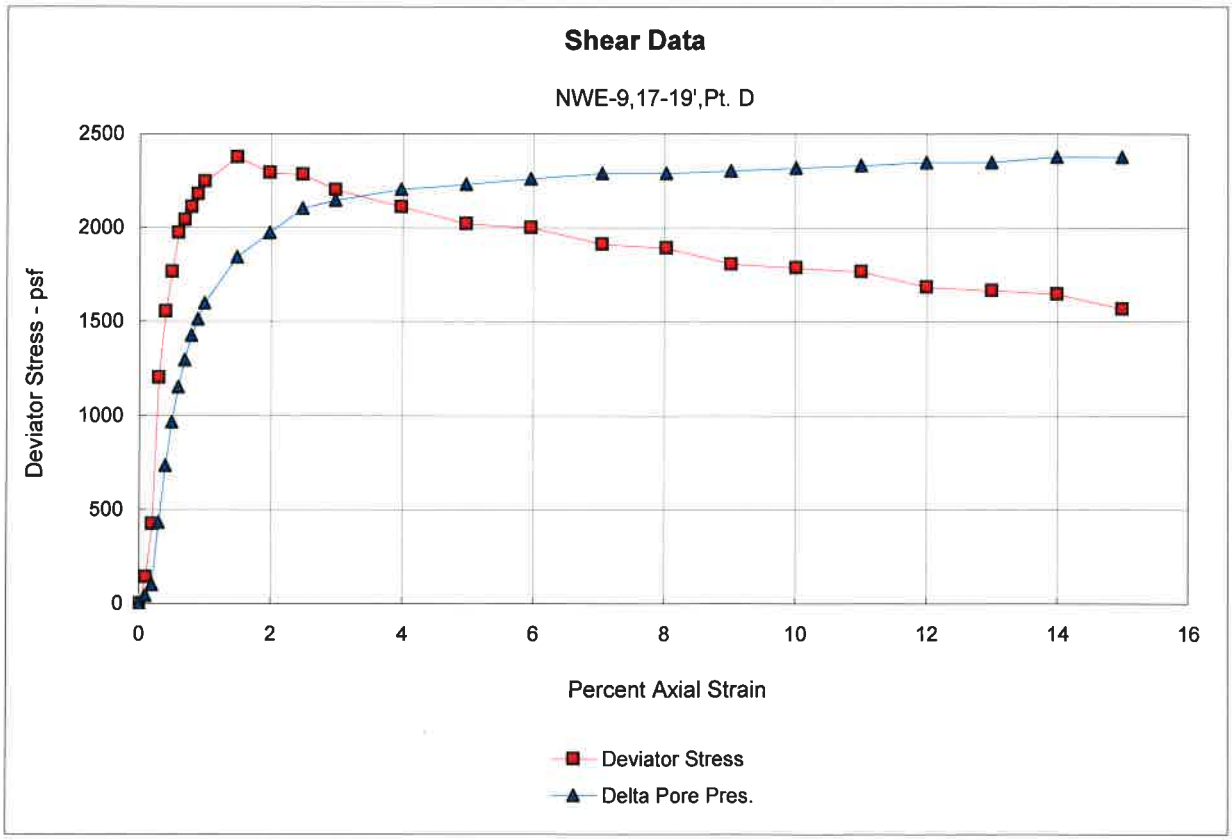
Init. Ht. (in)	5.875	Init. Area (sq in)	6.357
Consol. Ht. (in)	5.780	Consol. Area (sq in)	6.088
Back Pres. (psi)	108.6	Strain Rate (in/min)	0.0069

Axial Load (lbs.)	Axial Load (psf)	Delta Ht. (in)	Axial Strain (%)	Area Final (sq in)	Dev. Stress (psf)	Pore Pres. (psi)	Delta Pres. (psf)	Sigma 3' (psf)	Sigma 1' (psf)	Prin. Stress Ratio
0.0	0	0.000	0.00	6.088	0	108.6	0	2880	2880	1.00
6	142	0.006	0.10	6.094	142	108.9	43	2837	2979	1.05
18	426	0.011	0.20	6.100	425	109.3	101	2779	3204	1.15
51	1206	0.017	0.30	6.106	1203	111.6	432	2448	3651	1.49
66	1561	0.023	0.39	6.112	1555	113.7	734	2146	3701	1.72
75	1774	0.029	0.49	6.118	1765	115.3	965	1915	3680	1.92
84	1987	0.034	0.59	6.124	1975	116.6	1152	1728	3703	2.14
87	2058	0.040	0.69	6.130	2044	117.6	1296	1584	3628	2.29
90	2129	0.046	0.79	6.137	2112	118.5	1426	1454	3566	2.45
93	2200	0.052	0.89	6.143	2180	119.1	1512	1368	3548	2.59
96	2271	0.057	0.99	6.149	2248	119.7	1598	1282	3530	2.75
102	2413	0.086	1.49	6.180	2377	121.4	1843	1037	3414	3.29
99	2342	0.114	1.98	6.211	2295	122.3	1973	907	3203	3.53
99	2342	0.143	2.48	6.243	2284	123.2	2102	778	3061	3.94
96	2271	0.172	2.98	6.275	2203	123.5	2146	734	2937	4.00
93	2200	0.230	3.98	6.341	2112	123.9	2203	677	2789	4.12
90	2129	0.288	4.98	6.407	2023	124.1	2232	648	2671	4.12
90	2129	0.345	5.96	6.474	2002	124.3	2261	619	2621	4.23
87	2058	0.407	7.05	6.550	1913	124.5	2290	590	2503	4.24
87	2058	0.464	8.03	6.620	1892	124.5	2290	590	2483	4.21
84	1987	0.522	9.02	6.692	1808	124.6	2304	576	2384	4.14
84	1987	0.579	10.02	6.766	1788	124.7	2318	562	2349	4.18
84	1987	0.636	11.01	6.841	1768	124.8	2333	547	2315	4.23
81	1916	0.694	12.01	6.919	1686	124.9	2347	533	2219	4.16
81	1916	0.751	13.00	6.998	1667	124.9	2347	533	2200	4.13
81	1916	0.809	13.99	7.078	1648	125.1	2376	504	2152	4.27
78	1845	0.866	14.99	7.161	1568	125.1	2376	504	2072	4.11

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
FOR COHESIVE SOILS
ASTM D4767







Q:\Client Data File\2952\1\PICTURE\DSCF6165.jpg

Consolidated Undrained Triaxial Compression Test for Cohesive Soils
ASTM D 4767

Client	Swift River Environmental Services	Boring Number:	NWE-14
Job Number	2952-1	Depth:	17-19'
Project	North Weld Landfill Expansion	Sample Number:	Pt. A, B, & C
Location	--	Sampled Date:	--
Project Number	S152047	Sampled By:	--

Tested By: CAL

TEST TYPE TX/CUPP

σ_3 Confining Stresses (psf)	
SAMPLE A	11520
SAMPLE B	5760
SAMPLE C	2880

Peak Points	p' (psf)	q (psf)
SAMPLE A	7301	3331
SAMPLE B	4564	1828
SAMPLE C	2288	1050

Stress Condition at Maximum Deviator Stress (PSF)				
	σ3	σ1	σ'3	σ'1
SAMPLE A	11520	18181	3970	10631
SAMPLE B	5760	9416	2736	6392
SAMPLE C	2880	4980	1238	3338

SAMPLE A DATA

σ_3' (psf)	σ_1' (psf)	Deviator Stress $(\sigma_1-\sigma_3)$ (psf)	p' = $(\sigma_1'+\sigma_3')/2$ (psf)	q = $(\sigma_1-\sigma_3)/2$ (psf)
11520	11520	0	11520	0
11290	12393	1103	11842	552
10682	12383	1701	11533	851
10142	12236	2094	11189	1047
9867	12347	2480	11107	1240
9563	12256	2693	10910	1347
9095	12603	3508	10849	1754
8214	12879	4665	10547	2333
7507	12962	5455	10235	2728
6955	12769	5814	9862	2907
6404	12597	6193	9501	3097
4797	11428	6631	8113	3316
3970	10631	6661	7301	3331
3465	10027	6562	6746	3281
3162	9691	6529	6427	3265
2814	9088	6274	5951	3137
2621	8870	6249	5746	3125
2501	8602	6101	5552	3051
2409	8465	6056	5437	3028
2363	8393	6030	5378	3015
2363	8353	5990	5358	2995
2354	8336	5982	5345	2991
2344	8259	5915	5302	2958
2336	8259	5923	5298	2962
2327	8182	5855	5255	2928
2308	8096	5788	5202	2894
2336	8018	5682	5177	2841

SAMPLE B DATA

σ_3' (psf)	σ_1' (psf)	Deviator Stress $(\sigma_1-\sigma_3)$ (psf)	p' = $(\sigma_1'+\sigma_3')/2$ (psf)	q = $(\sigma_1-\sigma_3)/2$ (psf)
5760	5760	0	5760	0
5602	6143	541	5873	271
5342	6532	1190	5937	595
4608	7092	2484	5850	1242
3917	7045	3128	5481	1564
3427	6876	3449	5152	1725
3038	6591	3553	4815	1777
2736	6392	3656	4564	1828
2491	6144	3653	4318	1827
2275	5924	3649	4100	1825
2117	5762	3645	3940	1823
1656	5179	3523	3418	1762
1354	4645	3291	3000	1646
1152	4320	3168	2736	1584
1037	4083	3046	2560	1523
893	3806	2913	2350	1457
806	3585	2779	2196	1390
763	3412	2649	2088	1325
720	3339	2619	2030	1310
691	3183	2492	1937	1246
662	3127	2465	1895	1233
634	2972	2338	1803	1169
619	2934	2315	1777	1158
590	2783	2193	1687	1097
576	2745	2169	1661	1085
547	2597	2050	1572	1025
533	2560	2027	1547	1014

SAMPLE C DATA

σ_3' (psf)	σ_1' (psf)	Deviator Stress $(\sigma_1-\sigma_3)$ (psf)	p' = $(\sigma_1'+\sigma_3')/2$ (psf)	q = $(\sigma_1-\sigma_3)/2$ (psf)
2880	2880	0	2880	0
2477	3581	1104	3029	552
2218	3622	1404	2920	702
1771	3575	1804	2673	902
1469	3471	2002	2470	1001
1238	3338	2100	2288	1050
1066	3163	2097	2115	1049
950	2946	1996	1948	998
864	2858	1994	1861	997
778	2769	1991	1774	996
706	2695	1989	1701	995
518	2300	1782	1409	891
432	2106	1674	1269	837
389	1957	1568	1173	784
360	1920	1560	1140	780
317	1764	1447	1041	724
302	1639	1337	971	669
288	1517	1229	903	615
259	1475	1216	867	608
245	1355	1110	800	555
230	1328	1098	779	549
230	1316	1086	773	543
216	1290	1074	753	537
202	1263	1061	733	531
202	1251	1049	727	525
202	1239	1037	721	519
187	1212	1025	700	513

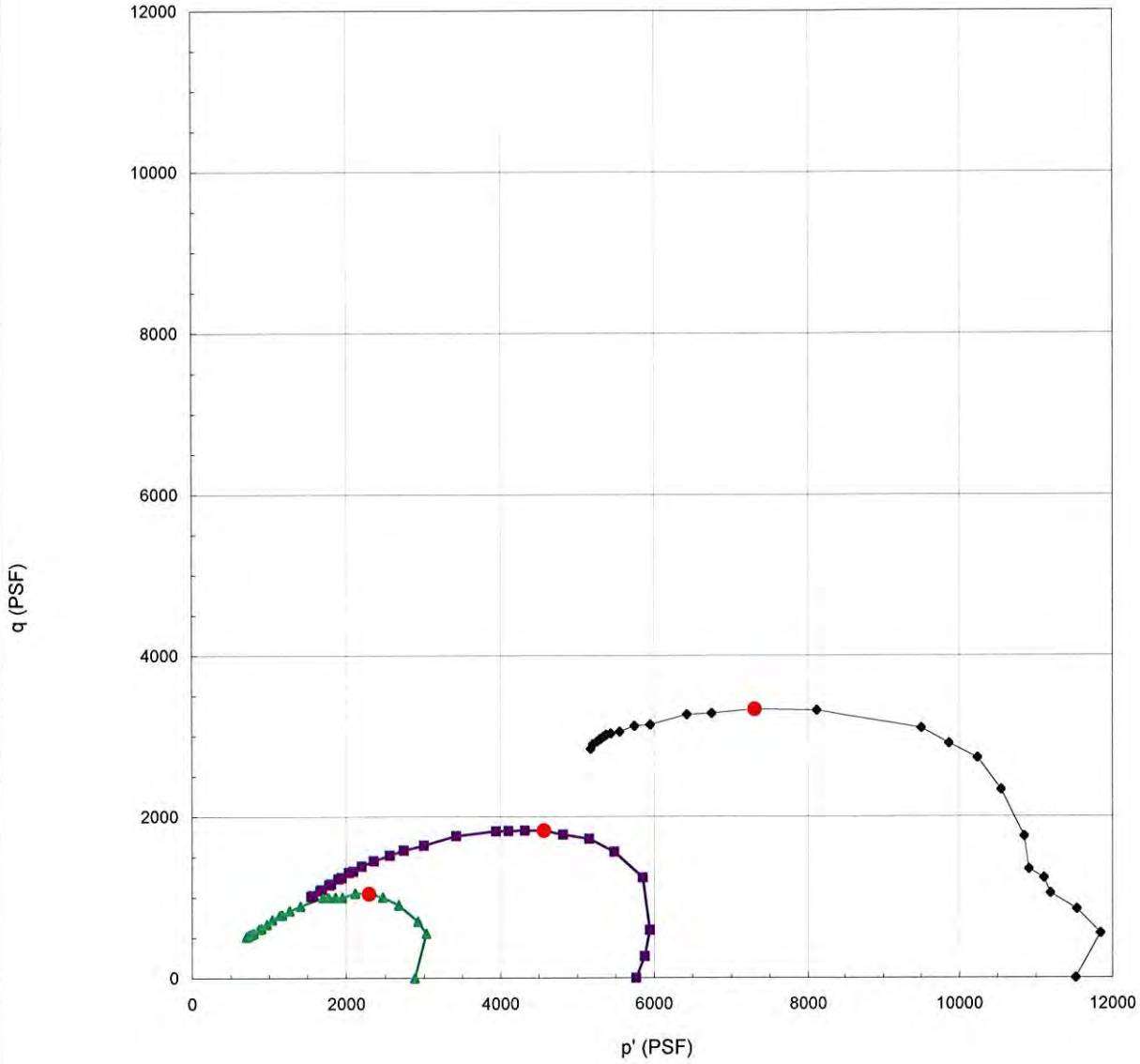
Data entry by: NN
Date: 3/16/16
FileName: 2952_1_PQPlots-ASTM-D4767-withmetric-R2_0.xls

Data checked by: [signature]
Date: 3/17/16

ATT

Effective Stress Path Analysis - p' q Plots

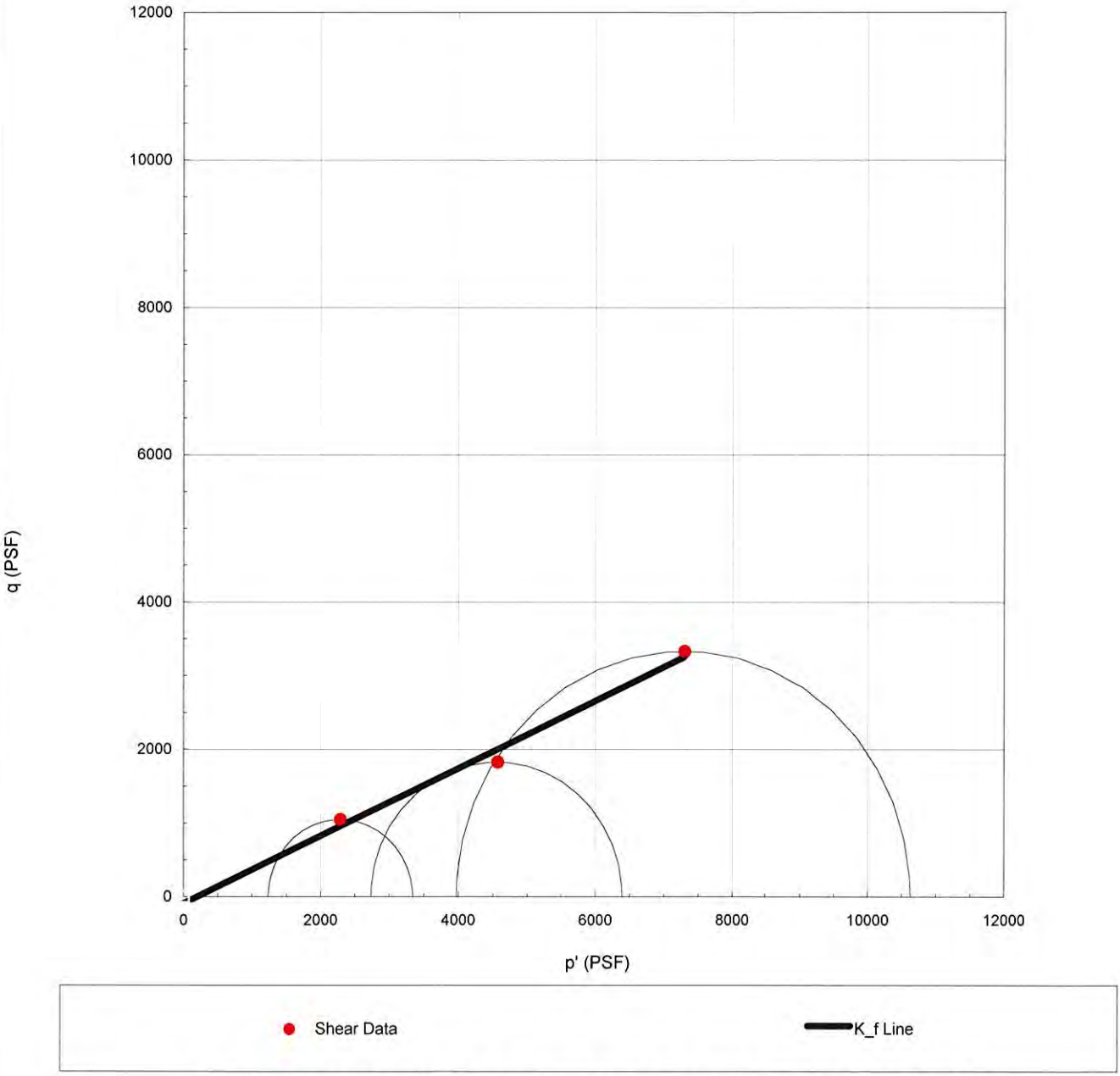
--,NWE-14,Pt. A, B, & C,17-19'



NOTE 1: The peak points shown in the plot represent maximum values of q [(σ1-σ3)/2].

Effective Stress Path Analysis - p'-q Regression Plot at Maximum q

--,NWE-14,Pt. A, B, & C,17-19'



Note: Peak points are plotted for visual verification only. Least squared regression analysis, yields a negative alpha (a) value; therefore no regression analysis has been provided.

NOTE 2: The line presented in the graph is the K_f line taken at Peak q values defined by the equation $q=a+p' \tan(\Psi)$ where a = the intercept on the q-axis in stress units and Ψ = the angle of the K_f line with respect to the horizontal in degrees.

NOTE 3: The K_f is NOT the Mohr-Coulomb failure envelope defined by the equation $\tau=c+\sigma \tan(\Phi)$. The equations $\sin(\Phi)=\tan(\Psi)$ and $c=a/\cos(\Phi)$ may be used to approximate values for Φ and c at the effective stress condition described in NOTE 1.

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ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/15/2016
BORING NO.	NWE-14	CELL NUMBER	20S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. A	CONF. PRES. (psf)	11520
LOCATION	--		
SAMPLE TYPE	Shebly Tube		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture (g)	661.43	699.23	
Wt. Wet Soil & Pan (g)	676.92	714.72	
Wt. Dry Soil & Pan (g)	595.14	595.14	
Wt. Lost Moisture (g)	81.78	119.58	
Wt. of Pan Only (g)	15.49	15.49	
Wt. of Dry Soil (g)	579.65	579.65	
Moisture Content %	14.1	20.6	
Wet Density (pcf)	111.6	130.6	
Dry Density (pcf)	97.8	108.3	
Init. Diameter (in)	2.408		
Init. Area (sq in)	4.554		
Init. Height (in)	4.959		
Vol. Bef. Consol. (cu ft)	0.01307		
Vol. After Consol. (cu ft)	0.01180		

Notes & Comments:

Data entry by: NN Date: 03/16/2016 Technician CAL
Data checked by: cwe Date: 3/16/16
FileName: 2952_1_TX_CUpp_ASTMD_4767_R0_3.xls

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/15/2016
BORING NO.	NWE-14	CELL NUMBER	20S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. A	CONF. PRES. (psf)	11520
LOCATION	--		
SAMPLE TYPE	Shebly Tube		

SATURATION DATA

Cell Pressure (psi)	Back Pressure (psi)	Burette Reading (cc)		Pore Pressure (psi)		Change	B
		Close	Open	Close	Open		
40.0	38.0	3.3	13.5				
50.0	48.0	14.2	15.3	37.7	44.6	6.9	0.69
60.0	58.0	15.2	16.1	48.2	55.8	7.6	0.76
70.0	68.0	16.3	17.0	58.1	66.0	7.9	0.79
80.0	78.0	16.9	17.5	68.1	77.0	8.9	0.89
90.0	88.0	17.6	18.2	78.1	87.1	9.0	0.90
100.0		18.3	18.4	87.6	97.3	9.7	0.97

CONSOLIDATION DATA

Elapsed Time (min)	SQRT TIME (min)	Burette Reading (cc)	Volume Deflection (cc)
0.00	0.0	0.30	0.00
0.25	0.5	28.40	-28.10
0.5	0.7	31.70	-31.40
1	1.0	34.00	-33.70
2	1.4	35.45	-35.15
4	2.0	36.50	-36.20
9	3.0	37.40	-37.10
16	4.0	37.90	-37.60
30	5.5	38.50	-38.20
60	7.7	39.05	-38.75
120	11.0	39.70	-39.40
240	15.5	40.20	-39.90
360	19.0	40.50	-40.20
1440	37.9	41.70	-41.40

Initial Height (in)	4.959	Initial Vol. (cc)	370.148
Height Change (in)	0.155	Vol. Change (cc)	56.500
Ht. After Cons. (in)	4.804	Cell Exp. (cc)	20.518
Initial Area (sq in)	4.554	Net Change (cc)	35.982
Area After Cons. (sq in)	4.244	Cons. Vol. (cc)	334.166

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D 4767

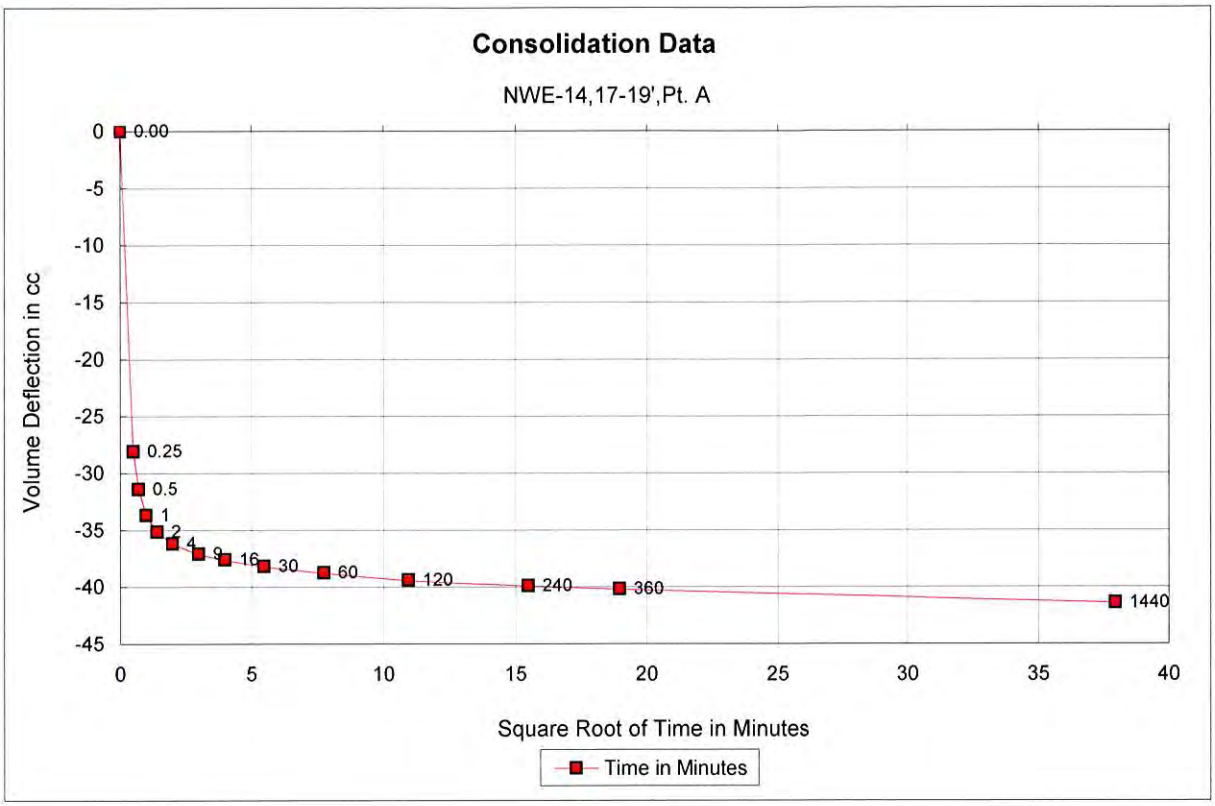
CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/15/2016
BORING NO.	NWE-14	CELL NUMBER	20S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. A	CONF. PRES. (psf)	11520
LOCATION	--		
SAMPLE TYPE	Shebly Tube		

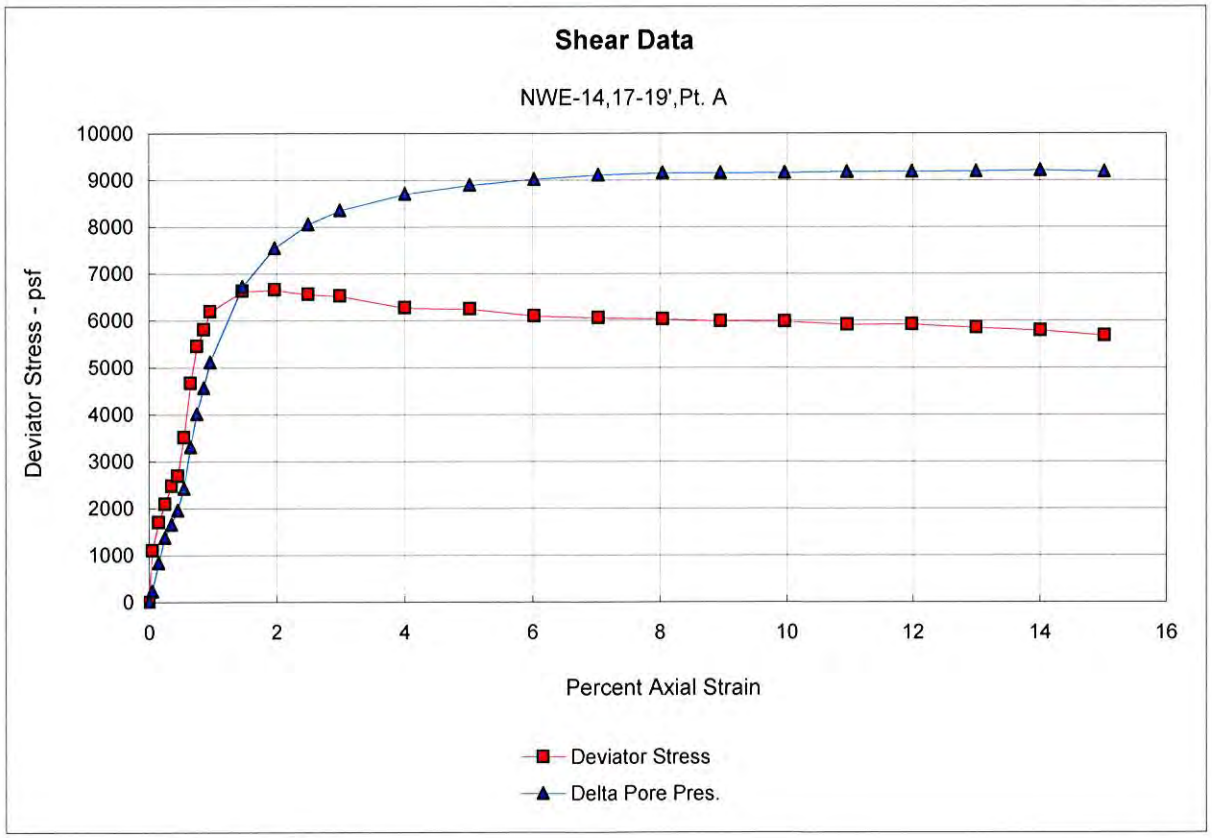
Init. Ht. (in)	4.959	Init. Area (sq in)	4.554
Consol. Ht. (in)	4.804	Consol. Area (sq in)	4.244
Back Pres. (psi)	87.4	Strain Rate (in/min)	0.0060

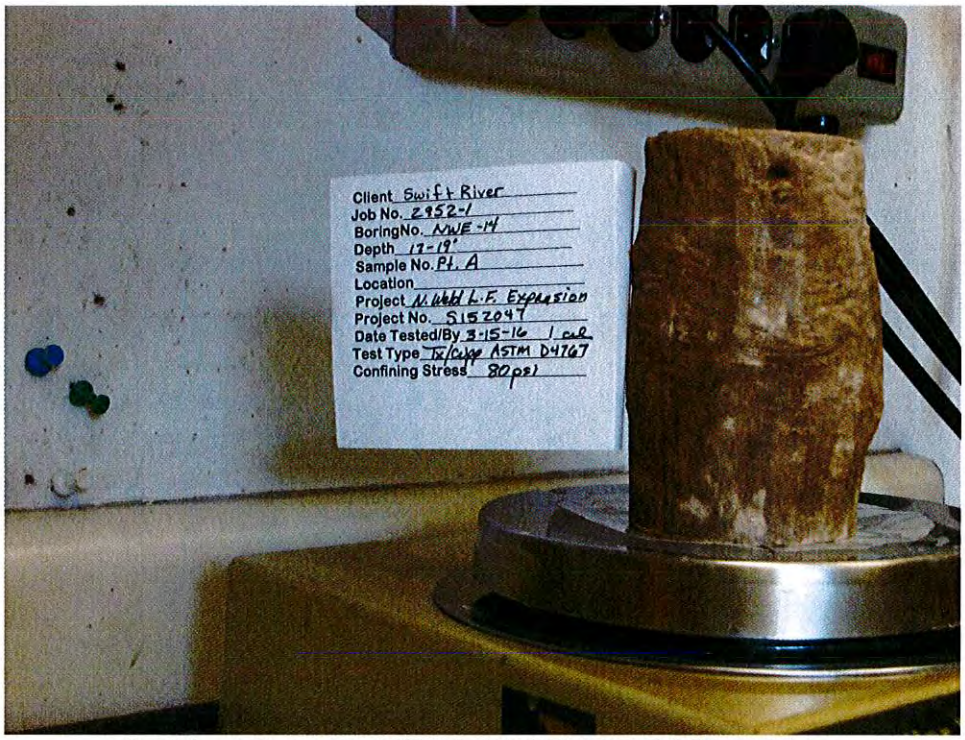
Axial Load (lbs.)	Axial Load (psf)	Delta Ht. (in)	Axial Strain (%)	Area Final (sq in)	Dev. Stress (psf)	Pore Pres. (psi)	Delta Pres. (psf)	Sigma 3' (psf)	Sigma 1' (psf)	Prin. Stress Ratio
0.0	0	0.000	0.00	4.244	0	87.4	0	11520	11520	1.00
33	1104	0.002	0.05	4.246	1103	89.0	230	11290	12393	1.10
50	1704	0.007	0.15	4.250	1701	93.2	838	10682	12383	1.16
62	2099	0.012	0.25	4.255	2094	96.9	1378	10142	12236	1.21
73	2489	0.017	0.35	4.259	2480	98.8	1653	9867	12347	1.25
80	2705	0.022	0.45	4.263	2693	100.9	1957	9563	12256	1.28
104	3527	0.027	0.55	4.268	3508	104.2	2425	9095	12603	1.39
138	4696	0.031	0.65	4.272	4665	110.3	3306	8214	12879	1.57
162	5497	0.036	0.75	4.276	5455	115.2	4013	7507	12962	1.73
173	5864	0.041	0.86	4.281	5814	119.1	4565	6955	12769	1.84
184	6254	0.046	0.96	4.285	6194	122.9	5116	6404	12597	1.97
198	6730	0.070	1.47	4.307	6632	134.0	6723	4797	11428	2.38
200	6795	0.095	1.97	4.329	6661	139.8	7550	3970	10631	2.68
198	6730	0.120	2.49	4.353	6563	143.3	8055	3465	10027	2.89
198	6730	0.144	3.00	4.375	6529	145.4	8358	3162	9691	3.06
193	6536	0.192	4.00	4.421	6274	147.8	8706	2814	9088	3.23
194	6579	0.241	5.01	4.468	6249	149.2	8899	2621	8870	3.38
191	6492	0.289	6.02	4.516	6101	150.0	9019	2501	8602	3.44
192	6514	0.338	7.03	4.565	6056	150.6	9111	2409	8465	3.51
193	6557	0.386	8.04	4.615	6030	150.9	9157	2363	8393	3.55
194	6579	0.430	8.95	4.661	5990	150.9	9157	2363	8353	3.53
196	6644	0.479	9.96	4.714	5982	151.0	9166	2354	8336	3.54
196	6644	0.527	10.97	4.767	5915	151.1	9176	2344	8259	3.52
198	6730	0.576	11.99	4.822	5924	151.1	9184	2336	8259	3.54
198	6730	0.625	13.00	4.878	5855	151.2	9193	2327	8182	3.52
198	6730	0.673	14.01	4.935	5787	151.3	9212	2308	8096	3.51
197	6687	0.722	15.02	4.994	5683	151.1	9184	2336	8018	3.43

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
FOR COHESIVE SOILS
ASTM D4767







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ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/14/2016
BORING NO.	NWE-14	CELL NUMBER	19S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. B	CONF. PRES. (psf)	5760
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture (g)	558.39	605.83	
Wt. Wet Soil & Pan (g)	572.63	620.07	
Wt. Dry Soil & Pan (g)	476.32	476.32	
Wt. Lost Moisture (g)	96.31	143.75	
Wt. of Pan Only (g)	14.24	14.24	
Wt. of Dry Soil (g)	462.08	462.08	
Moisture Content %	20.8	31.1	
Wet Density (pcf)	93.3	120.3	
Dry Density (pcf)	77.2	91.8	
Init. Diameter (in)	2.396		
Init. Area (sq in)	4.509		
Init. Height (in)	5.057		
Vol. Bef. Consol. (cu ft)	0.01320		
Vol. After Consol. (cu ft)	0.01110		

Notes & Comments:

Data entry by: NN Date: 03/15/2016 Technician CAL

Data checked by: CAL Date: 3/15/16

FileName: 2952_1_TX_CUpp_ASTMD_4767_R0_0.xls

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/14/2016
BORING NO.	NWE-14	CELL NUMBER	19S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. B	CONF. PRES. (psf)	5760
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

SATURATION DATA

Cell Pressure (psi)	Back Pressure (psi)	Burette Reading (cc)		Pore Pressure (psi)		Change	B
		Close	Open	Close	Open		
40.0	38.0	4.0	20.0				
50.0	48.0	20.5	21.8	38.7	44.2	5.5	0.55
60.0	58.0	22.0	23.1	47.5	54.8	7.3	0.73
70.0	68.0	23.2	24.0	57.9	66.0	8.1	0.81
80.0	78.0	24.0	24.7	67.7	76.4	8.7	0.87
90.0	88.0	24.9	25.5	78.1	87.5	9.4	0.94
100.0		25.8	25.8	88.2	97.9	9.7	0.97

CONSOLIDATION DATA

Elapsed Time (min)	SQRT TIME (min)	Burette Reading (cc)	Volume Deflection (cc)
0.00	0.0	0.40	0.00
0.25	0.5	33.90	-33.50
0.5	0.7	38.60	-38.20
1	1.0	41.80	-41.40
2	1.4	44.80	-44.40
4	2.0	46.70	-46.30
9	3.0	47.60	-47.20
16	4.0	49.35	-48.95
30	5.5	50.40	-50.00
60	7.7	51.25	-50.85
120	11.0	51.90	-51.50
240	15.5	52.50	-52.10
360	19.0	52.80	-52.40
1453	38.1	53.90	-53.50

Initial Height (in)	5.057	Initial Vol. (cc)	373.711
Height Change (in)	0.247	Vol. Change (cc)	76.400
Ht. After Cons. (in)	4.810	Cell Exp. (cc)	17.071
Initial Area (sq in)	4.509	Net Change (cc)	59.329
Area After Cons. (sq in)	3.988	Cons. Vol. (cc)	314.382

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D 4767

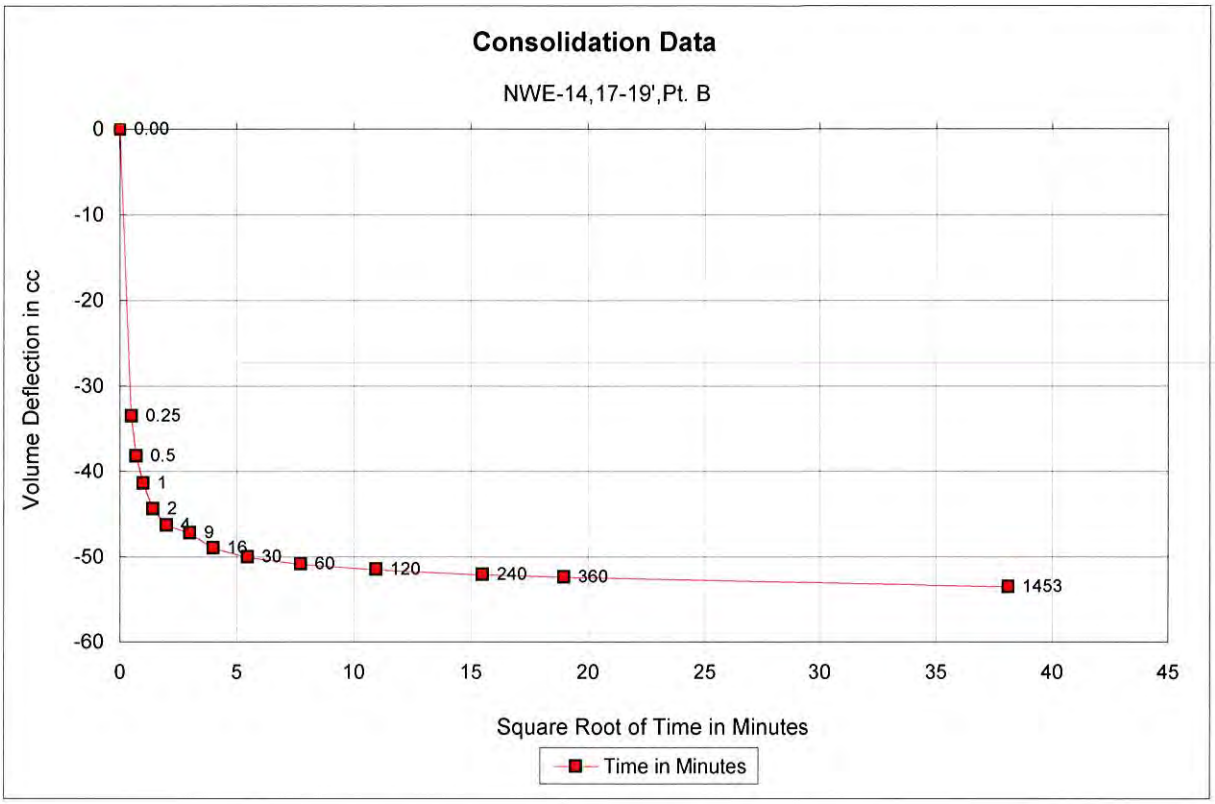
CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/14/2016
BORING NO.	NWE-14	CELL NUMBER	19S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. B	CONF. PRES. (psf)	5760
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

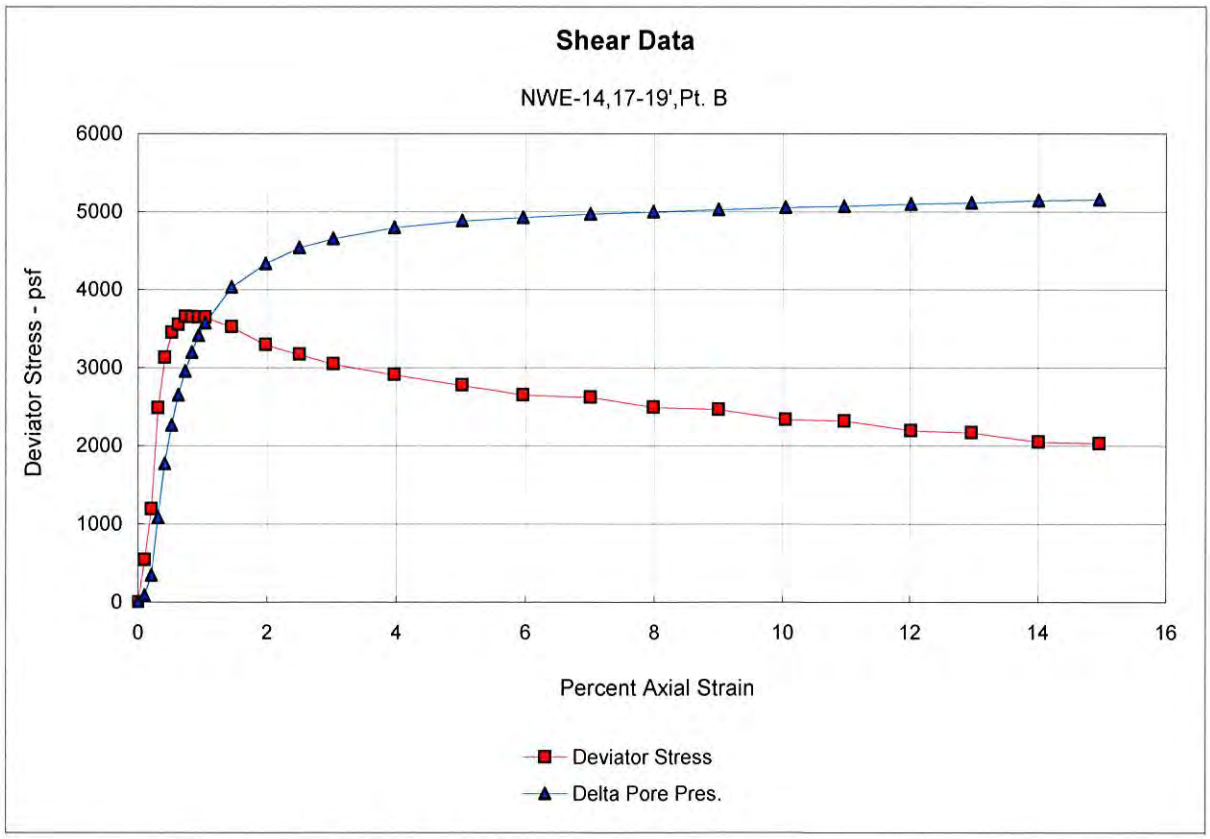
Init. Ht. (in)	5.057	Init. Area (sq in)	4.509
Consol. Ht. (in)	4.810	Consol. Area (sq in)	3.988
Back Pres. (psi)	87.5	Strain Rate (in/min)	0.0059

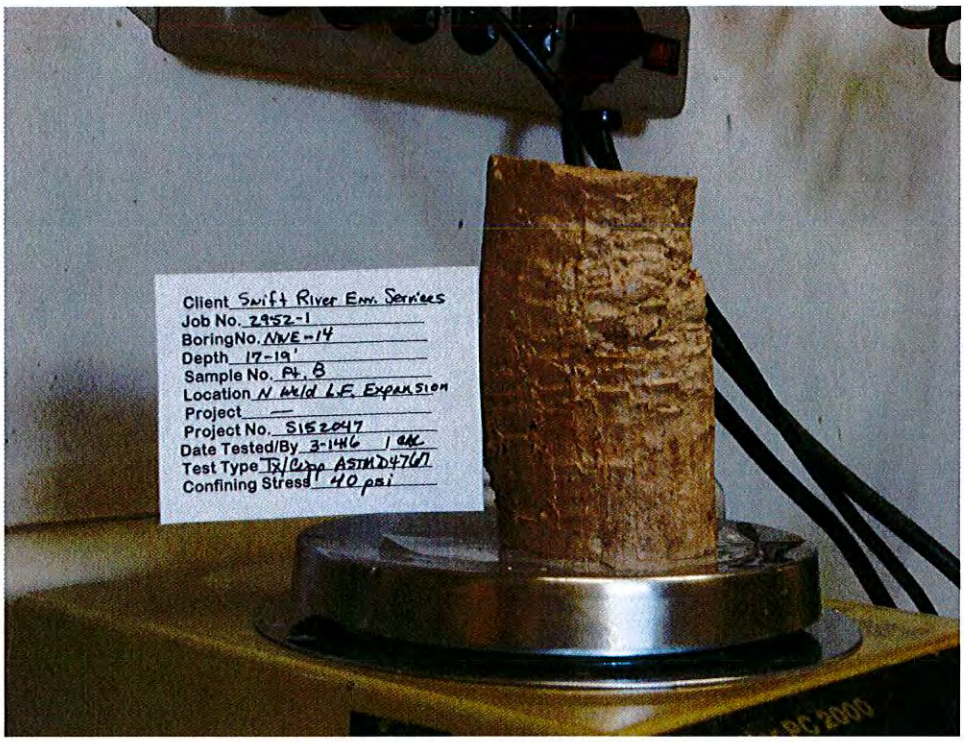
Axial Load (lbs.)	Axial Load (psf)	Delta Ht. (in)	Axial Strain (%)	Area Final (sq in)	Dev. Stress (psf)	Pore Pres. (psi)	Delta Pres. (psf)	Sigma 3' (psf)	Sigma 1' (psf)	Prin. Stress Ratio
0.0	0	0.000	0.00	3.988	0	87.5	0	5760	5760	1.00
15	542	0.005	0.10	3.992	541	88.6	158	5602	6143	1.10
33	1192	0.010	0.21	3.996	1189	90.4	418	5342	6532	1.22
69	2492	0.015	0.31	4.000	2484	95.5	1152	4608	7092	1.54
87	3142	0.020	0.42	4.005	3128	100.3	1843	3917	7045	1.80
96	3467	0.025	0.52	4.009	3448	103.7	2333	3427	6876	2.01
99	3575	0.030	0.63	4.013	3552	106.4	2722	3038	6591	2.17
102	3683	0.035	0.73	4.017	3656	108.5	3024	2736	6392	2.34
102	3683	0.040	0.84	4.021	3652	110.2	3269	2491	6144	2.47
102	3683	0.045	0.94	4.026	3649	111.7	3485	2275	5924	2.60
102	3683	0.050	1.04	4.030	3645	112.8	3643	2117	5762	2.72
99	3575	0.070	1.46	4.047	3523	116.0	4104	1656	5179	3.13
93	3358	0.095	1.98	4.068	3292	118.1	4406	1354	4645	3.43
90	3250	0.121	2.51	4.090	3168	119.5	4608	1152	4320	3.75
87	3142	0.146	3.03	4.112	3046	120.3	4723	1037	4083	3.94
84	3033	0.191	3.97	4.153	2913	121.3	4867	893	3806	4.26
81	2925	0.241	5.02	4.199	2778	121.9	4954	806	3585	4.45
78	2817	0.287	5.96	4.240	2649	122.2	4997	763	3412	4.47
78	2817	0.337	7.01	4.288	2619	122.5	5040	720	3339	4.64
75	2708	0.384	7.99	4.334	2492	122.7	5069	691	3183	4.61
75	2708	0.433	9.00	4.382	2465	122.9	5098	662	3127	4.72
72	2600	0.483	10.05	4.433	2339	123.1	5126	634	2972	4.69
72	2600	0.528	10.98	4.480	2314	123.2	5141	619	2934	4.74
69	2492	0.578	12.02	4.532	2192	123.4	5170	590	2783	4.71
69	2492	0.624	12.96	4.582	2169	123.5	5184	576	2745	4.76
66	2383	0.674	14.01	4.638	2049	123.7	5213	547	2597	4.75
66	2383	0.719	14.95	4.689	2027	123.8	5227	533	2560	4.80

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
FOR COHESIVE SOILS
ASTM D4767







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ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/14/2016
BORING NO.	NWE-14	CELL NUMBER	21S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. C	CONF. PRES. (psf)	2880
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

MOISTURE/DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture (g)	539.65	618.36	
Wt. Wet Soil & Pan (g)	555.20	633.91	
Wt. Dry Soil & Pan (g)	450.22	450.22	
Wt. Lost Moisture (g)	104.98	183.69	
Wt. of Pan Only (g)	15.55	15.55	
Wt. of Dry Soil (g)	434.67	434.67	
Moisture Content %	24.2	42.3	
Wet Density (pcf)	92.0	113.2	
Dry Density (pcf)	74.1	79.6	
Init. Diameter (in)	2.408		
Init. Area (sq in)	4.554		
Init. Height (in)	4.905		
Vol. Bef. Consol. (cu ft)	0.01293		
Vol. After Consol. (cu ft)	0.01204		

Notes & Comments:

Data entry by: NN Date: 03/15/2016 Technician CAL
Data checked by: Cal Date: 3/15/16
FileName: 2952_1_TX_CUpp_ASTMD_4767_R0_1.xls

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D4767

CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/14/2016
BORING NO.	NWE-14	CELL NUMBER	21S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. C	CONF. PRES. (psf)	2880
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

SATURATION DATA

Cell Pressure (psi)	Back Pressure (psi)	Burette Reading (cc)		Pore Pressure (psi)		Change	B
		Close	Open	Close	Open		
40.0	38.0	3.5	17.5				
50.0	48.0	20.2	21.4	38.9	43.6	4.7	0.47
60.0	58.0	24.2	25.2	47.7	54.4	6.7	0.67
70.0	68.0	25.6	26.5	57.7	65.4	7.7	0.77
80.0	78.0	26.9	27.9	67.7	76.2	8.5	0.85
90.0	88.0	28.1	28.8	78.1	87.2	9.1	0.91
100.0		29.1	29.1	88.1	97.7	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (min)	SQRT TIME (min)	Burette Reading (cc)	Volume Deflection (cc)
0.00	0.0	0.30	0.00
0.25	0.5	7.70	-7.40
0.5	0.7	8.30	-8.00
1	1.0	9.15	-8.85
2	1.4	9.80	-9.50
4	2.0	10.30	-10.00
9	3.0	11.00	-10.70
16	4.0	11.35	-11.05
30	5.5	11.80	-11.50
60	7.7	12.20	-11.90
120	11.0	12.70	-12.40
240	15.5	13.20	-12.90
360	19.0	13.35	-13.05
1456	38.2	14.50	-14.20

Initial Height (in)	4.905	Initial Vol. (cc)	366.118
Height Change (in)	0.064	Vol. Change (cc)	40.800
Ht. After Cons. (in)	4.841	Cell Exp. (cc)	15.773
Initial Area (sq in)	4.554	Net Change (cc)	25.027
Area After Cons. (sq in)	4.299	Cons. Vol. (cc)	341.091

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST FOR COHESIVE SOILS
ASTM D 4767

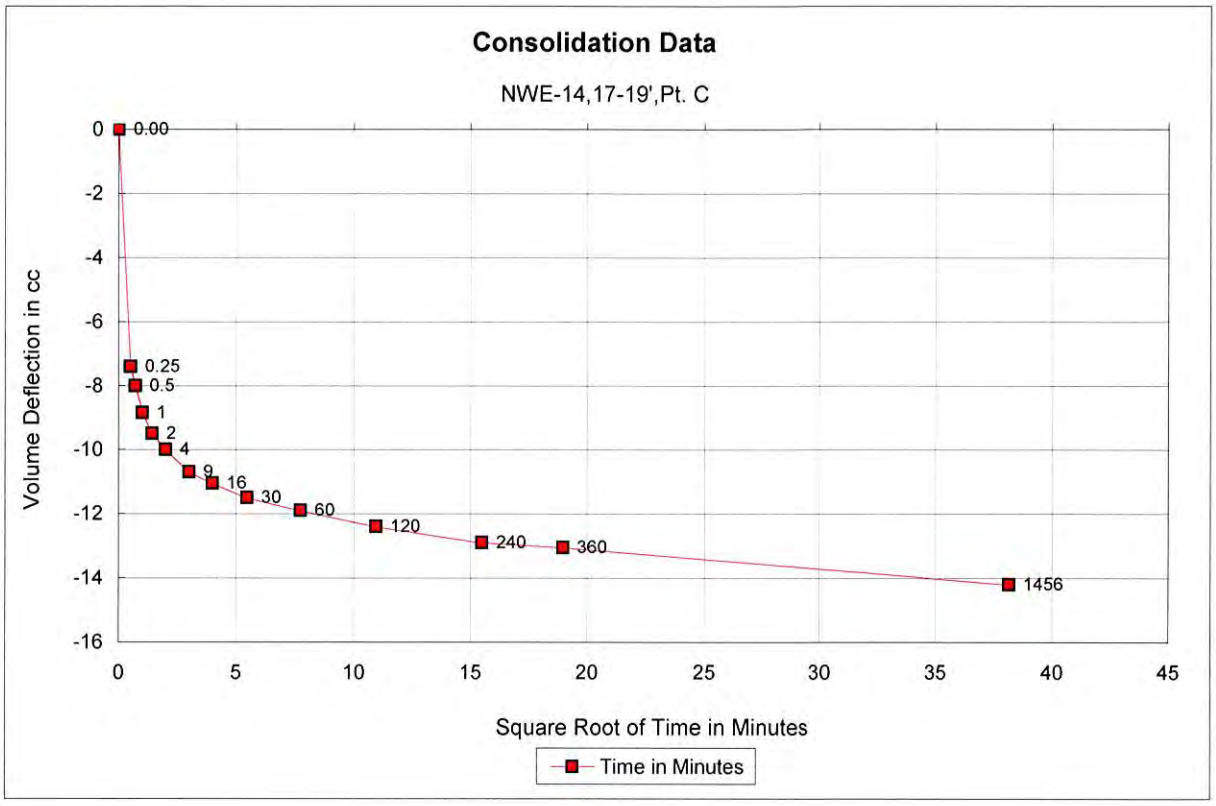
CLIENT	Swift River Environmental Services	JOB NO.	2952-1
PROJECT	North Weld Landfill Expansion	Date Sampled	--
PROJECT NO.	S152047	Date Tested	3/14/2016
BORING NO.	NWE-14	CELL NUMBER	21S
DEPTH	17-19'	SATURATED TEST	Yes
SAMPLE NO.	Pt. C	CONF. PRES. (psf)	2880
LOCATION	--		
SAMPLE TYPE	Shelby Tube		

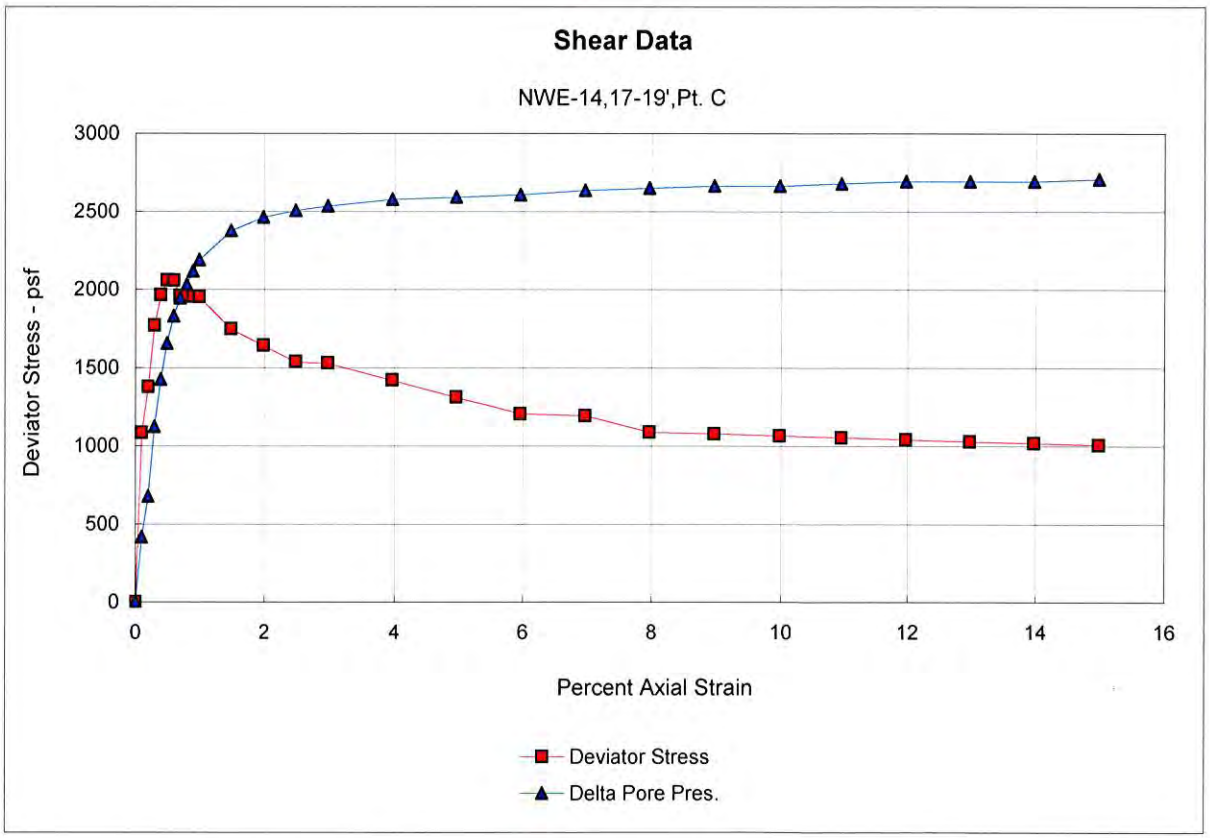
Init. Ht. (in)	4.905	Init. Area (sq in)	4.554
Consol. Ht. (in)	4.841	Consol. Area (sq in)	4.299
Back Pres. (psi)	88.1	Strain Rate (in/min)	0.0063

Axial Load (lbs.)	Axial Load (psf)	Delta Ht. (in)	Axial Strain (%)	Area Final (sq in)	Dev. Stress (psf)	Pore Pres. (psi)	Delta Pres. (psf)	Sigma 3' (psf)	Sigma 1' (psf)	Prin. Stress Ratio
0.0	0	0.000	0.00	4.299	0	88.1	0	2880	2880	1.00
33	1105	0.005	0.10	4.303	1104	90.9	403	2477	3581	1.45
42	1407	0.010	0.20	4.307	1404	92.7	662	2218	3622	1.63
54	1809	0.014	0.30	4.312	1803	95.8	1109	1771	3575	2.02
60	2010	0.019	0.40	4.316	2002	97.9	1411	1469	3471	2.36
63	2110	0.024	0.50	4.320	2100	99.5	1642	1238	3338	2.70
63	2110	0.029	0.59	4.325	2098	100.7	1814	1066	3163	2.97
60	2010	0.034	0.69	4.329	1996	101.5	1930	950	2946	3.10
60	2010	0.039	0.80	4.333	1994	102.1	2016	864	2858	3.31
60	2010	0.043	0.89	4.338	1992	102.7	2102	778	2769	3.56
60	2010	0.048	0.99	4.342	1990	103.2	2174	706	2695	3.82
54	1809	0.072	1.49	4.364	1782	104.5	2362	518	2300	4.44
51	1708	0.096	1.99	4.386	1674	105.1	2448	432	2106	4.88
48	1608	0.120	2.48	4.408	1568	105.4	2491	389	1957	5.03
48	1608	0.144	2.98	4.431	1560	105.6	2520	360	1920	5.33
45	1507	0.192	3.97	4.476	1448	105.9	2563	317	1764	5.57
42	1407	0.240	4.96	4.523	1337	106.0	2578	302	1639	5.42
39	1306	0.289	5.96	4.571	1229	106.1	2592	288	1517	5.27
39	1306	0.337	6.97	4.621	1215	106.3	2621	259	1475	5.69
36	1206	0.386	7.97	4.671	1110	106.4	2635	245	1355	5.53
36	1206	0.434	8.97	4.722	1098	106.5	2650	230	1328	5.76
36	1206	0.483	9.98	4.775	1086	106.5	2650	230	1316	5.71
36	1206	0.531	10.98	4.829	1074	106.6	2664	216	1290	5.97
36	1206	0.580	11.98	4.884	1061	106.7	2678	202	1263	6.27
36	1206	0.628	12.98	4.940	1049	106.7	2678	202	1251	6.21
36	1206	0.677	13.98	4.997	1037	106.7	2678	202	1239	6.15
36	1206	0.725	14.98	5.056	1025	106.8	2693	187	1212	6.48

ADVANCED TERRA TESTING

CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST
FOR COHESIVE SOILS
ASTM D4767







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Permeability Testing

Back Pressure Saturated – Flow Pump

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-12	TEST STARTED	03/30/2016	By: CAL
DEPTH	--	TEST FINISHED	04/07/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	5P	
LOCATION	--	PERMEANT	Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	514.64	601.25
Wt. Wet Soil & Pan - (g)	528.80	615.41
Wt. Dry Soil & Pan - (g)	476.76	476.76
Wt. Lost Moisture - (g)	52.04	138.65
Wt. of Pan Only - (g)	14.16	14.16
Wt. of Dry Soil - (g)	462.60	462.60
Moisture Content - (%)	11.2	30.0
Wet Density - (pcf)	100.3	123.1
Dry Density - (pcf)	90.1	94.7
Init. Diameter - (in)	2.761	
Init. Area - (sq in)	5.987	
Init. Height - (in)	3.266	
Vol. Bef. Consol. - (cu ft)	0.01132	
Vol. After Consol. - (cu ft)	0.01077	
Porosity - (%)	45.46	

FLOW PUMP CALCULATIONS

Pump Setting (gear number)	1
Percentage of Pump Setting	100
Q - (cc/s)	1.09E-01
Height - (in)	2.857
Diameter - (in)	2.880
Pressure - (psi)	0.128
Area after consol. - (sq cm)	42.017
Gradient	1.240
Permeability k - (cm/s)	2.1E-03
Permeability k - (m/s)	2.1E-05
Back Pressure - (psi)	78.0
Cell Pressure - (psi)	83.0
Ave. Effective Stress - (psi)	4.936
Average temperature degree - (c°)	22.2

Data entry by:	CKP	Date:	04/08/2016
Checked by:	CAL	Date:	04/11/2016

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-12	TEST STARTED	03/30/2016	By: CAL
DEPTH	--	TEST FINISHED	04/07/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	5P	
LOCATION	--	PERMEANT	Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	6.6	26.0				
50.0	48.0	27.1	28.3	38.7	46.1	7.4	0.74
60.0	58.0	28.4	29.3	48.7	56.9	8.2	0.82
70.0	68.0	29.5	30.3	58.7	67.8	9.1	0.91
80.0	78.0	30.4	31.1	68.7	78.1	9.4	0.94
90.0		31.3	31.4	78.7	88.3	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	0.00	0.00
0.25	0.50	1.30	-1.30
0.5	0.71	1.35	-1.35
1	1.00	1.40	-1.40
2	1.41	1.50	-1.50
4	2.00	1.50	-1.50
9	3.00	1.60	-1.60
16	4.00	1.60	-1.60
30	5.48	1.70	-1.70
60	7.75	1.70	-1.70
120	10.95	1.85	-1.85
240	15.49	1.90	-1.90
360	18.97	1.90	-1.90

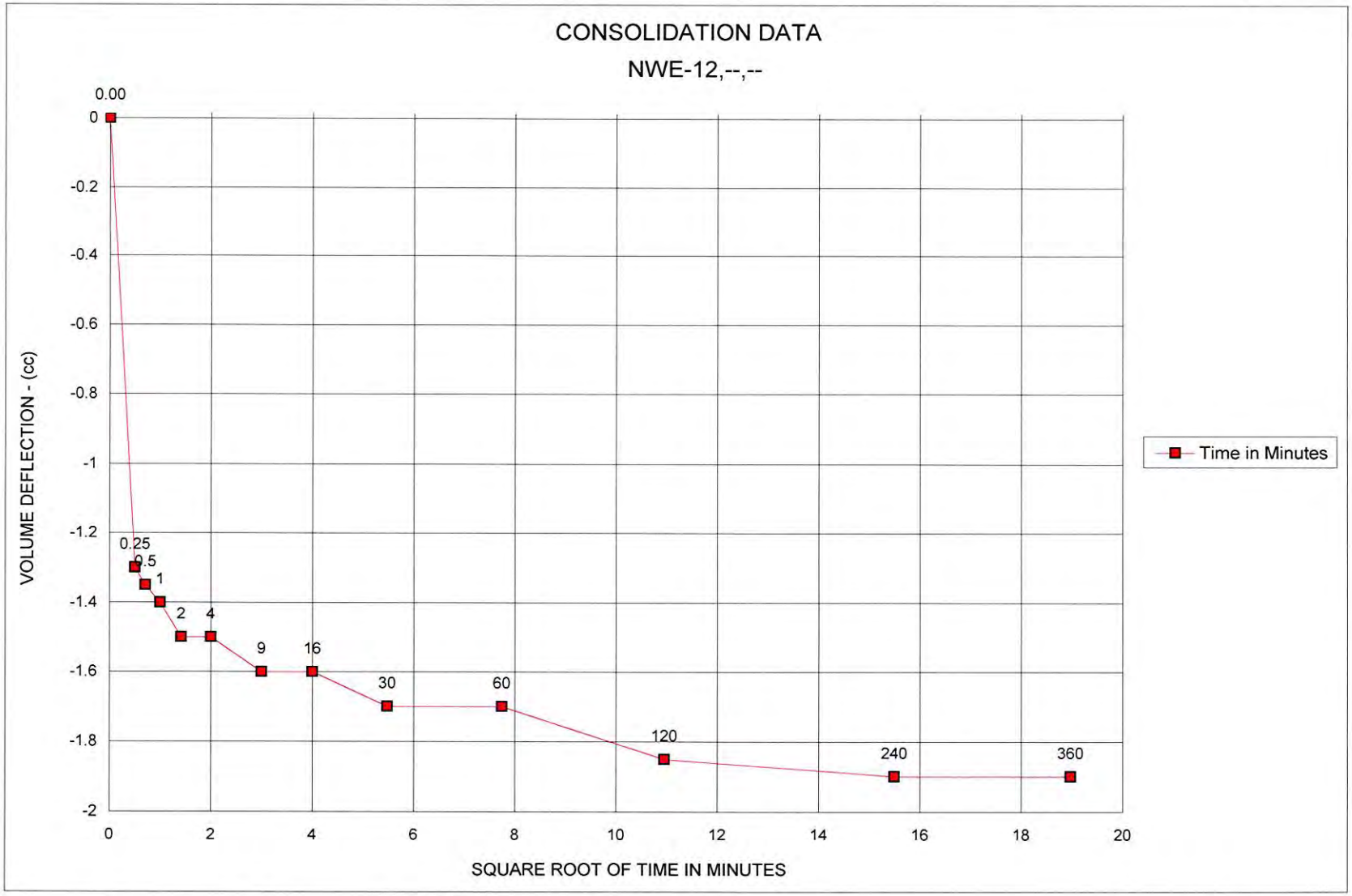
Initial Height - (in)	3.266	Init. Vol. - (cc)	320.49
Height Change - (in)	0.409	Vol. Change - (cc)	28.10
Ht. After Cons. - (in)	2.857	Cell Exp. - (cc)	12.57
Initial Area - (sq in)	5.987	Net Change - (cc)	15.53
Area After Cons. - sq in	6.513	Cons. Vol. - (cc)	304.96

ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO.	2952-2

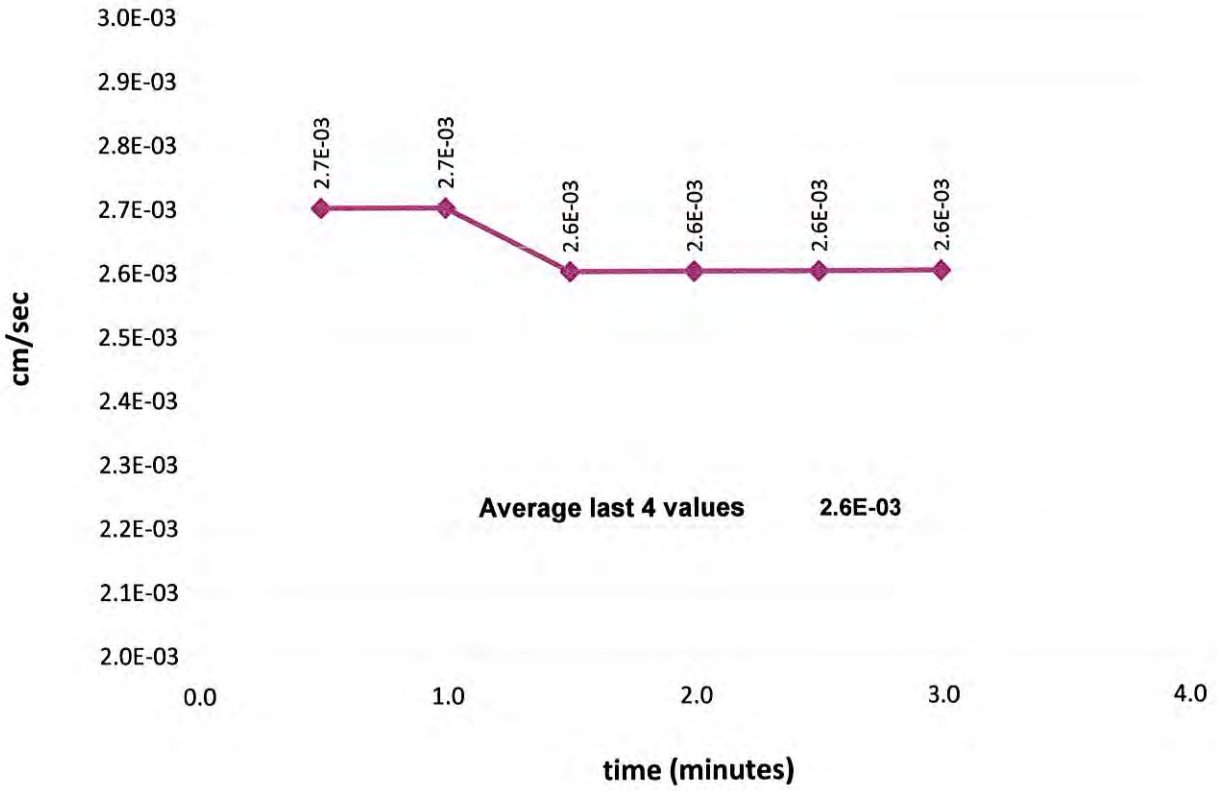


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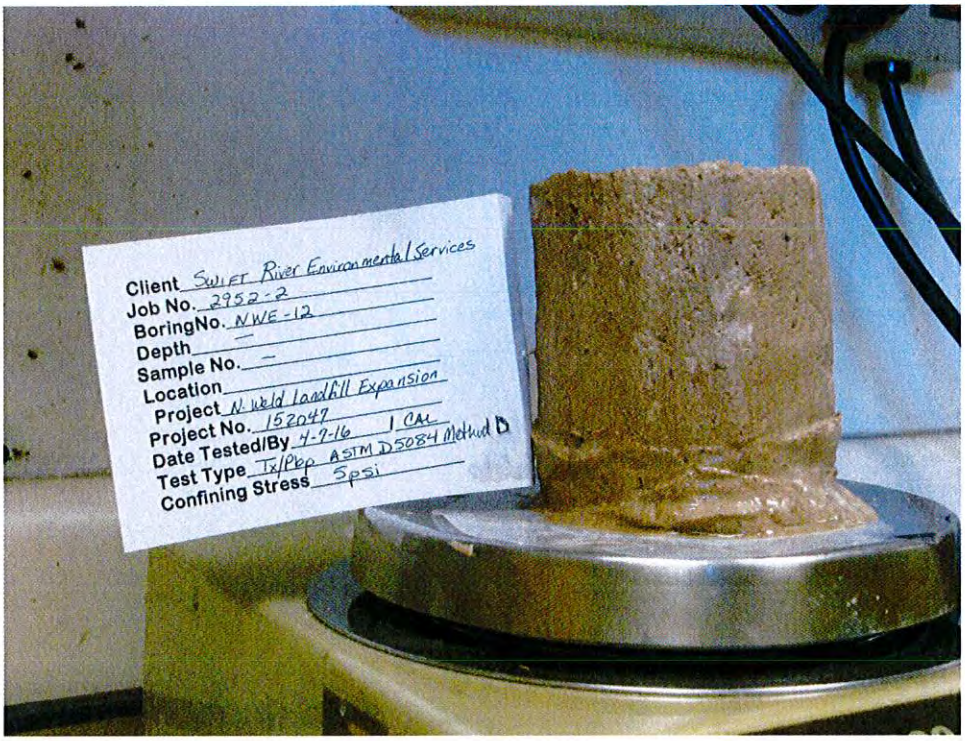
ADVANCED TERRA TESTING

Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	NWE-12		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/7/2016	Technician:	CAL



Data Entered By:	CAL		
Date:	4/7/2016	Checked By:	CKP
File Name:	2952_2_PrelimPerm_ASTMD-5084-methodD-R1_0.xls	Date:	4/8/16



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PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-7	TEST STARTED	3/30/2016	By: CAL
DEPTH	--	TEST FINISHED	4/12/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	12P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	575.98	674.95
Wt. Wet Soil & Pan - (g)	590.22	689.19
Wt. Dry Soil & Pan - (g)	534.17	534.17
Wt. Lost Moisture - (g)	56.05	155.02
Wt. of Pan Only - (g)	14.24	14.24
Wt. of Dry Soil - (g)	519.93	519.93
Moisture Content - (%)	10.8	29.8
Wet Density - (pcf)	101.1	124.1
Dry Density - (pcf)	91.3	95.6
Init. Diameter - (in)	2.822	
Init. Area - (sq in)	6.255	
Init. Height - (in)	3.470	
Vol. Bef. Consol. - (cu ft)	0.01256	
Vol. After Consol. - (cu ft)	0.01199	
Porosity - (%)	45.67	

FLOW PUMP CALCULATIONS	
Pump Setting (gear number)	1
Percentage of Pump Setting	100
Q - (cc/s)	1.09E-01
Height - (in)	3.455
Diameter - (in)	2.763
Pressure - (psi)	0.068
Area after consol. - (sq cm)	38.675
Gradient	0.545
Permeability k - (cm/s)	5.2E-03
Permeability k - (m/s)	5.2E-05
Back Pressure - (psi)	98.0
Cell Pressure - (psi)	103.0
Ave. Effective Stress - (psi)	4.966
Average temperature degree - (c°)	21.5

Data entry by: NN	Date: 04/13/2016
Checked by: CAL	Date: 04/13/2016

ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO. 2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-7	TEST STARTED	3/30/2016	By: CAL
DEPTH	--	TEST FINISHED	4/12/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	12P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	5.4	26.5				
50.0	48.0	28.4	29.6	38.7	43.7	5.0	0.50
60.0	58.0	29.5	30.6	48.6	55.2	6.6	0.66
70.0	68.0	30.7	31.7	58.6	66.4	7.8	0.78
80.0	78.0	31.5	32.4	68.7	77.0	8.3	0.83
90.0	88.0	32.6	33.4	78.7	87.7	9.0	0.90
100.0	98.0	33.4	34.1	88.8	97.9	9.1	0.91
110.0		34.4	34.6	98.7	108.3	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	0.50	0.00
0.25	0.50	1.60	-1.10
0.5	0.71	1.65	-1.15
1	1.00	1.65	-1.15
2	1.41	1.70	-1.20
4	2.00	1.75	-1.25
9	3.00	1.80	-1.30
16	4.00	1.80	-1.30
30	5.48	1.80	-1.30
60	7.75	1.85	-1.35
120	10.95	1.90	-1.40
240	15.49	1.95	-1.45
360	18.97	1.95	-1.45

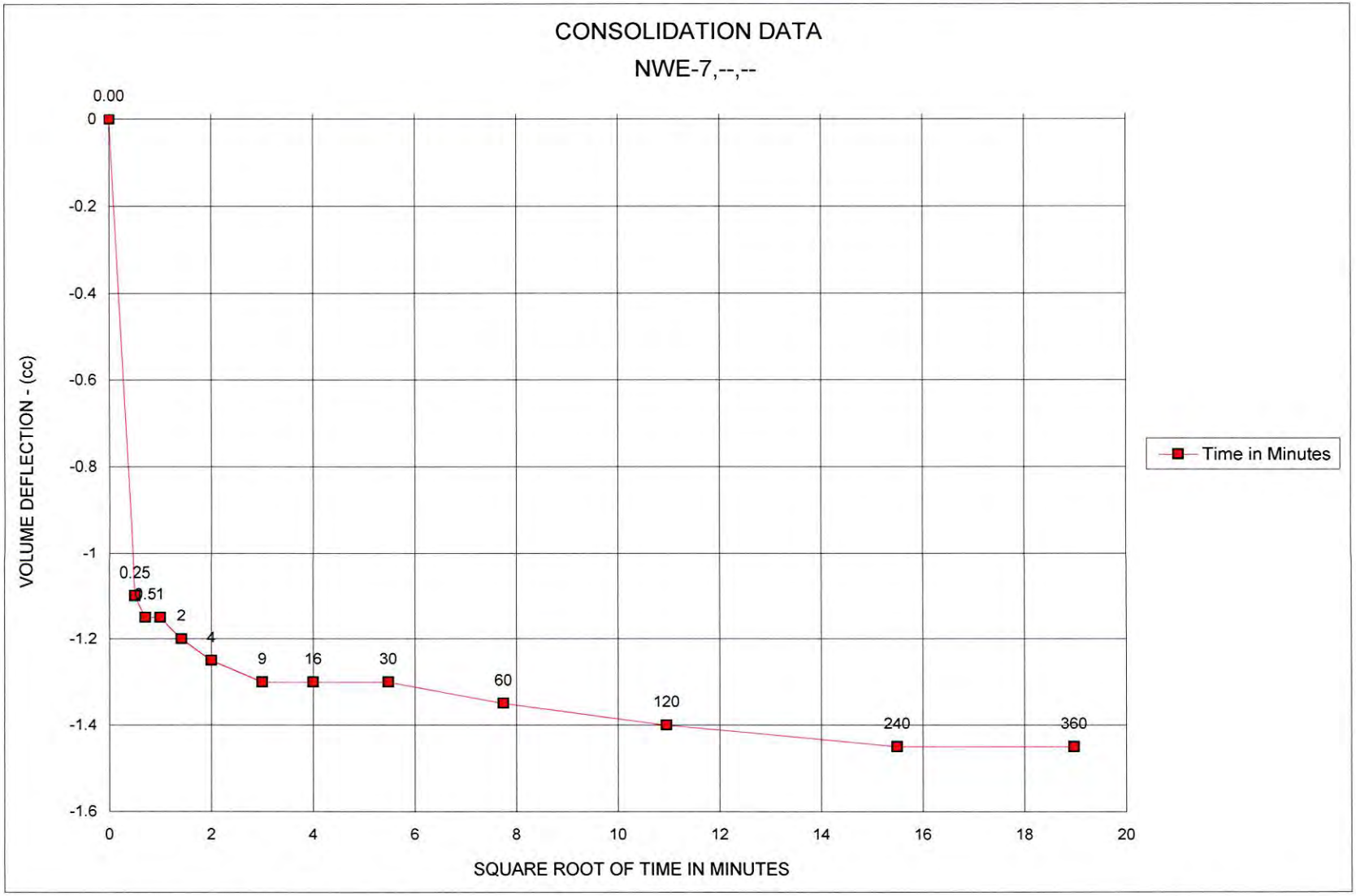
Initial Height - (in)	3.470	Init. Vol. - (cc)	355.72
Height Change - (in)	0.015	Vol. Change - (cc)	31.25
Ht. After Cons. - (in)	3.455	Cell Exp. - (cc)	14.99
Initial Area - (sq in)	6.255	Net Change - (cc)	16.26
Area After Cons. - sq in	5.995	Cons. Vol. - (cc)	339.46

ATT
ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

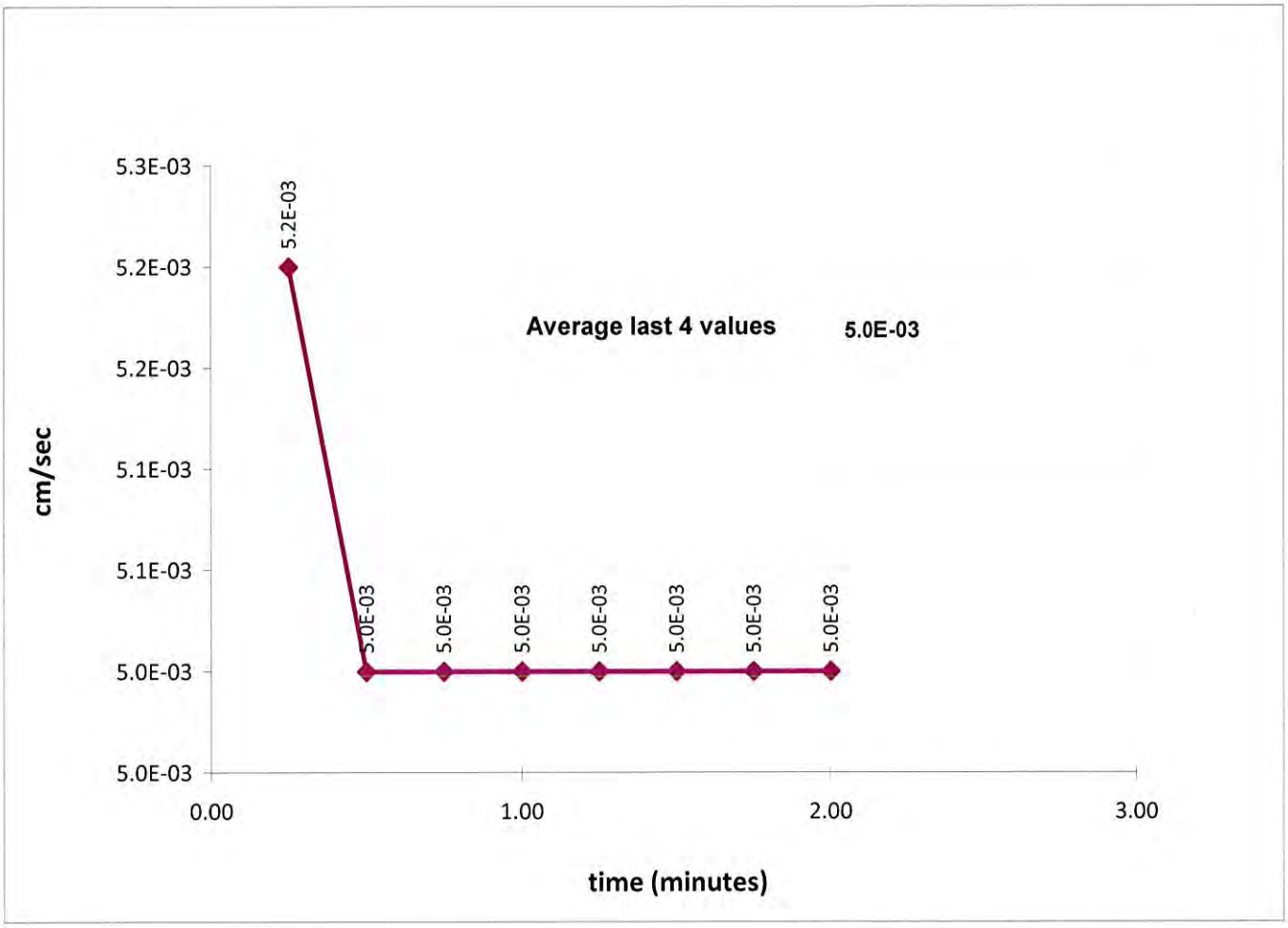
CLIENT	Swift River Environmental Services		JOB NO.	2952-2



ADVANCED TERRA TESTING

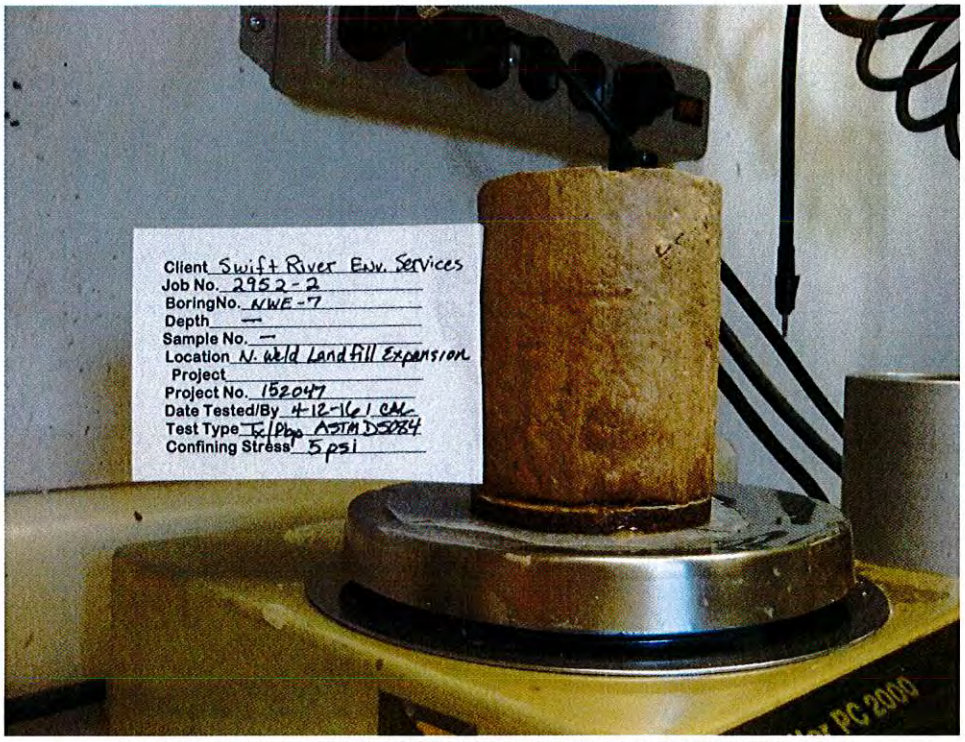
Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	NWE-7		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/12/2016	Technician:	CAL



Data Entered By: CAL
Date: 4/12/2016
File Name: 2952_2_PrelimPerm_ASTMD-5084-methodD-R1_1.xls

Checked By: DM
Date: 4/13/16



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PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	Test Pit #2	TEST STARTED	4/6/2016	By: CAL
DEPTH	5-9' bgs	TEST FINISHED	4/14/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	10P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Remolded -#4	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	487.63	500.97
Wt. Wet Soil & Pan - (g)	501.88	515.22
Wt. Dry Soil & Pan - (g)	440.45	440.45
Wt. Lost Moisture - (g)	61.43	74.77
Wt. of Pan Only - (g)	14.25	14.25
Wt. of Dry Soil - (g)	426.20	426.20
Moisture Content - (%)	14.4	17.5
Wet Density - (pcf)	135.3	136.7
Dry Density - (pcf)	118.2	116.3
Init. Diameter - (in)	2.410	
Init. Area - (sq in)	4.562	
Init. Height - (in)	3.010	
Vol. Bef. Consol. - (cu ft)	0.00795	
Vol. After Consol. - (cu ft)	0.00808	
Porosity - (%)	32.67	

FLOW PUMP CALCULATIONS	
Pump Setting (gear number)	12
Percentage of Pump Setting	100
Q - (cc/s)	2.30E-05
Height - (in)	3.005
Diameter - (in)	2.432
Pressure - (psi)	1.218
Area after consol. - (sq cm)	29.979
Gradient	11.220
Permeability k - (cm/s)	6.8E-08
Permeability k - (m/s)	6.8E-10
Back Pressure - (psi)	78.0
Cell Pressure - (psi)	83.0
Ave. Effective Stress - (psi)	4.391
Average temperature degree - (c°)	22.7

Data entry by:	NN	Date:	04/15/2016
Checked by:	CAL	Date:	04/15/2016

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO. 2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	Test Pit #2	TEST STARTED	4/6/2016	By: CAL
DEPTH	5-9' bgs	TEST FINISHED	4/14/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	10P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Remolded -#4	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	2.6	14.0				
50.0	48.0	12.9	14.1	38.4	45.8	7.4	0.74
60.0	58.0	13.1	14.2	48.5	56.9	8.4	0.84
70.0	68.0	14.2	15.1	58.3	67.1	8.8	0.88
80.0	78.0	15.1	16.0	68.3	77.7	9.4	0.94
90.0		16.1	16.2	78.2	87.8	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	0.30	0.00
0.25	0.50	0.70	-0.40
0.5	0.71	0.70	-0.40
1	1.00	0.70	-0.40
2	1.41	0.70	-0.40
4	2.00	0.75	-0.45
9	3.00	0.75	-0.45
16	4.00	0.80	-0.50
30	5.48	0.80	-0.50
60	7.75	0.85	-0.55
120	10.95	0.90	-0.60
240	15.49	0.90	-0.60
348	18.65	1.00	-0.70

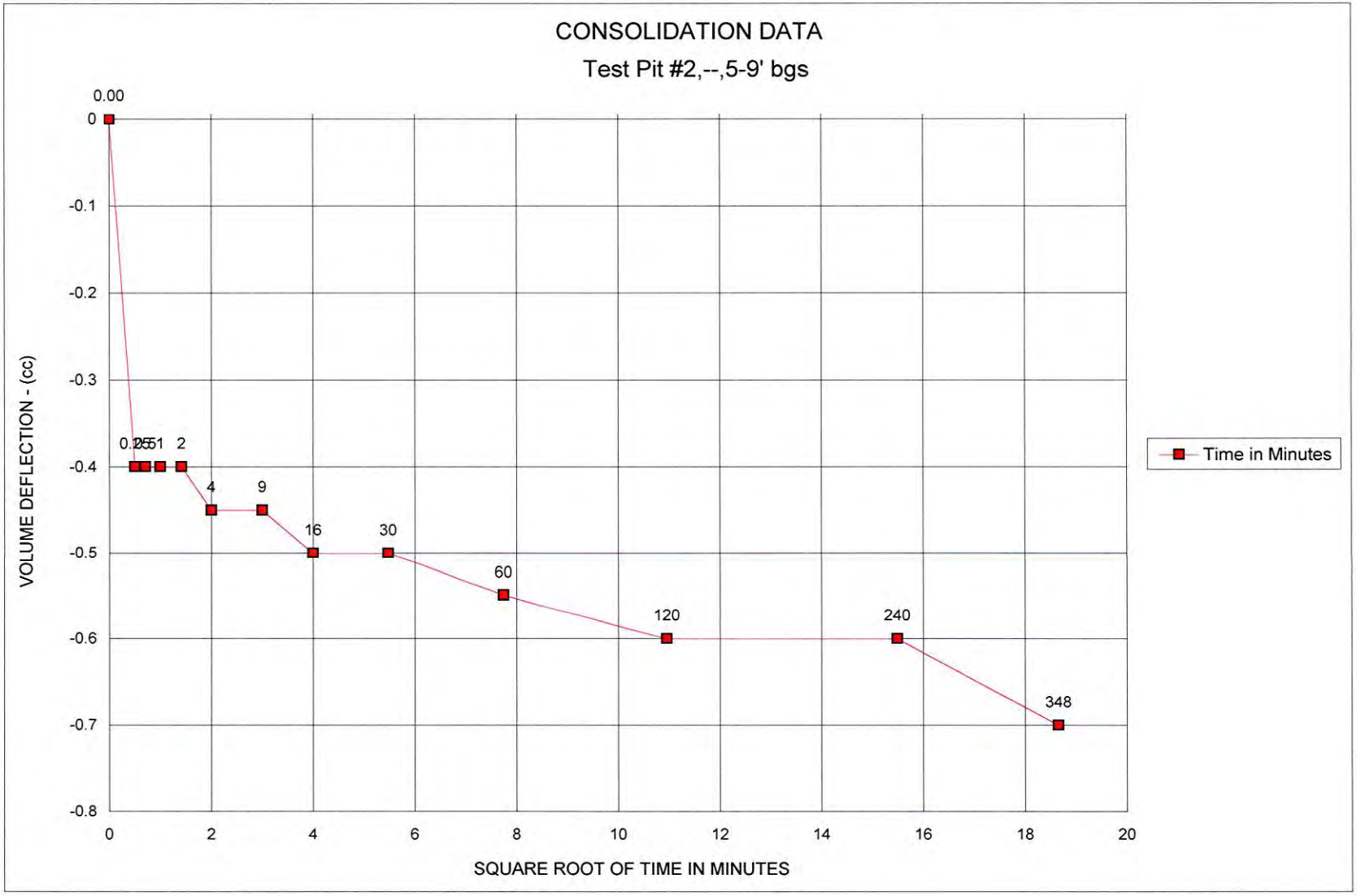
Initial Height - (in)	3.010	Init. Vol. - (cc)	225.05
Height Change - (in)	0.005	Vol. Change - (cc)	15.10
Ht. After Cons. - (in)	3.005	Cell Exp. - (cc)	18.92
Initial Area - (sq in)	4.562	Net Change - (cc)	-3.82
Area After Cons. - sq in	4.647	Cons. Vol. - (cc)	228.86

ATT
ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO.	2952-2

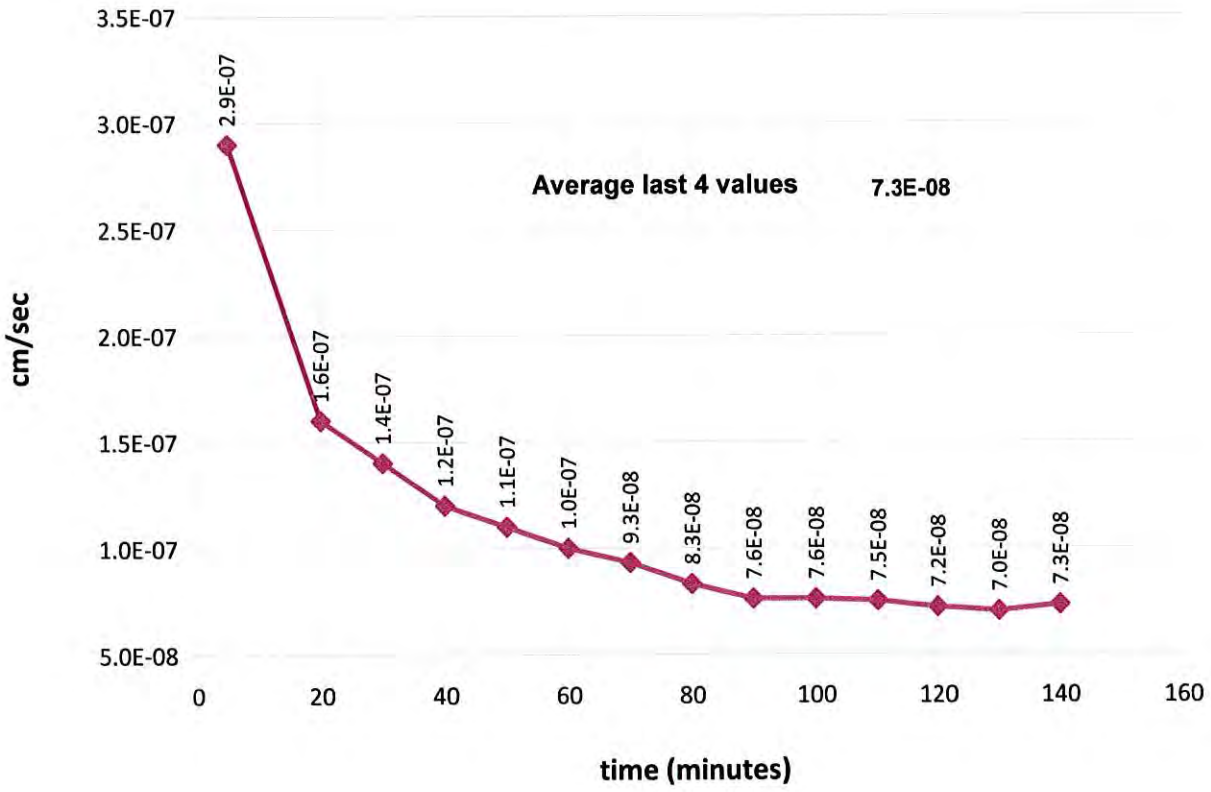


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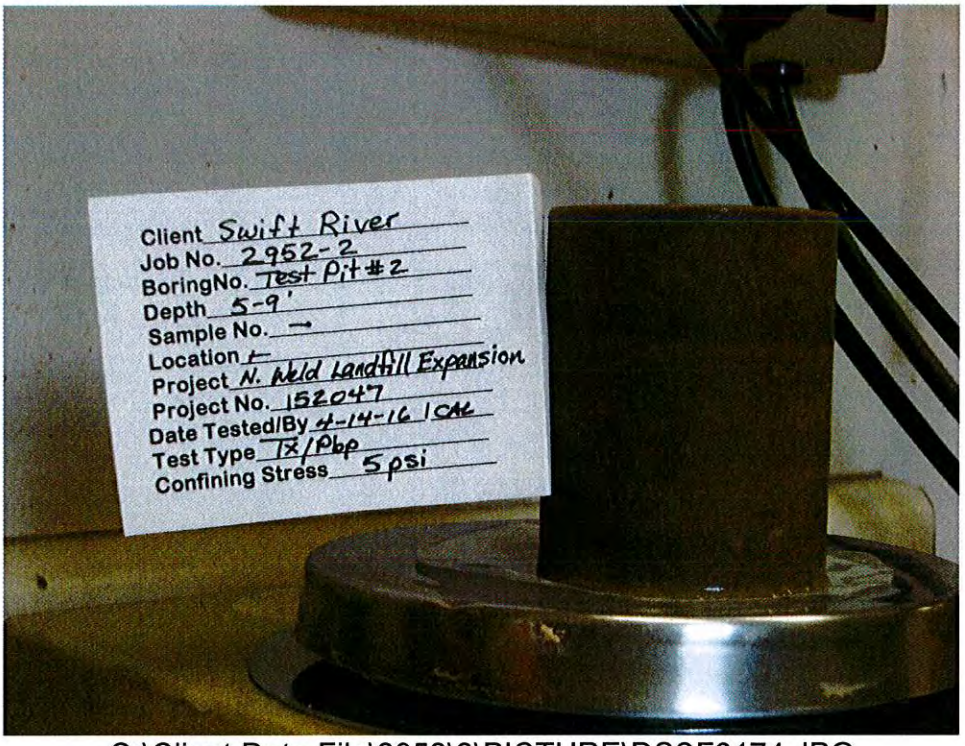
ADVANCED TERRA TESTING

Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	TP#2		
Job Number:	2952-2	Depth:	5-9'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/14/2016	Technician:	CAL



Data Entered By:	CAL		
Date:	4/14/2016		
File Name:	2952_2_PrelimPerm_ASTMD-5084-methodD-R1_2.xls	Checked By:	NN
		Date:	4/15/16



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ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	Test Pit #1	TEST STARTED	4/7/2016	
DEPTH	2-4' bgs	TEST FINISHED	4/18/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	8P	
LOCATION	--	PERMEANT	Tap Water	
SOIL DESC	Remolded -#4	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	479.25	496.15
Wt. Wet Soil & Pan - (g)	493.61	510.51
Wt. Dry Soil & Pan - (g)	429.83	429.83
Wt. Lost Moisture - (g)	63.78	80.68
Wt. of Pan Only - (g)	14.36	14.36
Wt. of Dry Soil - (g)	415.47	415.47
Moisture Content - (%)	15.4	19.4
Wet Density - (pcf)	131.3	142.3
Dry Density - (pcf)	113.8	119.1
Init. Diameter - (in)	2.412	
Init. Area - (sq in)	4.569	
Init. Height - (in)	3.043	
Vol. Bef. Consol. - (cu ft)	0.00805	
Vol. After Consol. - (cu ft)	0.00769	
Porosity - (%)	37.05	

FLOW PUMP CALCULATIONS	
Pump Setting	29
Velocity - (cm/sec)	1.93E-04
Q - (cc/s)	6.16E-06
Height - (in)	3.043
Diameter - (in)	2.358
Pressure - (psi)	0.960
Area after consol. - (cm*cm)	28.165
Gradient	8.733
Permeability k - (cm/s)	2.5E-08
Permeability k - (m/s)	2.5E-10
Back Pressure - (psi)	78.0
Cell Pressure - (psi)	83.0
Ave. Effective Stress - (psi)	4.520
Average Temperature Degree - (C°)	22.2

Data entry by:	NN	Date:	04/19/2016
Checked by:	CAL	Date:	04/19/2016

ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO. 2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	Test Pit #1	TEST STARTED	4/7/2016	
DEPTH	2-4' bgs	TEST FINISHED	4/18/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	8P	
LOCATION	--	PERMEANT	Tap Water	
SOIL DESC	Remolded -#4	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Pres. (psi)	Back Pres. (psi)	Burette Reading (cc)		Pore Pressure (psi)			
		Close	Open	Close	Open	Change	B
40.0	38.0	2.0	16.1				
50.0	48.0	22.8	23.8	38.6	46.8	8.2	0.82
60.0	58.0	24.5	25.4	48.6	57.4	8.8	0.88
70.0	68.0	26.1	27.0	58.4	67.4	9.0	0.90
80.0	78.0	27.4	28.2	67.8	77.2	9.4	0.94
90.0		28.2	28.4	78.1	87.6	9.5	0.95

CONSOLIDATION DATA

Elapsed Time (min)	SQRT Time (min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	0.40	0.00
0.25	0.50	0.80	-0.40
0.5	0.71	0.80	-0.40
1	1.00	0.80	-0.40
2	1.41	0.80	-0.40
4	2.00	0.90	-0.50
9	3.00	0.90	-0.50
16	4.00	1.00	-0.60
30	5.48	1.10	-0.70
60	7.75	1.20	-0.80
120	10.95	1.40	-1.00
240	15.49	1.50	-1.10
360	18.97	1.60	-1.20

Initial Height - (in)	3.043	Init. Vol. - (cc)	227.89
Height Change - (in)	0.000	Vol. Change - (cc)	28.70
Ht. After Cons. - (in)	3.043	Cell Exp. - (cc)	18.54
Initial Area - (sq in)	4.569	Net Change - (cc)	10.16
Area After Cons.-(sq in)	4.366	Cons. Vol. - (cc)	217.73

ATT
ADVANCED TERRA TESTING

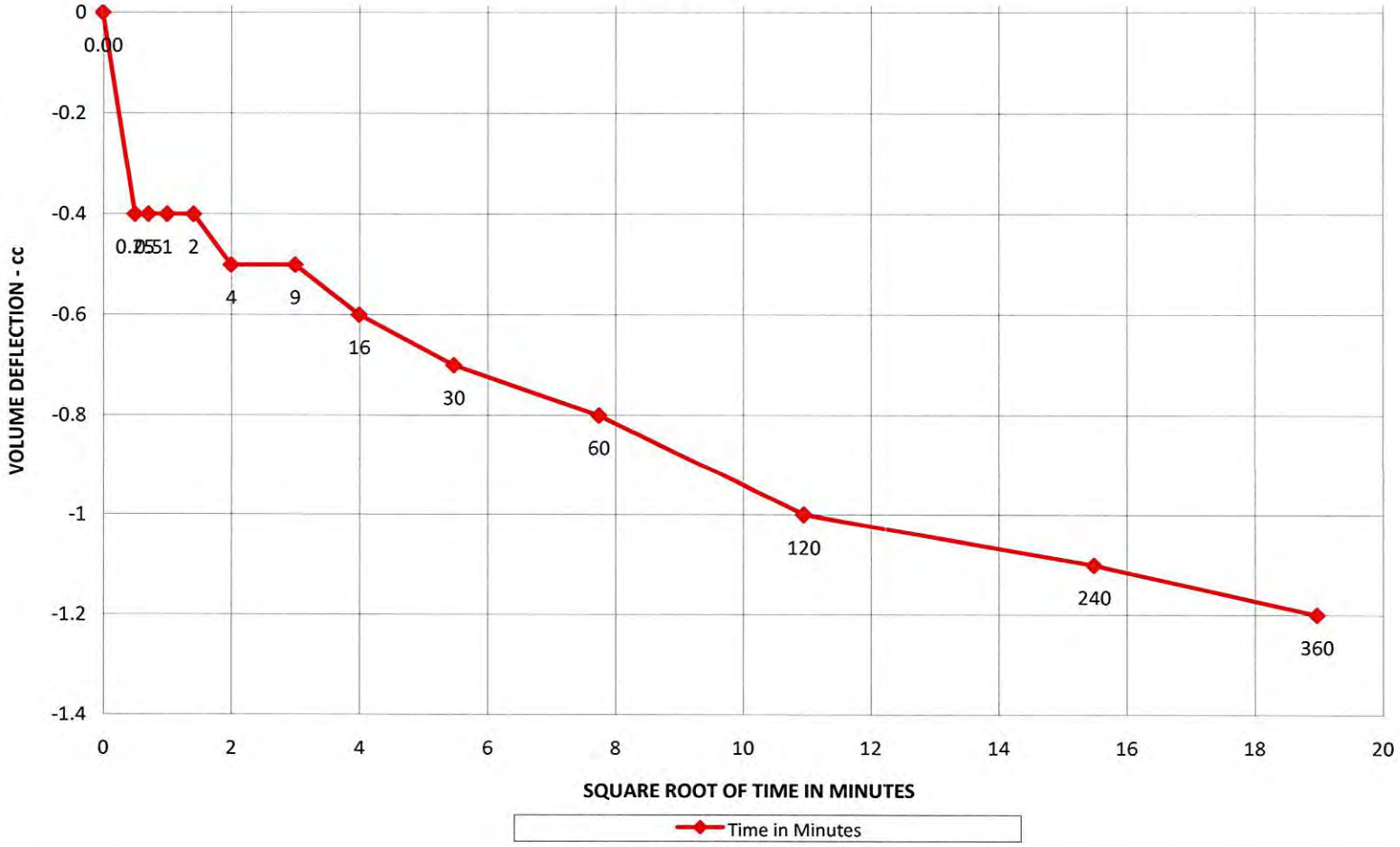
PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO.	2952-2

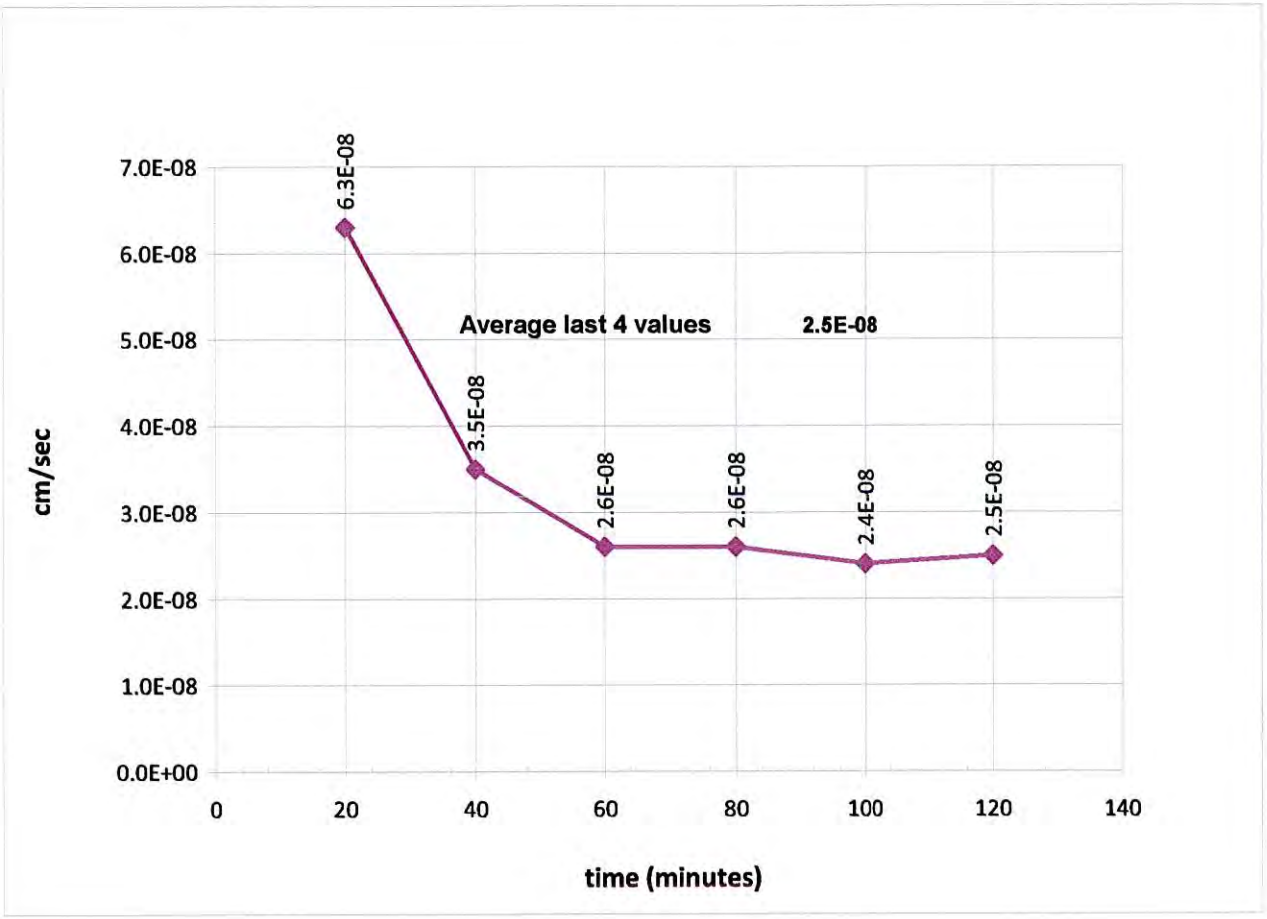
CONSOLIDATION DATA

Test Pit #1,--,2-4' bgs

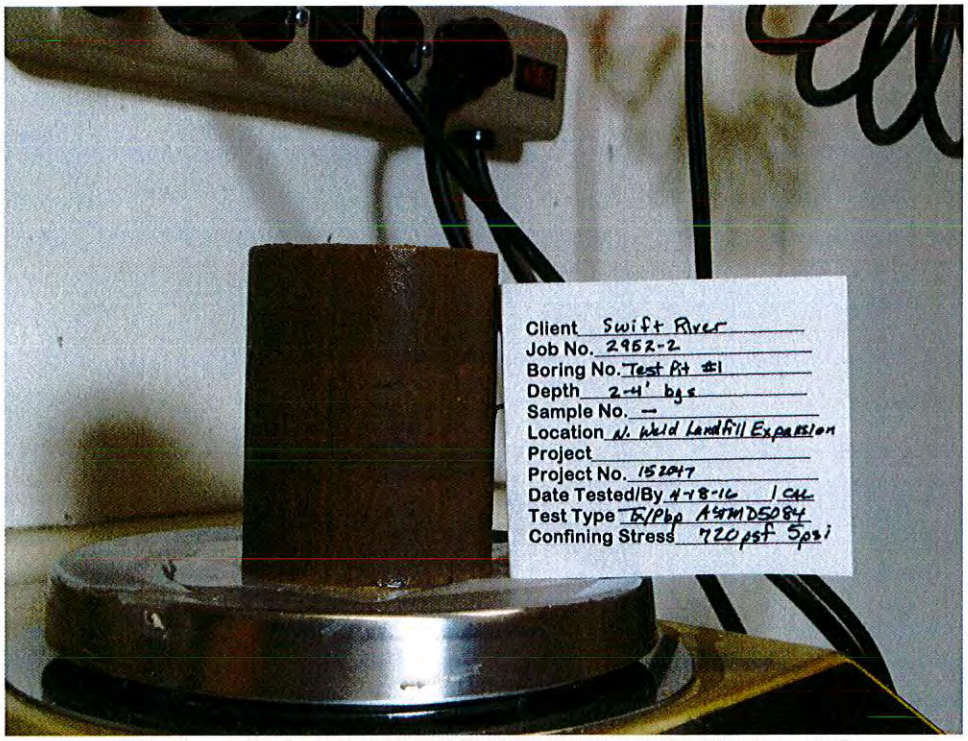


Preliminary Flow Pump Test Data
ASTM D5084 Method D

Client:	Swift River Environmental Services	Boring Number:	Test Pit #1		
Job Number:	2952-2	Depth:	2-4'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/18/2016	Technician:	CAL



Data Entered By:	CAL		
Date:	4/18/2016	Checked By:	NN
File Name:	2952_2_PrelimPerm_ASTMD-5084-methodD-R1_3.xls	Date:	4/19/16



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ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-3

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	S152047.01	SAMPLED	--	By: --
BORING NO.	Pit 3	TEST STARTED	5/24/2016	By: CAL
DEPTH	5-10'	TEST FINISHED	6/1/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	5P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Remolded -#4	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	483.68	502.44
Wt. Wet Soil & Pan - (g)	490.22	508.98
Wt. Dry Soil & Pan - (g)	430.11	430.11
Wt. Lost Moisture - (g)	60.11	78.87
Wt. of Pan Only - (g)	6.54	6.54
Wt. of Dry Soil - (g)	423.57	423.57
Moisture Content - (%)	14.2	18.6
Wet Density - (pcf)	133.0	136.1
Dry Density - (pcf)	116.4	114.7
Init. Diameter - (in)	2.416	
Init. Area - (sq in)	4.584	
Init. Height - (in)	3.023	
Vol. Bef. Consol. - (cu ft)	0.00802	
Vol. After Consol. - (cu ft)	0.00814	
Porosity - (%)	34.21	

Note: Unable to achieve requested remold criteria

FLOW PUMP CALCULATIONS	
Pump Setting (gear number)	11
Percentage of Pump Setting	100
Q - (cc/s)	5.71E-05
Height - (in)	3.015
Diameter - (in)	2.437
Pressure - (psi)	1.809
Area after consol. - (sq cm)	30.102
Gradient	16.608
Permeability k - (cm/s)	1.1E-07
Permeability k - (m/s)	1.1E-09
Back Pressure - (psi)	68.0
Cell Pressure - (psi)	73.0
Ave. Effective Stress - (psi)	4.096
Average temperature degree - (c°)	23.1

Data entry by:	NN	Date:	06/02/2016
Checked by:	PPM	Date:	6/2/16

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-3

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	S152047.01	SAMPLED	--	By: --
BORING NO.	Pit 3	TEST STARTED	5/24/2016	By: CAL
DEPTH	5-10'	TEST FINISHED	6/1/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	5P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Remolded -#4	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	2.0	12.5				
50.0	48.0	6.4	7.6	38.6	46.7	8.1	0.81
60.0	58.0	7.2	8.1	47.9	56.7	8.8	0.88
70.0	68.0	8.2	9.0	58.1	67.1	9.0	0.90
80.0		9.2	9.3	68.0	77.5	9.5	0.95

CONSOLIDATION DATA

Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	9.30	0.00
0.25	0.50	9.55	-0.25
0.5	0.71	9.60	-0.30
1	1.00	9.60	-0.30
2	1.41	9.65	-0.35
4	2.00	9.65	-0.35
9	3.00	9.70	-0.40
16	4.00	9.80	-0.50
30	5.48	9.85	-0.55
60	7.75	9.95	-0.65
120	10.95	10.00	-0.70
240	15.49	10.00	-0.70
360	18.97	10.10	-0.80

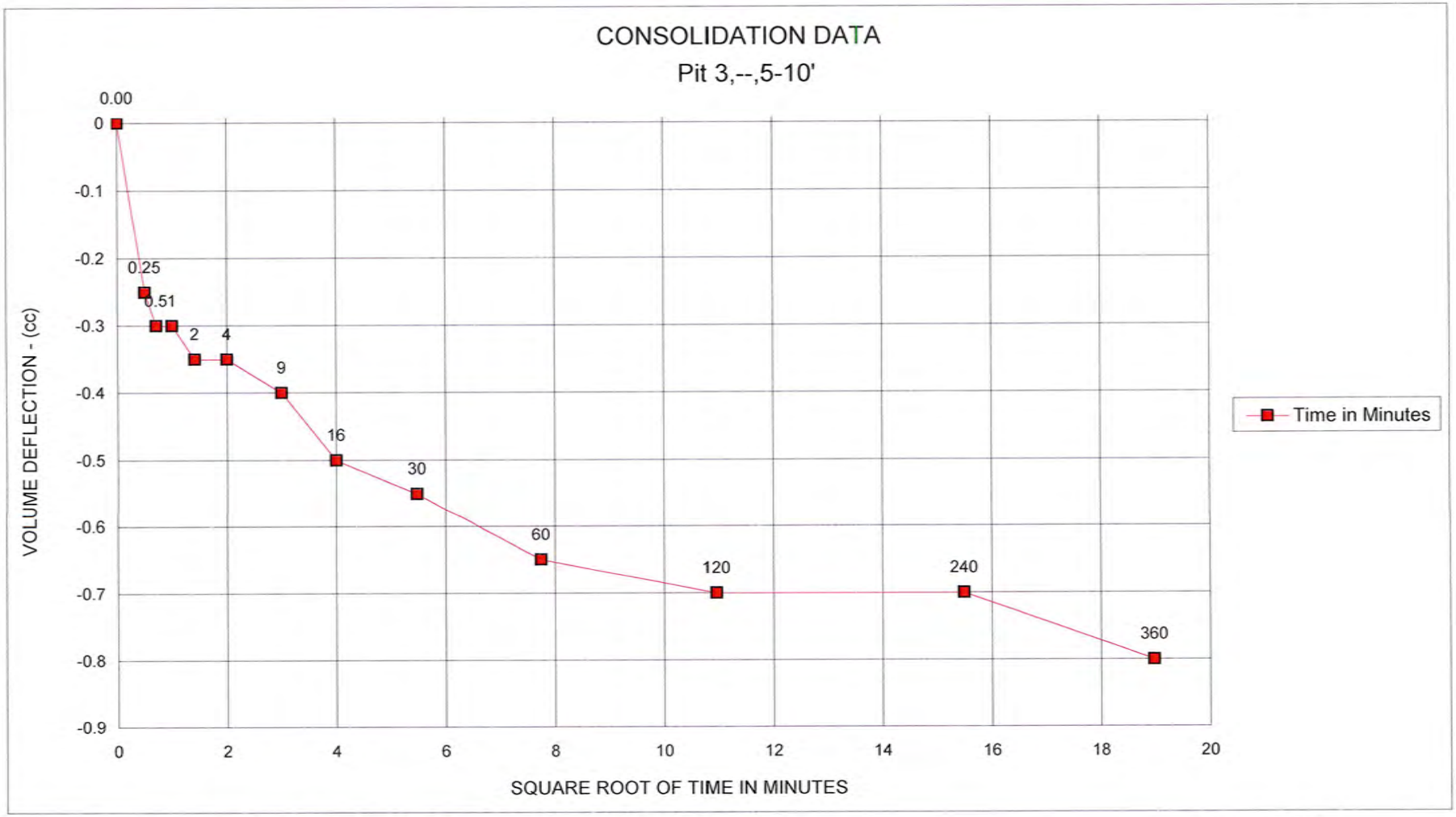
Initial Height - (in)	3.023	Init. Vol. - (cc)	227.14
Height Change - (in)	0.008	Vol. Change - (cc)	8.30
Ht. After Cons. - (in)	3.015	Cell Exp. - (cc)	11.72
Initial Area - (sq in)	4.584	Net Change - (cc)	-3.42
Area After Cons. - sq in	4.666	Cons. Vol. - (cc)	230.56

ATT
ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO.	2952-3

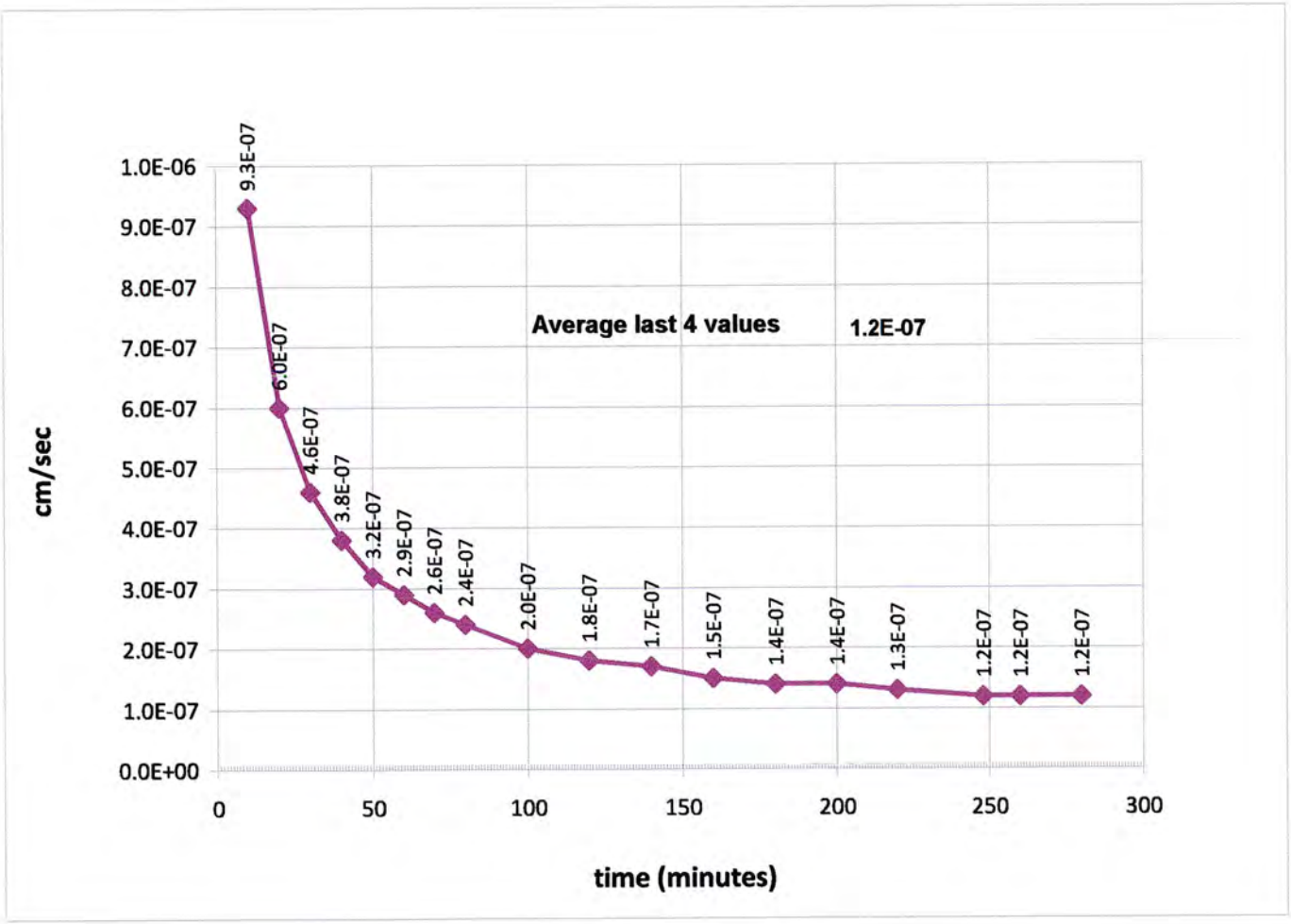


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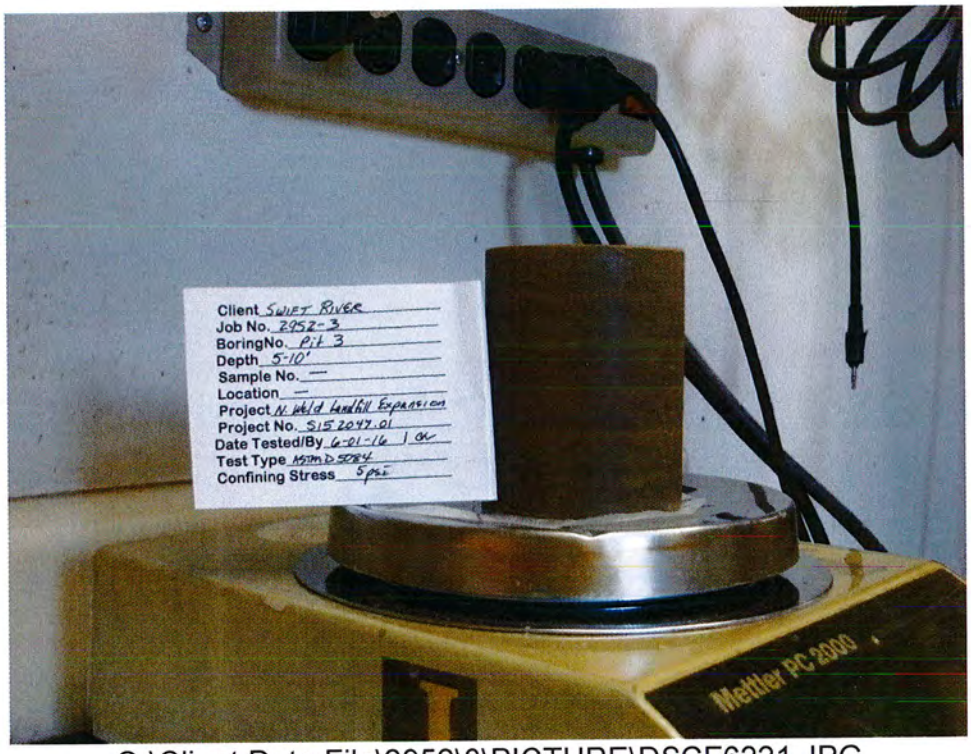
ADVANCED TERRA TESTING

Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	Pit 3		
Job Number:	2952-3	Depth:	5-10'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047.01	Test Date:	6/1/2016	Technician:	CAL



Data Entered By:	CAL		
Date:	6/1/2016		
File Name:	2952_3_PrelimPerm_ASTMD-5084-methodD-R0_1.xls	Checked By:	DPM
		Date:	6/2/16



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PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO. 2952-3

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	S152047.01	SAMPLED	--	By: --
BORING NO.	Pit 4	TEST STARTED	5/24/2016	
DEPTH	2-6'	TEST FINISHED	6/1/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	6P	
LOCATION	--	PERMEANT	Tap Water	
SOIL DESC	Remolded -#4	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST	
Wt. Soil + Moisture - (g)	478.33	493.20	**Note:** Unable to achieve requested remold criteria
Wt. Wet Soil & Pan - (g)	484.84	499.71	
Wt. Dry Soil & Pan - (g)	427.96	427.96	
Wt. Lost Moisture - (g)	56.88	71.75	
Wt. of Pan Only - (g)	6.51	6.51	
Wt. of Dry Soil - (g)	421.45	421.45	
Moisture Content - (%)	13.5	17.0	
Wet Density - (pcf)	130.9	136.5	
Dry Density - (pcf)	115.3	116.6	
Init. Diameter - (in)	2.415		
Init. Area - (sq in)	4.581		
Init. Height - (in)	3.039		
Vol. Bef. Consol. - (cu ft)	0.00806		
Vol. After Consol. - (cu ft)	0.00797		
Porosity - (%)	31.80		

FLOW PUMP CALCULATIONS	
Pump Setting	99
Velocity - (cm/sec)	6.53E-04
Q - (cc/s)	2.09E-05
Height - (in)	3.019
Diameter - (in)	2.410
Pressure - (psi)	0.272
Area after consol. - (cm*cm)	29.418
Gradient	2.494
Permeability k - (cm/s)	2.8E-07
Permeability k - (m/s)	2.8E-09
Back Pressure - (psi)	68.0
Cell Pressure - (psi)	73.0
Ave. Effective Stress - (psi)	4.864
Average Temperature Degree - (C°)	23.4

Data entry by: NN Date: 06/02/2016

Checked by: DRM Date: 6/2/16

ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO. 2952-3

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	S152047.01	SAMPLED	--	By: --
BORING NO.	Pit 4	TEST STARTED	5/24/2016	
DEPTH	2-6'	TEST FINISHED	6/1/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	6P	
LOCATION	--	PERMEANT	Tap Water	
SOIL DESC	Remolded -#4	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Pres. (psi)	Back Pres. (psi)	Burette Reading (cc)		Pore Pressure (psi)			
		Close	Open	Close	Open	Change	B
40.0	38.0	2.5	11.1				
50.0	48.0	3.3	14.4	38.8	46.1	7.3	0.73
60.0	58.0	14.9	16.1	48.2	56.5	8.3	0.83
70.0	68.0	16.6	17.4	58.4	67.4	9.0	0.90
80.0		17.9	17.9	68.2	78.0	9.8	0.98

CONSOLIDATION DATA

Elapsed Time (min)	SQRT Time (min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	17.90	0.00
0.25	0.50	18.40	-0.50
0.5	0.71	18.40	-0.50
1	1.00	18.45	-0.55
2	1.41	18.50	-0.60
4	2.00	18.50	-0.60
9	3.00	18.50	-0.60
16	4.00	18.50	-0.60
30	5.48	18.50	-0.60
60	7.75	18.55	-0.65
120	10.95	18.55	-0.65
240	15.49	18.55	-0.65
360	18.97	18.55	-0.65

Initial Height - (in)	3.039	Init. Vol. - (cc)	228.16
Height Change - (in)	0.020	Vol. Change - (cc)	16.40
Ht. After Cons. - (in)	3.019	Cell Exp. - (cc)	13.87
Initial Area - (sq in)	4.581	Net Change - (cc)	2.53
Area After Cons.-(sq in)	4.560	Cons. Vol. - (cc)	225.63

ATT
ADVANCED TERRA TESTING

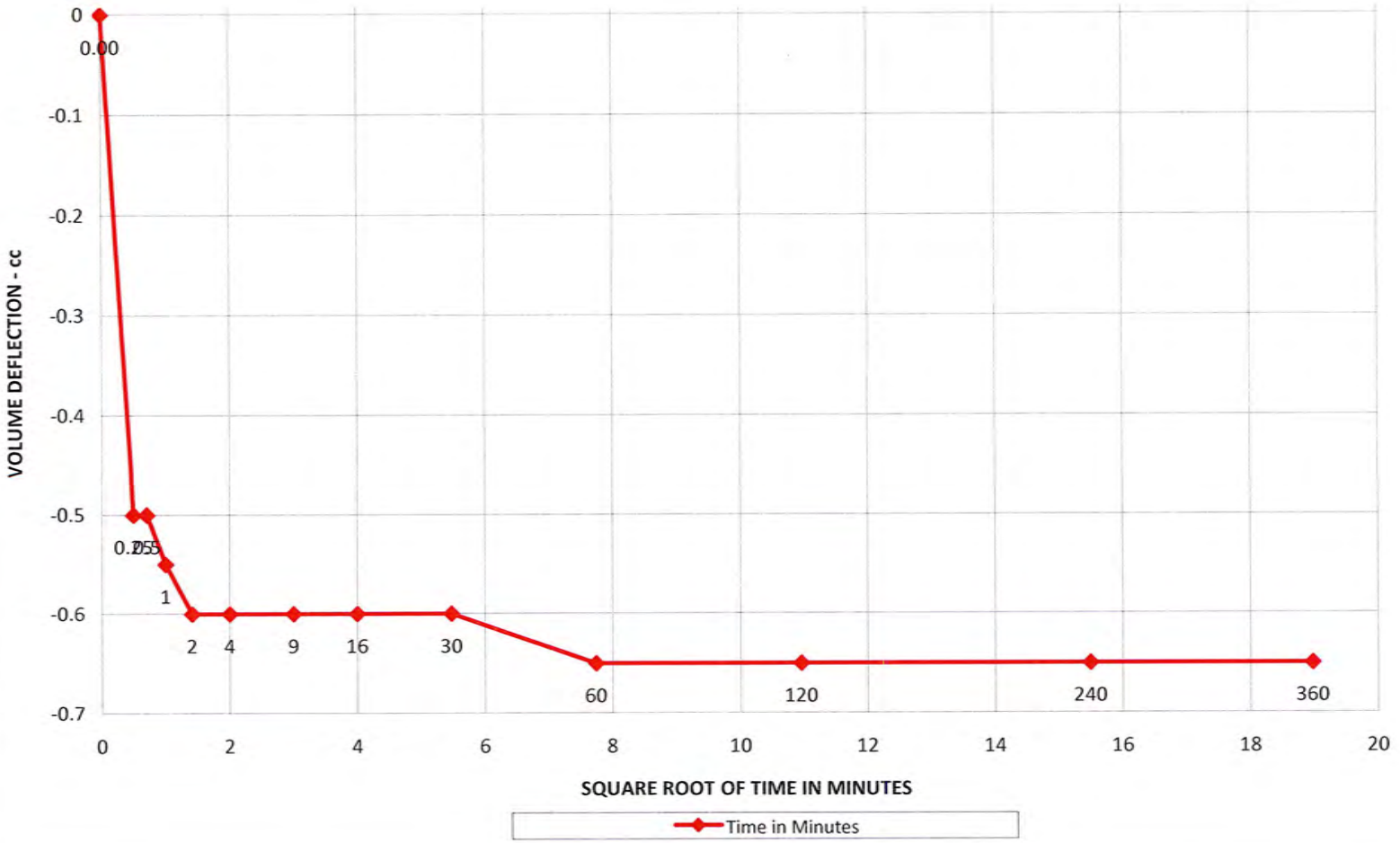
PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO.	2952-3

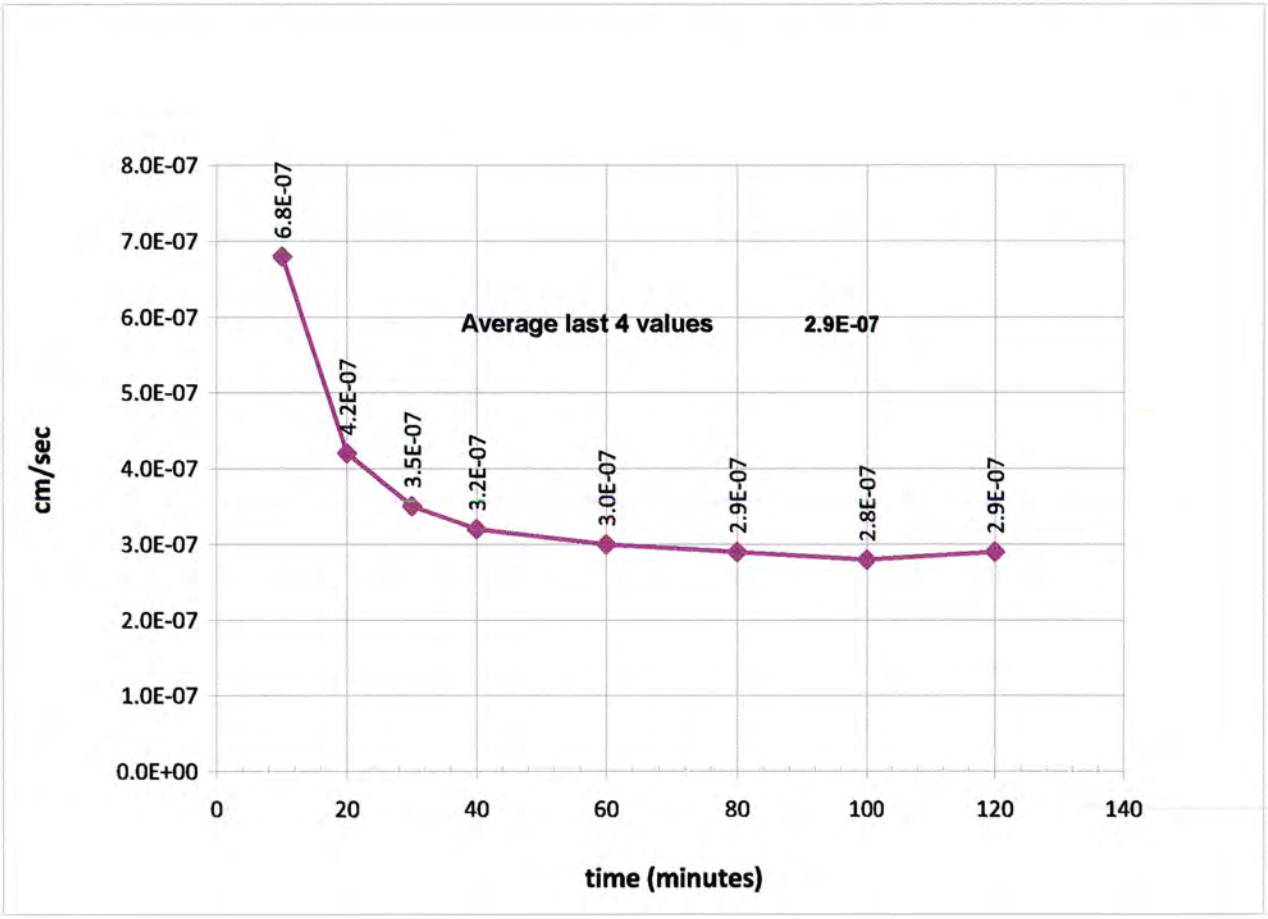
CONSOLIDATION DATA

Pit 4,--,2-6'

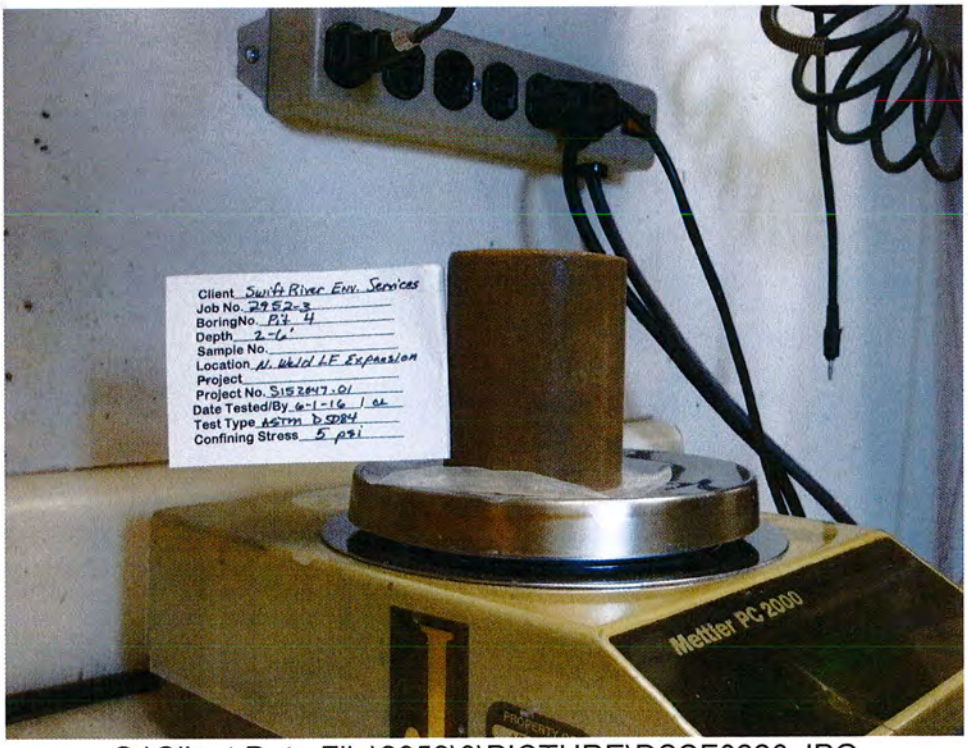


Preliminary Flow Pump Test Data
ASTM D5084 Method D

Client:	Swift River Environmental Services	Boring Number:	Pit 4		
Job Number:	2952-3	Depth:	2-6'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047.01	Test Date:	6/1/2016	Technician:	CAL



Data Entered By:	CAL		
Date:	6/1/2016		
File Name:	2952_3_PrelimPerm_ASTMD-5084-methodD-R0_2.xls	Checked By:	NN
		Date:	6/2/16



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PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-3

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	S152047.01	SAMPLED	--	By: --
BORING NO.	Pit 5	TEST STARTED	5/24/2016	By: CAL
DEPTH	2-6'	TEST FINISHED	5/31/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	12P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Remolded -#4	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	483.40	491.08
Wt. Wet Soil & Pan - (g)	497.64	505.32
Wt. Dry Soil & Pan - (g)	436.87	436.87
Wt. Lost Moisture - (g)	60.77	68.45
Wt. of Pan Only - (g)	14.24	14.24
Wt. of Dry Soil - (g)	422.63	422.63
Moisture Content - (%)	14.4	16.2
Wet Density - (pcf)	133.5	139.4
Dry Density - (pcf)	116.7	120.0
Init. Diameter - (in)	2.408	
Init. Area - (sq in)	4.554	
Init. Height - (in)	3.030	
Vol. Bef. Consol. - (cu ft)	0.00799	
Vol. After Consol. - (cu ft)	0.00776	
Porosity - (%)	31.13	

Note: Could not obtain Requested remold criteria.

FLOW PUMP CALCULATIONS	
Pump Setting (gear number)	11
Percentage of Pump Setting	100
Q - (cc/s)	5.71E-05
Height - (in)	3.001
Diameter - (in)	2.386
Pressure - (psi)	1.672
Area after consol. - (sq cm)	28.845
Gradient	15.422
Permeability k - (cm/s)	1.3E-07
Permeability k - (m/s)	1.3E-09
Back Pressure - (psi)	58.0
Cell Pressure - (psi)	63.0
Ave. Effective Stress - (psi)	4.164
Average temperature degree - (c°)	23.3

Data entry by:	DPM	Date:	06/01/2016
Checked by:	CAL	Date:	06/01/16

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-3

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	S152047.01	SAMPLED	--	By: --
BORING NO.	Pit 5	TEST STARTED	5/24/2016	By: CAL
DEPTH	2-6'	TEST FINISHED	5/31/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	12P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Remolded -#4	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	2.6	14.6				
50.0	48.0	15.0	16.0	39.2	48.1	8.9	0.89
60.0	58.0	16.1	17.0	48.3	57.5	9.2	0.92
70.0		17.3	17.4	58.4	67.9	9.5	0.95

CONSOLIDATION DATA

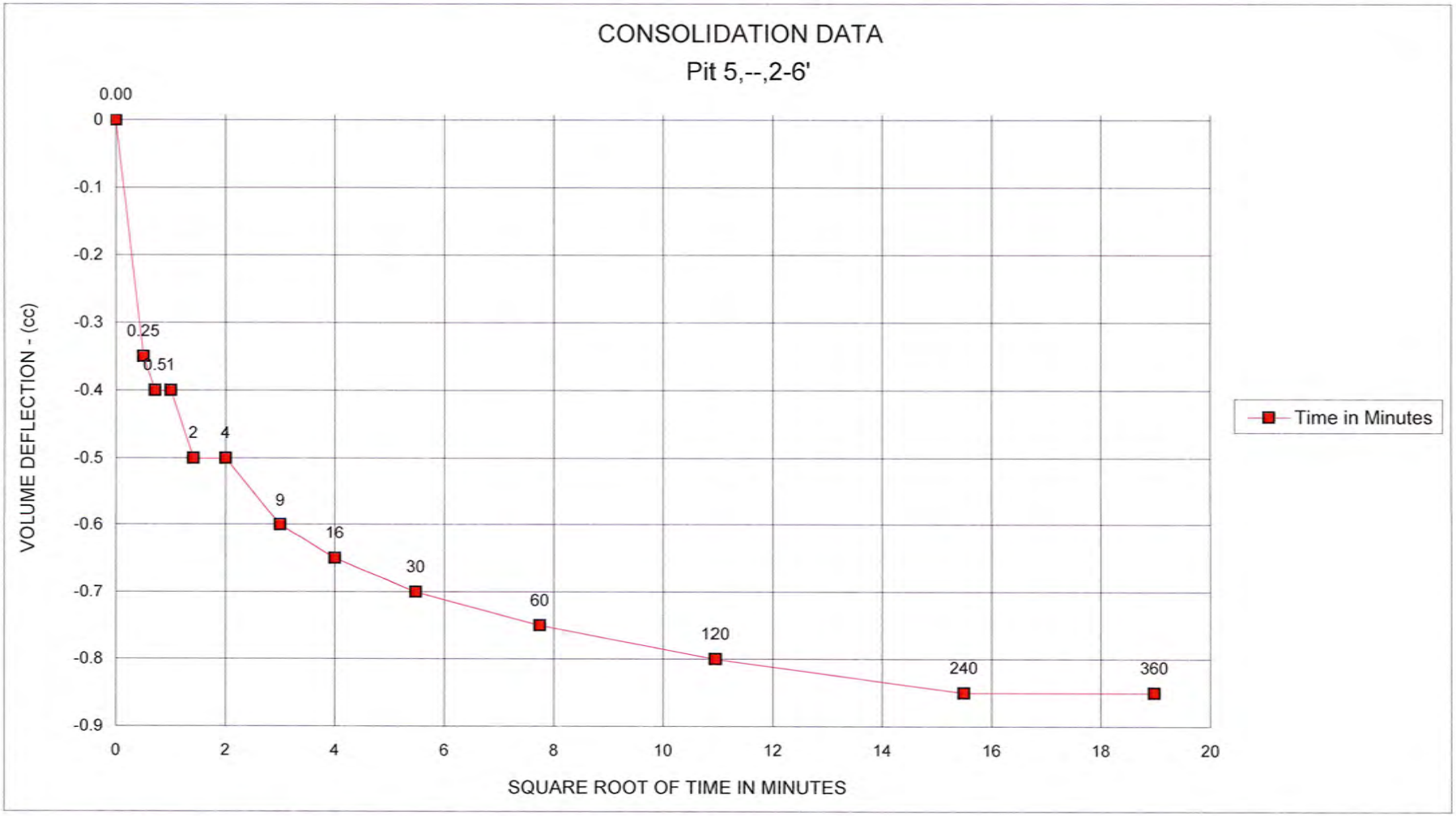
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	17.40	0.00
0.25	0.50	17.75	-0.35
0.5	0.71	17.80	-0.40
1	1.00	17.80	-0.40
2	1.41	17.90	-0.50
4	2.00	17.90	-0.50
9	3.00	18.00	-0.60
16	4.00	18.05	-0.65
30	5.48	18.10	-0.70
60	7.75	18.15	-0.75
120	10.95	18.20	-0.80
240	15.49	18.25	-0.85
360	18.97	18.25	-0.85

Initial Height - (in)	3.030	Init. Vol. - (cc)	226.16
Height Change - (in)	0.029	Vol. Change - (cc)	16.10
Ht. After Cons. - (in)	3.001	Cell Exp. - (cc)	9.85
Initial Area - (sq in)	4.554	Net Change - (cc)	6.25
Area After Cons. - sq in	4.471	Cons. Vol. - (cc)	219.91

ATT
ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD
ASTM D5084 Method D

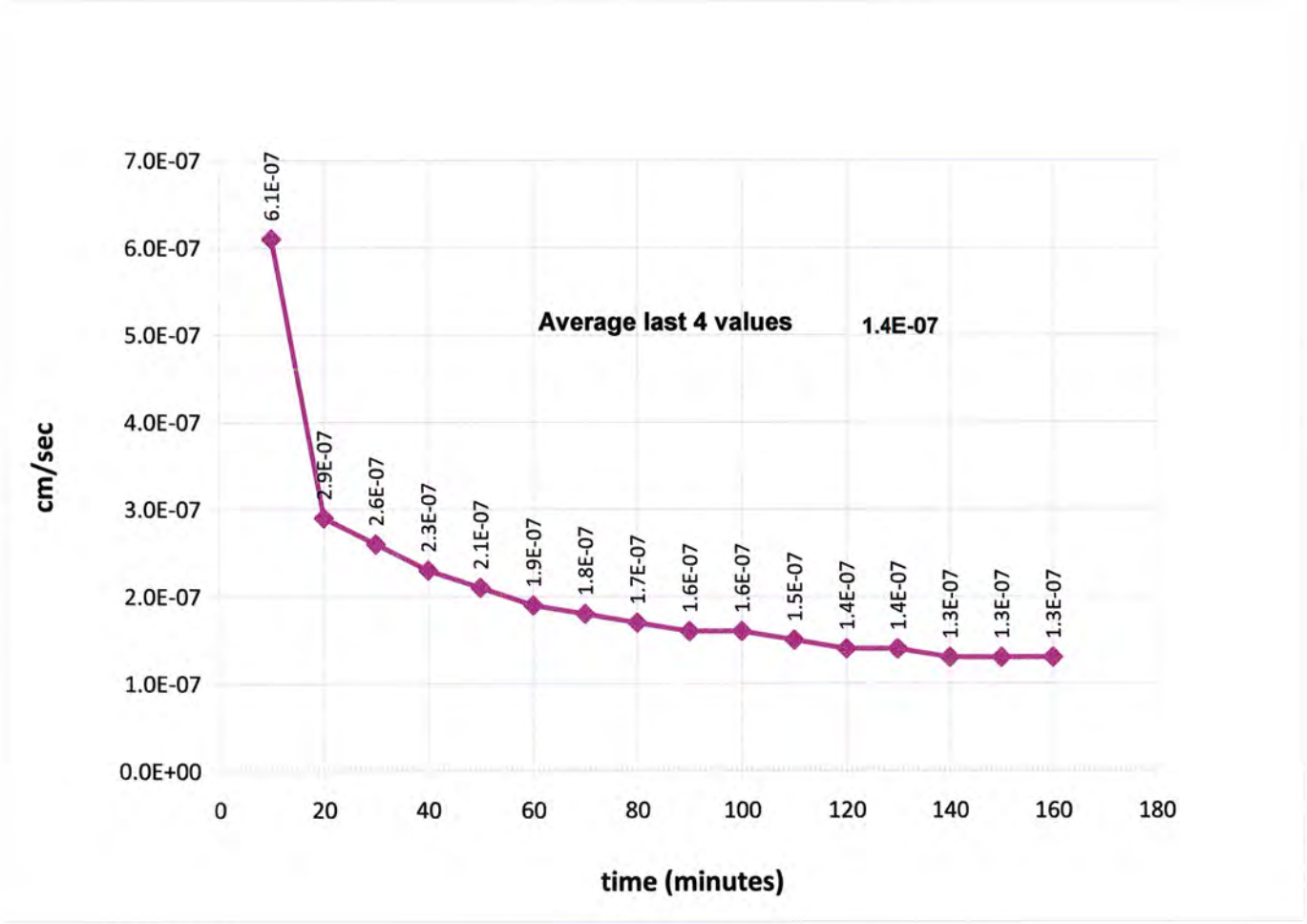
CLIENT	Swift River Environmental Services		JOB NO.	2952-3



ADVANCED TERRA TESTING

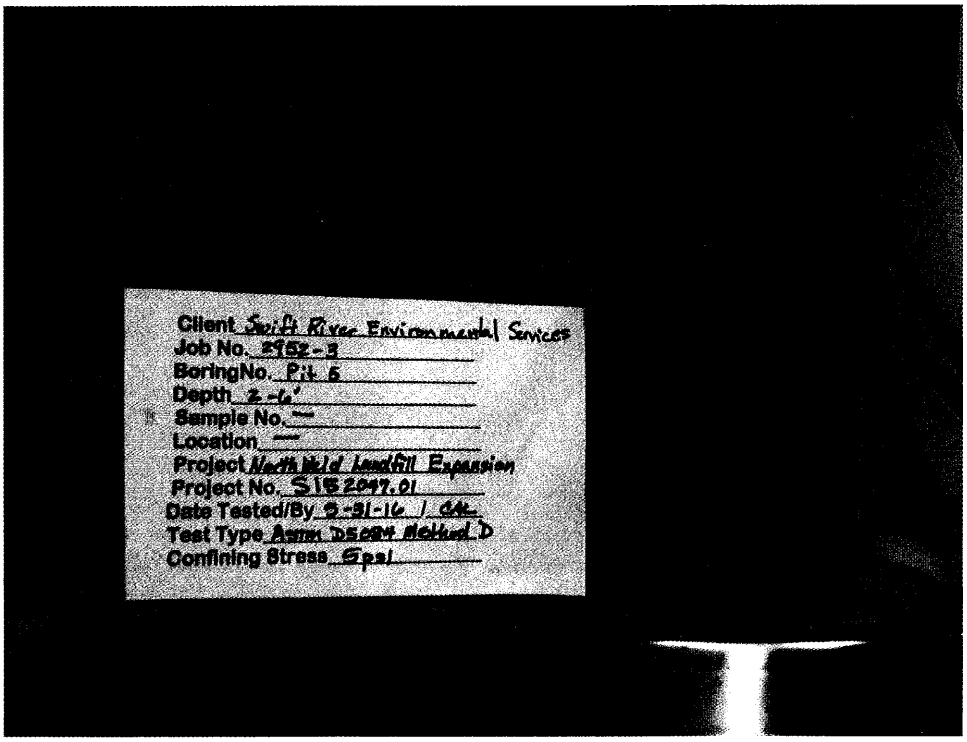
Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	Pit 5		
Job Number:	2952-3	Depth:	2-6'		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	S152047.01	Test Date:	5/31/2016	Technician:	CAL



Data Entered By: CAL
Date: 5/31/2016
File Name: 2952_3_PrelimPerm_ASTMD-5084-methodD-R0_0.xls

Checked By: DPM
Date: 6/01/16



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APPENDIX E

CHEMICAL LABORATORY TESTING RESULTS

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING



ANALYTICAL REPORT

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TestAmerica Denver
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Tel: (303)736-0100

TestAmerica Job ID: 280-80435-1
Client Project/Site: Swift River Environmental Services, LLC

For:
Swift River Environmental Services, LLC
26 West Dry Creek Circle
Suite 470
Littleton, Colorado 80120

Attn: Mr. Steve Wampler

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The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 280-80435-1

Laboratory: TestAmerica Denver

Narrative

CASE NARRATIVE

Client: Swift River Environmental Services, LLC

Project: Swift River Environmental Services, LLC

Report Number: 280-80435-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

Sample Receiving

The samples were received on 03/04/2016; the samples arrived in good condition, properly preserved and on ice. The temperature of the cooler at receipt was 19.3 C, which is above the recommended maximum temperature of 6.0 C. No ice was present.

The sample ID's on the containers matched the ID's on the paper attached to the chain of custody. The samples were logged per the container labels.

Sample collection dates and times were not provided.

The client was notified on 3/7/2016.

Holding Times

All holding times were met.

Method Blanks

All Method Blanks were within established control limits.

Sample Duplicate

All sample duplicate samples were within established control limits.

General Comments
The sample analyses were subcontracted to TestAmerica Corpus Christi; 1733 N. Padre Island Drive, Corpus Christi, TX, 78408.

Detection Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Client Sample ID: NWE-4 [14'-17'] — Lab Sample ID: 280-80435-1

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	8.9		0.054	0.054	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-8 [14'-18'] — Lab Sample ID: 280-80435-2

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	9.9		0.054	0.054	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-12 [9-14'] — Lab Sample ID: 280-80435-3

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	15		0.057	0.057	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-17 [9-14'] — Lab Sample ID: 280-80435-4

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	14		0.057	0.057	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-4 [17'-19'] — Lab Sample ID: 280-80435-5

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	11		0.065	0.065	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-8 [19'-24'] — Lab Sample ID: 280-80435-6

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	10		0.055	0.055	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-12 [14'-19'] — Lab Sample ID: 280-80435-7

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	10		0.057	0.057	meq/100gm	1	☼	9081	Total/NA

Client Sample ID: NWE-17 [16'-18'] — Lab Sample ID: 280-80435-8

Analyte	Result	Qualifier	RL	RL	Unit	Dil Fac	D	Method	Prep Type
Cation Exchange Capacity	12		0.056	0.056	meq/100gm	1	☼	9081	Total/NA

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Method	Method Description	Protocol	Laboratory
9081	Cation Exchange Capacity (CEC)	SW846	TAL CC
Moisture	Percent Moisture	EPA	TAL CC

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL CC = TestAmerica Corpus Christi, 1733 N. Padre Island Drive, Corpus Christi, TX 78408, TEL (361)289-2673

Sample Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
280-80435-1	NWE-4 [14'-17']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-2	NWE-8 [14'-18']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-3	NWE-12 [9-14']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-4	NWE-17 [9-14']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-5	NWE-4 [17'-19']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-6	NWE-8 [19'-24']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-7	NWE-12 [14'-19']	Solid	03/04/16 00:00	03/04/16 09:56
280-80435-8	NWE-17 [16'-18']	Solid	03/04/16 00:00	03/04/16 09:56

General Chemistry

Client Sample ID: NWE-4 [14'-17']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-1
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	6.9		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-4 [14'-17']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-1
Matrix: Solid
Percent Solids: 93.1

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	8.9		0.054	0.054	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-8 [14'-18']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-2
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	7.7		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-8 [14'-18']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-2
Matrix: Solid
Percent Solids: 92.3

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	9.9		0.054	0.054	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-12 [9-14']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-3
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	12.6		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-12 [9-14']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-3
Matrix: Solid
Percent Solids: 87.4

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	15		0.057	0.057	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-17 [9-14']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-4
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	12.3		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-17 [9-14']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-4
Matrix: Solid
Percent Solids: 87.7

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	14		0.057	0.057	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-4 [17'-19']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Lab Sample ID: 280-80435-5
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	23.2		0.1	0.1	%			03/08/16 16:03	1

General Chemistry

Client Sample ID: NWE-4 [17'-19']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-5
Matrix: Solid
Percent Solids: 76.8

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	11		0.065	0.065	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-8 [19'-24']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-6
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	9.1		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-8 [19'-24']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-6
Matrix: Solid
Percent Solids: 90.9

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	10		0.055	0.055	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-12 [14'-19']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-7
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	11.5		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-12 [14'-19']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-7
Matrix: Solid
Percent Solids: 88.5

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	10		0.057	0.057	meq/100gm	☼	03/22/16 14:00	03/23/16 16:48	1

Client Sample ID: NWE-17 [16'-18']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-8
Matrix: Solid

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Moisture	10.1		0.1	0.1	%			03/08/16 16:03	1

Client Sample ID: NWE-17 [16'-18']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-8
Matrix: Solid
Percent Solids: 89.9

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	12		0.056	0.056	meq/100gm	☼	03/22/16 16:14	03/23/16 16:48	1

Method: 9081 - Cation Exchange Capacity (CEC)

Lab Sample ID: MB 560-126251/1-A
Matrix: Solid
Analysis Batch: 126306

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 126251

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Cation Exchange Capacity	ND		0.050	0.050	meq/100gm		03/22/16 14:00	03/23/16 16:48	1

Lab Sample ID: 280-80435-1 DU
Matrix: Solid
Analysis Batch: 126306

Client Sample ID: NWE-4 [14'-17']
Prep Type: Total/NA
Prep Batch: 126251

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Cation Exchange Capacity	8.9			8.80		meq/100gm	☼			1	20

Method: Moisture - Percent Moisture

Lab Sample ID: 280-80435-1 DU
Matrix: Solid
Analysis Batch: 125839

Client Sample ID: NWE-4 [14'-17']
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier		DU Result	DU Qualifier	Unit	D			RPD	RPD Limit
Percent Moisture	6.9			6.0		%				13	40

QC Association Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

General Chemistry

Analysis Batch: 125839

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-80435-1	NWE-4 [14'-17']	Total/NA	Solid	Moisture	
280-80435-1 DU	NWE-4 [14'-17']	Total/NA	Solid	Moisture	
280-80435-2	NWE-8 [14'-18']	Total/NA	Solid	Moisture	
280-80435-3	NWE-12 [9-14']	Total/NA	Solid	Moisture	
280-80435-4	NWE-17 [9-14']	Total/NA	Solid	Moisture	
280-80435-5	NWE-4 [17'-19']	Total/NA	Solid	Moisture	
280-80435-6	NWE-8 [19'-24']	Total/NA	Solid	Moisture	
280-80435-7	NWE-12 [14'-19']	Total/NA	Solid	Moisture	
280-80435-8	NWE-17 [16'-18']	Total/NA	Solid	Moisture	

Prep Batch: 126251

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-80435-1	NWE-4 [14'-17']	Total/NA	Solid	9081	
280-80435-1 DU	NWE-4 [14'-17']	Total/NA	Solid	9081	
280-80435-2	NWE-8 [14'-18']	Total/NA	Solid	9081	
280-80435-3	NWE-12 [9-14']	Total/NA	Solid	9081	
280-80435-4	NWE-17 [9-14']	Total/NA	Solid	9081	
280-80435-5	NWE-4 [17'-19']	Total/NA	Solid	9081	
280-80435-6	NWE-8 [19'-24']	Total/NA	Solid	9081	
280-80435-7	NWE-12 [14'-19']	Total/NA	Solid	9081	
280-80435-8	NWE-17 [16'-18']	Total/NA	Solid	9081	
MB 560-126251/1-A	Method Blank	Total/NA	Solid	9081	

Analysis Batch: 126306

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-80435-1	NWE-4 [14'-17']	Total/NA	Solid	9081	126251
280-80435-1 DU	NWE-4 [14'-17']	Total/NA	Solid	9081	126251
280-80435-2	NWE-8 [14'-18']	Total/NA	Solid	9081	126251
280-80435-3	NWE-12 [9-14']	Total/NA	Solid	9081	126251
280-80435-4	NWE-17 [9-14']	Total/NA	Solid	9081	126251
280-80435-5	NWE-4 [17'-19']	Total/NA	Solid	9081	126251
280-80435-6	NWE-8 [19'-24']	Total/NA	Solid	9081	126251
280-80435-7	NWE-12 [14'-19']	Total/NA	Solid	9081	126251
280-80435-8	NWE-17 [16'-18']	Total/NA	Solid	9081	126251
MB 560-126251/1-A	Method Blank	Total/NA	Solid	9081	126251

Lab Chronicle

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Client Sample ID: NWE-4 [14'-17']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-1
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-4 [14'-17']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-1
Matrix: Solid
Percent Solids: 93.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Client Sample ID: NWE-8 [14'-18']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-2
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-8 [14'-18']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-2
Matrix: Solid
Percent Solids: 92.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Client Sample ID: NWE-12 [9-14']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-3
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-12 [9-14']
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80435-3
Matrix: Solid
Percent Solids: 87.4

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Lab Chronicle

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Client Sample ID: NWE-17 [9-14']

Lab Sample ID: 280-80435-4
Matrix: Solid
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-17 [9-14']

Lab Sample ID: 280-80435-4
Matrix: Solid
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Percent Solids: 87.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Client Sample ID: NWE-4 [17'-19']

Lab Sample ID: 280-80435-5
Matrix: Solid
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-4 [17'-19']

Lab Sample ID: 280-80435-5
Matrix: Solid
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Percent Solids: 76.8

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Client Sample ID: NWE-8 [19'-24']

Lab Sample ID: 280-80435-6
Matrix: Solid
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-8 [19'-24']

Lab Sample ID: 280-80435-6
Matrix: Solid
Date Collected: 03/04/16 00:00
Date Received: 03/04/16 09:56
Percent Solids: 90.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Lab Chronicle

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Client Sample ID: NWE-12 [14'-19']

Lab Sample ID: 280-80435-7
Date Collected: 03/04/16 00:00
Matrix: Solid
Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-12 [14'-19']

Lab Sample ID: 280-80435-7
Date Collected: 03/04/16 00:00
Matrix: Solid
Date Received: 03/04/16 09:56
Percent Solids: 88.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 14:00	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Client Sample ID: NWE-17 [16'-18']

Lab Sample ID: 280-80435-8
Date Collected: 03/04/16 00:00
Matrix: Solid
Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			125839	03/08/16 16:03	AMR	TAL CC

Client Sample ID: NWE-17 [16'-18']

Lab Sample ID: 280-80435-8
Date Collected: 03/04/16 00:00
Matrix: Solid
Date Received: 03/04/16 09:56
Percent Solids: 89.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	9081			4.0	100 mL	126251	03/22/16 16:14	EDR	TAL CC
Total/NA	Analysis	9081		1	4.0	100 mL	126306	03/23/16 16:48	EDR	TAL CC

Laboratory References:

TAL CC = TestAmerica Corpus Christi, 1733 N. Padre Island Drive, Corpus Christi, TX 78408, TEL (361)289-2673

Certification Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80435-1

Laboratory: TestAmerica Denver

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
A2LA	DoD ELAP		2907.01	10-31-17
A2LA	ISO/IEC 17025		2907.01	10-31-17
Alabama	State Program	4	40730	09-30-12 *
Alaska (UST)	State Program	10	UST-30	04-05-16
Arizona	State Program	9	AZ0713	12-19-16
Arkansas DEQ	State Program	6	88-0687	06-01-16
California	State Program	9	2513	08-31-16
Connecticut	State Program	1	PH-0686	09-30-16
Florida	NELAP	4	E87667	06-30-16
Georgia	State Program	4	N/A	01-09-17
Illinois	NELAP	5	200017	04-30-16
Iowa	State Program	7	370	11-30-16
Kansas	NELAP	7	E-10166	04-30-16
Louisiana	NELAP	6	02096	06-30-16
Maine	State Program	1	CO0002	03-03-17
Minnesota	NELAP	5	8-999-405	12-31-16
Nevada	State Program	9	CO0026	07-31-16
New Hampshire	NELAP	1	205310	04-28-16
New Jersey	NELAP	2	CO004	06-30-16
New York	NELAP	2	11964	04-01-16
North Carolina (WW/SW)	State Program	4	358	12-31-16
North Dakota	State Program	8	R-034	01-09-16 *
Oklahoma	State Program	6	8614	08-31-16
Oregon	NELAP	10	4025	01-09-17
Pennsylvania	NELAP	3	68-00664	07-31-16
South Carolina	State Program	4	72002001	01-09-16 *
Texas	NELAP	6	T104704183-15-11	09-30-16
USDA	Federal		P330-13-00202	07-02-16
Utah	NELAP	8	CO00026	07-31-16
Virginia	NELAP	3	460232	06-14-16
Washington	State Program	10	C583	08-03-16
West Virginia DEP	State Program	3	354	11-30-16
Wisconsin	State Program	5	999615430	08-31-16
Wyoming (UST)	A2LA	8	2907.01	10-31-17

Laboratory: TestAmerica Corpus Christi

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Oklahoma	State Program	6	2015-119	08-31-16
Texas	NELAP	6	T104704210-15-14	03-31-16
USDA	Federal		P330-14-00328	09-30-17

* Certification renewal pending - certification considered valid.

Chain of Custody Record

Temperature on Receipt _____

Drinking Water? Yes ☐ No ☐

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124 (1007)

Client	Project Manager	Date	Chain of Custody Number
Swift River Environmental	Pete Zlatev	3 MAR 2016	297299
Address	**Telephone Number (Area Code)/Fax Number**	**Lab Number**	**Page** 1 of 2
26 W Dry Creek Circle	303-695-4660 x 106		
City / **State** / **Zip Code**	**Site Contact**	**Lab Contact**	
Littleton / CO / 80120			
Project Name and Location (State)	**Carrier/Waybill Number**		
NW Landfill Expansion			
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	C.E.C.
Boring NWE-4 13-15	NA	NA				X	X						X
Boring NWE-4 18						X	X						X
Boring NWE-8 13-15						X	X						X
Boring NWE-8 21						X	X						X
Boring NWE-12 11-13						X	X						X
Boring NWE-12 17						X	X						X
Boring NWE-17 12-14						X	X						X
Boring NWE-17 17						X	X						X

Analysis (Attach list if more space is needed)

Special Instructions/ Conditions of Receipt

280-80435 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months
(A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: Sampler	4 MAR 16	0915	1. Received By:	3/4/16	0917
2. Relinquished By:	3/4/16	0956	2. Received By:	3/4/16	0956
3. Relinquished By:			3. Received By:		

Comments

19.5-0.2 IR#7 DW 3/4/16

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

[CATION EXCHANGE CAPACITY] - [8 SAMPLES]

SAMPLES: (LINER MATERIAL) (4 TOTAL)

- NWE-4 [14'-17']
- NWE-8 [14'-18']
- NWE-12 [9'-14']
- NWE-17 [9'-14']

SAMPLES: (SUBGRADE MATERIAL) (4 TOTAL)

- NWE-4 [17'-19']
- NWE-8 [19'-24']
- NWE-12 [14'-19']
- NWE-17 [16'-18']

Login Sample Receipt Checklist

Client: Swift River Environmental Services, LLC

Job Number: 280-80435-1

Login Number: 80435
List Number: 1
Creator: White, Denise E

List Source: TestAmerica Denver

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	N/A	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	False	No: Thermal preservation not required
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	NA: Not requested on COC
There are no discrepancies between the sample IDs on the containers and the COC.	False	No: IDs on containers do not match the COC. Logged in per CONTAINERS.
Samples are received within Holding Time (Excluding tests with immediate HTs)..	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	N/A	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Sampling Company provided.	True	
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	True	
Chlorine Residual checked.	N/A	

Login Sample Receipt Checklist

Client: Swift River Environmental Services, LLC

Job Number: 280-80435-1

Login Number: 80435
List Number: 2
Creator: Adams, Christi L

List Source: TestAmerica Corpus Christi
List Creation: 03/08/16 01:05 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	N/A	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

ANALYTICAL REPORT

Job Number: 280-81693-1

Job Description: 588|North Weld

For:
Waste Management
2400 West Union Avenue
Englewood, CO 80110

Attention: Mr. Tom Schweitzer



Approved for release.
Betsy A Sara
Project Manager II
4/25/2016 11:16 AM

Betsy A Sara, Project Manager II
4955 Yarrow Street, Arvada, CO, 80002
(303)736-0189
betsy.sara@testamericainc.com
04/25/2016

cc: Mr. Eric DiEsposti

The test results in this report relate only to the samples in this report and meet all requirements of NELAC, with any exceptions noted. Pursuant to NELAP, this report shall not be reproduced except in full, without the written approval of the laboratory. All questions regarding this report should be directed to the TestAmerica Denver Project Manager.

The Lab Certification ID# is 4025.

Reporting limits are adjusted for sample size used, dilutions and moisture content if applicable.

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CASE NARRATIVE

Client: Waste Management

Project: 588|North Weld

Report Number: 280-81693-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

This report may include reporting limits (RLs) less than TestAmerica's standard reporting limit. The reported sample results and associated reporting limits are being used specifically to meet the needs of this project. Note that data are not normally reported to these levels without qualification because they are inherently less reliable and potentially less defensible than required by the latest industry standards.

Sample Receiving

The samples were received on 04/07/2016; the samples arrived in good condition. These samples arrived at a temperature of 18.4 C which is above the recommended maximum temperature of 6.0 C. No ice was present. The laboratory proceeded with the requested analyses. The client was notified on 4/7/2016.

Holding Times

All holding times were within established control limits.

Method Blanks

All Method Blank samples were within established control limits.

Laboratory Control Samples

All Laboratory Control Samples were within established control limits.

Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

All MS and MSD samples were within established control limits.

General Comments

The analysis for Cation Exchange was performed at TestAmerica's Corpus Christi facility.

TestAmerica Corpus Christi
1733 N. Padre Island Drive
Corpus Christi, TX 78408
Phone: (361) 289-2673

EXECUTIVE SUMMARY - Detections

Client: Waste Management Job Number: 280-81693-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-81693-1	**PIT 1 2-4**					
Cation Exchange Capacity		17		0.058	meq/100gm	9081
Percent Moisture		13.6		0.1	%	Moisture
280-81693-2	**PIT 2 5-9**					
Cation Exchange Capacity		15		0.057	meq/100gm	9081
Percent Moisture		12.5		0.1	%	Moisture
280-81693-3	**PIT 3 3-5**					
Percent Moisture		8.9		0.1	%	Moisture
Soluble						
pH adj. to 25 deg C-Soluble		9.08	H	0.100	SU	9045C
Specific Conductance-Soluble		390		20	umhos/cm	9050A
280-81693-4	**PIT 4 2-6**					
Percent Moisture		8.3		0.1	%	Moisture
Soluble						
pH adj. to 25 deg C-Soluble		9.08	H	0.100	SU	9045C
Specific Conductance-Soluble		330		20	umhos/cm	9050A
280-81693-5	**PIT 4 6-12**					
Percent Moisture		11.3		0.1	%	Moisture
Soluble						
Sodium Adsorption Ratio		2.5		1.2	No Unit	20B
pH adj. to 25 deg C-Soluble		9.09	H	0.100	SU	9045C
Specific Conductance-Soluble		400		20	umhos/cm	9050A
280-81693-6	**PIT 5 6-10**					
Percent Moisture		11.5		0.1	%	Moisture
Soluble						
Sodium Adsorption Ratio		4.2		1.2	No Unit	20B
pH adj. to 25 deg C-Soluble		9.30	H	0.100	SU	9045C
Specific Conductance-Soluble		550		20	umhos/cm	9050A

METHOD SUMMARY

Client: Waste Management Job Number: 280-81693-1

Description	Lab Location	Method	Preparation Method
Matrix: Solid			
Sodium Adsorption Ratio	TAL DEN	USDA 20B	
Preparation, Sodium Absorption Ratio	TAL DEN		USDA 20B
pH	TAL DEN	SW846 9045C	
Deionized Water Leaching Procedure	TAL DEN		ASTM DI Leach
Specific Conductance	TAL DEN	SW846 9050A	
Deionized Water Leaching Procedure	TAL DEN		ASTM DI Leach
Organic Carbon, Total (TOC)	TAL DEN	SW846 9060A	
Percent Moisture	TAL DEN	EPA Moisture	
Cation Exchange Capacity (CEC)	TAL CC	SW846 9081	
Cation Exchange Capacity (CEC)	TAL CC		SW846 9081

Lab References:

TAL CC = TestAmerica Corpus Christi

TAL DEN = TestAmerica Denver

Method References:

ASTM = ASTM International

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

USDA = "USDA Agriculture Handbook 60, section 20B".

METHOD / ANALYST SUMMARY

Client: Waste Management

Job Number: 280-81693-1

Method	Analyst	Analyst ID
USDA 20B	Rhoades, Chris R	CRR
SW846 9045C	Uge, Ikem E	IEU
SW846 9050A	Martinez, Rut S	RSM
SW846 9060A	Cherry, Scott V	SVC
SW846 9081	Mathewson, John E	JEM
EPA Moisture	Lawrence, Caitlyn M	CML

SAMPLE SUMMARY

Client: Waste Management

Job Number: 280-81693-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
280-81693-1	PIT 1 2-4	Solid	03/22/2016 1150	04/07/2016 1133
280-81693-2	PIT 2 5-9	Solid	03/22/2016 1210	04/07/2016 1133
280-81693-3	PIT 3 3-5	Solid	03/22/2016 1230	04/07/2016 1133
280-81693-4	PIT 4 2-6	Solid	03/22/2016 1250	04/07/2016 1133
280-81693-5	PIT 4 6-12	Solid	03/22/2016 1255	04/07/2016 1133
280-81693-6	PIT 5 6-10	Solid	03/22/2016 1310	04/07/2016 1133

SAMPLE RESULTS

Client: Waste Management

Job Number: 280-81693-1

Client Sample ID: **PIT 3 3-5**

Lab Sample ID: 280-81693-3
Client Matrix: Solid

Date Sampled: 03/22/2016 1230
Date Received: 04/07/2016 1133

20B Sodium Adsorption Ratio-Soluble

Analysis Method:	20B	Analysis Batch:	280-321949	Instrument ID:	MT_025
Prep Method:	20B	Prep Batch:	280-320884	Lab File ID:	N/A
Dilution:	10			Initial Weight/Volume:	100 g
Analysis Date:	04/21/2016 1001			Final Weight/Volume:	50 mL
Prep Date:	04/14/2016 1806				

Analyte	DryWt Corrected: N	Result (No Unit)	Qualifier	RL
Sodium Adsorption Ratio		ND		1.2

Client: Waste Management

Job Number: 280-81693-1

Client Sample ID: **PIT 4 2-6**

Lab Sample ID: 280-81693-4
Client Matrix: Solid

Date Sampled: 03/22/2016 1250
Date Received: 04/07/2016 1133

20B Sodium Adsorption Ratio-Soluble

Analysis Method:	20B	Analysis Batch:	280-321949	Instrument ID:	MT_025
Prep Method:	20B	Prep Batch:	280-320884	Lab File ID:	N/A
Dilution:	10			Initial Weight/Volume:	100 g
Analysis Date:	04/21/2016 1009			Final Weight/Volume:	50 mL
Prep Date:	04/14/2016 1806				

Analyte	DryWt Corrected: N	Result (No Unit)	Qualifier	RL
Sodium Adsorption Ratio		ND		1.2

Client: Waste Management

Job Number: 280-81693-1

Client Sample ID: **PIT 4 6-12**

Lab Sample ID: 280-81693-5
Client Matrix: Solid

Date Sampled: 03/22/2016 1255
Date Received: 04/07/2016 1133

20B Sodium Adsorption Ratio-Soluble

Analysis Method:	20B	Analysis Batch:	280-321949	Instrument ID:	MT_025
Prep Method:	20B	Prep Batch:	280-320884	Lab File ID:	N/A
Dilution:	10			Initial Weight/Volume:	100 g
Analysis Date:	04/21/2016 1012			Final Weight/Volume:	50 mL
Prep Date:	04/14/2016 1806				

Analyte	DryWt Corrected: N	Result (No Unit)	Qualifier	RL
Sodium Adsorption Ratio		2.5		1.2

Client: Waste Management

Job Number: 280-81693-1

Client Sample ID: **PIT 5 6-10**

Lab Sample ID: 280-81693-6
Client Matrix: Solid

Date Sampled: 03/22/2016 1310
Date Received: 04/07/2016 1133

20B Sodium Adsorption Ratio-Soluble

Analysis Method:	20B	Analysis Batch:	280-321949	Instrument ID:	MT_025
Prep Method:	20B	Prep Batch:	280-320884	Lab File ID:	N/A
Dilution:	10			Initial Weight/Volume:	100 g
Analysis Date:	04/21/2016 1015			Final Weight/Volume:	50 mL
Prep Date:	04/14/2016 1806				

Analyte	DryWt Corrected: N	Result (No Unit)	Qualifier	RL
Sodium Adsorption Ratio		4.2		1.2

General Chemistry

Client Sample ID: **PIT 1 2-4**

Lab Sample ID: 280-81693-1 Date Sampled: 03/22/2016 1150
Client Matrix: Solid % Moisture: 13.6 Date Received: 04/07/2016 1133

Analyte	Result	Qual	Units	RL	Dil	Method
Cation Exchange Capacity	17		meq/100gm	0.058	1.0	9081
Analysis Batch: 560-127300	Analysis Date: 04/25/2016 1032					DryWt Corrected: Y
Prep Batch: 560-127298	Prep Date: 04/22/2016 1028					
Percent Moisture	13.6		%	0.1	1.0	Moisture
Analysis Batch: 280-320252	Analysis Date: 04/11/2016 1717					DryWt Corrected: N

General Chemistry

Client Sample ID: **PIT 2 5-9**

Lab Sample ID: 280-81693-2 Date Sampled: 03/22/2016 1210
Client Matrix: Solid % Moisture: 12.5 Date Received: 04/07/2016 1133

Analyte	Result	Qual	Units	RL	Dil	Method
Cation Exchange Capacity	15		meq/100gm	0.057	1.0	9081
Analysis Batch: 560-127300	Analysis Date: 04/25/2016 1032					DryWt Corrected: Y
Prep Batch: 560-127298	Prep Date: 04/22/2016 1028					
Percent Moisture	12.5		%	0.1	1.0	Moisture
Analysis Batch: 280-320252	Analysis Date: 04/11/2016 1717					DryWt Corrected: N

General Chemistry

Client Sample ID: **PIT 3 3-5**

Lab Sample ID: 280-81693-3 Date Sampled: 03/22/2016 1230
Client Matrix: Solid Date Received: 04/07/2016 1133

Analyte	Result	Qual	Units	RL	Dil	Method
Total Organic Carbon	ND		g/Kg	4.0	1.0	9060A
Analysis Batch: 280-320916	Analysis Date: 04/14/2016 2043				DryWt Corrected: N	

Analyte	Result	Qual	Units	RL	Dil	Method
pH adj. to 25 deg C-Soluble	9.08	H	SU	0.100	1.0	9045C
Analysis Batch: 280-321210	Analysis Date: 04/18/2016 0824				DryWt Corrected: N	
Specific Conductance-Soluble	390		umhos/cm	20	1.0	9050A
Analysis Batch: 280-321966	Analysis Date: 04/19/2016 2141				DryWt Corrected: N	
Percent Moisture	8.9		%	0.1	1.0	Moisture
Analysis Batch: 280-320252	Analysis Date: 04/11/2016 1717				DryWt Corrected: N	

General Chemistry

Client Sample ID: **PIT 4 2-6**

Lab Sample ID: 280-81693-4 Date Sampled: 03/22/2016 1250
Client Matrix: Solid Date Received: 04/07/2016 1133

Analyte	Result	Qual	Units	RL	Dil	Method
Total Organic Carbon	ND		g/Kg	4.0	1.0	9060A
Analysis Batch: 280-320916	Analysis Date: 04/14/2016 2052				DryWt Corrected: N	

Analyte	Result	Qual	Units	RL	Dil	Method
pH adj. to 25 deg C-Soluble	9.08	H	SU	0.100	1.0	9045C
Analysis Batch: 280-321210	Analysis Date: 04/18/2016 0824				DryWt Corrected: N	
Specific Conductance-Soluble	330		umhos/cm	20	1.0	9050A
Analysis Batch: 280-321966	Analysis Date: 04/19/2016 2141				DryWt Corrected: N	
Percent Moisture	8.3		%	0.1	1.0	Moisture
Analysis Batch: 280-320252	Analysis Date: 04/11/2016 1717				DryWt Corrected: N	

General Chemistry

Client Sample ID: **PIT 4 6-12**

Lab Sample ID: 280-81693-5 Date Sampled: 03/22/2016 1255
Client Matrix: Solid Date Received: 04/07/2016 1133

Analyte	Result	Qual	Units	RL	Dil	Method
Total Organic Carbon	ND		g/Kg	4.0	1.0	9060A
Analysis Batch: 280-320916	Analysis Date: 04/14/2016 2054				DryWt Corrected: N	

Analyte	Result	Qual	Units	RL	Dil	Method
pH adj. to 25 deg C-Soluble	9.09	H	SU	0.100	1.0	9045C
Analysis Batch: 280-321210	Analysis Date: 04/18/2016 0824				DryWt Corrected: N	
Specific Conductance-Soluble	400		umhos/cm	20	1.0	9050A
Analysis Batch: 280-321966	Analysis Date: 04/19/2016 2141				DryWt Corrected: N	
Percent Moisture	11.3		%	0.1	1.0	Moisture
Analysis Batch: 280-320252	Analysis Date: 04/11/2016 1717				DryWt Corrected: N	

General Chemistry

Client Sample ID: **PIT 5 6-10**

Lab Sample ID: 280-81693-6 Date Sampled: 03/22/2016 1310
Client Matrix: Solid Date Received: 04/07/2016 1133

Analyte	Result	Qual	Units	RL	Dil	Method
Total Organic Carbon	ND		g/Kg	4.0	1.0	9060A
Analysis Batch: 280-320916	Analysis Date: 04/14/2016 2056				DryWt Corrected: N	

Analyte	Result	Qual	Units	RL	Dil	Method
pH adj. to 25 deg C-Soluble	9.30	H	SU	0.100	1.0	9045C
Analysis Batch: 280-321210	Analysis Date: 04/18/2016 0824				DryWt Corrected: N	
Specific Conductance-Soluble	550		umhos/cm	20	1.0	9050A
Analysis Batch: 280-321966	Analysis Date: 04/19/2016 2141				DryWt Corrected: N	
Percent Moisture	11.5		%	0.1	1.0	Moisture
Analysis Batch: 280-320252	Analysis Date: 04/11/2016 1717				DryWt Corrected: N	

DATA REPORTING QUALIFIERS

Client: Waste Management Job Number: 280-81693-1

Lab Section	Qualifier	Description
General Chemistry		
	H	Sample was prepped or analyzed beyond the specified holding time

QUALITY CONTROL RESULTS

Client: Waste Management Job Number: 280-81693-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
Metals					
Prep Batch: 280-320884					
MB 280-320884/1-A	Method Blank	S	Solid	20B	
280-81693-3	PIT 3 3-5	S	Solid	20B	
280-81693-3DU	Duplicate	S	Solid	20B	
280-81693-4	PIT 4 2-6	S	Solid	20B	
280-81693-5	PIT 4 6-12	S	Solid	20B	
280-81693-6	PIT 5 6-10	S	Solid	20B	
Analysis Batch:280-321949					
MB 280-320884/1-A	Method Blank	S	Solid	20B	280-320884
280-81693-3	PIT 3 3-5	S	Solid	20B	280-320884
280-81693-3DU	Duplicate	S	Solid	20B	280-320884
280-81693-4	PIT 4 2-6	S	Solid	20B	280-320884
280-81693-5	PIT 4 6-12	S	Solid	20B	280-320884
280-81693-6	PIT 5 6-10	S	Solid	20B	280-320884

Report Basis
S = Soluble

Client: Waste Management Job Number: 280-81693-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
General Chemistry					
Prep Batch: 560-127298					
MB 560-127298/1-A	Method Blank	T	Solid	9081	
280-81693-1	PIT 1 2-4	T	Solid	9081	
280-81693-2	PIT 2 5-9	T	Solid	9081	
Analysis Batch:560-127300					
MB 560-127298/1-A	Method Blank	T	Solid	9081	560-127298
280-81693-1	PIT 1 2-4	T	Solid	9081	560-127298
280-81693-2	PIT 2 5-9	T	Solid	9081	560-127298
Analysis Batch:280-320252					
280-81658-A-2 DU	Duplicate	T	Solid	Moisture	
280-81693-1	PIT 1 2-4	T	Solid	Moisture	
280-81693-2	PIT 2 5-9	T	Solid	Moisture	
280-81693-3	PIT 3 3-5	T	Solid	Moisture	
280-81693-4	PIT 4 2-6	T	Solid	Moisture	
280-81693-5	PIT 4 6-12	T	Solid	Moisture	
280-81693-6	PIT 5 6-10	T	Solid	Moisture	
Analysis Batch:280-320916					
LCS 280-320916/3	Lab Control Sample	T	Solid	9060A	
MB 280-320916/4	Method Blank	T	Solid	9060A	
280-81693-3	PIT 3 3-5	T	Solid	9060A	
280-81693-3MS	Matrix Spike	T	Solid	9060A	
280-81693-3MSD	Matrix Spike Duplicate	T	Solid	9060A	
280-81693-4	PIT 4 2-6	T	Solid	9060A	
280-81693-5	PIT 4 6-12	T	Solid	9060A	
280-81693-6	PIT 5 6-10	T	Solid	9060A	
Prep Batch: 280-321059					
LCS 280-321059/1-A	Lab Control Sample	S	Solid	DI Leach	
280-81693-3	PIT 3 3-5	S	Solid	DI Leach	
280-81693-4	PIT 4 2-6	S	Solid	DI Leach	
280-81693-5	PIT 4 6-12	S	Solid	DI Leach	
280-81693-6	PIT 5 6-10	S	Solid	DI Leach	
280-81693-6DU	Duplicate	S	Solid	DI Leach	
Analysis Batch:280-321210					
LCS 280-321059/1-A	Lab Control Sample	S	Solid	9045C	
280-81693-3	PIT 3 3-5	S	Solid	9045C	
280-81693-4	PIT 4 2-6	S	Solid	9045C	
280-81693-5	PIT 4 6-12	S	Solid	9045C	
280-81693-6	PIT 5 6-10	S	Solid	9045C	
280-81693-6DU	Duplicate	S	Solid	9045C	

Client: Waste Management Job Number: 280-81693-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
General Chemistry					
Prep Batch: 280-321338					
LCS 280-321338/1-A	Lab Control Sample	S	Solid	DI Leach	
280-81693-3	PIT 3 3-5	S	Solid	DI Leach	
280-81693-4	PIT 4 2-6	S	Solid	DI Leach	
280-81693-5	PIT 4 6-12	S	Solid	DI Leach	
280-81693-6	PIT 5 6-10	S	Solid	DI Leach	
280-81693-6DU	Duplicate	S	Solid	DI Leach	
Analysis Batch:280-321492					
LCS 280-321338/1-A	Lab Control Sample	S	Solid	9045C	
280-81693-3	PIT 3 3-5	S	Solid	9045C	
280-81693-4	PIT 4 2-6	S	Solid	9045C	
280-81693-5	PIT 4 6-12	S	Solid	9045C	
280-81693-6	PIT 5 6-10	S	Solid	9045C	
280-81693-6DU	Duplicate	S	Solid	9045C	
Analysis Batch:280-321966					
LCS 280-321968/3-A	Lab Control Sample	S	Solid	9050A	
MB 280-321968/4-A	Method Blank	S	Solid	9050A	
280-81693-3	PIT 3 3-5	S	Solid	9050A	
280-81693-3DU	Duplicate	S	Solid	9050A	
280-81693-4	PIT 4 2-6	S	Solid	9050A	
280-81693-5	PIT 4 6-12	S	Solid	9050A	
280-81693-6	PIT 5 6-10	S	Solid	9050A	
Prep Batch: 280-321968					
LCS 280-321968/3-A	Lab Control Sample	S	Solid	DI Leach	
MB 280-321968/4-A	Method Blank	S	Solid	DI Leach	
280-81693-3	PIT 3 3-5	S	Solid	DI Leach	
280-81693-3DU	Duplicate	S	Solid	DI Leach	
280-81693-4	PIT 4 2-6	S	Solid	DI Leach	
280-81693-5	PIT 4 6-12	S	Solid	DI Leach	
280-81693-6	PIT 5 6-10	S	Solid	DI Leach	

Report Basis
S = Soluble
T = Total

Client: Waste Management

Job Number: 280-81693-1

Method Blank - Batch: 280-320884

Method: 20B
Preparation: 20B Soluble

Lab Sample ID:	MB 280-320884/1-A	Analysis Batch:	280-321949	Instrument ID:	MT_025
Client Matrix:	Solid	Prep Batch:	280-320884	Lab File ID:	N/A
Dilution:	10	Leach Batch:	N/A	Initial Weight/Volume:	100 g
Analysis Date:	04/21/2016 0958	Units:	No Unit	Final Weight/Volume:	50 mL
Prep Date:	04/14/2016 1806				
Leach Date:	N/A				

Analyte	Result	Qual	RL
Sodium Adsorption Ratio	ND		1.2

Duplicate - Batch: 280-320884

Method: 20B
Preparation: 20B Soluble

Lab Sample ID:	280-81693-3	Analysis Batch:	280-321949	Instrument ID:	MT_025
Client Matrix:	Solid	Prep Batch:	280-320884	Lab File ID:	N/A
Dilution:	10	Leach Batch:	N/A	Initial Weight/Volume:	100 g
Analysis Date:	04/21/2016 1006	Units:	No Unit	Final Weight/Volume:	50 mL
Prep Date:	04/14/2016 1806				
Leach Date:	N/A				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
Sodium Adsorption Ratio	ND	ND	NC	20	

Client: Waste Management

Job Number: 280-81693-1

Duplicate - Batch: 280-321210

Method: 9045C
Preparation: N/A

Lab Sample ID:	280-81693-6	Analysis Batch:	280-321210	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	280-321059	Initial Weight/Volume:	1 mL
Analysis Date:	04/18/2016 0824	Units:	SU	Final Weight/Volume:	1 mL
Prep Date:	N/A				
Leach Date:	04/15/2016 1536				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
pH adj. to 25 deg C-Soluble	9.30	9.300	0	5	

Client: Waste Management

Job Number: 280-81693-1

Duplicate - Batch: 280-321492

Method: 9045C
Preparation: N/A

Lab Sample ID:	280-81693-6	Analysis Batch:	280-321492	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	280-321338	Initial Weight/Volume:	1 mL
Analysis Date:	04/19/2016 1156	Units:	SU	Final Weight/Volume:	1 mL
Prep Date:	N/A				
Leach Date:	04/18/2016 1524				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
pH adj. to 25 deg C-Soluble	9.25	9.230	0.2	5	

Client: Waste Management Job Number: 280-81693-1

Method Blank - Batch: 280-321966

Method: 9050A
Preparation: N/A

Lab Sample ID:	MB 280-321968/4-A	Analysis Batch:	280-321966	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	280-321968	Initial Weight/Volume:	
Analysis Date:	04/19/2016 2141	Units:	umhos/cm	Final Weight/Volume:	25 mL
Prep Date:	N/A				
Leach Date:	04/19/2016 2104				

Analyte	Result	Qual	RL
Specific Conductance-Soluble	ND		20

Lab Control Sample - Batch: 280-321966

Method: 9050A
Preparation: N/A

Lab Sample ID:	LCS 280-321968/3-A	Analysis Batch:	280-321966	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	280-321968	Initial Weight/Volume:	
Analysis Date:	04/19/2016 2141	Units:	umhos/cm	Final Weight/Volume:	25 mL
Prep Date:	N/A				
Leach Date:	04/19/2016 2104				

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Specific Conductance-Soluble	14100	13800	98	90 - 110	

Duplicate - Batch: 280-321966

Method: 9050A
Preparation: N/A

Lab Sample ID:	280-81693-3	Analysis Batch:	280-321966	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	280-321968	Initial Weight/Volume:	
Analysis Date:	04/19/2016 2141	Units:	umhos/cm	Final Weight/Volume:	25 mL
Prep Date:	N/A				
Leach Date:	04/19/2016 2104				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
Specific Conductance-Soluble	370	362	1	20	

Method Blank - Batch: 280-320916

Method: 9060A
Preparation: N/A

Lab Sample ID:	MB 280-320916/4	Analysis Batch:	280-320916	Instrument ID:	WC_Leco
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	041416.csv
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	04/14/2016 2041	Units:	g/Kg	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Result	Qual	RL
Total Organic Carbon	ND		4.0

Lab Control Sample - Batch: 280-320916

Method: 9060A
Preparation: N/A

Lab Sample ID:	LCS 280-320916/3	Analysis Batch:	280-320916	Instrument ID:	WC_Leco
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	041416.csv
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	04/14/2016 2039	Units:	g/Kg	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Total Organic Carbon	123	98.8	81	46 - 130	

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-320916

Method: 9060A
Preparation: N/A

MS Lab Sample ID:	280-81693-3	Analysis Batch:	280-320916	Instrument ID:	WC_Leco
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	041416.csv
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	04/14/2016 2047			Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

MSD Lab Sample ID:	280-81693-3	Analysis Batch:	280-320916	Instrument ID:	WC_Leco
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	041416.csv
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	04/14/2016 2050			Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Total Organic Carbon	102	101	46 - 130	1	20		

Client: Waste Management

Job Number: 280-81693-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-320916

Method: 9060A
Preparation: N/A

MS Lab Sample ID:	280-81693-3	Units: g/Kg	MSD Lab Sample ID:	280-81693-3	
Client Matrix:	Solid		Client Matrix:	Solid	
Dilution:	1.0		Dilution:	1.0	
Analysis Date:	04/14/2016 2047		Analysis Date:	04/14/2016 2050	
Prep Date:	N/A		Prep Date:	N/A	
Leach Date:	N/A		Leach Date:	N/A	

Analyte	Sample Result/Qual	MS Spike Amount	MSD Spike Amount	MS Result/Qual	MSD Result/Qual
Total Organic Carbon	ND	120	120	122	121

Client: Waste Management

Job Number: 280-81693-1

Method Blank - Batch: 560-127298

Method: 9081
Preparation: 9081

Lab Sample ID:	MB 560-127298/1-A	Analysis Batch:	560-127300	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	560-127298	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	4 g
Analysis Date:	04/25/2016 1032	Units:	meq/100gm	Final Weight/Volume:	100 mL
Prep Date:	04/22/2016 1028				
Leach Date:	N/A				

Analyte	Result	Qual	RL
Cation Exchange Capacity	ND		0.050

Client: Waste Management

Job Number: 280-81693-1

Duplicate - Batch: 280-320252

Method: Moisture
Preparation: N/A

Lab Sample ID:	280-81658-A-2 DU	Analysis Batch:	280-320252	Instrument ID:	No Equipment Assigned
Client Matrix:	Solid	Prep Batch:	N/A	Lab File ID:	N/A
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	04/11/2016 1717	Units:	%	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
Percent Moisture	13.6	11.2	20	20	

Client: Waste Management Job Number: 280-81693-1

Laboratory Chronicle

Lab ID: 280-81693-1 **Client ID: PIT 1 2-4**

Sample Date/Time: 03/22/2016 11:50 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:9081	280-81693-A-1-A		560-127300	560-127298	04/22/2016 10:28	1	TAL CC	JEM
A:9081	280-81693-A-1-A		560-127300	560-127298	04/25/2016 10:32	1	TAL CC	JEM
A:Moisture	280-81693-B-1		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Lab ID: 280-81693-2 **Client ID: PIT 2 5-9**

Sample Date/Time: 03/22/2016 12:10 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:9081	280-81693-A-2-A		560-127300	560-127298	04/22/2016 10:28	1	TAL CC	JEM
A:9081	280-81693-A-2-A		560-127300	560-127298	04/25/2016 10:32	1	TAL CC	JEM
A:Moisture	280-81693-B-2		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Lab ID: 280-81693-3 **Client ID: PIT 3 3-5**

Sample Date/Time: 03/22/2016 12:30 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:20B	280-81693-A-3-A		280-321949	280-320884	04/14/2016 18:06	10	TAL DEN	SEJ
A:20B	280-81693-A-3-A		280-321949	280-320884	04/21/2016 10:01	10	TAL DEN	CRR
A:9045C	280-81693-A-3-C		280-321210		04/18/2016 08:24	1	TAL DEN	IEU
A:9050A	280-81693-A-3-J		280-321966		04/19/2016 21:41	1	TAL DEN	RSM
A:9060A	280-81693-A-3		280-320916		04/14/2016 20:43	1	TAL DEN	SVC
A:Moisture	280-81693-A-3		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Lab ID: 280-81693-3 MS **Client ID: PIT 3 3-5**

Sample Date/Time: 03/22/2016 12:30 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:9060A	280-81693-A-3 MS		280-320916		04/14/2016 20:47	1	TAL DEN	SVC

Lab ID: 280-81693-3 MSD **Client ID: PIT 3 3-5**

Sample Date/Time: 03/22/2016 12:30 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:9060A	280-81693-A-3 MSD		280-320916		04/14/2016 20:50	1	TAL DEN	SVC

Client: Waste Management Job Number: 280-81693-1

Laboratory Chronicle

Lab ID: 280-81693-3 DU **Client ID: PIT 3 3-5**

Sample Date/Time: 03/22/2016 12:30 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:20B	280-81693-A-3-B DU		280-321949	280-320884	04/14/2016 18:06	10	TAL DEN	SEJ
A:20B	280-81693-A-3-B DU		280-321949	280-320884	04/21/2016 10:06	10	TAL DEN	CRR
A:9050A	280-81693-A-3-K DU		280-321966		04/19/2016 21:41	1	TAL DEN	RSM

Lab ID: 280-81693-4 **Client ID: PIT 4 2-6**

Sample Date/Time: 03/22/2016 12:50 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:20B	280-81693-A-4-A		280-321949	280-320884	04/14/2016 18:06	10	TAL DEN	SEJ
A:20B	280-81693-A-4-A		280-321949	280-320884	04/21/2016 10:09	10	TAL DEN	CRR
A:9045C	280-81693-A-4-B		280-321210		04/18/2016 08:24	1	TAL DEN	IEU
A:9050A	280-81693-A-4-G		280-321966		04/19/2016 21:41	1	TAL DEN	RSM
A:9060A	280-81693-A-4		280-320916		04/14/2016 20:52	1	TAL DEN	SVC
A:Moisture	280-81693-A-4		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Lab ID: 280-81693-5 **Client ID: PIT 4 6-12**

Sample Date/Time: 03/22/2016 12:55 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:20B	280-81693-A-5-A		280-321949	280-320884	04/14/2016 18:06	10	TAL DEN	SEJ
A:20B	280-81693-A-5-A		280-321949	280-320884	04/21/2016 10:12	10	TAL DEN	CRR
A:9045C	280-81693-A-5-B		280-321210		04/18/2016 08:24	1	TAL DEN	IEU
A:9050A	280-81693-A-5-G		280-321966		04/19/2016 21:41	1	TAL DEN	RSM
A:9060A	280-81693-A-5		280-320916		04/14/2016 20:54	1	TAL DEN	SVC
A:Moisture	280-81693-A-5		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Lab ID: 280-81693-6 **Client ID: PIT 5 6-10**

Sample Date/Time: 03/22/2016 13:10 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:20B	280-81693-A-6-A		280-321949	280-320884	04/14/2016 18:06	10	TAL DEN	SEJ
A:20B	280-81693-A-6-A		280-321949	280-320884	04/21/2016 10:15	10	TAL DEN	CRR
A:9045C	280-81693-A-6-B		280-321210		04/18/2016 08:24	1	TAL DEN	IEU
A:9050A	280-81693-A-6-J		280-321966		04/19/2016 21:41	1	TAL DEN	RSM
A:9060A	280-81693-A-6		280-320916		04/14/2016 20:56	1	TAL DEN	SVC
A:Moisture	280-81693-A-6		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Client: Waste Management Job Number: 280-81693-1

Laboratory Chronicle

Lab ID: 280-81693-6 DU **Client ID: PIT 5 6-10**

Sample Date/Time: 03/22/2016 13:10 Received Date/Time: 04/07/2016 11:33

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:9045C	280-81693-A-6-C DU		280-321210		04/18/2016 08:24	1	TAL DEN	IEU
A:9045C	280-81693-A-6-G DU		280-321492		04/19/2016 11:56	1	TAL DEN	IEU

Lab ID: MB **Client ID: N/A**

Sample Date/Time: N/A Received Date/Time: N/A

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:20B	MB 280-320884/1-A		280-321949	280-320884	04/14/2016 18:06	10	TAL DEN	SEJ
A:20B	MB 280-320884/1-A		280-321949	280-320884	04/21/2016 09:58	10	TAL DEN	CRR
A:9050A	MB 280-321968/4-A		280-321966		04/19/2016 21:41	1	TAL DEN	RSM
A:9060A	MB 280-320916/4		280-320916		04/14/2016 20:41	1	TAL DEN	SVC
P:9081	MB 560-127298/1-A		560-127300	560-127298	04/22/2016 10:28	1	TAL CC	JEM
A:9081	MB 560-127298/1-A		560-127300	560-127298	04/25/2016 10:32	1	TAL CC	JEM

Lab ID: LCS **Client ID: N/A**

Sample Date/Time: N/A Received Date/Time: N/A

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:9045C	LCS 280-321059/1-A		280-321210		04/18/2016 08:24	1	TAL DEN	IEU
A:9045C	LCS 280-321338/1-A		280-321492		04/19/2016 11:56	1	TAL DEN	IEU
A:9050A	LCS 280-321968/3-A		280-321966		04/19/2016 21:41	1	TAL DEN	RSM
A:9060A	LCS 280-320916/3		280-320916		04/14/2016 20:39	1	TAL DEN	SVC

Lab ID: DU **Client ID: N/A**

Sample Date/Time: 04/04/2016 10:30 Received Date/Time: 04/06/2016 09:30

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:Moisture	280-81658-A-2 DU		280-320252		04/11/2016 17:17	1	TAL DEN	CML

Lab References:
TAL CC = TestAmerica Corpus Christi
TAL DEN = TestAmerica Denver

Chain of Custody Record

15.6 IR-0.2 07Apr16 Transferred

Temperature on Receipt _____

Drinking Water? Yes ☐ No ☒

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124 (1007)

Client	Project Manager	Date	Chain of Custody Number
SWIFT RIVER ENVIRONMENTAL	PETE ZLATEV	4/7/16	277383
Address	**Telephone Number (Area Code)/Fax Number**	**Lab Number**	**Page** _____ **of** _____
26 W DRY CREEK CIRCLE	303 695-4660 x 106		
City / **State** / **Zip Code**	**Site Contact**	**Lab Contact**	
LITTLETON / CO / 80120			
Project Name and Location (State)	**Carrier/Waybill Number**		
NW LANDFILL			
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH	Analysis (Attach list if more space is needed): 7503-10 (CEC)	AG. PROPERTIES	pH, SAR, EC, TOC
PIT 1 2-4	3/22/16	1150				X	X						X		
PIT 2 5-9		1210				X	X						X		
PIT 3 3-5		1230				X	X								X
PIT 4 2-6		1250				X	X								X
PIT 4 6-12		1255				X	X								X
PIT 5 6-10		1310				X	X								X

Special Instructions/ Conditions of Receipt

280-81693 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months
(A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☒ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By	4/7/16	10:48	1. Received By	4/7/16	10:48
2. Relinquished By	4/7/16	11:33	2. Received By	07Apr16	1133
3. Relinquished By			3. Received By		

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

TestAmerica Denver
4955 Yarrow Street
Arvada, CO 80002
Phone (303) 736-0100 Fax (303) 431-7171

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information (Sub Contract Lab)	Sampler:	Lab PM: Sara, Betsy A	Carrier Tracking No(s):	COC No: 280-346281.1
Client Contact: Shipping/Receiving	Phone:	E-Mail: betsy.sara@testamericainc.com		Page: Page 1 of 1
Company: TestAmerica Laboratories, Inc.				Job #: 280-81693-1

Address: 1733 N. Padre Island Drive, ,	Due Date Requested: 4/25/2016
City: Corpus Christi	TAT Requested (days):
State, Zip: TX, 78408	PO #:
Phone: 361-289-2673(Tel) 361-289-2471(Fax)	WO #:
Email:	Project #: 28003044
Project Name: 588|North Weld	SSOW#:
Site: 588|North Weld Landfill	

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - ph 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification - Client ID (Lab ID)	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	9081/9081_Prep Cation Exchange Capacity (CEC) - TA CC	Total Number of containers	Special Instructions/Note:
			Preservation Code:						
PIT 1 2-4 (280-81693-1)	3/22/16	11:50 Mountain		Solid			X	1	
PIT 2 5-9 (280-81693-2)	3/22/16	12:10 Mountain		Solid			X	1	

Possible Hazard Identification
Unconfirmed

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* _____ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment: Fedex Standard 107352395 4159

	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
1	[signature]	4-11-16 1595		[signature]	4-12-16 10:00	TACC
2	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
3	Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 1.4 / 2.0 COC IR9

04/25/2016

Login Sample Receipt Checklist

Client: Waste Management

Job Number: 280-81693-1

Login Number: 81693

List Source: TestAmerica Denver

List Number: 1

Creator: Muniz, Ashley T

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	N/A	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	False	
Cooler Temperature is acceptable.	False	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time (Excluding tests with immediate HTs)..	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Sampling Company provided.	True	
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	True	
Chlorine Residual checked.	N/A	

Login Sample Receipt Checklist

Client: Waste Management

Job Number: 280-81693-1

Login Number: 81693
List Number: 2
Creator: Etter, Corey M

List Source: TestAmerica Corpus Christi
List Creation: 04/12/16 05:05 PM

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	1.4 obs. / 2.0 corr. IR9
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	ICOC
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

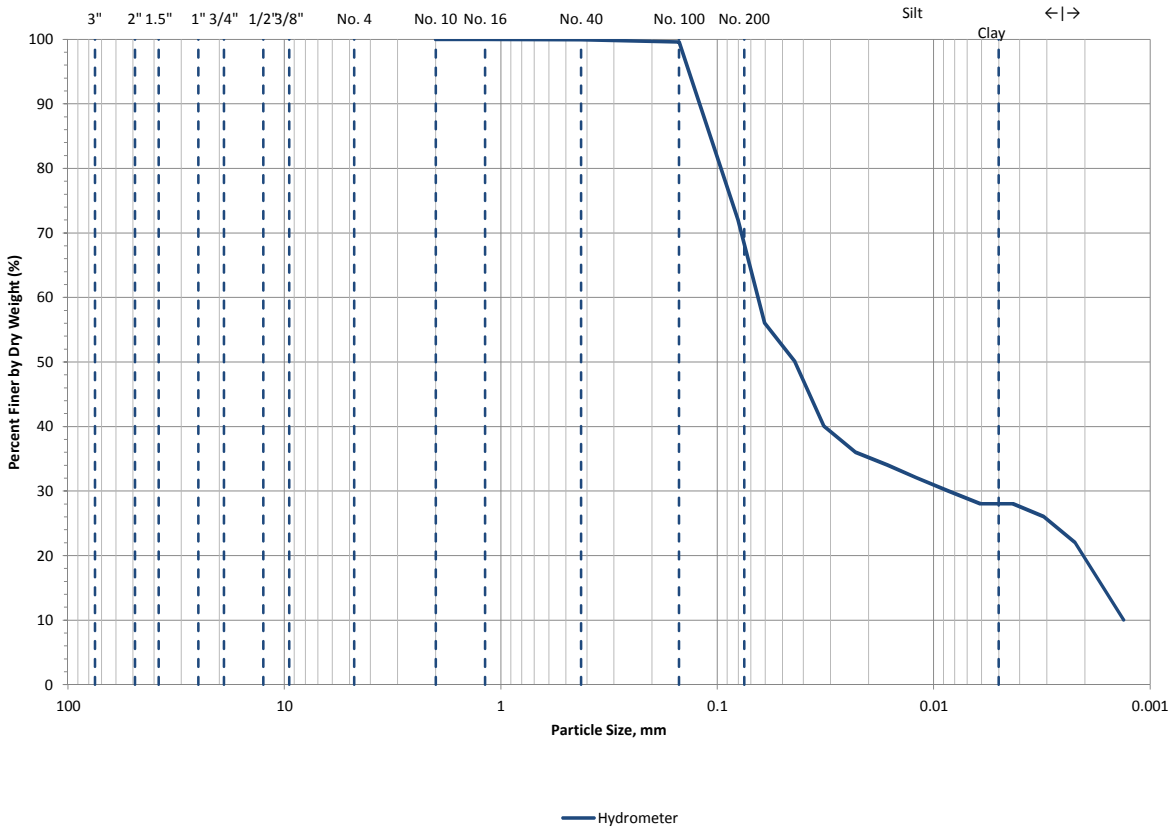
APPENDIX F

SOIL WATER CHARACTERISTIC CURVE RESULTS

Soil Water Characteristic Curve Results
Swift River Environmetal
Project No. 2016.R006

Applied Soil Water Technologies
56 Coney Island Drive
Sparks, Nevada 89431
Ph: 775.284.5500 Fax: 775.284.5504
www.appliedsoilwater.com

Sample	Suction		Gravimetric Moisture Content	Final Dry Density (pcf)	Final Volumetric Moisture Content	van Genuchten Parameters, cm				
	Bars	cm				α	*n*	*m*	θ_r	θ_s
Test Pit #4 6'-12' bgs	0.04	40.79	21.5	100.5	0.346	0.01	1.22482	0.18355	0.000	0.377
	0.333	339.6	18.0	98.5	0.284					
	1	1,020	13.9	98.5	0.219					
	4	4,079	9.8	99.4	0.156					
	10.7	10,911	8.1	102.8	0.133					
	22.5	22,943	6.2	102.7	0.102					
Test Pit #5 6'-10' bgs	0.04	40.79	25.1	99.4	0.400	0.006	1.24000	0.19355	0.000	0.408
	0.333	339.6	19.9	98.2	0.313					
	1	1,020	16.1	95.4	0.246					
	4	4,079	13.0	98.6	0.205					
	7.1	7,240	10.4	102.5	0.171					
	16.3	16,621	8.5	102.4	0.139					
	37.5	38,239	6.4	102.5	0.105					

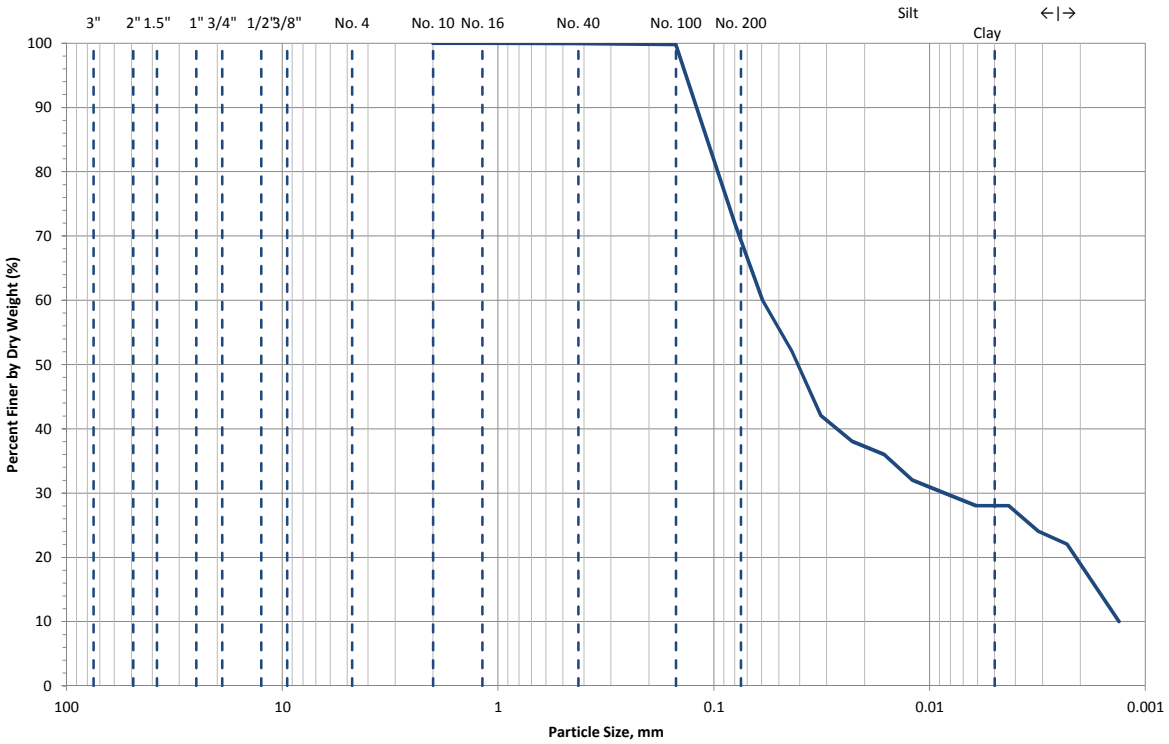


Particle Size, mm	Hydrometer Percent Passing by Dry Weight	Notes
2	100	
1.18	100	Results Generated By Post-Hydrometer Mechanical Sieve
0.425	99.93	
0.1500	99.6	
0.0801	72.0	
0.0605	56.0	
0.0438	50.0	
0.0321	40.0	
0.0230	36.0	
0.0164	34.0	Results Generated By Hydrometer Analysis Sedimentation
0.0120	32.0	
0.0086	30.0	
0.0061	28.0	
0.0043	28.0	
0.0031	26.0	
0.0022	22.0	
0.0013	10.0	

Swift River Environmental Services
Laboratory Testing

Hydrometer Analysis
Test Pit #4 6'-12' bgs
ASTM D422

Geo-Logic ASSOCIATES
56 Coney Island Drive
Sparks, Nevada 89431
Ph: 775.284.5500 Fax: 775.284.5504



Particle Size, mm	Hydrometer Percent Passing by Dry Weight	Notes
2	100.0	Results Generated By Post Hydrometer Mechanical Sieve
1.18	100.0	
0.425	99.9	
0.1500	99.8	
0.0801	72.0	Results Generated By Hydrometer Analysis Sedimentation
0.0596	60.0	
0.0434	52.0	
0.0319	42.0	
0.0228	38.0	
0.0163	36.0	
0.0120	32.0	
0.0086	30.0	
0.0061	28.0	
0.0043	28.0	
0.0031	24.0	
0.0023	22.0	
0.0013	10.0	

Swift River Environmental Services
Laboratory Testing

Hydrometer Analysis
Test Pit #5 6'-10' bgs
ASTM D422
Project No. 2016.R006

Geo-Logic ASSOCIATES
56 Coney Island Drive
Sparks, Nevada 89431

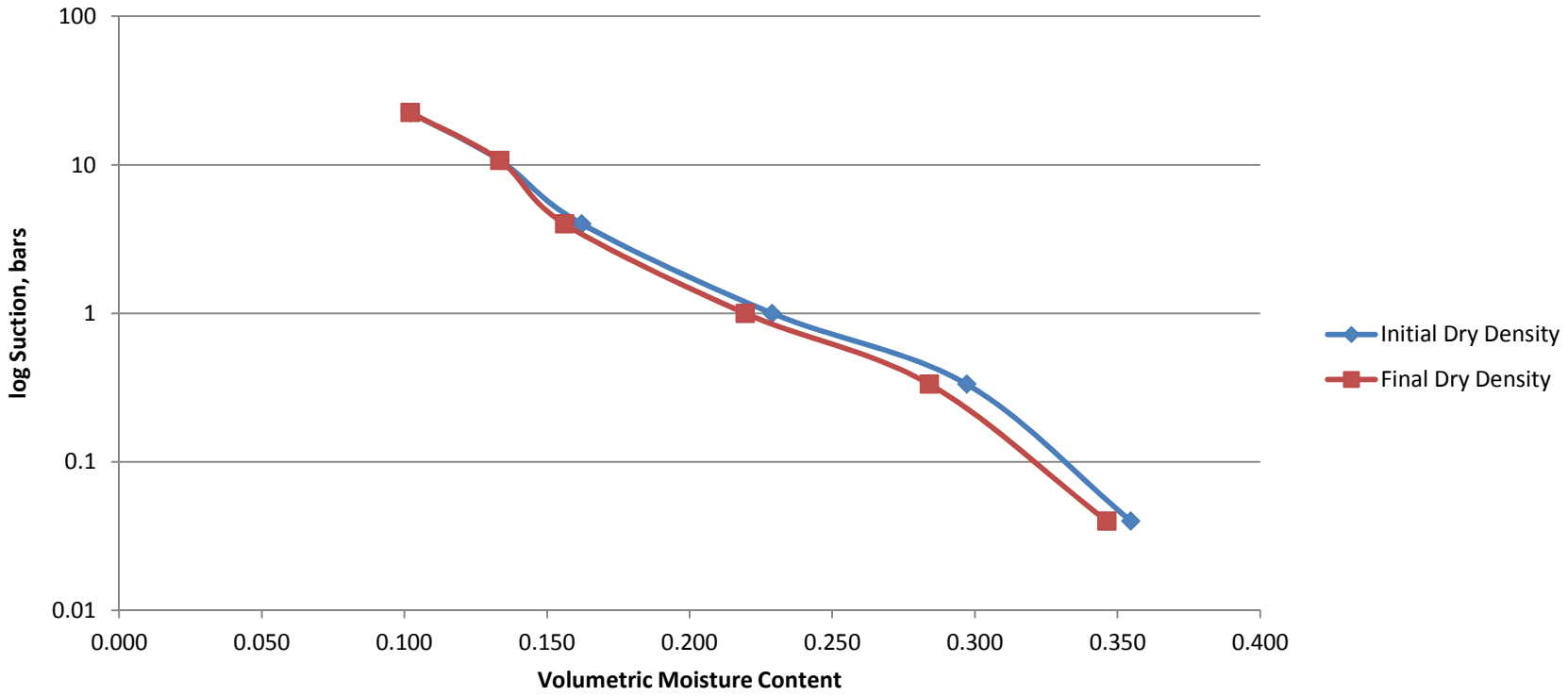
Soil Water Characteristic Curve Results
Swift River Environmental

Applied Soil Water Technologies
56 Coney Island Drive
Sparks, Nevada 89431
Ph: 775.284.5500 Fax: 775.284.5504
www.appliedsoilwater.com

Sample	Suction (Bars)	Gravimetric Moisture Content	Initial Dry Density (pcf)	Volumetric Moisture Content	Final Dry Density[1] (pcf)	Volumetric Moisture Content
Test Pit #4, 6'-12' bgs	0.04	21.5	102.9	0.355	100.5	0.346
	1/3	18.0	103.0	0.297	98.5	0.284
	1	13.9	102.7	0.229	98.5	0.219
	4	9.8	103.2	0.162	99.4	0.156
	10.7	8.1	102.8	0.133	102.8	0.133
	22.5	6.2	102.7	0.102	102.7	0.102
Test Pit #5, 6'-10' bgs	0.04	25.1	102.8	0.414	99.4	0.400
	1/3	19.9	102.9	0.328	98.2	0.313
	1	16.1	102.6	0.265	95.4	0.246
	4	13.0	102.8	0.214	98.6	0.205
	7.1	10.4	102.5	0.171	102.5	0.171
	16.3	8.5	102.4	0.139	102.4	0.139
	37.5	6.4	102.5	0.105	102.5	0.105

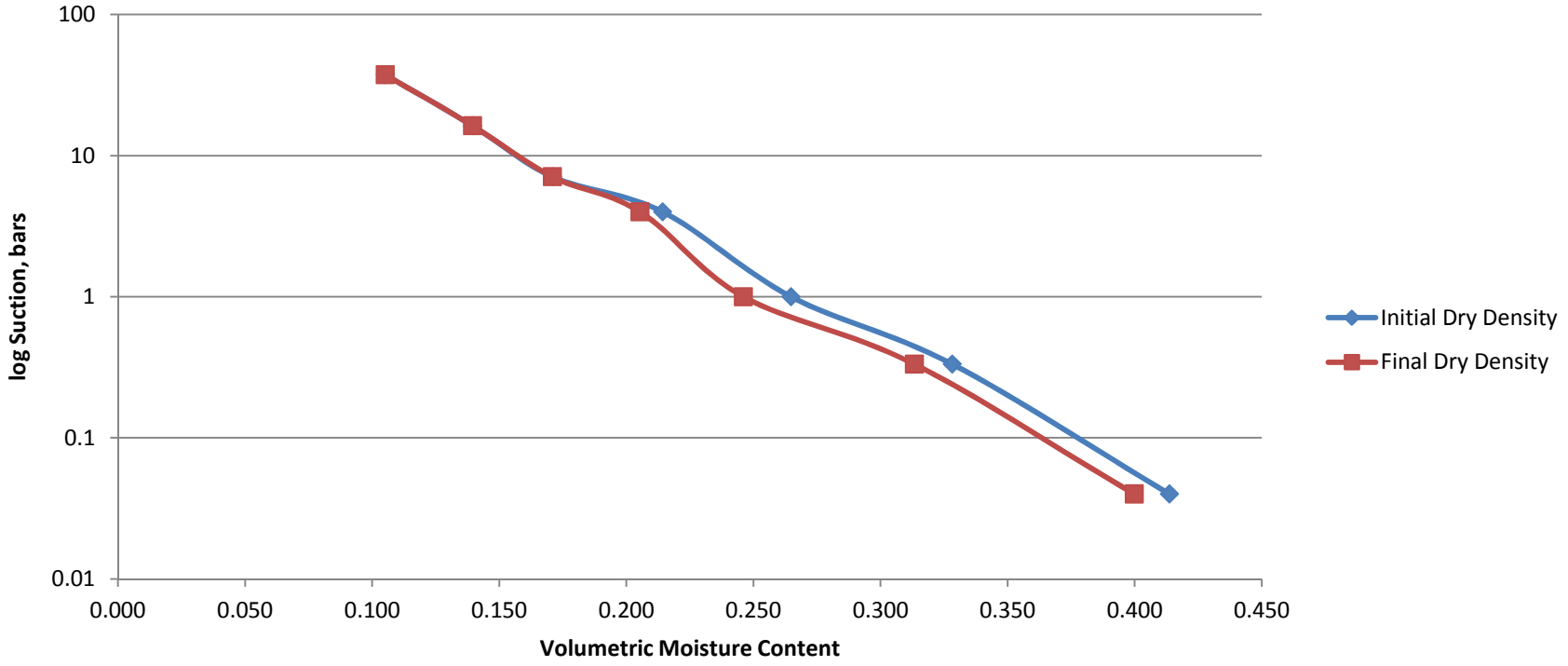
NOTE 1: Volumetric moisture content calculations from both the remolded and final dry densities are reported due to the amount of swelling that occurred during specimen saturation.

Laboratory Soil Water Characteristic Curve
TP#4, 6'-12' bgs



Swift River Environmental Services, LLC. **Laboratory Testing**	**Laboratory Soil Water Characteristic Curves** **ASTM D6836** **Project No. 2016.R006**	Applied Soil Water Technologies 56 Coney Island Drive Sparks, Nevada 89431 Ph: 775.284.5500 Fax: 775.284.5504 www.appliedsoilwater.com

Laboratory Soil Water Characteristic Curve
TP#5, 6'-10' bgs



Swift River Environmental Services, LLC. **Laboratory Testing**	**Laboratory Soil Water Characteristic Curves** **ASTM D6836** **Project No. 2016.R006**	Applied Soil Water Technologies 56 Coney Island Drive Sparks, Nevada 89431 Ph: 775.284.5500 Fax: 775.284.5504 www.appliedsoilwater.com

APPENDIX B-2

REPORT OF HYDROGEOLOGICAL CHARACTERIZATION, NORTH WELD LANDFILL UNIT 2, PERMITTING AND DEVELOPMENT (SWIFT RIVER ENVIRONMENTAL SERVICES, LLC; DECEMBER 2016)

FINAL REPORT

HYDROGEOLOGIC CHARACTERIZATION OF NORTH WELD LANDFILL UNIT 2

PERMITTING AND DEVELOPMENT

WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

Prepared by

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

An Alaska Native Corporation

26 West Dry Creek Circle, Suite 470 ♦ Littleton, Colorado ♦ 303-695-4660

DECEMBER 2016

FINAL REPORT

HYDROGEOLOGIC CHARACTERIZATION FOR NORTH WELD LANDFILL UNIT 2

Permitting and Development

Prepared by

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

An Alaska Native Corporation

December 2016

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1 INTRODUCTION AND PURPOSE

1.1 INTRODUCTION

This "Report of Hydrogeologic Characterization for North Weld Landfill Unit 2" describes activities conducted by Swift River Environmental Services, LLC (Swift River) to assist Waste Management Disposal Services of Colorado (WMDSC) with the permitting and development of the North Weld Landfill (NWLF) Unit 2. The Hydrogeologic Characterization was accomplished by completing a subsurface investigation of the NWLF Unit 2 area, conducting field and laboratory testing, and evaluating the collected data. The purpose for the investigation was to develop an understanding of hydrogeologic (i.e., groundwater) conditions that will be considered in landfill design and construction, and subsequent environmental monitoring. The hydrogeologic investigation included completion of soil borings, shallow test pits, installation of temporary piezometers and wells, field testing, and laboratory analyses. Field testing was done to determine hydraulic conductivity of the stratigraphic zones monitored in the temporary wells. Laboratory analyses were done to determine water-quality characteristics of groundwater samples. The hydrogeologic characterization investigation of NWLF Unit 2 was done concurrently with a geotechnical investigation of the NWLF Unit 2 area and the results of the geotechnical investigation, which are included in a separate report, were included in the evaluation of the hydrogeologic characterization. The process of planning, design, and permitting of NWLF Unit 2 includes completion of this Hydrogeologic Characterization and the Geotechnical Investigation.

A "Workplan for Hydrogeologic Characterization and Geotechnical Investigation" (Workplan, dated February 2016) was prepared by Swift River to be consistent with data requirements outlined in Colorado's Solid Waste Rules and was approved for implementation by WMDSC. The Hydrogeologic Characterization Investigation work closely followed the approved Workplan and consisted of the following tasks:

- Pre-field work planning, subcontractor arrangements, and mobilization to the site;
- Oversight and stratigraphic logging of soil borings and collection of disturbed and undisturbed soil samples;

- Installation and development of temporary monitoring wells;
- Groundwater sampling and sample submittal to the laboratory for analysis;
- Slug tests completed in temporary monitoring wells;
- Review and interpretation of field and laboratory analytical data;
- Development of boring logs, data summary tables, hydrogeologic cross-sections, and site characterization maps; and
- Preparation of this Hydrogeologic Characterization for NWLF Unit 2.

The locations of the soil borings, test pits, temporary piezometers, and temporary wells completed as part of this Hydrogeologic Characterization and the Geotechnical Investigation are shown in **Figure 3, Site Map and Hydrogeologic Characterization Investigation Locations.**

1.2 PURPOSE OF INVESTIGATION

The Hydrogeologic Characterization was performed to characterize geologic strata and groundwater conditions to a depth of about 129 feet below ground surface at the NWLF Unit 2. The hydrogeologic characterization of the NWLF Unit 2 provides the following technical information and data evaluation:

- Identify possible presence of groundwater within geologic strata between ground surface and about 20 feet below planned disposal cell base grade;
- Identify presence of groundwater regime(s) deeper than 20 feet below planned base grade with the principal purpose of determining saturated geologic intervals at NWLF Unit 2 that are appropriate for groundwater monitoring and determine correlation of such regime(s) with groundwater conditions beneath NWLF Unit 1;
- Evaluate the hydraulic conductivity of geologic materials below NWLF Unit 2 by soil laboratory testing and field (slug) test methods (i.e., groundwater); and
- Collect groundwater samples and determine baseline water quality conditions for volatile organic compounds and major ions.

Planned base grades, as considered for the Workplan and Hydrogeologic Characterization, are a preliminary estimate for the cell bottom configuration. The planned disposal cell base

grade is subject to change based on the findings of the Geotechnical Investigation[1] and Hydrogeologic Characterization, as well as on the basis of other design considerations. The "20-feet below planned base grade" depth objective for determination of the presence/absence of groundwater was selected to provide design flexibility in the event that a lower elevation base grade is determined through the Unit 2 design process.

The final primary purpose of the Hydrogeologic Characterization is the development of this report as the comprehensive compilation of hydrogeologic characterization data and the results of characterization data evaluation.

[1] The "Geotechnical Investigation, North Weld Landfill Unit 2, Final Report" is a separate report completed in December 2016.

2 SITE CONDITIONS

2.1 SITE LOCATION

The existing North Weld Landfill Unit 1 (NWLF Unit 1) is an active landfill that consists of a 122-acre waste disposal footprint. The proposed NWLF Unit 2 is contiguous property that is north of the NWLF Unit 1 footprint and includes approximate 359 acres. NWLF (Units 1 and 2) is located approximately five miles west of the town of Ault and 14 miles east of Fort Collins on Colorado State Highway 14, in northern Weld County, Colorado, as shown on **Figure 1, Site Location Map**. NWLF Unit 1 and Unit 2 primarily are located in the southwest and northwest quarters, respectively, of Section 7, Township 7 North, Range 66 West of the Sixth Principal Meridian. Unit 2 also extends into the northeast quarter of Section 7. The location is shown on **Figure 2, Topographic Map of NWLF Unit 2 and Vicinity.**

2.2 SITE TOPOGRAPHY

NWLF Unit 2 is topographically characterized as an upland area with a relative uniform slope toward the regional drainage feature (i.e., Coal Bank Creek) that is located about 0.25 mile (1320 feet) east of NWLF Unit 2. Natural, pre-development topographic elevations across the site range from a high of approximately 5,150 feet MSL along the western boundary of the area to a low of approximately 5,070 feet MSL along a man-made drainage channel (Pierce Lateral irrigation ditch) that marks the eastern boundary of the area (**Figure 6, Topography and Surface-Water Flow).** The NWLF Unit 2 topography is crossed by a few very shallow drainage swales, none of which include perennial surface-water flow features. The majority of the NWLF Unit 2 surface area is in agricultural use for dry land crops. **Figure 4** primarily shows the present land use of Section 7, including the NWLF Unit 1 landfill and the NWLF Unit 2 farmed field. **Figure 5** shows the topography and surface-water flow patterns and water features in the vicinity of NWLF Unit 2.

A west to east elongated soil stockpile that is associated with excavation of NWLF Unit 1 disposal cells is present along the southern side of the NWLF Unit 2 area. Elevations on the

stockpile are as high as 5149 feet MSL and represent stockpiles that rise no more than 50 feet above the natural NWLF Unit 2 terrain.

2.3 DEVELOPMENT HISTORY

NWLF is located on land that primarily was agricultural land used for dry-land farming prior to the development of the current landfill operation. Hydrogeologic and geotechnical investigations began in 1989 to evaluate the property for potential development as a municipal solid waste disposal site. NWLF received its initial Certificate of Designation (CD) from the Weld County Board of County Commissioners on June 28, 1990, and construction of the first disposal cell was completed in December 1991. NWLF opened to the public for its first receipt of municipal solid waste on February 3, 1992. Weld County "use by special review" (USR) designations for NWLF Unit 1 and other WMDSC operations at NWLF are indicted on maps provided with this report.

3 HYDROGEOLOGY DATA COLLECTION

3.1 INVESTIGATION SUMMARY

From February 19 to March 2, 2016, Swift River personnel oversaw the drilling of eight soil borings for the installation of temporary wells in the NWLF Unit 2 area. The planned depth of each temporary well was based on the objective of identifying the presence or absence of shallow or deep groundwater to a depth of about 100 feet. The shallow temporary wells were planned to be about 50 feet deep and the deep temporary wells were planned to be about 100 feet deep. Well depths were adjusted in the field based on groundwater conditions observed, and the actual maximum depth of investigation was extended to 129 feet below ground surface at temporary well TW-2. Shallow temporary wells were designated TW-1, 5, and 9 and deep temporary wells were designated TW-2, 4, 6, 8, and 10. Shallow wells TW-3 and TW-7 were planned, but were not drilled based on the absence of shallow groundwater in the paired deep wells (TW-4 and TW-8).

Soil samples were collected from each boring by a continuous coring method for visual inspection and description. All of the temporary monitoring wells except shallow well TW-1 were located about 50 feet outside the proposed NWLF Unit 2 footprint. Shallow temporary well TW-1 was located within the boundary of NWLF Unit 1. With the exception of well TW-1 and deep well TW-2 (located on the west side of NWLF Unit 2), the temporary wells were proposed as paired shallow/deep wells along the north and eastern side of the NWLF Unit 2. The planned paired well locations were TW-3/TW-4, TW-5/TW-6, TW-7/TW-8, and TW-9/TW-10. As noted above, planned temporary wells TW-3 and TW-7 were not drilled.

Boring records are provided in **Appendix C** and stratigraphic interpretation and test results pertinent to the hydrogeologic characterization of the NWLF Unit 2 are summarized in **Sections 4** and **5.**

3.2 FIELD DATA COLLECTION

3.2.1 Hydrogeologic Boring Locations

Swift River personnel walked and observed surface conditions in the NWLF Unit 2 area and staked locations for 10 temporary monitoring wells on February 5, 2016. Nine proposed temporary well locations were positioned about 50 feet outside the proposed NWLF Unit 2 footprint to avoid cell, access road, and drainage ditch construction. One shallow temporary well (TW-1) was located within the boundaries of NWLF Unit 1. A single deep well (TW-2) was proposed at location on the west side of NWLF Unit 2. Other temporary well positions were proposed as paired shallow/deep wells located along the north and eastern side of the NWLF Unit 2 were at TW-3/TW-4, TW-5/TW-6, TW-7/TW-8, and TW-9/TW-10. Based on encountered field conditions, temporary wells TW-3 and TW-7 were not drilled or installed. Ultimately, eight temporary wells were installed; the locations are shown on **Figure 3, Site Map and Hydrogeologic Characterization Investigation Locations** included in **Appendix A**.

The planned depth of each temporary well boring was based on the objective of identifying the presence or absence of shallow or deep groundwater and monitoring the same. The well borings were planned to be 50 feet deep for the shallow wells and 100 feet deep for the deep wells, but drilled depths were adjusted based on actual subsurface conditions, with one boring (TW-2) extending to 129 feet below ground surface. The three installed temporary shallow well locations were designated TW-1, 5, and 9 and the five temporary deep well locations were designated TW-2, 5, 6, 8, and 10. The planned drilling depths are presented in the Workplan and actual drilling depths are presented in **Table 1** included in **Appendix B**.

3.2.2 Drilling and Well Installation

The temporary well borings were drilled by Drilling Engineers, Inc. of Ft. Collins, Colorado. The hydrogeologic characterization drilling program began on February 19, 2016 and was completed on March 2, 2016. Borings were drilled using a CME-75 drill rig with an 8.25 inch outer diameter hollow-stem auger. The borings were sampled using a five-feet long

continuous soil sampler to maximize recovery of penetrated materials for thorough description and development of lithologic boring logs. Material descriptions and depths were recorded in the field and are presented in the soil boring records included in **Appendix C**.

3.2.3 Lithologic Sample Description

During boring advancement, Swift River prepared detailed descriptions of recovered soil material and retained representative portions of the soil samples from each five-foot long continuous core sample. Samples were marked with the boring number and depth. The retained soil samples were available during review of the soil boring records to aid in correlation between different borings and development of cross-sections across the NWLF Unit 2 area.

3.2.4 Temporary Monitoring Wells

3.2.4.1 Drilling and Well Installation

Eight soil borings were advanced for the installation of the temporary monitoring wells. At paired monitor well locations, the deep well was drilled and installed first to determine the presence of shallow water. Temporary wells were drilled where shallow groundwater was present.

The temporary wells were installed with the following construction details.

- 2.0-inch inside diameter Schedule 40 PVC casing, screen, and bottom cap.
- Screen lengths of 5 to 20 feet of 0.010-inch factory-slotted well screen.
- Well screen positioned at the bottom of the boring.
- Sand pack was installed with a 10/20 sand filter around the well screen to about three feet above the well screen.
- Bentonite pellet seal, two-feet thick, placed above the sand pack and hydrated with potable water.
- Bentonite grout, place from the pellet seal to four feet below ground surface.

- Bentonite chips placed from the top of the grout to the ground surface.
- Casing projection above ground surface of approximately 3 feet, completed with a locked "J" cap.

Because the monitoring wells were completed as temporary for this investigation, concrete surface pads with protective posts were not installed. Alternatively, a high-visibility marker was placed on top of each well. Additional wellhead protection (e.g., steel T-posts) were installed by WMDSC.

Temporary well construction details are summarized in **Table 1**.

3.2.4.2 Well Development

Well development was started on March 3, 2016 and completed on March 6, 2016. Well development was accomplished by bailing/surging to remove water and sediment from the temporary wells and by pumping using a non-dedicated submersible pump. Measurements of pH, temperature, and specific conductance were collected at regular intervals through the development process. Well development was continued until the change in pH, turbidity, temperature, and conductivity readings from the development water stabilized to within 10 percent over three consecutive measurements and the water was relatively clear (i.e., visual turbidity changed from brown to tan or no color). With the exception of wells TW-2 and TW-9 that had low yield and slow recovery, the NWLF Unit 2 temporary wells were developed thoroughly in general accordance with typical industry practice. Well development details are included in **Table 2**.

3.2.4.3 Groundwater Elevation Measurements

Groundwater samples were collected by Swift River on May 3 and 4, 2016 from the eight temporary wells. Prior to groundwater purging and sampling at each well, water-level measurements were made and recorded to the nearest 0.01 foot. The groundwater levels are considered together with data for monitoring wells on the NWLF Unit 1 area to develop the groundwater-level contour maps (**Figures 17 and 18**) used to determine groundwater-

flow direction and gradient. The monitor well completion summary, datum elevation, depths to groundwater, and water-level elevations are presented in **Tables 2 and 3**.

3.2.4.4 Groundwater Sampling and Analyses

Groundwater sampling was done at wells TW-1, TW-2, TW-4, TW-5, TW-6, TW-8, TW-9, and TW-10. Purging and sampling were performed with a non-dedicated QED SamplePro® low-flow bladder pump using dedicated tubing and a new bladder for each well sampled. In accordance with the low-flow purging protocol, a minimum of three times the sampling system volume was removed.[2] Field measurements of pH, specific conductance, and temperature were made to confirm that these measured values stabilized (i.e., changed by 10 percent or less) between purging of two sequential sampling system volumes. Field measurements also were recorded for turbidity, dissolved oxygen, and oxidation-reduction potential (ORP). Samples for Subtitle D Appendix I VOCs, dissolved metals, and general water-quality parameters, including major anions and cations were collected immediately after purging. Groundwater color, clarity, and odor were observed and noted on groundwater sampling data sheets. The following field and analytical parameters were determined.

- Field Measurements: Water Level, Specific Conductance, pH, temperature, turbidity, dissolved oxygen and ORP.
- Laboratory Analyses: Calcium, Chloride, Magnesium, Sulfate, Potassium, Carbonate, Sodium, Bicarbonate, and volatile organic compounds (VOCs).

Field information forms (FIFs) were prepared to include well completion information, field parameter measurements, purge volumes, and general field observations for this sampling event. The FIFs are included with the laboratory analytical report provided in **Appendix D**. A summary of the results is shown in **Table 4.**

[2] Sampling system volume includes the combined volumes of bladder pump, tubing, and flow-through cell. Low flow purging does not consider the total volume of water inside the well.

3.2.4.5 Well Completion Reports

In accordance with 2005 Colorado Water Well Construction Rules, well completion reports for the temporary wells that encountered groundwater were filed with the Office of the State Engineer on June 8, 2016. Temporary wells must be abandoned or permitted within one year (or 18 months, per a recent rule change). WMDSC will make the determination within one year to complete the wells for long-term use or to properly abandon them. Appropriate documentation of the decision must be submitted to the State Engineer. Surface completion of wells as long-term monitoring points should include providing locking well cover, concrete pad, and steel barrier posts. Well completion reports are included in **Appendix C**.

3.3 LABORATORY AND FIELD QUALITY ASSURANCE AND QUALITY CONTROL

Groundwater samples and drilling water samples collected at NWLF Unit 2 as part of this Hydrogeologic Characterization were submitted to TestAmerica Laboratories, Inc., in Arvada, Colorado, for chemical analysis. TestAmerica, a Waste Management contract laboratory, is qualified to perform chemical analysis for municipal solid waste landfill sites.

Groundwater samples collected on May 3 and 4, 2016 were submitted to TestAmerica for analysis on May 5, 2016. Drilling water samples were collected on March 4, 2016 and submitted on the same day.

Laboratory reports listing laboratory-specific reporting limits (e.g., Practical Quantification Limits, PQLs, and Method Detection Limits, MDLs) are included in **Appendix D**.

3.3.1 Sample Receiving

The groundwater sample shipping container was received in acceptable condition, properly preserved and on ice, with a cooler temperature of 4.5 ° C at the laboratory. The cooler temperature was within the desired range (4° C ± 2° C).

The drilling water sample was received in acceptable condition, properly preserved and on ice, with a cooler temperature of 0.2 ° C at the laboratory. The cooler temperature was lower

than the desired range, but review of receipt documentation did not reveal a laboratory concern regarding sample condition related to the low temperature.

3.3.2 Holding Times

The laboratory identified no holding time issues with the groundwater samples or the drilling water samples.

3.3.3 Trip Blanks

VOCs were not detected in the trip blanks that accompanied the groundwater samples while being transported from and back to the laboratory. A trip blank was not believed necessary for the single drilling water sample analyzed.

3.3.4 Method Blanks

The Method Blank results (MB) were within established control limits for both sample sets.

3.3.5 Laboratory Control Samples

The following information was provided for the Laboratory Control Sample (LCS) results.

- **Report Number 82795-1 (Groundwater Sampling)**

  The Method 2320B LCS/LCSD exhibited RPD data outside the QC control limits for Total Alkalinity. Both the LCS and LCSD were recovered within QC control limits, demonstrating that the laboratory performed the method within acceptable guidelines; therefore, corrective action is deemed unnecessary.

- **Report Number 80430-1 (Drilling Water Sampling)**

  All Laboratory Control Samples were within established control limits.

The LCS results do not impact the validity of the reported data and have no impact on data interpretations contained in this Hydrogeologic Characterization report.

3.3.6 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

All MS and MSD samples for the groundwater sampling and the drilling water sampling were within established control limits.

3.3.7 Organics

The following laboratory QC comment is applicable to the organics analyses.

- **Report Number 82795-1 (Groundwater Sampling)**

  The Method 8260B surrogate recovery of 1,2-Dichloroethane-d4 was above the upper control limit for samples TW-5 and TW-D. Because the data are considered to be biased high and all target analytes in the sample were non-detect above the reporting limits, corrective action was deemed unnecessary.

- **Report Number 80430-1 (Drilling Water Sampling)**

  The Method 8260B surrogate recovery of Dibromofluoromethane was below control limits during the analysis of sample RIG TANK. Because the chromatograms exhibited clear evidence of matrix interference and all other quality control samples met acceptance criteria, corrective action was deemed unnecessary.

3.3.8 Inorganic Chemistry

The laboratory made no quality control comments with regard to general inorganic chemistry (i.e., selected metals and anions) for either sample set.

3.3.9 Duplicate Sample

A duplicate sample, labeled TW-D, was collected from well TW-4 and submitted for VOC analyses. No VOCs were detected in the original sample TW-4 or in the sample identified as TW-D.

No duplicate samples were collected for the drilling water sampling.

3.4 SAMPLE ANALYSES RESULTS

3.4.1 Groundwater Sample Results

The results of groundwater sample analyses are discussed in **Section 5.3**.

3.4.2 Drilling Water Sample Results

Two water samples were collected during well installation and development and analyzed for VOCs. One sample was collected from the water tank installed on the drilling rig. The other sample was taken from distilled water poured through the non-dedicated bailer used during development.

The water-quality analyses results indicated the presence of VOCs (one quantified result and three estimated – J flag - concentrations less than the reporting limit) in the collected samples.

- Rig Tank:
  Acetone at 2.7 ug/L (J flag, RL = 10 ug/L),
  Chlorodibromomethane at 0.22 ug/L (J flag, RL = 1.0 ug/L),
  Chloroform at 18 ug/L (RL = 1.0 ug/L)
  Dichlorobromomethane at 1.6 ug/L (RL = 1.0 ug/L)

- Bailer Blank:
  Toluene at 0.23 ug/L (J flag, RL = 1.0 ug/L).

The water represented by these samples originated at a City of Ft. Collins treated water source, such as a hydrant. Both chlorodibromomethane and dichlorobromomethane are halogenated methanes that frequently are detected in trace amounts in municipal water supplies and are a byproduct of the chlorinated water treatment process. The source of the two VOCs detected at estimated concentrations lower than the laboratory reporting limit (toluene and acetone) is unknown, but are likely to be false positives, laboratory artifacts, or related either to the water source (i.e., City of Ft. Collins water system) or the conveyance used by the drilling firm to transport water (e.g., water tank).

The laboratory data are included in **Appendix D**.

3.5 HYDRAULIC CONDUCTIVITY TESTS

3.5.1 Slug Tests

Slug testing was performed on April 4 and 5, 2016 in six of the eight wells installed during the Hydrogeologic Characterization. Tests were performed in wells TW-4, TW-5, TW-6, TW-8, TW-9, and TW-10. Wells TW-1 and TW-2 could not be tested because of insufficient water column in the well. A thorough discussion of the testing procedure and results is provided in **Appendix F**.

A slug (i.e., weighted small-diameter tube) constructed of 1-inch inner-diameter PVC pipe was used in the testing. The slug was sealed with end caps and a lifting line attached to one end. To conduct the test, the slug was quickly submerged or quickly removed from the groundwater within the well casing. The fully submerged (or fully removed) slug produced a theoretical rise or drop in the water level in the well equal to the volume displaced by the slug. An In-Situ Level Troll 700 transducer was used to rapidly measure and record the details (water level and time) of recovery to pre-test levels. During the test, the data were down-loaded and graphed to observe the test progress and to determine when the water table had returned to pre-test conditions and the test could be concluded.

"Slug-in" and "slug out" (i.e., slug lowered and slug removed) tests were done in each well tested. Although "slug out" tests often are considered more representative of tested zone properties, the results of both test types were very similar and both tests are considered to have been valid for determining representative water-bearing zone properties. The results of the testing showed a hydraulic conductivity range from about 2.06×10^{-2} to 7.54×10^{-3} cm/sec for the tested zones and are summarized in **Table 5**. The results showed the presence relatively high permeability material, about one order of magnitude greater than the results field tests performed in groundwater zones for the previous NWLF Unit 1 hydrogeologic characterization. The differences are assumed to be accurate and reflective of small differences in the properties of the water-bearing zones beneath the two units.

3.5.2 Laboratory Permeability Tests

Laboratory tests were performed to determine the permeability of natural materials a few feet below the planned base grade (i.e., top of liner) in the NWLF Unit 2. These tests were run on the undisturbed samples from Boring NWE-7 (17-19 feet BGS) and Boring NWE-12 (14-16 feet BGS). The purpose of this testing was to provide data that could be used to evaluate the initial rate at which a hypothetical release of landfill leachate (e.g., the result of a liner failure) could move vertically toward groundwater. Although tests showed the tested material to have a relatively high permeability (2.1 to 5.2 x 10^{-3} cm/sec), deeper vadose zone layers (i.e., siltstones and claystones) are likely to be much less permeable than the samples tested, perhaps 1 x 10^{-6} cm/sec or less.

The laboratory sheets are included in **Appendix E**. Boring records included in **Appendix C** provide detailed descriptions of the material between the planned base grade and groundwater level.

4 REGIONAL GEOLOGY

4.1 REGIONAL STRATIGRAPHY AND STRUCTURE

NWLF is located on the northwestern flank of the structural Denver Basin as shown on **Figure 7** in plan view and subsurface cross-sections. The Denver Basin is a large asymmetric oval-shaped syncline in eastern Colorado, southeastern Wyoming, and southwestern Nebraska that began forming during the Colorado orogeny. The greatest thickness of sedimentary rocks in the basin occurs along the axis of the basin, which is a north-south-trending line that approximately connects Denver and Cheyenne. The Basin includes sedimentary units from Paleozoic age through Cenozoic age, with the Pennsylvanian Fountain Formation as the oldest sedimentary unit in the Basin and the Dawson Arkose as the uppermost (i.e., youngest) bedrock unit.

NWLF is located on the northern portion of the basin that extends into Wyoming. In this area, the uppermost geological stratum, or bedrock, is the Laramie Formation. The regional dip of these sedimentary strata in the area of NWLF is toward the southeast at about one to two degrees below horizontal. The regional dip increases west of NWLF with proximity to the uplifted Front Range.

4.1.1 Surficial Strata

Unconsolidated surficial soil of alluvial and eolian deposits unconformably overlie the older bedrock units. The alluvium primarily consists of interbedded sands and gravels of glacial and interglacial sediment deposits with minor amounts of silt and clay. The wind-deposited eolian deposits, which thinly blanket the region, are composed of very fine-grained materials, including silty sand and sandy silt. Floodplains near present streams are underlain by sand and gravel deposits.

The surficial deposits include the Pleistocene Verdos Alluvium and undifferentiated Pleistocene to Holocene eolium. The Verdos Alluvium consists of interbedded sands and gravels representing glacial and interglacial pediment deposits. There are minor amounts

of clay and varying amounts of silt interspersed within the sand and gravel. Eolian, or wind-derived, deposits generally blanket the region and consist of very fine to fine grained silty sand. Sandy and gravelly alluvium underlie flood plains of streams in the area.

4.1.2 Denver Basin Bedrock Strata

The succession of sedimentary strata from the Precambrian basement to the base of the unconsolidated surficial deposits consist of a varied mixture of claystone, siltstone, limestone, sandstone, shale and conglomerates which comprise several thousand vertical feet. The bedrock strata of significance to the NWLF site and area including, from youngest to oldest, the Laramie formation, Fox Hills Sandstone, and Pierre Shale. A generalized stratigraphic column for the site area is presented on **Figure 8.** General descriptions of the Laramie, Fox Hills, and Pierre strata follow.

Laramie Formation - The Laramie formation is the uppermost Cretaceous unit present in the NWLF area. The lithology of the Laramie is variable, generally consisting of interbedded silty sandstone, siltstones, and carbonaceous shales with thin lignite and coal layers. The Laramie varies from 400 to 1,200 feet thick across the basin, but has been eroded in the NWLF area to a total thickness of a few tens of feet to about 100 feet.

The contact between the Fox Hills Sandstone and the Laramie formation is transitional and is considered to be marked at a predominantly marine horizon that is overlain by fresh and brackish water deposits area accompanied by coals and lignitic shales.

Fox Hills Sandstone - The Fox Hills is divided into two units, the Lower Member and the Milliken Member. The Lower Member generally is an erosion-resistant sandstone containing occasional thin shale beds and concretions. These sandstones are thinly bedded, very fine to fine-grained, gray to greenish-yellow or tan and are well sorted. The Lower Member in the vicinity of NWLF can be 30 to 50 feet thick (Briscoe, 1972). The top of the Lower Member is marked by a two to four feet thick zone that contains concretions that are stained by iron-oxide, hematite, or phosphatic material. The upper unit of the Fox Hills, the

Milliken Member, is a tan to yellow, very fine to fine-grained sandstone. The unit contains ferruginous and calcareous concretions.

The contact between the Pierre Shale and the Fox Hills formation is placed at a transitional and gradational change from persistent sandstones typical of the Fox Hills formation to gray siltstones and sandstones. Typical shale strata might not mark the transition in all areas.

Pierre Shale - The Pierre Shale, which marks the base of the Denver groundwater basin, overlies the Niobrara formation and is approximately 8,000 feet thick. The outcrop of the Pierre Shale extends from approximately 0.75 miles west of NWLF to the eastern margin of the Front Range Uplift, approximately 20 miles farther west. The Pierre Shale is estimated to underlie NWLF at 300 feet or deeper below the ground surface.

4.2 REGIONAL HYDROGEOLOGY

The Denver groundwater basin is considered to be comprised of four Cretaceous-age bedrock aquifers overlying the Pierre Shale. From youngest to oldest, they include the Dawson, Denver, Arapaho, and Laramie-Fox Hills formations. Each of these formations, depending on location in the basin, can be from a few hundred feet to more than 1,000 feet thick. In erosional areas and on the basin perimeter, some or all of the upper formations will be absent. In the NWLF area, only the Laramie-Fox Hills formations remains. Sandstone and conglomerate are the principal water-yielding material in the bedrock aquifers, constituting less than half of the formations. Shale, claystone, and siltstone constitute the remainder of the bedrock formations. The water-bearing sandstone and conglomerate occur as thick layers that extend over large areas and also as thinner lenses of limited areal extent. The water-yielding rocks typically are interlayered with shale.

Regionally, the bedrock aquifer groundwater flow direction in the vicinity of NWLF is toward the southeast, as shown on **Figure 10**.

4.3 WELL SURVEY

The Office of the State Engineer's records of permitted groundwater wells in the vicinity of the NWLF were reviewed. The well survey was based upon a search radius that extends approximately one mile from NWLF Units 1 and 2, and included an area of investigation comprised of all eight sections adjacent to NWLF, excluding all wells contained within NWLF Unit 1 site boundaries, as shown on **Figure 19**. Uses reportedly are for monitoring, domestic, stock, irrigation, and geothermal.

Seventeen (17) wells were identified as within one mile of the NWLF Units 1 and 2. A tabulation is provided in **Table 6.** Wells within 0.5 mile of the NWLF boundaries are listed below.

- Potts: One deep (reportedly 300 feet total depth) geothermal loop well is located 0.4 mile to the southwest in Section 13-T7N-R67W.
- Conoco Phillips: Three shallow monitor wells located 0.3 miles to the east-southeast in Section 18-T7N-R66W. Two reportedly are 30 feet deep and are screened from 20 to 30 feet. The depth of the third monitor well was not in the State records.
- Carter: One deep (reportedly 150 feet total depth and screened interval not reported) domestic well is located 0.4 miles to the east in Section 7-T7N-R66W.
- Benson Well South: One shallow (reportedly 25 feet total depth and screened interval not reported) domestic and stock well is located 0.5 miles to the northeast in Section 8-T7N-R66W.
- Roberts: One assumed shallow (total depth and screened interval not provided) domestic and stock well is located 0.5 miles to the west in Section 12-T7N-R67W.

5 SITE GEOLOGY

Five cross-sections were developed to depict subsurface conditions beneath NWLF Units 1 and 2 using the data from the 2016 Geotechnical Investigation of NWLF Unit 2. Several of these cross-sections use 2016 NWLF Unit 2 subsurface data to extend stratigraphic cross-sections that were developed from data collected for the 1992 hydrogeologic investigation of NWLF Unit 1. With regard to geologic structure, Unit 1 is down dip from Unit 2. Geologic strata (in particular, the top of the Fox Hills Sandstone) occur at lower elevations beneath Unit 1 than beneath Unit 2. As a result, the 1992 Unit 1 data were collected from deeper borings than were advanced for the 2016 Unit 2 investigation. These include boring log descriptions for three borings near the perimeter of NWLF Unit 1 – soil boring TH-23 and former wells MW-7 and MW-11. Thus, the 1992 data were useful in the stratigraphic interpretation of the 2016 data. However, the 1992 subsurface material descriptions were developed based on recovered air-rotary cuttings rather than the type of discrete-depth samples obtained in each 2016 boring. As a result, the 1992 sample descriptions are more generalized because lithologic descriptions and depth of stratigraphic boundaries were based on cuttings. Nevertheless, stratigraphic and geologic interpretations utilizing both the 1992 cuttings and 2016 discrete sample data provide a reasonably accurate stratigraphic depiction of lithology and geologic contacts across both Units 1 and 2 of the NWLF.

Consistent with the lithology of the adjoining NWLF Unit 1 to the south, the NWLF Unit 2 is mantled by unconsolidated surficial deposits that lie unconformably over sedimentary bedrock. Many of the soil borings advanced for the 2016 Geotechnical Investigation were terminated in the eolian and alluvial deposits above the Laramie Formation. The eolian deposits typically consist of clayey silt and very fine to fine-grained silty sand and were from seven to 20 feet thick across the NWLF Unit 2. The alluvium consists of interbedded coarser-grained sand and fine gravel with varying amounts of silt and clay interspersed within the sand and gravel. These deposits were from 17 to about 45 feet thick across the NWLF Unit 2.

The Laramie Formation is the uppermost bedrock formation underlying the surficial materials across NWLF Unit 2. All of the NWLF Unit 2 soil borings advanced for the

Hydrogeologic Characterization Investigation penetrated into the Laramie Formation. The top of the Laramie Formation underlying the landfill is an unconformable (i.e., eroded) surface, occurring at varying depths below ground surface, and is characterized as a mixture of weathered claystone, siltstone, and fine-grained sandstone interstratified with laterally discontinuous coal or lignite layers.

Three of the deeper borings completed as temporary wells (TW-2, TW-4, and TW-6) extended into the upper portion of the Fox Hills Formation. The Fox Hills Formation is characterized by laterally continuous fine-grained sandstone across the NWLF Unit 1 and Unit 2 area.

5.1 SITE STRATIGRAPHY AND STRUCTURE

5.1.1 Site Stratigraphy

NWLF, including Unit 2, is located in an upland area, which is covered by Pleistocene-age eolian deposits (Qe) and glacial outwash alluvium (Qv) overlying bedrock stratigraphy consisting of the Laramie Formation (K_L) and Fox Hills Sandstone (K_{FH}). In turn, the Pierre Shale (K_P) underlies the Fox Hills. The permeable sandstones at the base of the Laramie Formation and the Fox Hills Sandstone form the Laramie-Fox Hills (LFH) Aquifer that generally consists of interbedded layers of fine-grained sandstone, siltstone, and shale, with a combined thickness of as much as 300 feet. In the vicinity of NWLF, the total thickness of the Laramie-Fox Hills is about 200 feet with groundwater flow toward the southeast, as shown on **Figure 10**. At depth, the sandstone and siltstone generally are poorly cemented and light to medium gray in color. In shallow depths and outcrops, the sandstone and siltstone can vary from friable to very hard, depending on the degree of iron mineralization (USGS, HA-730C).

Considering the NWLF Unit 2 investigations, the eolian (wind-deposited) materials at the site are as much as 30 feet in thickness and the alluvium deposits beneath the eolian deposits are as much as 20 feet thick. In the NWLF Unit 2 area, their combined thickness ranges between 17 and 45 feet thick feet. The Laramie Formation is present beneath the entire

NWLF area, including all of NWLF Unit 2. Within the proposed NWLF Unit 2 footprint, the Laramie Formation occurs at depths below natural ground surface ranging from 17 to 45 feet. Where penetrated by Unit 2 borings, the Laramie Formation is about 30 feet thick, but it is likely to be more than 60 feet thick elsewhere across the Unit 1 and 2 area.

5.1.2 Structure

The bedrock formations locally dip gently to the southeast. Consistent with the regional geology, the estimated bedrock dip at NWLF Units 1 and 2 is between one and two degrees to the southeast. **Figure 9** shows the regional structural contours on the base of the Laramie-Fox Hills from Robson, et al. (1998) with a dip of 1.7 degrees beneath Section 7. This structural dip appears on the cross-sections beneath NWLF. Of note, the hydrogeologic characterization of the NWLF Unit 1 (ATEC, 1993) includes a map showing a gentle dip of bedrock to the northeast; the map is attributed to Shelton and Rogers (1987). The basin-wide Robson, et al. (1998) reference considered for this 2016 Hydrogeologic Characterization appears to match better with the subsurface data collected for NWLF Unit 2.

Five cross-sections were developed for this report and are included in **Appendix A**. The locations of the cross-sections are shown on **Figure 11**, included in **Appendix A**. The cross-sections extend across the NWLF Unit 2, and are identified as follows.

- **Figure 12: Cross-Section A-A' from South to North -** Wells MW-10, TH-23, MW-3, and TW-2.
- **Figure 13: Cross-Section B-B' from South to North -** Wells MW-4, MW-7 (abandoned), MW-12, and TW-5/TW-6.
- **Figure 14: Cross-Section C-C' from Southwest to Northeast -** Wells TW-2, TW-4, and TW-5/TW-6
- **Figure 15: Cross-Section D-D' from West to East -** Wells MW-3, MW-11 (abandoned), MW-12, and TW9/TW-10.
- **Figure 16: Cross-Section E-E' from Northwest to Southeast -** Wells TW-5/TW-6, TW-8, and TW-9/TW-10

These cross-sections illustrate a general structural dip toward the southeast. The structure within the shallow subsurface materials, as indicated by the inclination of stratigraphic contacts, is similar to the regional eastward dip of Denver Basin bedrock and the eastward slope of local surface topography.

The planned base grade elevation for Unit 2[3] ranges from about less than 10 feet to about 30 feet below present ground surface in areas other than beneath the soil stockpile. The contact between eolian and alluvial deposits, typically marked by the presence of coarse sand and fine gravel, occurs between 10 feet below and 10 feet above the planned base grade elevation beneath much of the NWLF Unit 2 disposal cell footprint. Beneath the extreme southwest portion of the Unit 2 footprint, the planned base grade elevation is below the alluvium and penetrates as much as 20 feet into the Laramie Formation. Nowhere does the planned base grade penetrate into the Fox Hills Sandstone.

Specific groundwater information depicted on the five cross-sections developed across the NWLF Unit 1 and Unit 2 area is a follows.

- Cross-section, A-A' from South to North along the west side of the NWLF – Shows the dipping Fox Hills Sandstone becoming nearer to the ground surface on the north. In this area of NWLF, the uppermost water-bearing zone is the Fox Hills Sandstone and is monitored by existing wells MW-10 and MW-3 and temporary well TW-2.

- Cross-Section B-B' from South to North along the east side of the NWLF - Shows the Fox Hills Sandstone becoming nearer to the ground surface on the north. The uppermost continuous water-bearing zone in existing wells MW-4 and MW-12 and temporary well TW-6 is the Fox Hills Sandstone. Shallower groundwater is present at the contact between alluvium and the Laramie Formation at wells TW-1 and TW-5. This shallow water-bearing zone appears to be locally continuous beneath the eastern portions of NWLF Units 1 and 2, but is not present beneath all of either unit.

- Cross-Section C-C' from Southwest to Northeast along the north side of the NWLF Unit 2 – Shows the apparent dip of the Fox Hills Sandstone to be toward the east (actual structural dip is toward the southeast). A deep water-bearing zone is present in the Fox Hills Sandstone at temporary wells TW-2, TW-4, and TW-6. This cross-

[3] The "20-feet below planned base grade" depth objective for determination of the presence/absence of groundwater was selected to provide design flexibility in the event that a lower elevation base grade is determined through the Unit 2 design process. See Section 1.2.

section also shows the presence of shallow groundwater in temporary well TW-5 in sand at the contact between alluvium and the Laramie Formation.

- Cross-Section D-D' from West to East along the north side of the NWLF Unit 1 and south side of the NWLF Unit 2 – Shows the Fox Hills Sandstone dipping to the east (actual structural dip is toward the southeast) and a deep water-bearing zone in existing wells MW-3 and MW-12 and former well MW-11. This cross-section shows the presence of shallow groundwater in alluvial sands in temporary wells TW-1 and TW-9. This cross-section also shows the presence of groundwater in a deeper Laramie sand (and lignite seam) in temporary well TW-10 that is not hydraulically connected to the shallower alluvium.

- Cross-section E-E' from Northwest to Southeast along the east side of NWLF Unit 2 – Shows the Fox Hills Sandstone dipping to the southeast. The continuous water-bearing zone in the Fox Hills Sandstone is monitored in temporary well TW-6. This cross-section also shows the presence of groundwater in Laramie sands (and lignite seams) at temporary wells TW-8 and TW-10. The difference in groundwater levels in these two wells suggests that they are hydraulically isolated and not laterally continuous. This cross-section also shows the presence of groundwater in the alluvium above the top of the Laramie sand in temporary wells TW-5 and TW-9.

5.2 SITE HYDROGEOLOGY

5.2.1 Groundwater Occurrence

Groundwater associated with Unit 2 (see Sections 6.1 and 6.2) was encountered during drilling efforts at various locations and depths, as described below.

- Alluvium/Laramie Formation: Gravelly sands and sandstones at the contact between alluvium and the Laramie Formation are screened at temporary wells TW-1, TW-5, and TW-9. This zone is present beneath only a small part of the NWLF Unit 2 area. Groundwater flow within the zone appears to be eastward under the influence of local surface water drainage features (in particular, Coal Bank Creek). This areally discontinuous water-bearing zone also appears to be monitored at well MW-9 beneath NWLF Unit 1. This zone is assumed to be an unconfined water-table zone.

- Laramie Formation: Separate sands and lignite seams monitored at temporary wells TW-8 and TW-10 are not areally continuous beneath NWLF Unit 2, occurring instead as hydraulically isolated water-bearing sands. These discontinuous water-bearing zones appear to be confined beneath NWLF Unit 2.

- Fox Hills Sandstone: Monitored at temporary wells TW-2, TW-4, and TW-6. This sandstone appear to be areally continuous beneath both NWLF Units 1 and 2, with

water levels that can be correlated and mapped together across all of NWLF. This zone appears to be confined beneath all or most of the two landfill units.

The shallow discontinuous water-bearing strata typically are separated from deeper continuous water bearing strata by finer-grained, low permeability materials, including clayey silts, silty clays, or claystone. The boring records included in **Appendix C** show the lithologic sequences penetrated by Unit 2 borings and the presence of coarser grained (e.g., sands) and finer grained (e.g., silts and clays) materials. Coarser grained materials usually have higher hydraulic conductivities, typically in the 10^{-3} cm/sec range, and finer grained materials usually have lower hydraulic conductivities, typically 10^{-6} cm/sec and lower.

Water-bearing strata encountered during the Hydrogeologic Characterization Investigation occur below the planned NWLF Unit 2 base grade level and have groundwater levels that also are below planned base grade levels in NWLF Unit 2[4]. Two temporary piezometers (TP-1 and TP-2) were installed in the NWLF Unit 2 area during the Geotechnical Investigation to determine if groundwater was present within 20 feet or less below the planned base grade. Neither piezometer had water at the time of installation, one day later, or approximately two months later.

5.2.2 Groundwater Flow

Groundwater level, flow direction, and gradient across the NWLF Unit 2 area is consistent with water levels measured across the NWLF Unit 1 area. Locally, the predominant flow direction in the deeper Fox Hills Sandstone is toward the southwest.

- Alluvium/Laramie Formation: **Figure 17** shows that flow within this areally discontinuous zone is assumed to be eastward under the influence of local surface-water drainage features (in particular, Coal Bank Creek, located about 1,300 feet to the east). Discharge is assumed to occur as seepage to deeper zones or as discharge to the ground surface in areas of lower topographic elevation.
- Laramie Formation: Groundwater levels in the sand lenses and lignite seams monitored at temporary wells TW-8 and TW-10 indicate that the two water-bearing

[4] See Section 1.2 for explanation of design flexibility provided by the "20-feet below planned base grade" depth objective for determination of the presence/absence of groundwater.

zones are hydraulically separated. As a result, the groundwater levels in the two wells do not represent properties of a single zone that can be correlated to determine groundwater flow. A southwestward direction of potential groundwater flow is assumed on the basis of the structural dip of the water-bearing strata and the known flow direction for the underlying Fox Hills Sandstone. Since these zones are hydraulically isolated, any actual groundwater flow will be controlled by the rate of seepage from the water-bearing sand into the lower permeability Laramie strata (typically sandy silts and siltstones) in which the water-bearing sands are encased.

- Fox Hills Sandstone: **Figure 18** shows NWLF Units 1 and 2 water levels in the Fox Hills Sandstone correlated and mapped together. The groundwater flow direction is toward the southwest.

5.2.3 Hydraulic Conductivity

Hydraulic conductivity for the water-bearing zones identified by this hydrogeologic characterization were measured by slug tests performed in temporary wells. The hydraulic conductivity (permeability) of typical non-water-bearing strata present immediately beneath the planned disposal cell base grade was determined by laboratory testing of undisturbed samples. The results of testing are summarized in **Table 5.** Each of these test methods confirmed the present of material with hydraulic conductivities at least one order of magnitude greater than was determined by similar tests performed for the 1992 NWLF Unit 1 hydrogeologic characterization.

- Alluvium/Laramie Formation: Slug tests in temporary wells TW-1, TW-5, and TW-9 provide a range of hydraulic conductivities from 1.4×10^{-1} to 5.1×10^{-2} centimeters per second (cm/sec) with a geometric mean of 4.1×10^{-2} cm/sec.

- Laramie Formation: Slug tests in temporary wells TW-8 and TW-10 provide a range of hydraulic conductivities from 1.7×10^{-3} to 2.5×10^{-3} centimeters per second (cm/sec) with a geometric mean of 2.0×10^{-3} cm/sec.

- Fox Hills Sandstone: Slug tests in temporary wells TW-2, TW-4, and TW-6 provide a range of hydraulic conductivities from 1.9×10^{-2} to 7.5×10^{-2} centimeters per second (cm/sec) with a geometric mean of 1.2×10^{-2} cm/sec.

Laboratory determinations of permeability (i.e., hydraulic conductivity) were done for undisturbed samples taken within two to three feet below the planned Unit 2 landfill cell base grade. Those tests, which were done for eolian and alluvial deposit samples above groundwater level, yielded values of 2.1×10^{-2} and 5.2×10^{-2} cm/sec. These values are

essentially identical to the slug test determinations of hydraulic conductivity for the same material, the Alluvium/Laramie groundwater zone.

This group of tests confirm that the hydraulic conductivity of silty and sandy material in the NWLF Unit 2 groundwater zones, and in the non-saturated materials above groundwater, are in the relatively narrow range between 2.0×10^{-3} and 4.1×10^{-2} cm/sec. These values are one to two orders of magnitude higher than the average value (5.7×10^{-4} cm/sec) derived for the deep groundwater zone by the NWLF Unit 1 hydrogeologic characterization. The difference suggests that the higher hydraulic conductivities that characterize the NWLF Unit 2 subsurface materials are reflective of variations in the lithology of materials beneath the two units.

5.2.4 Flow Rate

Considering the three deeper (Fox Hills Sandstone) temporary wells where groundwater level was measured on May 3 and 4, 2016, a piezometric surface map was prepared that shows deep zone groundwater flow to the southwest, which is consistent with historical conditions for NWLF Unit 1. Horizontal groundwater seepage velocity in the water-bearing zone was estimated using the following equation:

$$V = (K_h i)/n_e$$

Where:

- v = groundwater velocity,
- K_h = horizontal hydraulic conductivity,
- i = hydraulic gradient (vertical change in groundwater elevation/corresponding horizontal distance), and
- n_e = effective porosity.

The calculation uses the geometric mean horizontal hydraulic conductivity of the Fox Hills Sandstone of 1.16×10^{-2} cm/sec from 2016 slug testing, estimated effective porosity of 0.20 (GMP 1992), and average hydraulic gradient of 0.003 as estimated from the northern portion of the groundwater contour map that is NWLF Unit 2. Based on these estimates, the

horizontal groundwater seepage velocity in the actively monitored zone beneath the facility is approximately 180 feet per year.

By contrast, the Fox Hills Sandstone flow rate estimated for NWLF Unit 1 groundwater typically is about 30 feet per year. The order of magnitude difference between the estimated flow rates beneath the two units is the result of the 20X difference in the hydraulic conductivities determined for the two units, 1.16×10^{-2} for Unit 2 and 5.7×10^{-4} cm/sec for Unit 1, and the steeper groundwater flow gradient for Unit 1. Both differences are reflections of the variability of the lithologic properties of Fox Hills Sandstone beneath the two units.

5.3 SITE GROUNDWATER QUALITY

Groundwater samples were collected on May 4 and 5, 2016 from each of the eight temporary wells and analyzed for volatile organic compounds (VOCs) and major anions and cations. A non-dedicated submersible pump and dedicated tubing were used to collect the water samples by the low-flow purging and sampling method. The results of water-quality analyses were used to develop the Stiff and Piper diagrams characterize water chemistry and natural spatial variability for the three groundwater zones. These water-quality data are summarized in **Table 4.** The Stiff and Piper diagrams are included in **Figures 20** and **21,** respectively.

The laboratory reports are included in **Appendix D**.

5.3.1 General Water Quality

Stiff diagram depictions of major ion chemistry in water are constructed by extending three parallel horizontal axes on each side of a vertical zero axis. Concentrations of four cations (Na+K, Ca, and Mg) are plotted to the left of zero. Concentrations of four anions (Cl, HCO_3 + CO_3, and SO_4) are plotted to the right of zero. The ions are plotted in the same sequence and are presented in units of concentrations of milliequivalents per liter (meq/L). The width of the pattern is an indication of total ionic content. The Stiff patterns provide a relatively distinctive method of visually depicting differences or similarities in water chemistry.

Piper trilinear diagrams are in the form of two triangles bracketing a diamond-shaped plotting field, as used by J.D. Hem (USGS, Water-Supply Paper 2254, 1985). Each vertex represents 100 percent of a particular ion or group of ions. The composition of cations is indicated by a point in the cation triangle, and the composition of anions by a point in the anion triangle. The coordinates at each point add to 100 percent. Anions and cations are combined to plot in the diamond-shaped field. Trilinear diagrams aid in data evaluation by providing visual depictions of trends or a comparison of differences in water quality between wells.

The Stiff and Piper diagrams show variations in basic water quality between, and within, the three groundwater zones beneath NWLF Unit 2. These zones and the sampled wells within the zones are as follow.

1. Alluvium/Laramie sand. (TW-1, TW-5, TW-9)
2. Laramie sand. (TW-8, TW-10)
3. Fox Hills sandstone (TW-2, TW-4, TW-6)

5.3.1.1 Alluvium/Laramie Upper Sand

This shallow discontinuous water-bearing zone is present beneath the east side of Unit 2. It is described as silty sand with clay, or fine to coarse sand with gravel. Temporary wells TW-1, TW-5, and TW-9 are completed in this zone. Water quality generally more mineralized than the Fox Hills Sandstone, primarily based on elevated magnesium and sulfate. It is a magnesium, sulfate, and bicarbonate-type water, as shown on **Figure 21**.

5.3.1.2 Laramie Sand

This areally discontinuous water-bearing zone occurs as isolated bodies described as silty sand, siltstone, lignite, and claystone. These Laramie sands were deposited in a coastal plain environment, including swamps, small rivers, and coals. The more permeable silts and sands deposited by small rivers are encased in less permeable clays, and can produce small amounts of groundwater (Raynolds in CFWE, 2007). The sand and siltstone within the unit

are likely of limited lateral extent and therefore contain groundwater because they are more permeable than the adjacent lowly permeable claystone. The water quality, based on temporary wells TW-8 and TW-10, is similar to the Fox Hills Sandstone, primarily based on calcium-magnesium and sulfate-bicarbonate. It is a calcium-magnesium and sulfate-bicarbonate type water, as shown on **Figure 21**.

5.3.1.3 Fox Hills Sandstone

An areally continuous water-bearing zone described as clayey, silty sandstone and siltstone to dense sand and sandstone. These Fox Hills sands and silts were deposited in beach environment and are more laterally extensive compared to the overlying Laramie sands (Raynolds, 2002). The silty sand and siltstone is present beneath the entire site. Temporary wells TW-2, TW-4, and TW-6 are completed in the Fox Hills Sandstone. Water quality in the temporary wells ranges from less mineralized (temporary well TW-6) to more mineralized (temporary well TW-2) **(Figure 20)**. It is a calcium, magnesium, sulfate, bicarbonate-type water. **(Figure 21)**

5.3.2 Analytical Results

5.3.2.1 Volatile Organic Compounds (VOCs)

Groundwater samples were analyzed for Volatile Organic Compounds (VOCs) by USEPA Method 8260 B. Detections of VOCs were:

- TW-1. Tetrachloroethene at 5.8 ug/L (reporting limit 5.0 ug/L), and
- TW-6. Chloroform at 6.4 ug/L (reporting limit 5.0 ug/L).

These are wells in locations up-gradient from the active operations of NWLF Unit 1 and neither VOC detection is attributed to the landfill. The chloroform detection in the well TW-6 sample could be attributed to a water treatment residual in drilling water obtained from the City of Ft. Collins; however, the well development process was intended to remove water added during drilling and well installation.

5.3.2.2 Major Ion Chemistry

Stiff diagrams of the groundwater samples are shown in **Figure 20** and trilinear Piper plots are shown in **Figure 21.**

5.3.3 Comparison of NWLF Unit 2 Water Quality to Regional Water Quality

Typical water analysis for the Laramie-Fox Hills Aquifer is described as a sodium bicarbonate type with elevated total dissolved solids (TDS) ranging from 200 to 2,000 mg/L, and overall poor water quality for human consumption. According to the Colorado Ground Water Atlas, the higher TDS concentrations occur in the north and eastern margins of the Laramie-Fox Hills Aquifer. Present groundwater quality in the area is considered poor, and exceeds the Secondary Maximum Contaminant Level of 250 mg/L.

In addition to TDS, sulfate is the other constituent that makes the Laramie-Fox Hills poor water quality for human consumption. The presence of sulfate in Laramie and Fox Hills water is expected, based on general statements from the Groundwater Atlas of Colorado (CGS, 2003):

- Water in the Laramie-Fox Hills tends to be a sodium bicarbonate type with sodium sulfate dominating along the northern and eastern margins of the Denver Basin.
- Sulfate concentrations in excess of the drinking water standards occur in areas including the north-central margin south of Greeley.
- Elevated sulfate concentrations are reportedly in part due to the association of sulfur with coal and other organic material present in subsurface material.

Local water quality of the NWLF Unit 2 is more mineralized although lower in sodium and potassium compared to regional. From subsurface samples described from the NWLF Units 1 and 2 site investigations, lignite and organic clay are present at most drilling locations that penetrate the Laramie Formation and Fox Hills Sandstone. Sulfate concentrations exceed the SMCL for sulfate (250 mg/L) at all five existing monitor wells for NWLF Unit 1, and in six of the eight temporary wells installed at NWLF Unit 2. Temporary wells TW-5 and TW-6 have lower mineralization compared to all other Unit 1 and Unit 2 wells.

6 FINDINGS & RECOMMENDATIONS

6.1 CONCEPTUAL HYDROGEOLOGIC MODEL

The Conceptual Hydrogeologic Model for NWLF Unit 2, as shown in **Figure 22,** is based on the findings of the NWLF Unit 2 Hydrogeologic Characterization and existing information reviewed from past Unit 1 site characterization efforts. Strata of hydrogeologic significance beneath NWLF include Pleistocene (geologic age) eolium and alluvium deposits, underlain by weathered and unweathered Cretaceous Laramie Formation sediments, in turn underlain by the Cretaceous Fox Hills Sandstone. The surficial eolium (wind-deposited) and alluvium (fluvial or water-deposited) materials are comprised of silts and fine sands, with sandy gravel characterizing the alluvium at the unconformable contact with the underlying Laramie Formation. The Laramie Formation is comprised of non-marine, fluvial claystone and siltstone (clays and silts, where weathered), representing deposition in a low-energy coastal plain environment, and discontinuous fluvial sand and sandstone layers and lenses that were deposited in meandering channels within the coastal plain. The Laramie Formation is underlain by the Fox Hills Sandstone, which is comprised of massive sandstone layers, intermixed with shale, deposited in a nearshore marine environment, possibly as beach or barrier island sands.

Shallow groundwater beneath NWLF is observed in the three stratigraphic zones, the uppermost an areally discontinuous zone present locally at the contact between alluvium and weathered Laramie Formation, typically associated with the more permeable gravelly alluvium. The next deeper zone where groundwater is observed includes areally discontinuous sand and sandstone layers within the Laramie Formation. The deepest continuous groundwater zone significant to NWLF occurs in the areally continuous Fox Hills Sandstone.

Alluvium/Laramie Formation: Groundwater that is present in the gravelly alluvium overlying the Laramie Formation and in the uppermost, weathered portion of the Laramie occurs beneath the eastern part of the NWLF Unit 2 area. Groundwater flow potential within

this areally discontinuous zone appears to mirror the eastward slope of surface topography and be toward the lower elevations along Coal Bank Creek. This creek is the local discharge point for shallow alluvial groundwater. Groundwater within this zone is recharged by infiltration of precipitation through the vadose zone where discharge is laterally to Coal Bank Creek or vertically, by seepage, into the underlying Laramie Formation. This alluvial water-bearing zone, where penetrated by NWLF Unit 2 borings, ranges from about 5 to 20 feet thick. The hydraulic conductivity of this zone is estimated to be 4×10^{-2} cm/sec, based on slug tests.

Laramie Formation Sands: Groundwater that is observed in this zone occurs in discontinuous siltstone and fine-grained sandstone lenses, and lignite/coal seams, that are interbedded within the dominantly fine-grained bedrock (i.e., siltstone and claystone) of the Laramie Formation. Therefore, observed groundwater exists sporadically within the Laramie Formation in isolated water-bearing lenses or seams that appear not to be hydraulically connected. Groundwater flow potential within this zone is assumed to be southward, in the general direction of the structural dip of these sedimentary strata (Topper et al., 2003). Groundwater is recharged by infiltration of precipitation through the vadose zone and by seepage from locally saturated portions of the overlying alluvium. Discharge of Laramie Formation groundwater occurs by vertical seepage into the underlying Laramie-Fox Hills Aquifer. The water-bearing lenses within the Laramie Formation penetrated by NWLF Unit 2 borings range between 1.5 and 7.0 feet thick. The typical hydraulic conductivity of the Laramie Formation's discontinuous water-bearing intervals is estimated to be 2×10^{-3} cm/sec; however, as the water-bearing sands and sandstone lenses (and saturated lignite seams) are fully encased within lower permeability Laramie Formation siltstone and claystone, the effective hydraulic conductivity is that of the siltstones and claystones is much slower, estimated to be 1×10^{-6} cm/sec or less.

Fox Hills Sandstone: The deepest occurrence of groundwater of significance to NWLF Unit 2 occurs in the Fox Hills Sandstone. This sandstone is an areally continuous zone that underlies all of NWLF Units 1 and 2. Groundwater flow within this zone is southward, in the general direction of the structural dip of these sedimentary strata. Groundwater within this

zone is recharged by seepage from overlying strata and by lateral migration from off-site areas where the Fox Hills occurs at or near the land surface and is directly recharged by precipitation. Discharge occurs by lateral flow and by local pumping. Vertical discharge into the underlying Pierre Shale is assumed to be negligible since the hydraulic conductivity contrast between the Fox Hills Sandstone and Pierre Shale is approximately 4 orders of magnitude. The full thickness of the Fox Hills Sandstone was not determined by NWLF Unit 2 borings, but is estimated to be about 200 feet based on NWLF Unit 1 wells and regional information. The hydraulic conductivity of this water-bearing zone is assumed to be relatively consistent across the NWLF and estimated to be 1.2×10^{-2} cm/sec, based on NWLF Unit 1 slug testing.

6.2 GROUNDWATER MONITORING

Groundwater monitoring will be performed to satisfy solid waste groundwater monitoring requirements. The proposed well network and associated groundwater monitoring plan for NWLF Unit 2 will be developed and approved by the Colorado Department of Public Health and Environment (CDPHE) in the future and prior to any solid waste acceptance into Unit 2. In some instances, the temporary wells installed for the 2016 Hydrogeologic Characterization could become permanent monitor wells. In other instances, the 2016 wells will not be important to groundwater monitoring. Anticipated groundwater monitoring strategies pertaining to each water-bearing zone are provided below.

- Alluvium/Laramie Formation: This zone exists only beneath the eastern part of the NWLF Unit 2 area and flow is presumed to be eastward toward Coal Bank Creek. This zone is not considered to be a viable water source for domestic or agricultural use because of its limited areal extent between Unit 2 and Coal Bank Creek. The single water well (see **Figure 20**) present in this area is the Carter well, a 150 feet deep well likely producing from the Fox Hills Sandstone. The construction of the landfill cell (i.e., liner and final cover) is anticipated to eliminate some or all recharge to this zone.

- Laramie Formation: Saturated sand lenses and lignite seams are monitored at temporary wells TW-8 and TW-10. These lenses and seams are not areally continuous beneath NWLF Unit 2, occurring instead as isolated water-bearing sands and lignites. The direction of groundwater flow potential is anticipated to be toward the southwest, mirroring flow in the underlying Fox Hills Sandstone. However, these saturated lenses and seams are encased in lower permeability Laramie silt and

siltstone layers meaning that lateral flow is restricted. These lenses and seams are assumed not to have a direct hydraulic connection to shallower or deeper groundwater (i.e., Alluvium or Fox Hills). Groundwater monitoring is not anticipated to be required for these isolated lenses and seams.

- Fox Hills Sandstone: This deep zone is present beneath all of Unit 2 and is monitored at temporary wells TW-2, TW-4, and TW-6. This zone is continuous beneath NWLF Units 1 and 2. Temporary wells TW-4 and TW-6 are appropriately located for up-gradient groundwater monitoring and could provide background groundwater quality information for the Fox Hills Sandstone for both Units 1 and 2. As the groundwater flow direction in the Fox Hills Sandstone beneath Unit 2 is southward toward Unit 1, future detection monitoring of this groundwater zone could be provided by existing Unit 1 monitor wells MW-4, MW-5, and MW-10.

The future Fox Hills Sandstone groundwater detection monitoring well network for Unit 2 will be determined at a later time. However, as noted above, some of the existing Fox Hills Sandstone wells that monitor Unit 1 could be appropriate for incorporation into the Unit 2 detection monitoring program when it is developed.

6.3 GROUNDWATER MONITORING PLAN

A single Comprehensive Groundwater Monitoring and Reporting Plan that covers groundwater monitoring for the entire NWLF, probably as an amendment to the present Unit 1 plan, ultimately will be developed to incorporate Unit 2 and monitor wells associated with Unit 2.

6.4 WELL CLOSURE

Pursuant to Rule 5.2.31 of the Colorado Water Well Construction Rules (2 CCR 402-2), a Notice of Intent (NOI) was filed before drilling the monitoring and observation holes and Well Construction Reports (Form GWS-31) were filed within sixty (60) days after drilling. Copies of Form GWS-31 are included in **Appendix C.**

Monitoring and Observation Holes must either be abandoned in accordance with the Colorado rules within one year (or 18 months per a recent rule change) after construction or they must be converted to a well by filing for a Monitoring Well permit. If abandoned, Well Abandonment Report (Form GWS-9) must be submitted within sixty (60) days after

abandoning the hole. A decision with regard to abandoning or converting the temporary wells should be made by March 2017. If development of NWLF Unit 2 does not begin prior to that date, it probably will be advantageous to WMC to convert most, if not all, of the temporary wells to permanent wells.

The temporary piezometers installed within the Unit 2 footprint did not intercept groundwater and are not considered to be wells. However, they do extend to depths below the planned Unit 2 base grade and need to be properly abandoned (e.g., filled with granular bentonite) before landfill cell construction. Their locations have been marked in a manner to reduce the likelihood they will be damaged or rendered inaccessible for final closure by farming or construction activity.

7 REFERENCES

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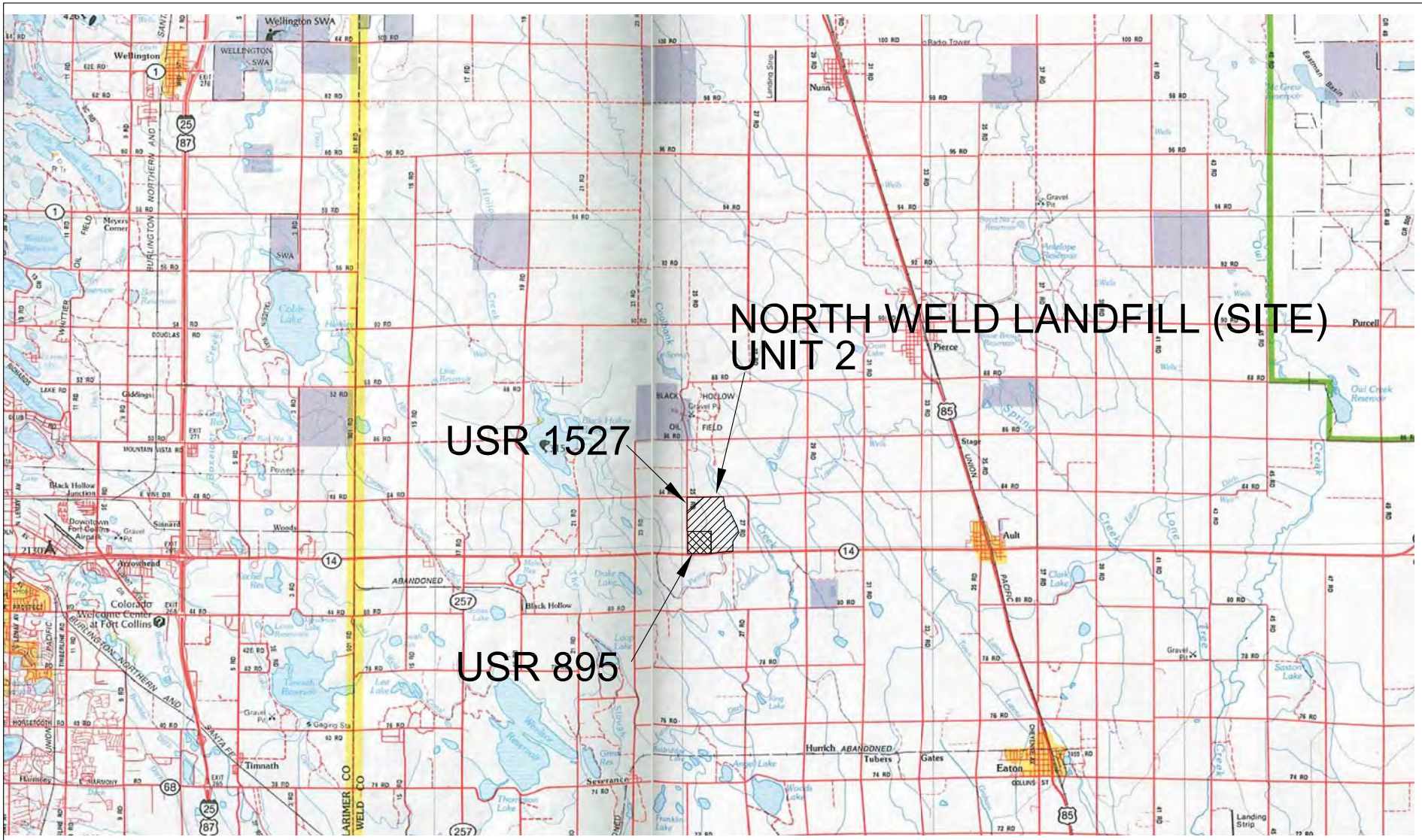
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APPENDIX A

FIGURES

Figure 1: Site Location Map
Figure 2: Topographic Map of NWLF Unit 2 and Vicinity
Figure 3: Site Map and Hydrogeologic Characterization Investigation Locations
Figure 4: Land Use of NWLF Unit 2 and Vicinity
Figure 5: Topography and Surface Water Flow Patterns and Water Features in Vicinity of NWLF Unit 2
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Figure 7: Location of NWLF within the Denver Basin in Plan View and Geologic Cross-Sections
Figure 8: Stratigraphic and Hydrogeologic Units in the Denver Basin
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Figure 22: Conceptual Hydrogeologic Model



SOURCE:
Colorado Atlas & Gazetteer
Seventh Edition 2004 DeLorme

WASTE MANAGEMENT OF COLORADO, INC.
PROPOSED NORTH WELD DISPOSAL SERVICES LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 1
SITE LOCATION MAP

R67W

R66W

T 7 N

USR 1527

FORT COLLINS - 14 MILES

AULT - 5 MILES

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QUADRANGLE LOCATION

LEGEND

NWLF UNIT 2

USR (895) NWLF UNIT 1

Miles

0 ¼ ½ ¾ 1

1 inch = 2,000 feet

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO. INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
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SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 2
TOPOGRAPHIC MAP OF
NORTH WELD UNIT 2 AND VICINITY

460500 N

459000 N

457500 N

456000 N

2190000 E

2188500 E

2187000 E

2185500 E

500'

TW-10

TW-9

TW-8

NWE-20

PIT-5

NWE-19

TW-5

TW-6

NWE-18

NWE-17

NWE-16

PIT-4

TW-1

GP-19

MW-2

MW-4

NWE-15

NWE-14

NWE-13

GP-18

NWE-22a

MW-9

NWE-12

NWE-11

NWE-10

PIT-3

NWE-9

NWE-8/TP-1

PIT-2

NWE-7

GP-17

USR 895

TW-4

NWE-6

NWE-5

NWE-4

GP-16

MW-5

NWE-3

NWE-2

NWE-21/TP-2

PIT-1

USR 1527

NWE-1

TW-2

MW-10

MW-3

LEGEND

- SHALLOW LARAMIE WELL
- DEEP FOX HILLS WELL OR ABANDONED WELL
- PLANNED UNIT 2 LEACHATE COLLECTION SUMP
- 5100 EXISTING INDEX CONTOUR
- EXISTING UN-IMPROVED SITE ROAD
- NWE-1 GEOTECHNICAL BORING
- TW-1 SHALLOW TEMPORARY WELL
- TW-2 DEEP TEMPORARY WELL
- TP-1 TEMPORARY PIEZOMETER
- PIT-1 TEST PIT
- GP-16 GAS PROBE

TOPOGRAPHY AS OF FEBRUARY 21, 2016

TRUE NORTH

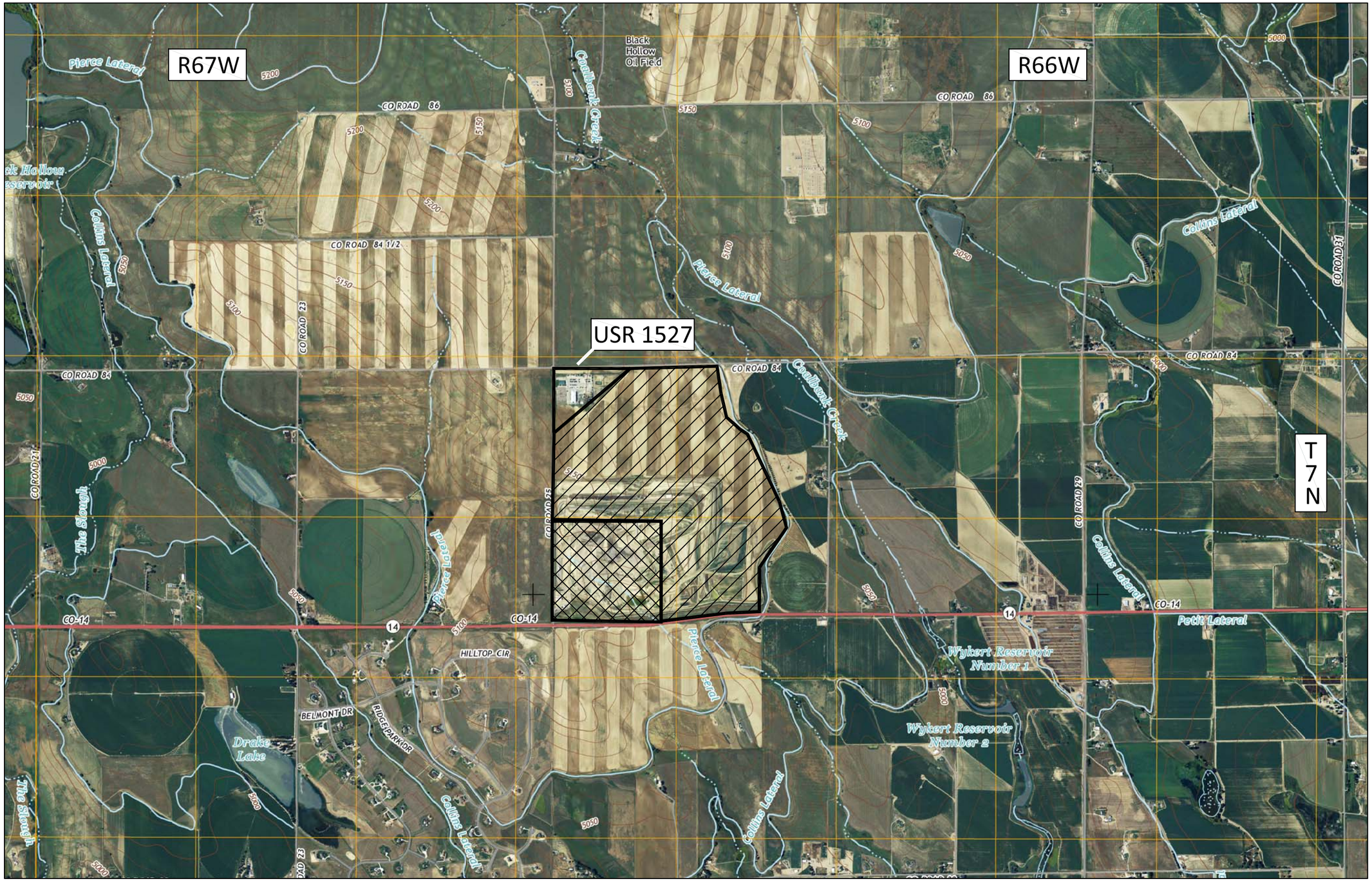
300 0 300 600 900

SCALE IN FEET

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 3
SITE MAP AND HYDROGEOLOGICAL CHARACTERIZATION INVESTIGATION LOCATIONS



LEGEND:

NWLF UNIT 2

USR (895) NWLF UNIT 1

0 1/4 1/2 3/4 1 Miles

1 inch = 2,000 feet

WASTE MANAGEMENT DISPOSAL SERVICES
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PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 4
LAND USE OF NWLF UNIT 2
AND VICINITY

R67W

R66W

N

W

E

S

T 8 N

T 7 N

USR 1527

Black Hollow Oil Field

Gravel Pit

Oil Well

Drill Hole

Oil Well

LATERAL

PIERCE

Coalbank

Pierce Lateral

COLLINS

Creek

LATERAL

LATERAL

LAKESIDE

LATERAL

DITCH

Wells

Copyright:© 2013 National Geographic Society, i-cubed

0 ¼ ½ ¾ 1 Miles

1 inch = 2,000 feet

LEGEND

NWLF UNIT 2

USR (895) NWLF UNIT 1

QUADRANGLE LOCATION

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO. INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 5
TOPOGRAPHY AND SURFACE WATER
FLOW PATTERNS IN VICINITY OF
NWLF UNIT 2

460500 N

459000 N

457500 N

456000 N

2190000 E

2188500 E

2187000 E

2185500 E

Pierce Lateral

500'

TW-10

TW-9

TW-8

NWE-20

PIT-5

NWE-19

NWE-17

NWE-16

PIT-4

NWE-18

TW-5

TW-6

GP-19

MW-2

TW-1

NWE-15

NWE-14

NWE-13

MW-4

GP-18

NWE-22a

MW-9

NWE-12

NWE-11

NWE-10

PIT-3

NWE-9

NWE-8/TP-1

PIT-2

NWE-7

GP-17

USR 895

TW-4

NWE-6

NWE-5

NWE-4

GP-16

MW-5

NWE-3

NWE-2

NWE-21/TP-2

PIT-1

USR 1527

NWE-1

TW-2

MW-10

MW-3

LEGEND

- SHALLOW LARAMIE WELL
- DEEP FOX HILLS WELL OR ABANDONED WELL
- PLANNED UNIT 2 LEACHATE COLLECTION SUMP
- 5100 — EXISTING INDEX CONTOUR
- EXISTING UN-IMPROVED SITE ROAD
- NWE-1 — GEOTECHNICAL BORING
- TW-1 — SHALLOW TEMPORARY WELL
- TW-2 — DEEP TEMPORARY WELL
- TP-1 — TEMPORARY PIEZOMETER
- PIT-1 — TEST PIT
- GP-16 — GAS PROBE
- AREAS OF CONCENTRATED FLOW POTENTIAL

TOPOGRAPHY AS OF FEBRUARY 21, 2016

N

TRUE NORTH

300 0 300 600 900

SCALE IN FEET

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 6
TOPOGRAPHY AND SURFACE
WATER FLOW PATTERNS (DETAIL)

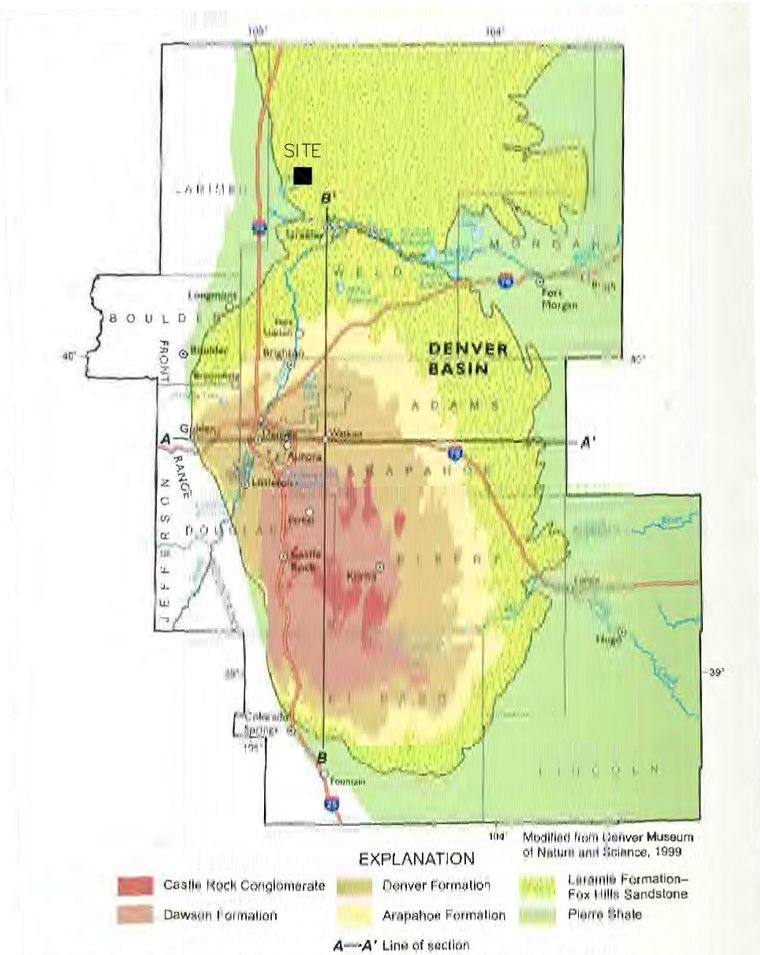


Figure 6.1-2. Generalized Denver Basin bedrock geology.

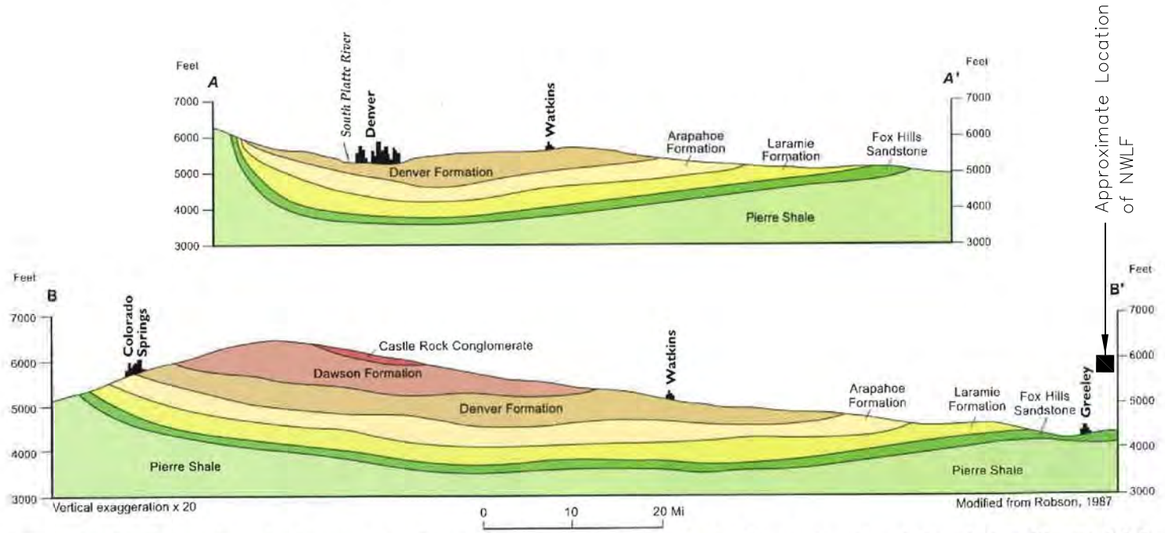


Figure 6.1-3. General geologic cross sections through the Denver Basin. Line of section is located in Figure 6.1-2.

Approximate Location of NWLF

FROM: Ground Water Altas of Colorado
(Topper et al., 2003, Page 86)

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OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 7
LOCATION OF NWLF
WITHIN THE DENVER BASIN
IN PLAN VIEW AND
GEOLOGIC CROSS-SECTIONS

Era	System	Series	Stratigraphic Unit	Unit Thickness (feet)	Physical Description	Hydrogeologic Unit		Saturated Thickness (feet)	Hydrologic Characteristics
Cenozoic	Quaternary	Holocene / Pleistocene	Alluvium	0–125	Unconsolidated gravel, sand, silt, and clay	Alluvial aquifer		0–100	Unconfined, shallow aquifer; very permeable; yields as high as 3,000 gpm
	Tertiary	Oligocene	Castle Rock Conglomerate	0–50	Fine to coarse arkosic sandstone and conglomerate	None		0	Exposed in cliffs; forms cap rock on buttes; well drained, does not yield water
		Eocene / Paleocene	Dawson Formation	0–1,200	Sandstone and conglomeratic sandstone with interbedded siltstone and shale	Denver Basin Aquifer System	Dawson aquifer	0–400	Water table aquifer in shallow units, and confined at depth. Transmissivity ranges from 500–5,000 gpd/ft; storage coefficients range from 0.002–0.009; specific yields vary from 15–25%; domestic water source and municipal supply for Castle Rock; may yield as much as 300 gpm
Mesozoic	Cretaceous	Upper Cretaceous	Denver Formation	800–1,000	Shale, silty claystone, and interbedded sandstone; beds of lignite and carbonaceous siltstone and shale common		Denver aquifer	0–350	Water table aquifer near outcrop area; generally confined; least permeable of Denver Basin aquifers; transmissivity ranges from 250–2,000 gpd/ft; storage coefficient 0.002; specific yield 10–17%; domestic and municipal water source; yields up to 200 gpm
			Arapahoe Formation	400–700	Sandstone, conglomeratic sandstone, and interbedded shale and siltstone		Arapahoe aquifer	0–400	Water table aquifer near outcrop area; generally confined; most permeable of Denver Basin aquifers; transmissivity ranges from 500–5,000 gpd/ft; storage coefficient 0.002–0.009; specific yield 10–25%; principal aquifer source for municipal water; yields up to 700 gpm
			Laramie Formation	100–600	Upper part shale, silty shale, siltstone, and interbedded fine sandstone; bituminous coal seams common		Laramie confining unit	0–400	Shale is impermeable
					Lower part sandstone and shale		Laramie Fox-Hills aquifer	0–250	Water table aquifer near outcrop area; generally confined; moderately permeable; transmissivity ranges from 1,000–7,000 gpd/ft; storage coefficient 0.001; specific yield 15–20%; source for domestic and municipal water; yields up to 350 gpm
			Fox Hills Sandstone	100–200	Sandstone and siltstone interbedded with shale				
			Pierre Shale	4,500–7,000	Shale, calcareous, silty, and dense.	Confining unit		0	Impermeable

Modified from Robson and Banta, 1995

Stratigraphic Unit of NWLF Unit 2

FROM: Ground Water Altas of Colorado (Topper et al., 2003, Page 86)

WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 8
STRATIGRAPHIC AND HYDROGEOLOGIC UNITS IN THE DENVER BASIN

R67W

R66W

N

W

E

S

T 8 N

T 7 N

USR 1527

5100

5000

4900

4800

4700

4600

T 1.7°

Black Hollow Oil Field

Coalbank Creek

PIERCE LATERAL

GOLTENS LATERAL

LAKESIDE LATERAL

DITCH

Drill Hole

Oil Well

Gravel Pit

Wells

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LEGEND

NWLF UNIT 2

USR (895) NWLF UNIT 1

0 ¼ ½ ¾ 1 Miles

1 inch = 2,000 feet

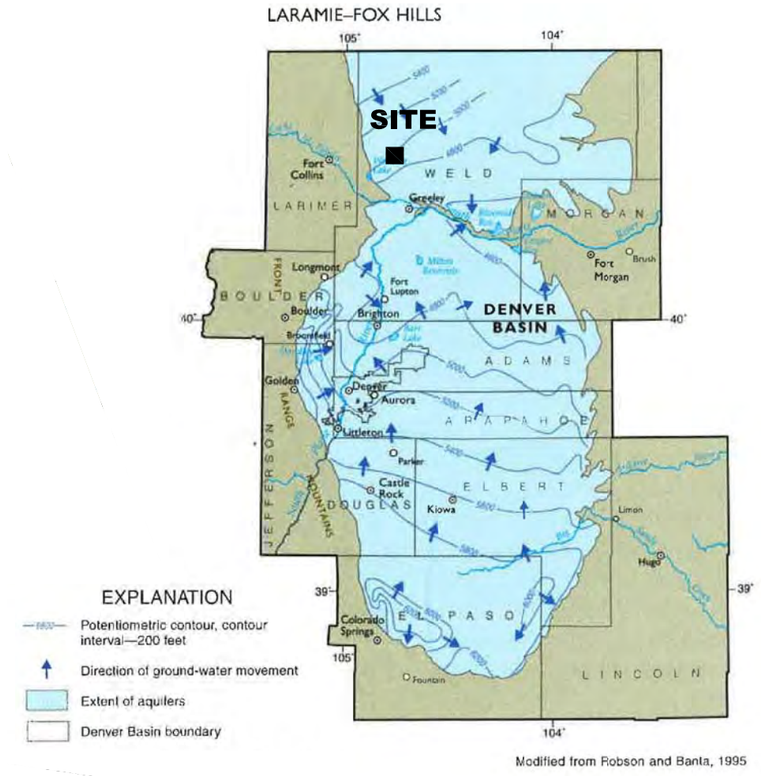
REFERENCE:
Robson, S.G., Van Slyke, G., and Graham, G., 1998, Structure, Outcrop, and Subcrop of the Bedrock Aquifers along the Western Margin of the Denver Basin, Colorado. Colorado Department of Natural Resources, Hydrologic Investigations Atlas HA-742.

C.I. = 100' above mean sea level

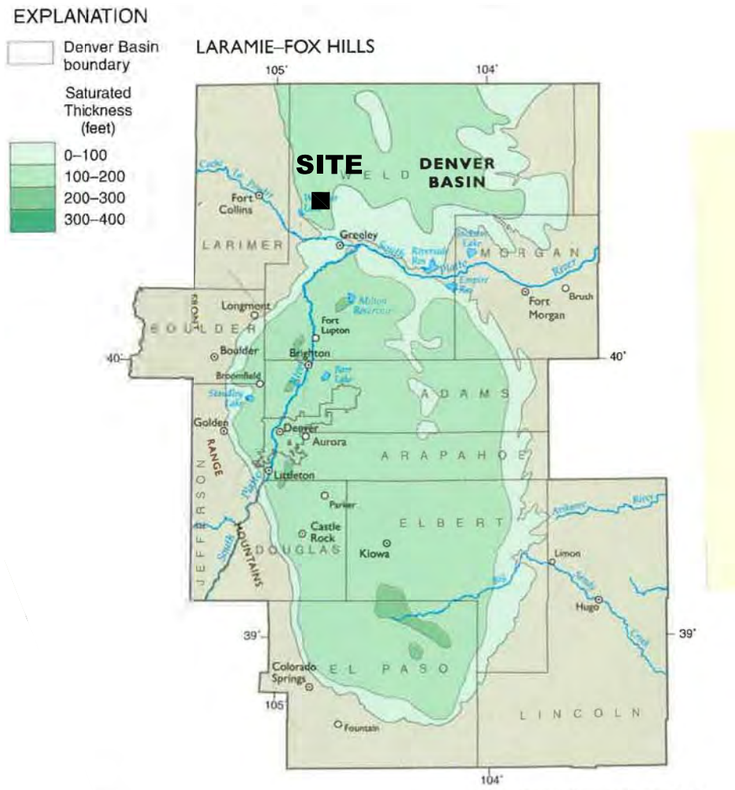
WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO. INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 9
STRUCTURE CONTOURS ON BASE
OF LARAMIE-FOX HILLS IN THE
DENVER BASIN



Modified from Robson and Banta, 1995



Modified from Robson and Banta, 1995

FROM: Ground Water Altas of Colorado
(Topper et al., 2003, Pages 87 and 89)

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 10
REGIONAL GROUNDWATER FLOW DIRECTIONS AND SATURATED THICKNESS OF THE LARAMIE–FOX HILLS AQUIFER IN THE DENVER BASIN

460500 N

459000 N

457500 N

456000 N

2190000 E

2188500 E

2187000 E

2185500 E

500'

A

A'

B

B'

C

C'

D

D'

E

E'

TW-10

TW-9

TW-8

NWE-20

PIT-5

NWE-19

NWE-17

NWE-16

PIT-4

NWE-18

TW-5

GP-19

TW-1

MW-12

MW-6,7 (abnd)

MW-4

NWE-15

NWE-14

NWE-13

GP-18

NWE-22a

MW-9

NWE-12

NWE-11

NWE-10

PIT-3

NWE-9

NWE-8/TP-1

PIT-2

NWE-7

GP-17

TW-4

MW-11 (abnd)

GP-16

MW-5

NWE-6

NWE-5

NWE-4

NWE-3

NWE-2

NWE-1/TP-2

PIT-1

NWE-1

MW-10

TH-23 (abnd)

MW-3

LEGEND

- SHALLOW LARAMIE WELL
- DEEP FOX HILLS WELL OR ABANDONED WELL
- PLANNED UNIT 2 LEACHATE COLLECTION SUMP
- 5100 — EXISTING INDEX CONTOUR
- EXISTING UN-IMPROVED SITE ROAD
- NWE-1 — GEOTECHNICAL BORING
- TW-1 — SHALLOW TEMPORARY WELL
- TW-2 — DEEP TEMPORARY WELL
- TP-1 — TEMPORARY PIEZOMETER
- PIT-1 — TEST PIT
- GP-16 — GAS PROBE
- A' — A — CROSS-SECTION LOCATIONS

TOPOGRAPHY AS OF FEBRUARY 21, 2016

N

TRUE NORTH

300 0 300 600 900

SCALE IN FEET

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 11
CROSS-SECTION LOCATION MAP

SOUTH

A

D – D'

C – C'

A'

NORTH

ELEVATION

EXISTING GROUND SURFACE

PLANNED BASE GRADE LINE

MW–10
TOC ELEV: 5126.96
GL ELEV: 5124.7

(PROJECTED 125')
TH–23 (ABANDONED)
GL ELEV: 5138.9

(PROJECTED 250')
MW–3
TOC ELEV: 5150.35
GL ELEV: 5148.1

TW–2
TOC ELEV: 5139.1
GL ELEV: 5135.5

FILL

Q_V SILTY SAND WITH GRAVEL

K_L SILTY SAND WITH CLAY

SANDY SILT

CLAYEY SILT WITH VERY FINE SAND

SANDY SILT

SHALE WITH CARBONACEOUS LAYERS

LIGNITE

SANDSTONE

SHALE

4993.5 (3/1/16)
K_{FH}

VERY FINE SILTY SANDSTONE

TD: 159.5'

Q_E CLAYEY SILT AND CLAY

Q_V SILTY SAND, FINE TO COARSE, WITH GRAVEL

CLAYEY SILT

SILT

SILTY CLAY

CLAYEY SILT

SILT, TRACES OF CLAY

SHALE

LIGNITE

SILTSTONE / SHALE

CARBONACEOUS SHALE / LIGNITE

SILTSTONE WITH SOME CLAY

SANDSTONE / SILTSTONE

SHALE / CLAYSTONE

VERY FINE SANDSTONE/SILTSTONE (BROWN)

VERY FINE SANDSTONE/SILTSTONE (GRAY)

TD: 162.0'

K_L

K_{FH}

5015.8 (3/1/16)

CLAYEY SILT

INTERBEDDED SAND AND GRAVEL, TRACE ORGANICS

LAMINATED CLAYSTONE, IRON STAINED

SANDSTONE WITH 1" CLAY LAYERS, IRON STAINED, MOIST

SILTY SANDSTONE, POORLY CEMENTED, MOIST

SANDSTONE, WELL CEMENTED

LAMINATED SHALE

LAMINATED CLAYSTONE WITH SANDSTONE LAYERS; MICROFOSSILS

CLAYEY SANDY SILTSTONE

LAMINATED SANDSTONE, OXIDIZED

LAMINATED TO MASSIVE BEDDED SANDSTONE; OCCASIONAL SILTSTONE / CLAYSTONE LAYERS

TD: 150.0' (COMPLETED WELL)

SHALE WITH HARD SILTSTONE / SANDSTONE

SANDSTONE AND SHALE
TD: 304.0'(4844.1'MSL),PLUGGED BACK TO 150.0'

CLAYEY SILT
Q_E
SANDY SILT

Q_V SILTY SAND WITH CLAY

K_L HARD CLAYSTONE

DENSE SILTY SAND

DENSE SAND WITH SILT

K_{FH}

DENSE SANDSTONE

VERY DENSE SANDSTONE

HARD CLAYSTONE

SILTY SAND

5011.0 (5/3/16)

TD: 129.0'

5170 5160 5150 5140 5130 5120 5110 5100 5090 5080 5070 5060 5050 5040 5030 5020 5010 5000 4990 4980 4970 4960 4950 4940 4930 4920

LEGEND:

NWE–01 Geotechnical Boring

TW–1 Temporary Well

MW–3 Existing Monitor Well

Q_E = Quaternary Eolian

Q_V = Quaternary Verdos

K_L = Top of Cretaceous Laramie Formation

K_{FH} = Top of Cretaceous Fox Hills Sandstone

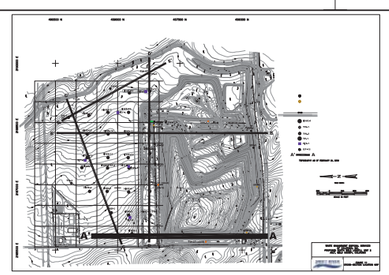
= Erosional Surface

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

Groundwater Level (March and May, 2016)

Well Screen



See Figure 11 For Cross–Section Location

NOTE: See boring records for detailed description of subsurface material

200 0 200 400
SCALE: 1"= 200'
VERTICAL EXAGGERATION OF 13X

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 12
CROSS–SECTION A–A'
JUNE 2016

SOUTH B

D–D'

C–C'

B', NORTH

ELEVATION

MW–4
TOC ELEV: 5081.58
GL ELEV: 5079.8

MW–7 (ABANDONED)
(PROJECTED 130')
GL ELEV: 5093.9

TW–01
(PROJECTED 255')
TOC ELEV: 5105.5
GL ELEV: 5102.5

MW–12
(PROJECTED 80')
TOC ELEV: 5094.3
GL ELEV: 5092.5

EXISTING GROUND SURFACE

PLANNED BASE GRADE LINE

TW–6
(PROJECTED 365')
TOC ELEV: 5080.3
GL ELEV: 5077.0

TW–5
TOC ELEV: 5079.5
GL ELEV: 5076.3

Q_E SILTY SAND

Q_V SAND, TRACES OF GRAVEL

K_L STIFF CLAY

SAND

SAND, TRACES OF GRAVEL

CLAYSTONE AND ORGANIC SHALE

LIGNITE

SANDSTONE

SILTSTONE AND CLAYSTONE

SANDSTONE

LIGNITE AND ORGANIC SHALE

SANDSTONE
5007.3 (3/1/16)

SHALE

LIGNITE

SANDSTONE

SANDSTONE AND SILTY SHALE
BIOTURBATED; TRACE FOSSILS

LIGNITE/COAL

SHALE WITH INTERBEDDED SILTY SANDSTONE

K_{FH}

SILTY SANDSTONE; MASSIVE TO LAMINATED BEDDING;
THIN COAL BEDS
TD: 115.0' (COMPLETED WELL)

SANDSTONE INTERBEDDED WITH BLACK SHALE

SILTY SHALE; LAMINATED; BIOTURBATED,
TRACE FOSSILS

SANDSTONE; TRACE FOSSILS
TD: 264.0'(4815.8'MSL), PLUGGED TO 115.0'

SANDY SILT

SILTY SAND WITH SOME GRAVEL

CLAYEY SILT

SHALE

CLAYEY SILT / SILTSTONE

LIGNITE / COAL

CLAYEY SILT / SILTSTONE

SANDSTONE

SILTSTONE

LIGNITE / COAL

CLAYEY SILTSTONE AND SANDSTONE

LIGNITE

SANDSTONE

SHALE
LIGNITE

SILTY CLAYEY SANDSTONE
SILTY CLAYSTONE
LIGNITE

TD: 128.0'

SILTY CLAY

CLAYEY SILT

SILTY SAND WITH GRAVEL

SANDY SILT

SILTY SAND

TW–1 SAND
SILTY SAND
5057.7 (5/4/16)
CLAYSTONE

TD: 49.4'

CLAYEY SILT

GRAVELY SAND WITH SOME SILT

SILTY SAND, TRACES OF CLAY

SANDY, SILTY CLAY

LIGNITE
5025.1 (3/1/16)

SANDY SILTSTONE

SHALE AND LIGNITE

SILTSTONE

SHALE AND SILTY SANDSTONE

SHALE

SILTY SANDSTONE

SHALE WITH ORGANICS (ILLEGIBLE)

SILTY SHALE

CLAYEY, SILTY SANDSTONE AND SILTSTONE

TD: 119.0'

Q_E

Q_V

K_L

K_{FH}

SILTY CLAY

SANDY SILT

SILTY SAND

SAND WITH GRAVEL

TW–5 SAND DENSE SAND, MOIST

TW–6 5029.7 (6/3/16)

MEDIUM DENSE SAND, WET

DENSE SAND, DAMP

HARD CLAYSTONE

DENSE SAND AND SANDSTONE

TD: 109.0'

SILTY CLAY

SILTY SAND

CLAYSTONE WITH SAND
5041.6 (5/3/16) TW–5

SILTY SAND
TW–5 SAND

TD: 49.0'

Q_E

Q_V

K_L

K_{FH}

LEGEND:

NWE–01 Geotechnical Boring

TW–1 Temporary Well

MW–3 Existing Monitor Well

Q_E = Quaternary Eolian

Q_V = Quaternary Verdos

K_L = Top of Cretaceous Laramie Formation

K_{FH} = Top of Cretaceous Fox Hills Sandstone

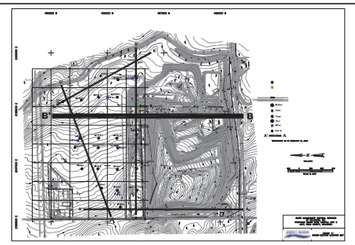
= Erosional Surface

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

Groundwater Level (March and May, 2016)

Well Screen



See Figure 11 For Cross–Section Location

NOTE: See boring records for detailed description of subsurface material

200 0 200 400
SCALE: 1"= 200'
VERTICAL EXAGGERATION OF 13X

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 13
CROSS–SECTION B–B'
JUNE 2016

SOUTHWEST

C

A–A'

E–E'

NORTHEAST

C'

ELEVATION

TW–2
TOC ELEV: 5139.1
GL ELEV: 5135.5

CLAYEY SILT

Q_E

SANDY SILT

Q_V

SILTY SAND WITH CLAY

K_L

HARD CLAYSTONE

DENSE SILTY SAND

DENSE SAND WITH SILT

DENSE SANDSTONE

VERY DENSE SANDSTONE

VERY HARD CLAYSTONE

SILTY SAND

5011.0 (5/3/16)

TD: 129.0'

TW–4
(PROJECTED 575')
TOC ELEV: 5112.8
GL ELEV: 5109.6

TOP SOIL

CLAYEY SILT

SANDY SILT

SILTY SAND

CLAYSTONE WITH SAND LAYERS

DENSE SILTY SAND

MEDIUM DENSE SAND WITH SILT

VERY DENSE FINE GRAINED SANDSTONE

K_{FH}

5024.1 (5/3/16)

TD: 104.0'

PLANNED BASE GRADE LINE

TW–6
TOC ELEV: 5080.3
GL ELEV: 5077.0

TW–5
TOC ELEV: 5079.5
GL ELEV: 5076.3

SILTY CLAY

SANDY SILT

SILTY SAND

SAND WITH GRAVEL

CLAYSTONE WITH SAND
5041.6 (5/3/16) TW–5

TW–5 SAND

DENSE SAND, MOIST

SILTY SAND
TW–5 SAND

TW–6 5029.7 (5/3/16)

MEDIUM DENSE SAND, WET

DENSE SAND, DAMP

HARD CLAYSTONE

DENSE SAND AND SANDSTONE

TD: 109.0'

5150 5140 5130 5120 5110 5100 5090 5080 5070 5060 5050 5040 5030 5020 5010 5000 4990 4980 4970 4960 4950 4940 4930 4920 4910 4900

200 0 200 400

SCALE: 1"= 200'
VERTICAL EXAGGERATION OF 13X

LEGEND:

NWE–01 Geotechnical Boring

TW–1 Temporary Well

MW–3 Existing Monitor Well

Q_E = Quaternary Eolian

Q_V = Quaternary Verdos

K_L = Top of Cretaceous Laramie Formation

K_{FH} = Top of Cretaceous Fox Hills Sandstone

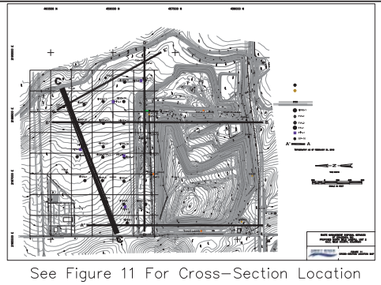
= Erosional Surface

= Predominantly Sand and Sandstone

= Planned Base Grade (WM 2012)

Groundwater Level (March and May, 2016)

Well Screen



See Figure 11 For Cross–Section Location

NOTE: See boring records for detailed description of subsurface material

WASTE MANAGEMENT DISPOSAL SERVICES
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SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

FIGURE 14
CROSS–SECTION C–C'
JUNE 2016

WEST D A–A' B–B' E–E' D' EAST

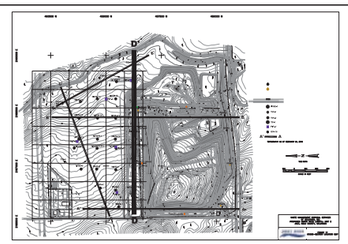
ELEVATION

MW–3 (PROJECTED 250') TOC ELEV: 5150.35 GL ELEV: 5148.1
NWE–21/TP–2 ELEV: 5164.6
NWE–22A ELEV: 5150.5
MW–11 (ABANDONED) (PROJECTED 425') GL ELEV: 5126.0
MW–12 (PROJECTED 125') RAISED TOC: 5094.3 GL ELEV: 5092.5
TW–1 (PROJECTED 400') TOC ELEV: 5105.5 GL ELEV: 5102.5
NWE–19 ELEV: 5081.3
TW–9 TOC ELEV: 5076.4 GL ELEV: 5073.7
TW–10 TOC ELEV: 5075.7 GL ELEV: 5073.2

EXISTING GROUND SURFACE
PLANNED BASE GRADE LINE
STOCKPILE
CLAYEY SILT
CLAY AND SILT
FINE/COARSE SAND
INTERBEDDED SAND AND GRAVEL, TRACE ORGANICS
CLAYEY SILT
HARD CLAYSTONE
LAMINATED CLAYSTONE, IRON STAINED
LIGNITE
SANDSTONE WITH 1" CLAY LAYERS, IRON STAINED, MOIST
DENSE SILTY SAND
SILTY SANDSTONE, POORLY CEMENTED, MOIST
SANDSTONE, WELL CEMENTED
LAMINATED SHALE
LAMINATED CLAYSTONE WITH SANDSTONE LAYERS; MICROFOSSILS
CLAYEY SANDY SILTSTONE
LAMINATED SANDSTONE, OXIDIZED
5015.8 (3/1/16)
LAMINATED SANDSTONE WITH SILTSTONE / CLAYSTONE LAYERS
TD: 150.0' (COMPLETED WELL)
SHALE WITH HARD SILTSTONE / SANDSTONE
SANDSTONE
SANDSTONE AND SHALE
TD: 304.0'(4844.1'MSL),PLUGGED AT 150.0'
TD: 76.0'
FINE SILTY SAND
COARSE SILTY SAND
SILTSTONE
CLAYSTONE
SILTSTONE
SILTSTONE WITH SAND
CLAYSTONE
LIGNITE
SILTSTONE
LIGNITE
SILTSTONE
SANDSTONE
SHALE
SANDSTONE
SHALE
SILTSTONE WITH CEMENTED LAYERS
TD: 159.0'
Q_V
K_L
K_{FH}
STOCKPILE
DENSE SAND
SILTSTONE
CLAYSTONE
COAL
SANDSTONE
SILTSTONE
TD: 80.0'
GRAVELY SAND WITH SOME SILT
TW–1 SAND
SANDY, SILTY CLAY (ILLEGIBLE)
LIGNITE
SANDY SILTSTONE
SHALE AND LIGNITE
SILTSTONE
SHALE AND SILTY SANDSTONE
SHALE
SILTY SANDSTONE
SHALE WITH ORGANICS (ILLEGIBLE)
SILTY SHALE
CLAYEY, SILTY SANDSTONE AND SILTSTONE
TD: 119.0'
SILTY CLAY
CLAYEY SILT
SILTY SAND WITH GRAVEL
SANDY SILT
SILTY SAND
5057.7 (5/4/16)
SAND CLAYSTONE
TD: 49.4'
5025.1 (3/1/16)
SOFT, CLAYEY SILT
FIRM, CLAYEY SILT
SOFT, SANDY SILT WITH COARSE SAND AND GRAVEL
TD: 31.0'
TW–9 SAND WITH GRAVEL
TW–9 5033.8 (5/4/16)
TD: 47.0'
SILTY CLAY
CLAYEY SILT
CLAYEY SAND
SAND WITH GRAVEL
STIFF CLAY
SAND
STIFF CLAY
5019.4 (5/4/16) TW–10
SILTY SAND
CLAYSTONE
LIGNITE
SAND
SANDY SILT
DENSE SAND WITH SILT
LIGNITE
SILTY SAND WITH CLAY
CLAYSTONE
HARD SANDSTONE
TD: 98.5'

LEGEND:

NWE–01 Geotechnical Boring
TW–1 Temporary Well
MW–3 Existing Monitor Well
Q_E = Quaternary Eolian
Q_V = Quaternary Verdos
K_L = Top of Cretaceous Laramie Formation
K_{FH} = Top of Cretaceous Fox Hills Sandstone
= Erosional Surface
= Predominantly Sand and Sandstone
= Planned Base Grade (WM 2012)
Groundwater Level (March and May, 2016)
Well Screen



See Figure 11 For Cross–Section Location

NOTE: See boring records for detailed description of subsurface material

200 0 200 400
SCALE: 1"=200'
VERTICAL EXAGGERATION OF 13X

WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

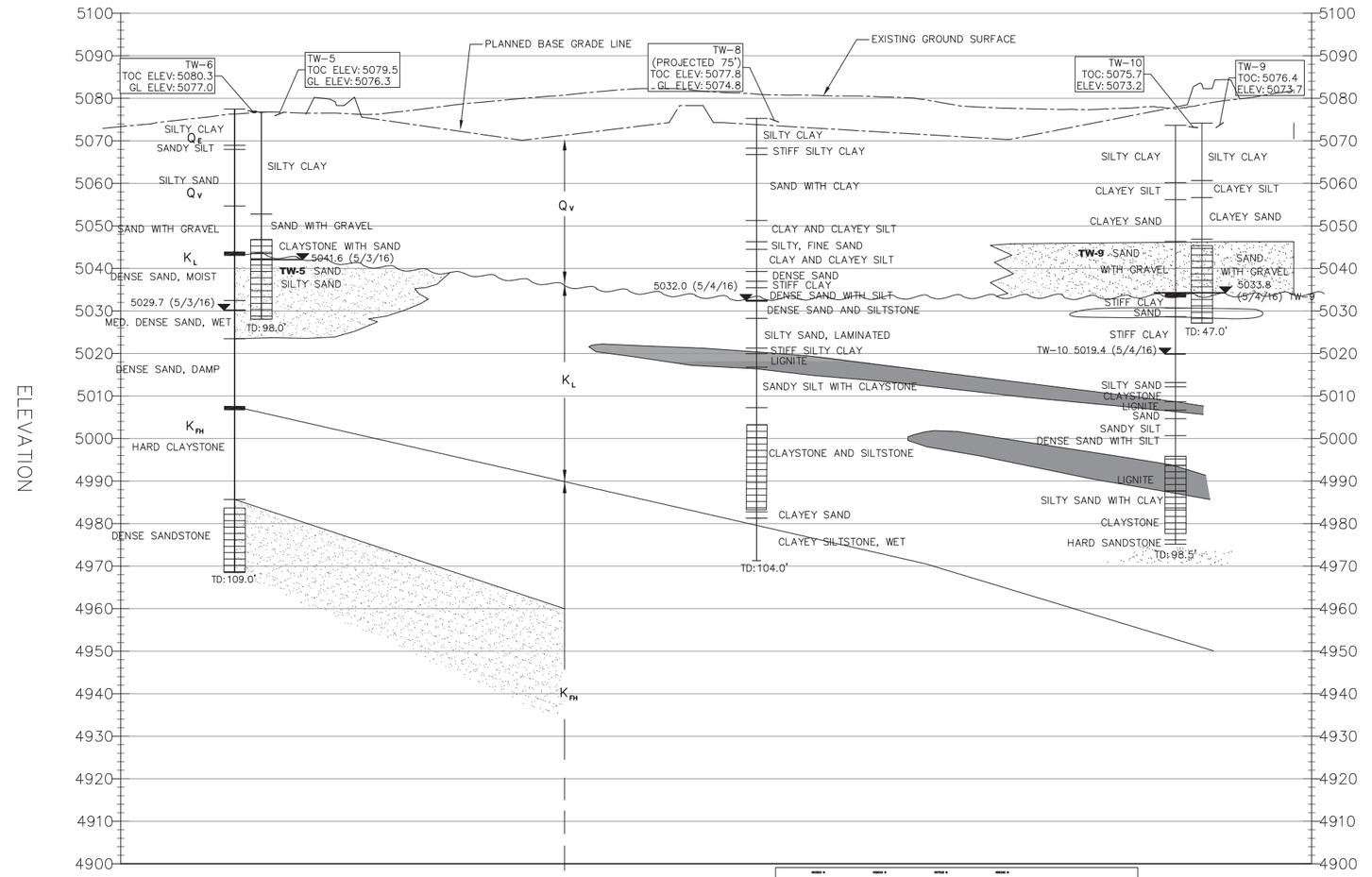
FIGURE 15
CROSS–SECTION D–D'
JUNE 2016

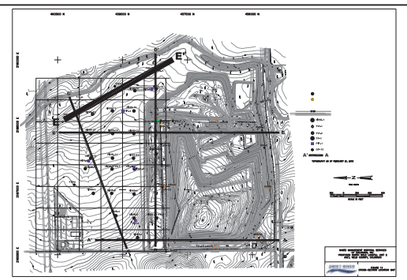
NORTHWEST E

C–C'

D–D'

SOUTHEAST E'





See Figure 11 For Cross–Section Location

200 0 200 400

SCALE: 1"= 200'

VERTICAL EXAGGERATION OF 13X

NWE–01 Geotechnical Boring

TW–1 Temporary Well

MW–3 Existing Monitor Well

Q_E = Quaternary Eolian

Q_V = Quaternary Verdos

K_L = Top of Cretaceous Laramie Formation

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= Erosional Surface

= Predominantly Sand and Sandstone

___/ = Planned Base Grade (WM 2012)

Groundwater Level (March and May, 2016)

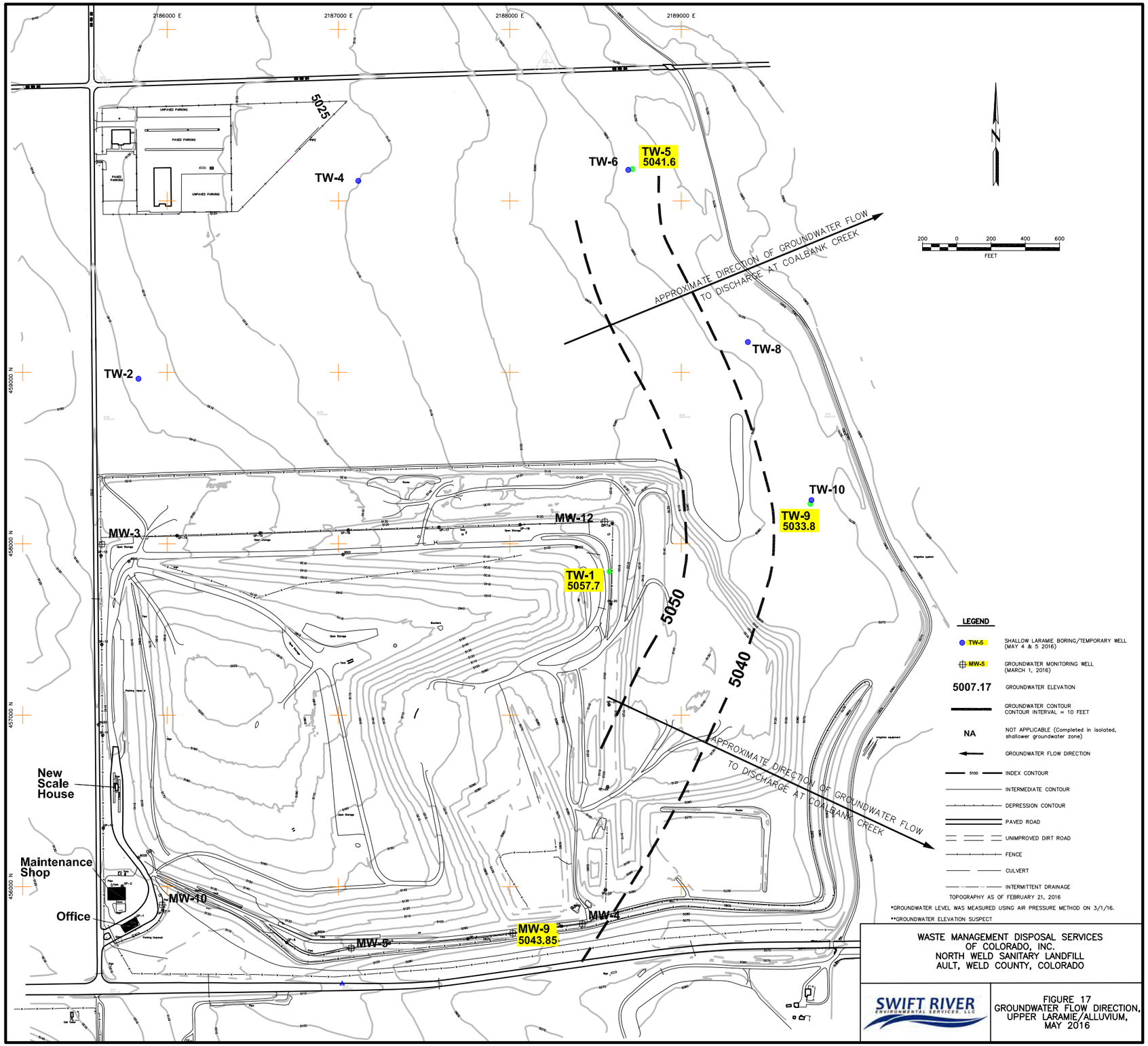
Well Screen

NOTE: See boring records for detailed description of subsurface material

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
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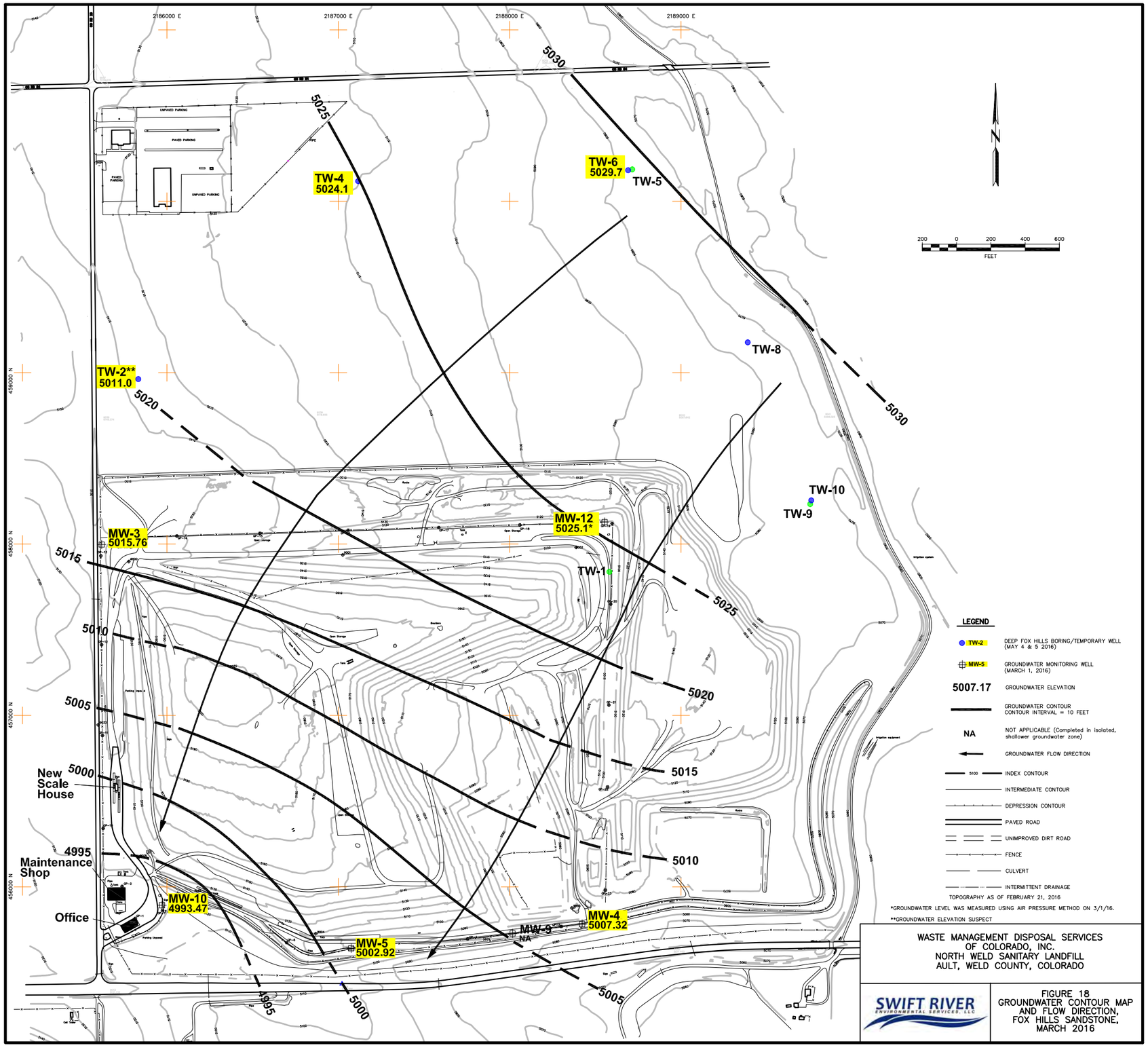
FIGURE 16
CROSS–SECTION E–E'
JUNE 2016

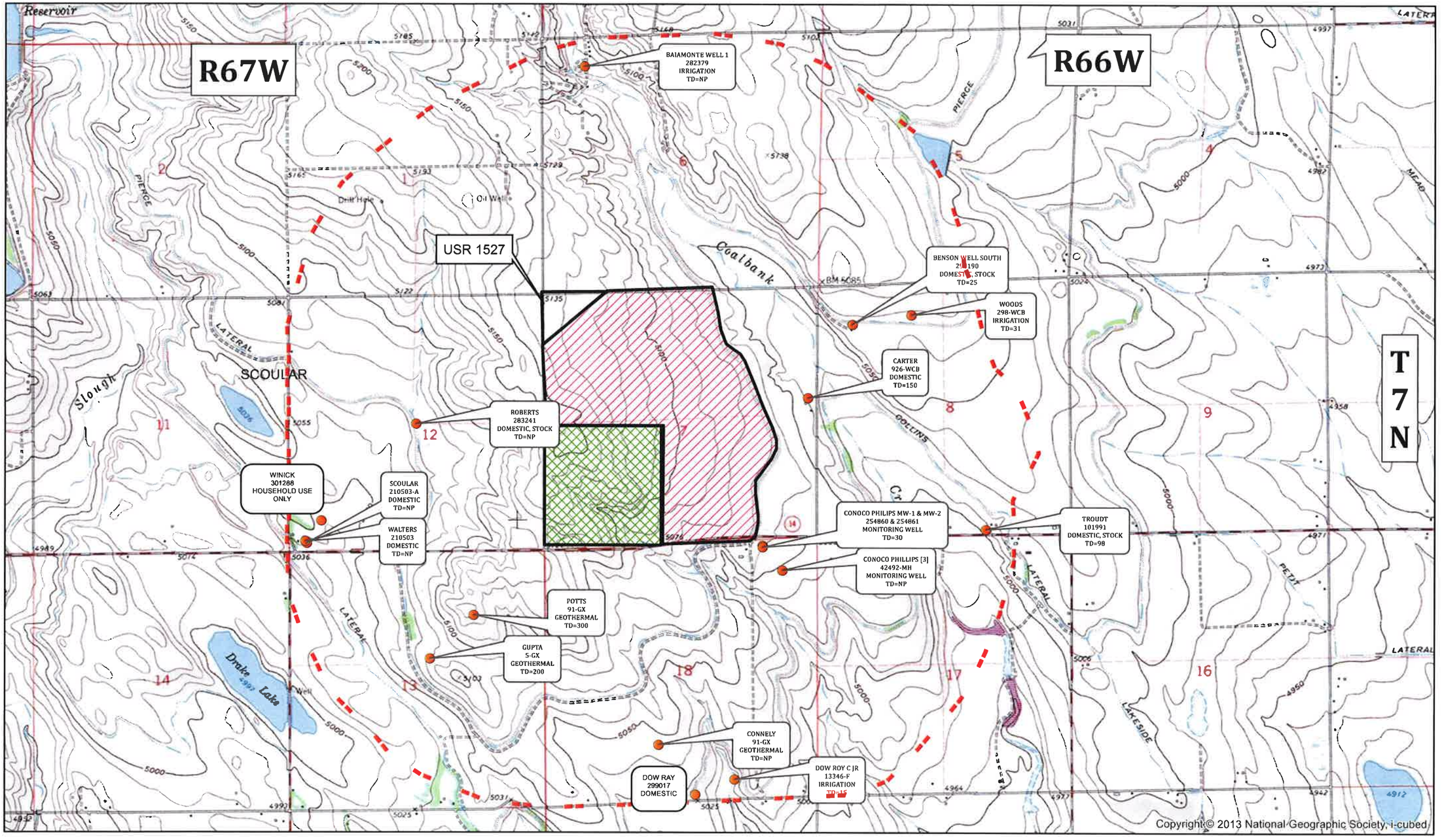


WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
NORTH WELD SANITARY LANDFILL
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 17
GROUNDWATER FLOW DIRECTION,
UPPER LARAMIE/ALLUVIUM,
MAY 2016


2186000 E
2187000 E
2188000 E
2189000 E
459000 N
458000 N
457000 N
456000 N
5030
5025
5020
5015
5010
5005
5000
4995
UNPAVED PARKING
PAVED PARKING
TW-4
5024.1
TW-6
5029.7
TW-5
TW-8
TW-2**
5011.0
TW-10
TW-9
MW-12
5025.1*
MW-3
5015.76
TW-1
New
Scale
House
4995
Maintenance
Shop
Office
MW-10
4993.47
MW-4
5007.32
MW-9
NA
MW-5
5002.92
N
200 0 200 400 600
FEET
LEGEND
TW-2 DEEP FOX HILLS BORING/TEMPORARY WELL (MAY 4 & 5 2016)
MW-5 GROUNDWATER MONITORING WELL (MARCH 1, 2016)
5007.17 GROUNDWATER ELEVATION
GROUNDWATER CONTOUR CONTOUR INTERVAL = 10 FEET
NA NOT APPLICABLE (Completed in isolated, shallower groundwater zone)
GROUNDWATER FLOW DIRECTION
5100 INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR
PAVED ROAD
UNIMPROVED DIRT ROAD
FENCE
CULVERT
INTERMITTENT DRAINAGE
TOPOGRAPHY AS OF FEBRUARY 21, 2016
*GROUNDWATER LEVEL WAS MEASURED USING AIR PRESSURE METHOD ON 3/1/16.
**GROUNDWATER ELEVATION SUSPECT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.
NORTH WELD SANITARY LANDFILL
AULT, WELD COUNTY, COLORADO
SWIFT RIVER ENVIRONMENTAL SERVICES, LLC
FIGURE 18
GROUNDWATER CONTOUR MAP AND FLOW DIRECTION, FOX HILLS SANDSTONE, MARCH 2016





QUADRANGLE LOCATION

LEGEND:

WELL NUMBER
PERMIT NUMBER
USES
TOTAL DEPTH

NWLF UNIT 2

USR (895) NWLF UNIT 1

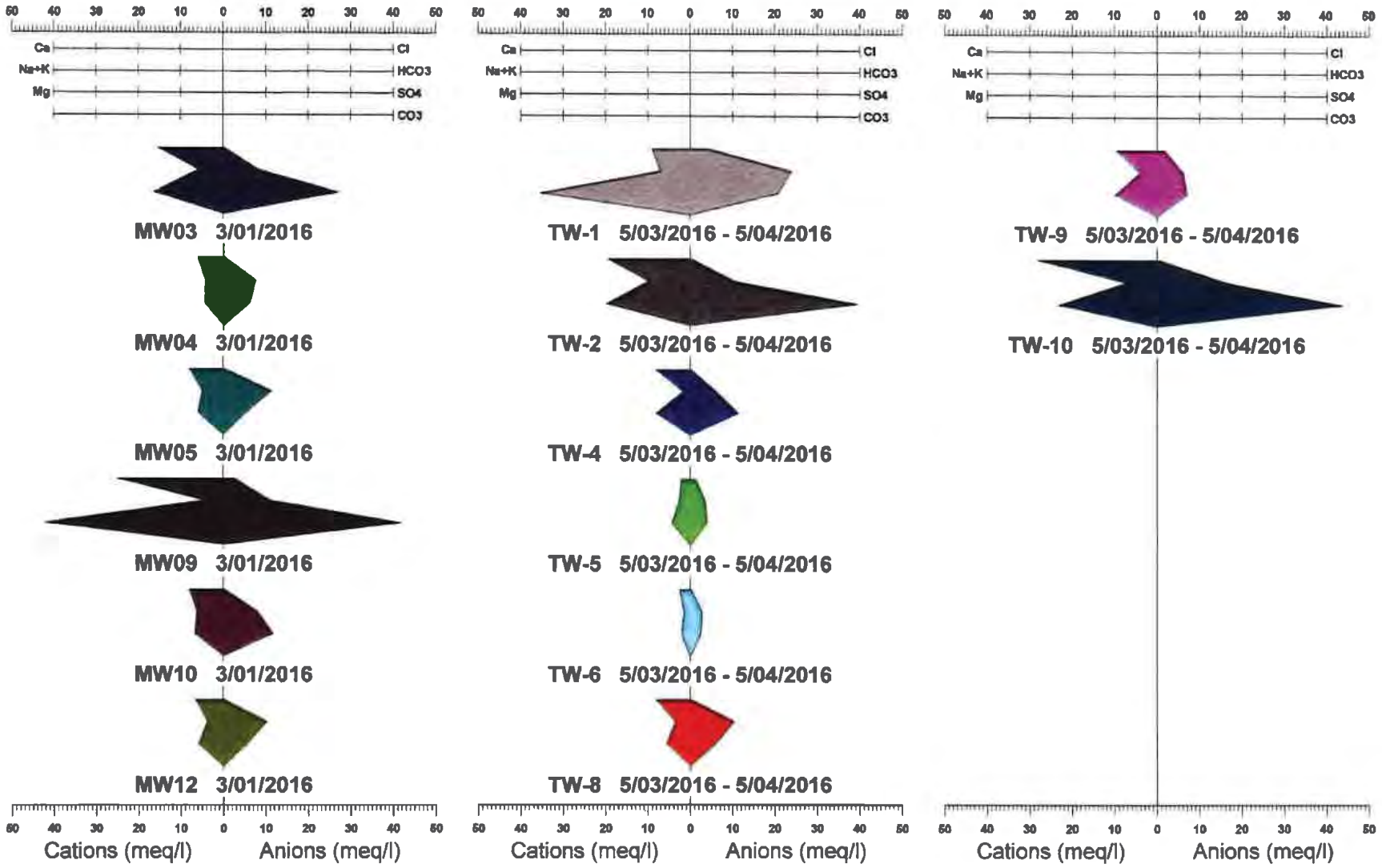
Miles
0 ¼ ½ ¾ 1
1 inch = 2,056 feet

NP = Total Depth Not Provided
SOURCE: Office of the State Engineer, Division of Water Resources

WASTE MANAGEMENT DISPOSAL SERVICES
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PROPOSED NORTH WELD LANDFILL UNIT 2
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FIGURE 19
PERMITTED WATER WELLS WITHIN
ONE MILE OF NWLF UNITS 1 AND 2



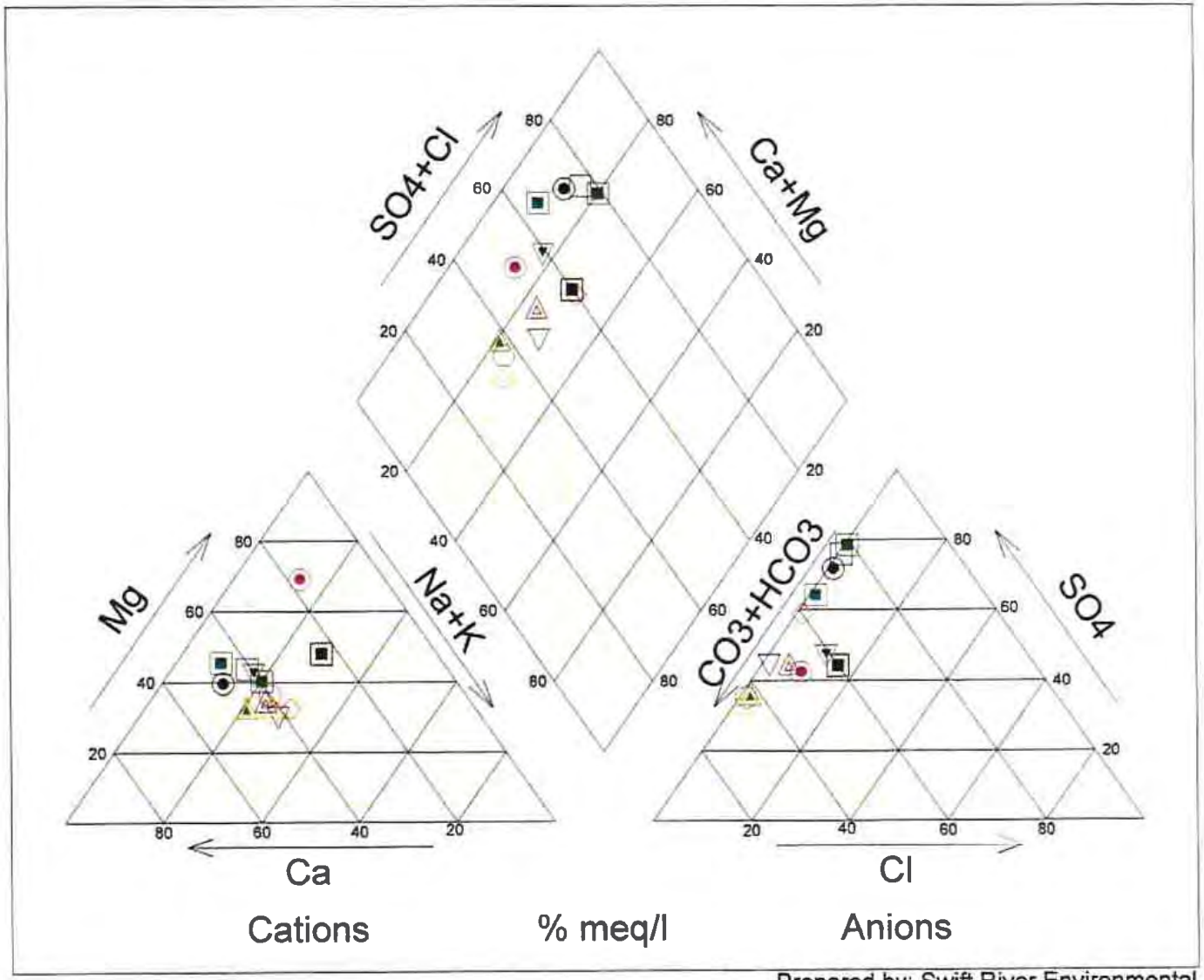
Prepared by: Swift River Environmental

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PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 20
STIFF DIAGRAMS FOR TEMPORARY WELLS AND MONITOR WELLS, NWLF UNITS 1 AND 2

MW03	3/01/2016	
MW04	3/01/2016	
MW05	3/01/2016	
MW09	3/01/2016	
MW10	3/01/2016	
MW12	3/01/2016	
TW-1	5/03/2016 -	5/04/2016
TW-2	5/03/2016 -	5/04/2016
TW-4	5/03/2016 -	5/04/2016
TW-5	5/03/2016 -	5/04/2016
TW-6	5/03/2016 -	5/04/2016
TW-8	5/03/2016 -	5/04/2016
TW-9	5/03/2016 -	5/04/2016
TW-10	5/03/2016 -	5/04/2016

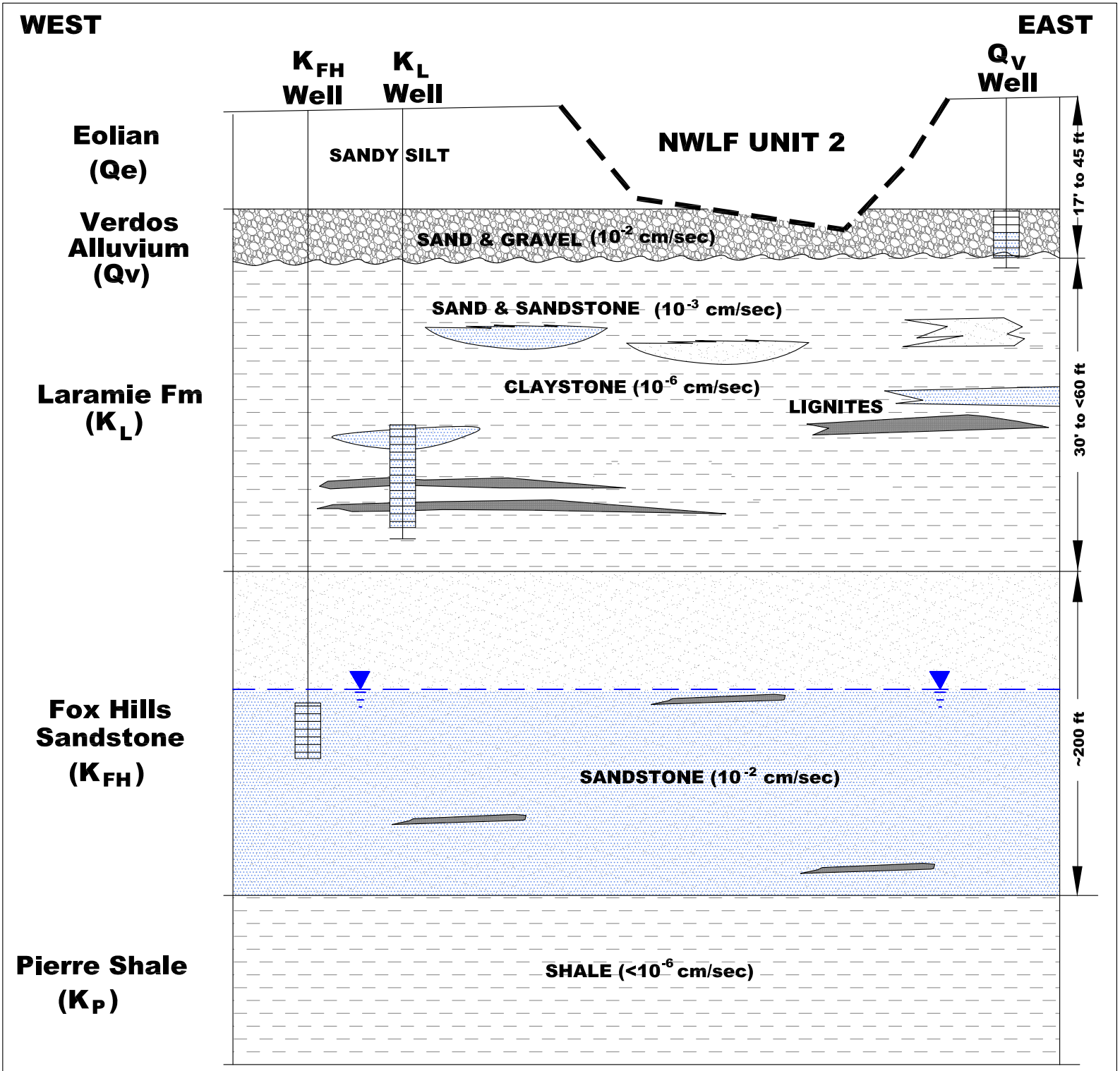


Prepared by: Swift River Environmental

WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

FIGURE 21
PIPER DIAGRAM FOR TEMPORARY WELLS AND MONITOR WELLS, NWLF UNITS 1 AND 2



WASTE MANAGEMENT DISPOSAL SERVICES
OF COLORADO, INC.
PROPOSED NORTH WELD LANDFILL UNIT 2
AULT, WELD COUNTY, COLORADO

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

FIGURE 22
CONCEPTUAL HYDROGEOLOGIC MODEL

APPENDIX B

TABLES

Table 1: Temporary Well Construction Details
Table 2: Temporary Well Development Details
Table 3: Groundwater Elevation Data
Table 4: Water Sampling Data
Table 5: Hydraulic Conductivity Test Results
Table 6: Permitted Water Wells within One Mile of NWLF Units 1 and 2

TABLE 1
Temporary Well Construction Details

Well Number	Date Drilled		Ground Surface Elevation (Ft MSL)	Depth Drilled (Ft BGS)	Well Bottom (Ft BGS)	Screen Bottom (Ft BGS)	Screen Top (Ft BGS)	Sand Pack Top (Ft BGS)	Bentonite Seal (Ft BGS)
	Start	End							
TW-01	2/19/2016	2/19/2016	5102.5	49.4	49.4	49.1	39.1	36.0	34.0
TW-02	2/22/2016	2/23/2016	5135.5	129.0	129.0	128.7	108.7	105.7	103.7
TW-03	NA	NA	NA	NA	NA	NA	NA	NA	NA
TW-04	2/23/2016	3/2/2016	5109.6	104.0	103.5	103.2	88.2	84.4	82.4
TW-05	2/25/2016	2/25/2016	5076.3	49.0	49.0	48.7	28.7	25.5	23.5
TW-06	2/24/2016	2/25/2016	5077.0	109.0	109.0	108.8	93.8	90.5	88
TW-07	NA	NA	NA	NA	NA	NA	NA	NA	NA
TW-08	3/1/2016	3/1/2016	5074.8	104.0	92.3	92.0	72.0	69.0	67.0
TW-09	2/29/2016	2/29/2016	5073.7	49.0	47.3	47.0	32.0	29.0	26.5
TW-10	2/26/2016	2/26/2016	5073.2	98.5	97.8	97.5	77.5	73.8	71.2

Notes: Ground Surface Elevations are estimated from NWLF Unit 2 topographic map.
Ft MSL = Elevation in feet above mean sea level
Ft BGS = Feet below ground surface
NA = Planned shallow wells TW-3 and TW-7 were not drilled based on the absence of shallow groundwater in paired deep wells TW-4 and TW-8, respectively.

TABLE 2
Temporary Well Development Details

Well Number	Date Installed	Date Developed	Ground Surface Elevation (Ft MSL)	Stickup (Feet)	Top of Casing Elevation (Ft MSL)	Development Method	Initial, Final Depth to Water (Ft BGS)	Initial, Final Well Depth (Ft BGS)	Initial, Final Conductivity (µS/cm)	Initial, Final pH (std units)	Initial, Final Temperature (° C)	Cumulative Volume Removed (gal)	Initial, Final Comments (color, turbidity, odor)
TW-01	2/19/2016	3/7/2016	5102.5	3.0	5105.5	Bailer, Pump	44.6	49.2	3564	7.18	11.2	0.3	Dark brown, cloudy, no odor
							44.6	49.2	3717	7.08	10.5	40.0	Light tan, clear, no odor
TW-02	2/23/2016	3/3/2016	5135.5	3.6	5139.1	Bailer	124.5	129.0	1481	7. 61	9.9	0.5	Brown, cloudy, no odor
							127.3	129.0	3407	7.49	12.7	5.0	Brown, cloudy, no odor
TW-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
TW-04	3/2/2016	3/7/2016	5109.6	3.2	5112.8	Bailer, Pump	89.0	102.9	1428	7.42	11.4	0.3	Brown, cloudy, no odor
							91.2	103.6	1467	7.36	12.4	30.0	Light tan, clear, no odor
TW-05	2/25/2016	3/3/2016	5076.3	3.2	5079.5	Bailer, Pump	33.2	48.8	668	9.05	12.8	1.5	Brown, cloudy, no odor
							49.5	48.8	732	8.29	13.0	37.5	No color, clear, no odor
TW-06	2/25/2016	3/3/2016	5077.0	3.3	5080.3	Bailer, Pump	46.3	108.8	351	9.05	16.0	0.3	Dark brown, cloudy, no odor
							57.4	108.8	627	8.12	14.8	60.0	No color, clear, no odor
TW-07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
TW-08	3/1/2016	3/4/2016	5074.8	3.0	5077.8	Bailer, Pump	42.0	92.5	660	8.68	11.8	0.3	Dark brown, cloudy, no odor
							94.0	92.6	1903	7.29	16.2	70.0	No color, clear, no odor
TW-09	2/29/2016	3/4/2016	5073.7	2.7	5076.4	Bailer	43.4	47.6	1825	7.53	15.0	0.3	Light brown, slightly cloudy, no odor
							49.9	47.5	2104	7.54	15.6	3.8	Light brown, slightly cloudy, no odor
TW-10	2/26/2016	3/4/2016	5073.2	2.5	5075.7	Bailer, Pump	53.5	98.0	1217	7.27	13.3	0.5	Brown, cloudy, no odor
							99.6	98.1	3088	7.22	16.3	40.0	No color, clear, no odor

Notes: Ground Surface Elevations are estimated from NWLF Unit 2 topographic map.
Ft MSL = Elevation in feet above mean sea level
Ft BGS = Feet below ground surface
NA = Planned shallow wells TW-3 and TW-7 were not drilled based on the absence of shallow groundwater in paired deep wells TW-4 and TW-8, respectively.

TABLE 3
Groundwater Elevation Data

Well Number	Stratigraphic Unit	Date Measured	Top of Casing Elevation (Ft MSL)	Total Depth (Ft below datum)	Depth to Groundwater (Ft below datum)	Groundwater Elevation (Ft MSL)
Monitor Wells - NWLF Unit 1						
MW-3	K_{FH} - Fox Hills Fm	3/1/2016	5150.35	152.0	134.59	5015.76
MW-4	K_{FH} - Fox Hills Fm	3/1/2016	5081.58	119.7	74.26	5007.32
MW-5	K_{FH} - Fox Hills Fm	3/1/2016	5101.01	116.4	98.09	5002.92
MW-9	Q_V - Verdos Alluvium/Laramie	3/1/2016	5087.14	57.6	43.29	5043.85
MW-10	K_{FH} - Fox Hills Fm	3/1/2016	5126.96	158.3	133.49	4993.47
MW-12	K_{FH} - Fox Hills Fm	3/1/2016	5102.2 **	130.3	77.1 *	5025.1 *
Temporary Wells - NWLF Unit 2						
TW-01	Q_V - Verdos Alluvium/Laramie	5/4/2016	5105.5	52.0	47.8	5057.7
TW-02	K_{FH} - Fox Hills Fm	5/3/2016	5139.1	132.3	128.0	5011.1
TW-04	K_{FH} - Fox Hills Fm	5/3/2016	5112.8	106.4	88.7	5024.1
TW-05	Q_V - Verdos Alluvium/Laramie	5/3/2016	5079.5	51.9	37.9	5041.6
TW-06	K_{FH} - Fox Hills Fm	5/3/2016	5080.3	112.1	50.6	5029.7
TW-08	K_L - Laramie Fm	5/4/2016	5077.8	95.0	45.8	5032.0
TW-09	Q_V - Verdos Alluvium/Laramie	5/4/2016	5076.4	49.7	42.6	5033.8
TW-10	K_L - Laramie Fm	5/4/2016	5075.7	100.0	56.3	5019.4

Notes: Ft MSL = Elevation in feet above mean sea level (National Vertical Datum 1988).
Datum is top of PVC Casing.

* Depth to groundwater obtained by air pressure method. Groundwater elevation is approximate.

** Approximate top of casing elevation as resurveyed 8/26/13.

Q_V - Verdos Alluvium/Laramie

K_L - Laramie Fm

K_{FH} - Fox Hills Fm

TABLE 4
Water Sampling Data

NWLF Unit 1 Wells - Analytical Data Summary for 3/01/2016

Constituents	Units	MW03	MW04	MW05	MW09	MW10	MW12
Alkalinity, bicarbonate (as caco3)	MG/L	420	370	570	550	400	510
Calcium-dissolved	MG/L	310	120	160	500	160	130
Chloride	MG/L	8.7	8.6	11.0	94.0	9.1	8.5
Magnesium-dissolved	MG/L	200	52	73	510	82	71
Potassium-dissolved	MG/L	8.1	10.0	9.3	9.4	8.2	6.0
Sodium-dissolved	MG/L	130	89	110	100	140	85
Sulfate	MG/L	1300	290	260	2000	560	270

NWLF Unit 2 Wells - Analytical Data Summary for 5/03/2016 to 5/04/2016

Constituents	Units	TW-1	TW-2	TW-4	TW-5	TW-6	TW-8	TW-9	TW-10
Alkalinity, bicarbonate (as caco3)	MG/L	1200	530	310	180	140	520	310	830
Calcium-dissolved	MG/L	180	390	160	43	50	160	190	560
Chloride	MG/L	160.0	11.0	8.2	50.0	11.0	11.0	64.0	24.0
Magnesium-dissolved	MG/L	430	240	97	53	25	68	120	280
Potassium-dissolved	MG/L	<5.0	11.0	5.1	<5.0	5.8	7.5	9.3	13.0
Sodium-dissolved	MG/L	160	220	34	58	29	77	89	160
Sulfate	MG/L	1000	1900	550	190	120	290	340	2100

TABLE 5
Hydraulic Conductivity Test Results

Well or Boring Number	Groundwater Zone	Screened Interval Lithology	Test	Hydraulic Conductivity (cm/sec)	Geometric Mean of Test Values (cm/sec)
TW-5	Q_V- Verdos Alluvium/Laramie	Silty fine-grained sand	Slug In	1.90E-02	4.06E-02
			Slug Out	5.13E-03	
TW-9	Q_V- Verdos Alluvium/Laramie	Fine to coarse sand with gravel	Slug In	2.02E-01	
			Slug Out	1.38E-01	
TW-8	K_L - Laramie Fm	Fissile siltstone and claystone with lignite and 3.5 ft coal seam	Slug In	2.54E-03	2.04E-03
			Slug Out	2.13E-03	
TW-10	K_L - Laramie Fm	Fine-grained sand and siltstone, with 4 ft coal seam	Slug In	1.68E-03	
			Slug Out	1.89E-03	
TW-4	K_{FH} - Fox Hills Fm	Fine-grained sandstone	Slug In	6.15E-03	1.16E-02
			Slug Out	7.54E-03	
TW-6	K_{FH} - Fox Hills Fm	Fine-grained sand and sandstone	Slug In	2.06E-02	
			Slug Out	1.88E-02	
NWE-07	Qe -Eolian Deposit	Clayey silt, transition to gravelly sand	Laboratory	2.1 E -02	2.1 E -02
NWE-12	Q_V- Verdos Alluvium/Laramie	Sandy and silty clay	Laboratory	5.20E-02	5.20E-02

Note:
"Slug In" indicates test initiated by weighted tube insertion into groundwater in well.
"Slug Out" indicates test initiated by weighted tube removal from groundwater in well.
Because of similarity in values, both slug in and slug out test results are used to calculate the geometric mean.

TABLE 6
Permitted Wells Within One Mile of NWLF Units 1 and 2

	Well Identifications				Location Information		S/T/R Location Information					Detailed Location Information				Other Information
	Well Name	Receipt Number	Permit Number	Well Depth	UTM_x	UTM_y	Township	Range	Section	q160	q40	Feet N or S	From Nearest Section Line	Feet E or W	From Least Section Line	Uses
T7N, R66W	CONNELY	**0053997A**	**91-GX**	*NP*	514950.4	4491089	T7N	R66W	18	SW	SE	1183	S	2329	W	CLOSED LOOP GEOTHERMAL
	CONOCO PHILIPS MW-1	**0519377J**	**254860**	30	515607.2	4492340.5	T7N	R66W	18	NE	NE	138	N	1110	E	MONITORING WELL
	CONOCO PHILIPS MW-2	**0519377K**	**254861**	30	515608.7	4492331.4	T7N	R66W	18	NE	NE	168	N	1105	E	MONITORING WELL
	CONOCO PHILLIPS [3]	**42492**	**42492-MH**	*NP*	515731.5	4492184.9	T7N	R66W	18	NE	NE	*NP*	*NP*	*NP*	*NP*	MONITORING WELL
	DOW RAY	**3671342**	**299017**	40	515180.1	4490774	T7N	R66W	18	SE	SW	120	S	2515	E	DOMESTIC, STOCK
	DOW ROY C JR	**9061557**	**13346-F**	15	515428.3	4490869	T7N	R66W	18	SE	SW	400	S	1700	E	IRRIGATION
	BENSON WELL SOUTH	**3670199**	**298190**	25	516177.9	4493734.1	T7N	R66W	8	NW	NW	798	N	730	W	DOMESTIC, STOCK
	TROUDT	**93883**	**101991**	98	517015.5	4492436.4	T7N	R66W	8	SE	SW	100	S	1750	E	DOMESTIC, STOCK
	WOODS	**C620298**	**298-WCB**	31	516549.5	4493793.5	T7N	R66W	8	NW	NE	*NP*	*NP*	*NP*	*NP*	IRRIGATION
	CARTER	**C620926**	**926-WCB**	150	515897	4493273	T7N	R66W	7	NE	SE	2280	N	180	E	DOMESTIC
	BAIAMONTE WELL 1	**3643214**	**282379**	*NP*	514500	4495372	T7N	R66W	6	NW	NW	544	N	595	W	IRRIGATION
T7N, R67W	GUPTA	**0545048X**	**5-GX**	200	513511.9	4491638	T7N	R67W	13	NE	SW	2215	N	2386	E	GEOTHERMAL
	POTTS	**3658689B**	**91-GX**	300	513788.9	4491912	T7N	R67W	13	NW	NE	1319	N	1474	E	GEOTHERMAL, CLOSED LOOP GEOTHERMAL
	ROBERTS	**3645507**	**283241**	*NP*	513430.1	4493120	T7N	R67W	12	NW	SW	0	N	0	W	DOMESTIC, STOCK
	SCOULAR	**0429682B**	**210503-A**	*NP*	512738.7	4492370.9	T7N	R67W	12	SW	SW	200	S	360	W	DOMESTIC
	WALTERS	**0429682A**	**210503**	*NP*	512729.6	4492382.9	T7N	R67W	12	SW	SW	240	S	330	W	DOMESTIC
	WINICK	**3674203**	**301288**	*NP*	512829.9	4492511.5	T7N	R67W	12	SW	SW	*NP*	*NP*	*NP*	*NP*	HOUSEHOLD USE ONLY

NP = Not Provided by the Office of State Engineer (OSE) database
[ ] = Number added by SRES for clarification
OSE records review conducted 6/3/16

APPENDIX C

TEMPORARY WELL INSTALLATION RECORDS – BORING LOGS AND COMPLETION REPORTS

SAMPLE INFORMATION

SOIL SAMPLING

SPLIT–BARREL SAMPLE & SPT

CONTINUOUS SAMPLE

THIN–WALL TUBE SAMPLE
(PER ASTM D1587)

SPT VALUE IS BLOWS PER 12 INCH PENETRATION UNLESS OTHERWISE SPECIFIED.

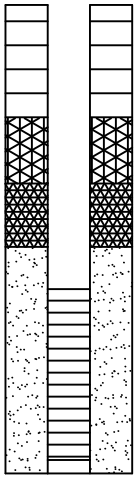
SAMPLE ODORS, WHERE APPROPRIATE

NONE	NO ODOR	MO	MODERATE ODOR
WO	WEAK ODOR	SO	STRONG ODOR

GRAPHIC LOG

	FILL		GRAVEL
	CLAY*		CONCRETE
	SILT*		ASPHALT
	SAND		COAL OR LIGNITIC MATERIAL

WELL COMPLETION DETAIL



PORTLAND CEMENT/
SODIUM BENTONITE
GROUT

SODIUM BENTONITE
CHIP

SODIUM BENTONITE PELLET
SEAL

SAND OR GRAVEL
BACKFILL

SCREENED INTERVAL

CAP

NOTE:

A BORING/WELL RECORD IS CONSIDERED REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE BORING/WELL LOCATION ON THE DATES SHOWN. IT IS NOT WARRANTED TO REPRESENT SUBSURFACE CONDITIONS AT OTHER LOCATIONS OR TIMES.

SUBSURFACE CONDITIONS SHOWN ON THESE RECORDS OR ON PROFILES DEVELOPED FROM THESE RECORDS ARE NOT WARRANTED, THEY ARE ESTIMATED BASED ON ACCEPTED ENGINEERING AND GEOLOGIC PRINCIPLES AND PRACTICES AND REASONABLE PROFESSIONAL JUDGEMENT.

* USCS CLASSIFICATION USED WHERE TEST RESULTS ARE AVAILABLE.

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

LEGEND FOR
MONITOR WELL AND
SOIL BORING RECORDS

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
	Estimated Ground Surface: 5102.5'							3.0' Stickup; Locking "J" Cap	
0	TOPSOIL: Stiff, brown (10YR 5/4), silty CLAY, minor gypsum, mottling, moist to damp								0
0.75	Stiff, brown (10YR 5/4), silty CLAY, minor gypsum mottling, damp	CL			48"			Bentonite Chips	
4.0'									
5					25"			8.25" Borehole	5
10					46"				10
13.0	Reddish brown (5YR 5/6), clayey SILT with few fine gravel, damp								
15								Bentonite Grout	15
16.3	Firm to very firm, tan (10YR 7/4), silty fine-grained SAND with clay few coarse sand and to coarse-grained gravel, damp	SM			43"				
20					33"			2" i.d. SCH 40 PVC	20
23.3	Stiff, tan (10YR 7/4), fine-grained sandy SILT	CL							
24.0	Dense, brown (10YR 6/6), silty fine- to coarse grained-SAND, damp	SM			45"				
25									25
30					40"				30
	...becomes stiff, brown-gray (10YR 6/2) clay @ 33.75' to 34.25'								
34.0'								Bentonite Pellets	
35									35
36.0'								10-20 Washed Silica Sand	
39.1'									
40									40

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-1

Coordinates: N 457837, E 2188581

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 19, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
40									40
41.3	Medium dense gray–brown (5YR 6/6), silty clayey fine–grained SAND	SM			33"				
45	...cemented layers, wet @45.25'							10–20 Washed Silica Sand	45
45.5	TOP OF LARAMIE FM Very stiff, grey weathered CLAYSTONE with rust–color streaks	CL			49"			2" I.D. PVC Well Screen 0.010" Slots	
49.4	...2" clayey coal seam @ 48.75'							49.1' 49.4'	
50	B.T. @ 49.4'								50
55									55
60									60
65									65
70									70
75									75
80									80

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–1
Coordinates: N 457837, E 2188581
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 19, 2016

FORM NO GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St , Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054984

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave.

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: NW 1/4, SE 1/4, Sec., 7 Twp. 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 2250 ft. from ☐ N or ☒ S section line and 2640 ft. from ☒ E or ☐ W section line

SUBDIVISION: N/A LOT --- BLOCK --- FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☐ Zone 13

Owner's Well Designation: TW-1

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5102.5 (est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/19/2016 TOTAL DEPTH 49.4 feet DEPTH COMPLETED 49.1 feet

5. GEOLOGIC LOG

Depth	Type	Grain Size	Color	Water Loc.
0 to 49	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	49.4

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+3.0	39.1

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	39.1	49.1

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	36.0-49.4

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	34.0-36.0

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	10.2 cu ft	---	4.0-34.0	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: --- Production Rate --- gpm

Pumping Level --- ft. Date/Time measured --- Test Length (hrs) ---

Remarks: ---

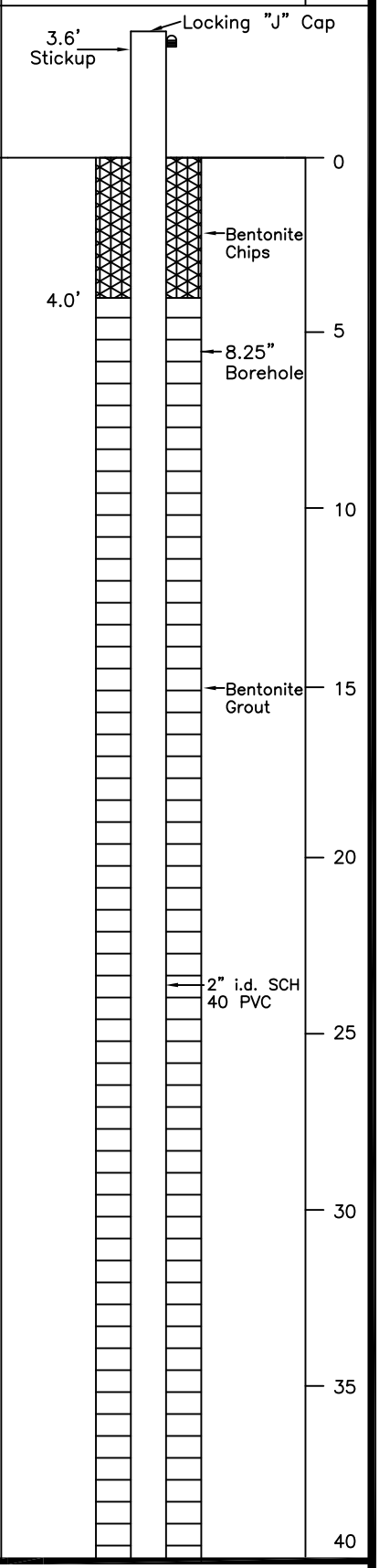
13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name:	Phone w/area code:	License Number:
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5135.5'						
0	TOPSOIL: Stiff, brown (10YR 5/4), silty CLAY with roots, damp	CL/ ML					
1.2	Stiff, brown (10YR 5/4), clayey SILT, damp	CL			42"	NO	
5					36"	NO	
9.0	Stiff, reddish brown (10YR 6/6) fine grained sandy SILT, damp						
10					56"	NO	
14.0	Firm, tan (10YR 7/4) and brown (10YR 5/4) mottled silty fine-grained SAND with clay, damp	SM			52"	NO	
15							
20					39"	NO	
25					43"	NO	
30					42"	NO	
35	TOP OF LARAMIE FM Hard, gray (5YR 6/1) with orange streaks weathered CLAYSTONE	CL			60"	NO	
40							



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-2
Coordinates: N 458962, E 2185832
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 22, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
40									40
					58"	NO		8.25" Borehole	
45		CL			55"	NO			45
50	...medium dense fine–grained silty sand @ 51.75'				58"	NO		Bentonite Grout	50
54.3									
55	Dense, brown (10YR 6/6), fine–grained silty SAND, weakly cemented, damp ...weathered claystone @ 55.3' to 55.75' and 57.0' to 57.5'				56"	NO			55
60					54"	NO			60
65		SM			55"	NO		2" i.d. SCH 40 PVC	65
70	TOP OF FOX HILLS								70
70.5	Dense, tan and light brown and gray brown, fine–grained SAND with silt, weakly to moderately cemented				59"	NO			
75									75
					60"	NO			
80									80

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–2
Coordinates: N 458962, E 2185832
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 22, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
80	Dense, brown and gray (10YR 6/6–10YR 6/2) fine–grained SANDSTONE, damp to sightly moist	SP			58"	NO		8.25" Borehole	80
85					50"	NO			85
90					58"	NO		2" i.d. SCH 40 PVC	90
95					59"	NO		Bentonite Grout	95
96.8	Very dense, gray (N6), fine–grained strongly cemented SANDSTONE, slighty moist								
100					48"	NO			100
103.7'								Bentonite Pellets	
105									105
105.7'					60"	NO			
107.0	Very hard, black and rust–color orange CLAYSTONE, damp	CL						10–20 Washed Silica Sand	
108.0	Medium dense, light brown (10YR 7/4), fine–grained silty SAND, weakly cemented with rust–color staining								
108.7'									
110	...black, gray rust–color stained CLAYSTONE @ 112.0'	SP			55"	NO		2" I.D. PVC Well Screen 0.010" Slots	110
115	...weathered CLAYSTONE with sand layers @ 114.0'				54"	NO			115
120									120

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–2

Coordinates: N 458962, E 2185832

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 22, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
120	See 180.0' to 120.0'	SP			60"	NO			120
125					60"	NO		10–20 Washed Silica Sand; 2" I.D. PVC Well Screen 0.010" Slots; 128.7'–129.0'	125
130	B.T. @ 129.0'								130
135									135
140									140
145									145
150									150
155									155
160									160

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–2

Coordinates: N 458962, E 2185832

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 22, 2016

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054988

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave.

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: SW 1/4, NW 1/4, Sec., 7 Twp. 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 1730 ft. from ☒ N or ☐ S section line and 260 ft. from ☐ E or ☒ W section line

SUBDIVISION: N/A LOT --- BLOCK --- FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-2

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5135.5 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/22/2016 TOTAL DEPTH 129.0 feet DEPTH COMPLETED 128.7 feet

5. GEOLOGIC LOG

Depth	Type	Grain Size	Color	Water Loc.
0 to 129	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	129.0

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+3.6	108.7

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	108.7	128.7

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	105.7-129.(

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	103.7-105.7

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	33.9 cu ft	---	4.0-103.7	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft Date/Time measured: --- Production Rate --- gpm

Pumping Level --- ft Date/Time measured --- Test Length (hrs) ---

Remarks: ---

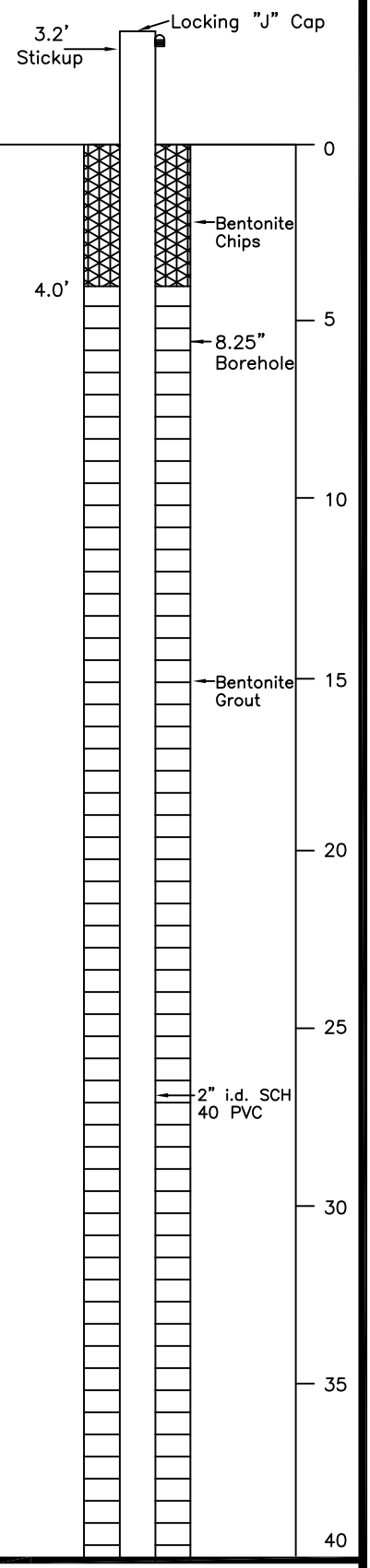
13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name:	Phone w/area code	License Number:
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5109.6'						
0	TOPSOIL: Firm, brown (10YR 5/4) silty CLAY with roots and clayey silt, damp	CL/ ML			44"	NO	
2.5	Stiff, brown (10YR 5/4) clayey SILT, damp	CL			60"	NO	
5							
10					57"	NO	
15					56"	NO	
18.0	Stiff, reddish-brown (10YR 6/6), fine-grained sandy SILT with clay and few medium to coarse sand, damp						
20					54"	NO	
22.0	Medium dense, tan (10YR 7/4) silty fine- to coarse-grained SAND with mottling, damp	SM			53"	NO	
25							
30	TOP OF LARAMIE FM						
30.5	Stiff, brownish-gray (10YR 6/2) with rust-color staining weathered CLAYSTONE with silty fine-grained sand streaks, damp	CL			55"	NO	
35					60"	NO	
37.8	Dense, brown (10YR 6/6), silty fine-grained SAND with thin weathered (1/2") CLAYSTONE layers, rust-color staining, damp						
40							



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record
Location TW-4
Coordinates: N 460117, E 2187115
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 23, 2016

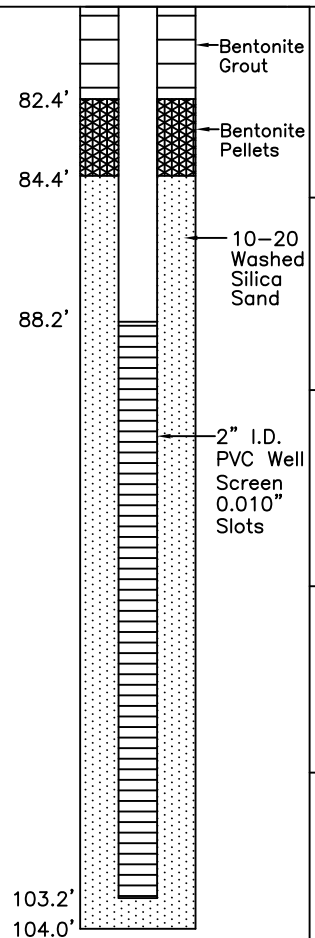
DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
40	See 37.8' to 40.0'	CL			58"	NO		8.25" Borehole	40
45					60"	NO			45
50									50
51.0	Medium dense, tan (10YR 7/4) fine-grained SAND with silt, weak to moderate cementation, damp	SP			59"	NO		Bentonite Grout	
55					60"	NO			55
59.0	TOP OF FOX HILLS								
60	Very dense, gray-brown with rust-color staining, weathered fine-grained SANDSTONE				28"	NO			60
	...highly weathered gray fine-grained silty sand @ 63.25'								
65					60"	NO		2" i.d. SCH 40 PVC	65
70					58"	NO			70
	...very hard cemented brown-gray, fine-grained sandstone @ 74.0' to 76.0'								
75					42"	NO			75
80									80

SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-4
Coordinates: N 460117, E 2187115
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 23, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
80	...very hard layer @ 80.5' to 82.0'				0"	NO			80
85	...hard layer @ 85.0' to 89.0'				0"	NO			85
90	...stiff, gray brown, fine-grained sandy clay, damp @ 91.5' to 92.0'	SP			48"	NO			90
95	...color change to yellow brown (10YR 6/6), wet @ 98.25'				53"	NO			95
100					60"	NO			100
105	B.T. @ 104.0'								105
110									110
115									115
120									120



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-4
Coordinates: N 460117, E 2187115
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 23, 2016

FORM NO GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054990

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave.

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: NW 1/4, NW 1/4, Sec., 7 Twp 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 620 ft. from ☒ N or ☐ S section line and 1535 ft from ☐ E or ☒ W section line

SUBDIVISION: N/A LOT --- BLOCK --- FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-4

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5109.6 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/23/2016 TOTAL DEPTH 104.0 feet DEPTH COMPLETED 103.2 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0 to 104	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	104.0

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+3.2	88.2

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	88.2	103.2

8. FILTER PACK:

Material: Silica Sand
Size: 10-20
Interval: 84.4-104.0

9. PACKER PLACEMENT:

Type: Bentonite Chips
Depth: 82.4-84.4

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	26.6 cu ft	---	4.0-82.4	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: --- Production Rate --- gpm.

Pumping Level --- ft. Date/Time measured --- Test Length (hrs) ---

Remarks: ---

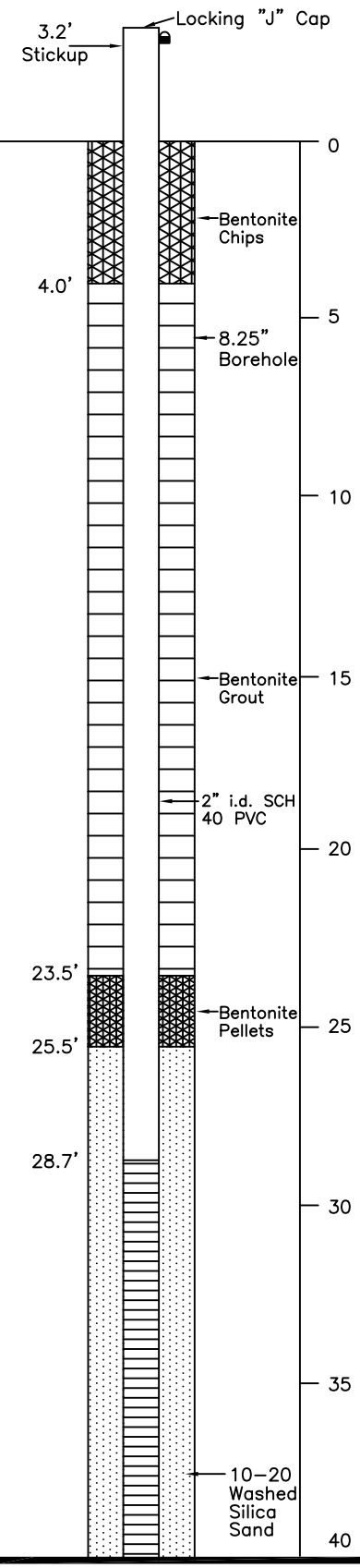
13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name:	Phone w/area code	License Number
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5076.3'						
0	No samples 0' – 24.0' (see boring record for TW–6)						
24.0	Stiff, brown, fine to coarse grained SAND, with fine to coarse gravel, damp	SM			22"	NO	
30	TOP OF LARAMIE FM Stiff, gray–brown CLAYSTONE with fine SAND, damp	CL			52"	NO	
33.3	Medium dense, gray–brown, silty fine–grained SAND with rust–color staining, damp	SM			38"	NO	
40							



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–5
Coordinates: N 460186, E 2188715
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 25, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
40	Medium dense, yellow–brown, fine–grained SAND, moist to very moist	SM			52"	NO		10–20 Washed Silica Sand; 2" I.D. PVC Well Screen 0.010" Slots	40
45	...Becomes wet @ 45.5'				58"	NO		48.7' 49.0'	45
50	B.T. @ 49.0'								50
55									55
60									60
65									65
70									70
75									75
80									80

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record
Location TW–5
Coordinates: N 460186, E 2188715
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 25, 2016

FORM NO GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St , Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www water state co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054986

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: NW 1/4, NE 1/4, Sec , 7 Twp 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 610 ft. from ☒ N or ☐ S section line and 2510 ft. from ☒ E or ☐ W section line

SUBDIVISION: N/A LOT --- , BLOCK --- , FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-5

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5076.3 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/25/2016 TOTAL DEPTH 49.0 feet DEPTH COMPLETED 48.7 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc
0 to 49	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	49.0

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+3.2	49.0

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	28.7	48.7

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	25.5-48.7

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	23.5-25.5

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	6.6 cu ft	---	4.0-23.5	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: --- Production Rate --- gpm

Pumping Level --- ft. Date/Time measured --- Test Length (hrs) ---

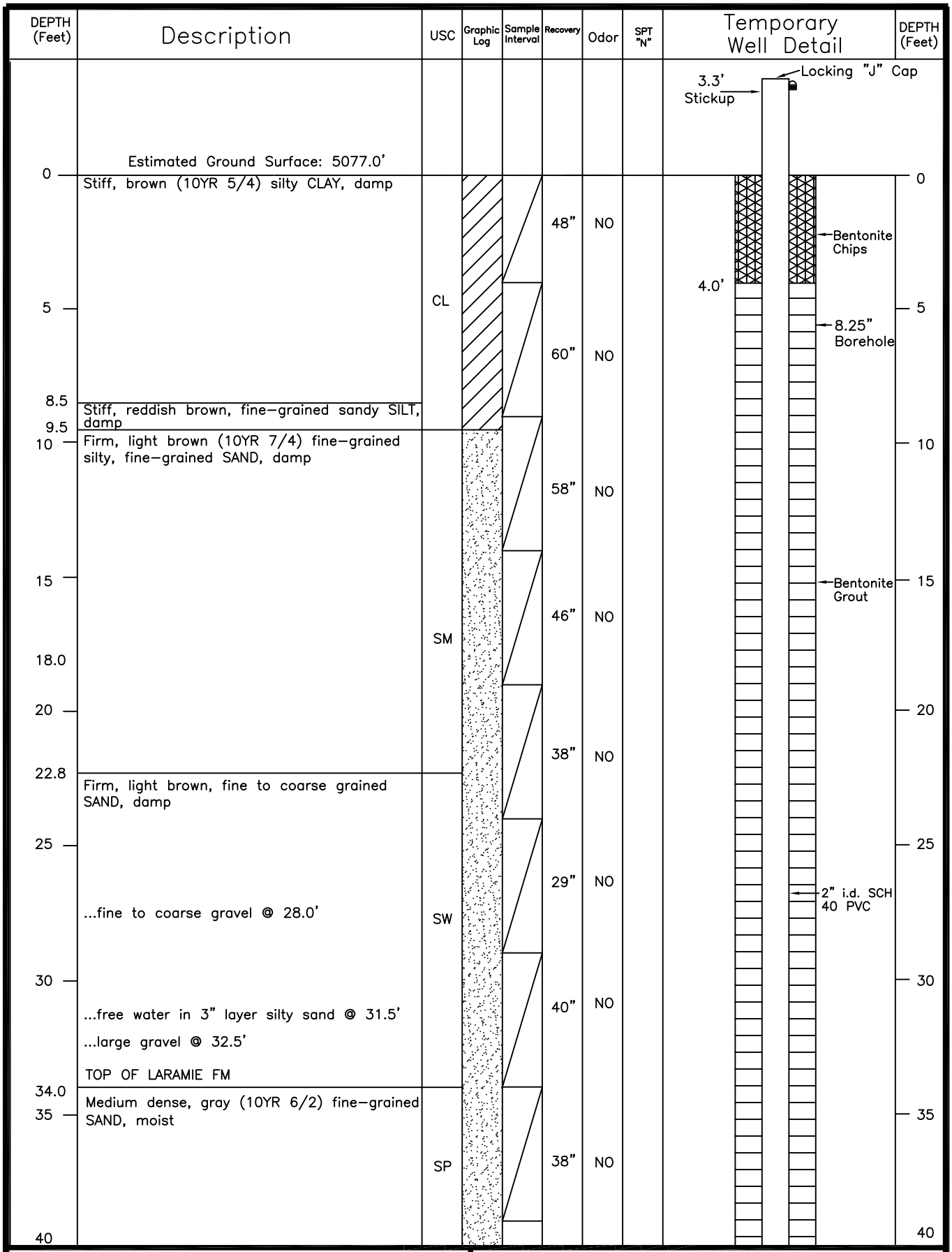
Remarks: ---

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name	Phone w/area code:	License Number:
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-6
Coordinates: N 460181, E 2188691
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 24, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
40	...color change to yellowish brown (10YR 6/6 – 10YR 5/4), moist @ 42.0'				45"	NO		8.25" Borehole	40
45	Medium dense, yellow–brown (10YR 6/6 – 10YR 5/4), fine–grained SAND, moist to wet	SP			60"	NO			45
50					60"	NO		Bentonite Grout	50
54.0	Dense, yellowish–brown (10YR 6/6 – 10YR 5/4) fine–grained SAND, weakly cemented, damp								
55					60"	NO			55
60	...very stiff, gray–brown, claystone, damp @ 63.5' to 64.8'	SM			55"	NO			60
65	...2" gray claystone layer @ 68.0'				60"	NO		2" i.d. SCH 40 PVC	65
70	TOP OF FOX HILLS								70
70.3	Hard, medium gray, CLAYSTONE with sand stringers, fine–grained, damp				58"	NO			
75		CL			60"	NO			75
80									80

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–6

Coordinates: N 460181, E 2188691

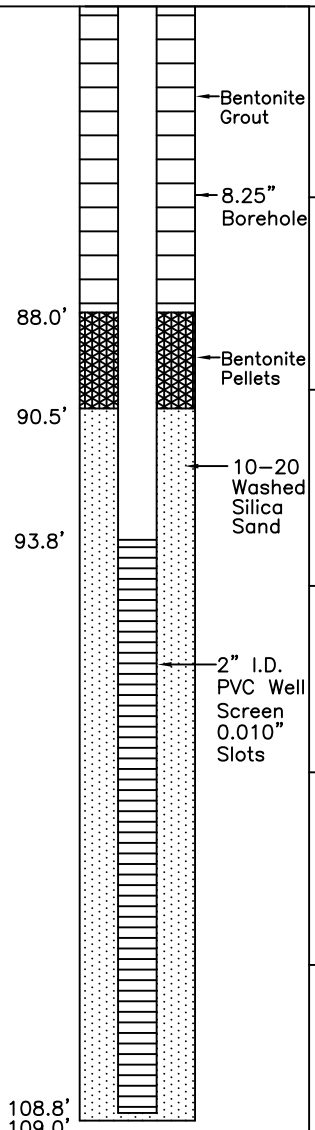
Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 24, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
80	Same as 70.3' to 80.0'	CL			60"	NO	
85					60"	NO	
90							
91.8	Dense, gray, fine-grained SAND and SANDSTONE, wet	SP			58"	NO	
95	...hard sandstone @ 93.5' to 95.3'				60"	NO	
	...black claystone layers @ 96.25' to 97.0' and 97.0' to 97.25'						
100					59"	NO	
105					60"	NO	
109.0	B.T. @ 109.0'						
110							
115							
120							

Temporary Well Detail



DEPTH (Feet): 80, 85, 90, 95, 100, 105, 110, 115, 120

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-6

Coordinates: N 460181, E 2188691

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 24, 2016

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054986

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave.

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: NW 1/4, NE 1/4, Sec. 7 Twp. 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 615 ft. from ☒ N or ☐ S section line and 2525 ft. from ☒ E or ☐ W section line

SUBDIVISION: N/A LOT --- BLOCK --- FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-6

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5077.0 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/24/2016 TOTAL DEPTH 109.0 feet DEPTH COMPLETED 108.8 feet

5. GEOLOGIC LOG

Depth	Type	Grain Size	Color	Water Loc.
0 to 109	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	109.0

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+3.3	93.8

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	93.8	108.8

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	90.5-109.0

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	88.0-90.5

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	28.5 cu ft	---	4.0-88.0	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: --- Production Rate --- gpm

Pumping Level --- ft. Date/Time measured --- Test Length (hrs) ---

Remarks: ---

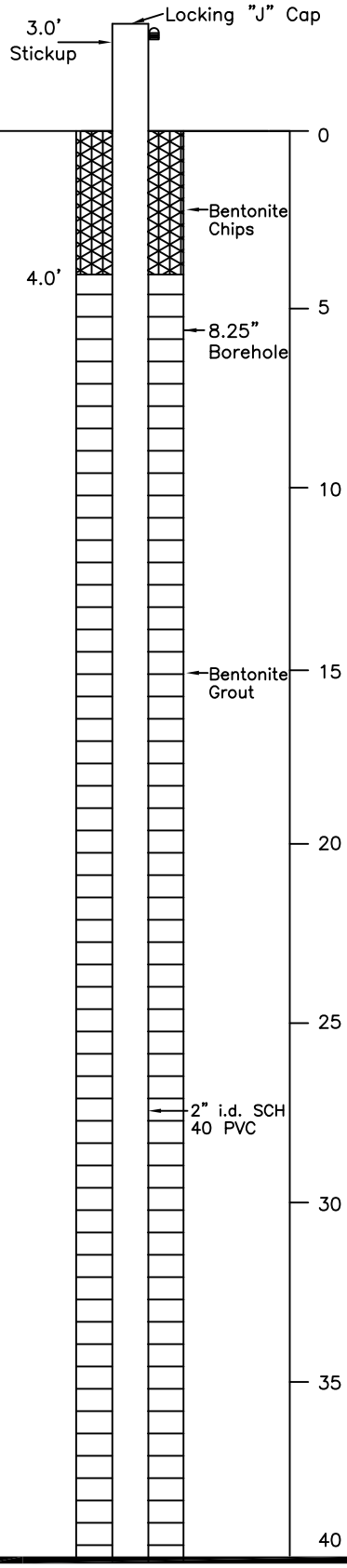
13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name:	Phone w/area code	License Number
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"
	Estimated Ground Surface: 5074.8'						
0	Firm, brown (10YR 5/4) silty CLAY, damp	CL			40"	NO	
5					48"	NO	
7.0	Stiff, reddish brown (10YR 6/6) clayey SILT with few coarse SAND, damp						
8.5	Firm, tan and brown mottled fine-grained SAND with clay, few coarse sand, damp	SM			53"	NO	
10							
15					37"	NO	
18.0							
20					32"	NO	
24.0	Stiff, brown (10YR 5/4) clayey SILT and silty CLAY, damp	CL			60"	NO	
25							
29.0	Medium dense, brown (10YR 5/4) silty fine-grained SAND, damp	SM					
30							
30.8	Stiff, reddish brown and brown with gypsum mottling CLAY and clayey SILT with minor coarse sand, damp	CL			59"	NO	
35							
36.0	Medium dense, brown with rust-color staining, fine-grained SAND	SP			42"	NO	
38.3	Stiff, gray brown, CLAY, damp	CL					
40							



SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-8

Coordinates: N 459177, E 2189389

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date March 1, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
39.8									
40	Medium dense, brownish–gray (10YR 6/2), find to coarse SAND with silt, damp	SM			58"	NO			40
	TOP OF LARAMIE FM								
43.0	Medium dense, gray–brown (10YR 6/2), fine–grained SAND, weathered SILTSTONE and silty CLAY, damp	SM/ CL			52"	NO			
45								8.25" Borehole	45
47.0	Medium dense, gray–brown (10YR 6/2), silty fine–grained SAND, with fine laminations, damp	SM			59"	NO			
50									50
54.0	Stiff, brown and gray, silty CLAY, laminated	CL							
55								Bentonite Grout	55
55.3	Lignite layer, black, damp	OL			58"	NO			
58.5	Dense, medium light gray, fine–grained sandy SILT with thin claystone layers, damp	CL			48"	NO			
60								2" i.d. SCH 40 PVC	60
65					42"	NO			65
67.0'								Bentonite Pellets	
68.0	Dark gray and black CLAYSTONE and SILTSTONE, fissile, damp								
69.0'									
70					59"	NO			70
72.0'	...black thinly laminated coal, dry @ 70.0' to 71.25'							10–20 Washed Silica Sand	
75					60"	NO		2" I.D. PVC Well Screen 0.010" Slots	75
80									80

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–8

Coordinates: N 459177, E 2189389

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date March 1, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
80	See 68.0' to 80.0'	CL			60"	NO			80
	...with thin lignite layers between 84.0' to 89.0'								
85					59"	NO		2" I.D. PVC Well Screen 0.010" Slots	85
	...wet zone between 87.0' to 88.0'								
90					60"	NO			90
92.5	Dense, medium gray, clayey fine-grained SAND, damp	SM						92.0' 10-20 Washed Silica Sand	
94.0	Dense, black, fissile clayey SILTSTONE, saturated, with thin lignite layers throughout	CL			60"	NO			
95									95
	...fine-grained SAND, damp, from 97.5' to 98.0'								
100					60"	NO			100
104.0	B.T. @ 104.0'							104.0'	
105									105
110									110
115									115
120									120

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-8

Coordinates: N 459177, E 2189389

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date March 1, 2016

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054985

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave.

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: SW 1/4, NE 1/4, Sec, 7 Twp 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 1610 ft from ☒ N or ☐ S section line and 1835 ft. from ☒ E or ☐ W section line.

SUBDIVISION: N/A, LOT ---, BLOCK ---, FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-8

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5074.8 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 03/01/2016 TOTAL DEPTH 104.0 feet DEPTH COMPLETED 92.0 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0 to 104	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	104.0

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+3.0	67.0

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	72.0	92.0

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	69.0-104.0

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	67.0-69.0

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	21.4 cu ft	---	4.0-67.0	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: --- Production Rate --- gpm

Pumping Level --- ft. Date/Time measured --- Test Length (hrs) ---

Remarks: ---

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name	Phone w/area code:	License Number:
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
	Estimated Ground Surface: 5073.7'							2.7' Stickup; Locking "J" Cap	
0	Firm, brown (10YR 5/4) clayey SILT and silty CLAY, roots in upper 6", damp	CL			34"	NO		Bentonite Chips	0
4.0'									
5					57"	NO		8.25" Borehole	5
10					52"	NO			10
13.0	Firm, reddish brown (10YR 6/6) clayey SILT with fine-grained sand, damp								
15					51"	NO		Bentonite Grout	15
16.8	Stiff, tan (10YR 7/4) fine-grained sandy CLAY, damp								
20								2" i.d. SCH 40 PVC	20
21.0	Medium dense, light brown (10YR 6/6) and tan mottled, silty fine-grained SAND with clay minor medium coarse sand and fine gravel, damp	SM			48"	NO			
25					32"	NO			25
26.5'								Bentonite Pellets	
29.0'									
30					33"	NO			30
32.0'								10-20 Washed Silica Sand	
32.5	Medium dense, reddish brown (5YR 6/4) fine-coarse SAND with fine gravel, damp								
35					26"	NO			35
	...large gravel, slightly moist @ 38.0'							2" I.D. PVC Well Screen 0.010" Slots	
39.0	TOP OF LARAMIE FM								
40	See 40.0' to 46.8'	CL							40

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-9

Coordinates: N 458233, E 2189754

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 29, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
40	...becomes firm, black clay with coal, saturated @ 40.75'								40
	Very stiff, brown, gray CLAY with rust–color mottling, damp	CL			59"	NO		10–20 Washed Silica Sand	
45									45
46.8	Gray–brown with rust–color mottling, weathered CLAYSTONE, damp				58"	NO		47.0' 2" I.D. PVC Well Screen 0.010" Slots 49.0'	
	B.T. @ 49.0'								
50									50
55									55
60									60
65									65
70									70
75									75
80									80

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–9

Coordinates: N 458233, E 2189754

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 29, 2016

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St , Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www water state co us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054985

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave.

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: SW 1/4, NE 1/4, Sec., 7 Twp 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 2560 ft. from ☒ N or ☐ S section line and 1455 ft. from ☒ E or ☐ W section line.

SUBDIVISION: N/A , LOT --- , BLOCK --- , FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-9

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5073.7 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/29/2016 TOTAL DEPTH 49.0 feet DEPTH COMPLETED 47.0 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc
0 to 49	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	49.0

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+2.7	32.0

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	32.0	47.0

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	29.0-49.0

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	26.5-29.0

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	7.7 cu ft	---	4.0-26.5	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: --- Production Rate --- gpm

Pumping Level --- ft. Date/Time measured --- Test Length (hrs) ---

Remarks: ---

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name:	Phone w/area code	License Number
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

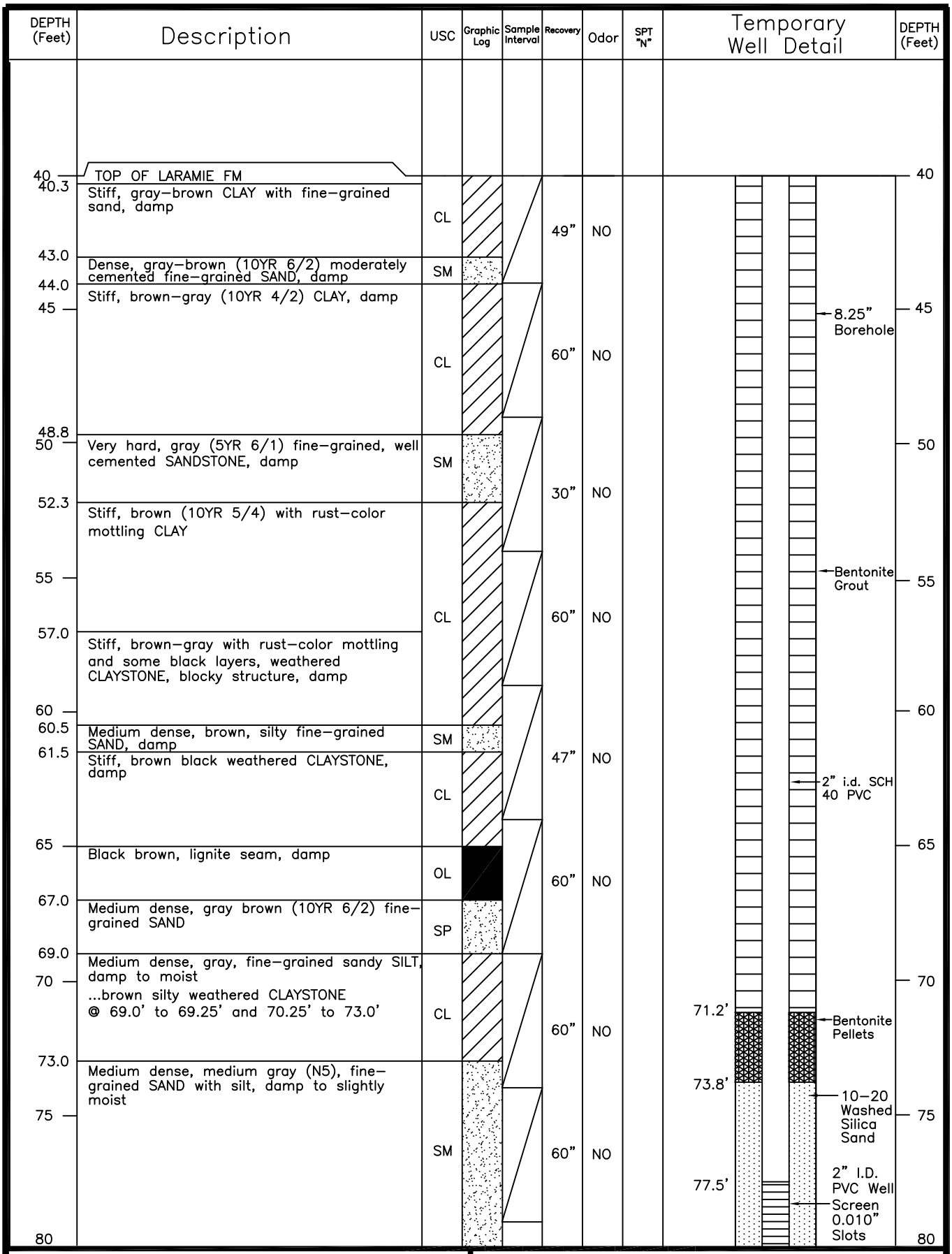
Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
	Estimated Ground Surface: 5073.2'							2.5' Stickup; Locking "J" Cap	
0	Firm, brown (10YR 5/4) silty CLAY and clayey SILT, roots in upper 6", damp	CL			36"	NO		Bentonite Chips	0
5					60"	NO		4.0'; 8.25" Borehole	5
10					52"	NO			10
13.5	Stiff, reddish brown clayey SILT with fine to coarse mottled, damp								
15					49"	NO		Bentonite Grout	15
17.5	Stiff, tan (10YR 7/4) clayey fine-grained SAND, damp	SC			48"	NO			
20									20
25					36"	NO		2" i.d. SCH 40 PVC	25
27.3	Medium dense, fine to coarse SAND with fine gravel, damp								
29.0	Medium dense, reddish brown (5YR 6/4) fine to coarse SAND with fine gravel, damp								
30					27"	NO			30
35		SW			21"	NO			35
40	...becomes saturated @ 40.0'								40

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW-10
Coordinates: N 458255, E 2189760
Drilled By Drilling Engineers Drilling Method HSA
Logged By PAZ Checked By SLW
Installation Date February 26, 2016



SWIFT RIVER
ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–10

Coordinates: N 458255, E 2189760

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 26, 2016

DEPTH (Feet)	Description	USC	Graphic Log	Sample Interval	Recovery	Odor	SPT "N"	Temporary Well Detail	DEPTH (Feet)
80	Medium dense, medium gray (N5), clayey SILTSTONE, weathered	CL			60"	NO			80
82.5	Black lignite seam	OL							
85									85
86.0	Medium dense, medium gray (N5), silty fine–grained SAND with clay, damp	SM			60"	NO		10–20 Washed Silica Sand	
90	Medium dense, medium gray, silty CLAYSTONE	CL			60"	NO		2" I.D. PVC Well Screen 0.010" Slots	90
95	...lignite @ 97.3' to 98.0'				60"	NO		97.5'	95
98.2		SM							
98.5	Hard, gray SANDSTONE							98.5'	
	B.T. @ 98.5'								
100									100
105									105
110									110
115									115
120									120

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

Soil Boring Record

Location TW–10

Coordinates: N 458255, E 2189760

Drilled By Drilling Engineers Drilling Method HSA

Logged By PAZ Checked By SLW

Installation Date February 26, 2016

FORM NO. GWS-31 4/2012

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Ste 821, Denver, CO 80203
Main (303) 866-3581 Fax (303) 866-3589 www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER: MH-054985

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Waste Management of Colorado

MAILING ADDRESS: 2400 West Union Ave

CITY: Englewood STATE: CO ZIP CODE: 80110

TELEPHONE NUMBER w/area code: (303) 914-1445

3. WELL LOCATION AS DRILLED: SW 1/4, NE 1/4, Sec., 7 Twp. 7 ☒ N or S, ☐ Range 66 ☐ E or W ☒

DISTANCES FROM SEC. LINES: 2550 ft. from ☒ N or ☐ S section line and 1450 ft. from ☒ E or ☐ W section line.

SUBDIVISION: N/A, LOT ---, BLOCK ---, FILING (UNIT) ---

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☒ Zone 13

Owner's Well Designation: TW-10

Easting: ---

STREET ADDRESS AT WELL LOCATION: 40000 Weld County Road 25, Ault, CO 80610

Northing: ---

4. GROUND SURFACE ELEVATION 5073.2 (Est.) feet DRILLING METHOD Hollow Stem Auger

DATE COMPLETED 02/26/2016 TOTAL DEPTH 98.5 feet DEPTH COMPLETED 97.5 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0 to 98.5	Sand, silt, and clay			
See attached log				

6. HOLE DIAM (in.)

	From (ft)	To (ft)
8.25	0	98.5

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2.375	PVC	0.154	+2.5	77.5

PERFORATED CASING: Screen Slot Size (in): 0.010

2.375	PVC	0.154	77.5	97.5

8. FILTER PACK:

Material	Silica Sand
Size	10-20
Interval	73.8-98.5

9. PACKER PLACEMENT:

Type	Bentonite Chips
Depth	71.2-73.8

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
Grout	22.9 cu ft	---	4.0-71.2	Tremie
Chips	1.4 cu ft	---	0-4.0	Direct

Remarks:

11. DISINFECTION: Type NA Amt. Used N/A

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD N/A

Static Level --- ft. Date/Time measured: ---, Production Rate --- gpm

Pumping Level --- ft. Date/Time measured --- , Test Length (hrs) ---

Remarks: ---

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed (or name entered if filing online) and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license. If filing online the State Engineer considers entering of licensed contractor name to be compliance with Rule 17.4

Company Name:	Phone w/area code:	License Number:
Swift River Environmental Services, LLC	(303) 695-4660	---

Mailing Address: 26 West Dry Creek Circle, Ste. 470, Littleton, CO 80120

Sign (or enter name if filing online)	Print Name and Title	Date
Cathryn Stewart	Cathryn Stewart, Project Manager	06/06/2016

APPENDIX D

LABORATORY TESTING RESULTS – GROUNDWATER AND RIG WATER

Water Quality Results

May 3 and 4, 2016

ANALYTICAL REPORT

Job Number: 280-82795-1

Job Description: 588|North Weld

For:
Waste Management
2400 West Union Avenue
Englewood, CO 80110

Attention: Mr. Tom Schweitzer



Approved for release.
Betsy A Sara
Project Manager II
5/16/2016 1:47 PM

Betsy A Sara, Project Manager II
4955 Yarrow Street, Arvada, CO, 80002
(303)736-0189
betsy.sara@testamericainc.com
05/16/2016

cc: Mr. Eric DiEsposti

The test results in this report relate only to the samples in this report and meet all requirements of NELAC, with any exceptions noted. Pursuant to NELAP, this report shall not be reproduced except in full, without the written approval of the laboratory. All questions regarding this report should be directed to the TestAmerica Denver Project Manager.

The Lab Certification ID# is 4025.

Reporting limits are adjusted for sample size used, dilutions and moisture content if applicable.

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CASE NARRATIVE

Client: Waste Management

Project: 588|North Weld

Report Number: 280-82795-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

This report may include reporting limits (RLs) less than TestAmerica's standard reporting limit. The reported sample results and associated reporting limits are being used specifically to meet the needs of this project. Note that data are not normally reported to these levels without qualification because they are inherently less reliable and potentially less defensible than required by the latest industry standards.

Sample Receiving

The samples were received on 05/05/2016; the samples arrived in good condition, properly preserved and on ice. The temperature of the cooler at receipt was 4.5 C.

Holding Times

All holding times were within established control limits.

Method Blanks

All Method Blank samples were within established control limits.

Laboratory Control Samples

The Method 2320B LCS/LCSD exhibited RPD data outside the QC control limits for Total Alkalinity. Both the LCS and LCSD were recovered within QC control limits, demonstrating that the laboratory performed the method within acceptable guidelines; therefore, corrective action is deemed unnecessary.

All other Laboratory Control Samples were within established control limits.

Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

All MS and MSD samples were within established control limits.

Organics

The Method 8260B surrogate recovery of 1,2-Dichloroethane-d4 was above the upper control limit for samples TW-5 and TW-D. Because the data are considered to be biased high and all target analytes in the sample were non-detect above the reporting limits, corrective action was deemed unnecessary.

EXECUTIVE SUMMARY - Detections

Client: Waste Management Job Number: 280-82795-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-82795-1	**TW-1**					
Tetrachloroethene		5.8		5.0	ug/L	8260B
Depth to water		47.76			ft	Field Sampling
Field pH		6.72			SU	Field Sampling
Field Conductivity		3856			umhos/cm	Field Sampling
Field Temperature		13.1			Degrees C	Field Sampling
Field Turbidity		286.0			NTU	Field Sampling
Field Dissolved Oxygen		30.0			mg/L	Field Sampling
Field EH/ORP		179.0			millivolts	Field Sampling
Chloride		160		0.50	mg/L	300.0
Sulfate		1000		5.0	mg/L	300.0
Total Alkalinity		1200	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		1200		10	mg/L	SM 2320B
Dissolved						
Calcium		180000		5000	ug/L	6010B
Magnesium		430000		5000	ug/L	6010B
Sodium		160000		5000	ug/L	6010B
280-82795-2	**TW-2**					
Depth to water		128.04			ft	Field Sampling
Field pH		7.00			SU	Field Sampling
Field Conductivity		3521			umhos/cm	Field Sampling
Field Temperature		14.9			Degrees C	Field Sampling
Field Turbidity		24.9			NTU	Field Sampling
Field Dissolved Oxygen		13.9			mg/L	Field Sampling
Field EH/ORP		70.5			millivolts	Field Sampling
Chloride		11		0.50	mg/L	300.0
Sulfate		1900		5.0	mg/L	300.0
Total Alkalinity		530	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		530		10	mg/L	SM 2320B
Dissolved						
Calcium		390000		5000	ug/L	6010B
Magnesium		240000		5000	ug/L	6010B
Potassium		11000		5000	ug/L	6010B
Sodium		220000		5000	ug/L	6010B

EXECUTIVE SUMMARY - Detections

Client: Waste Management Job Number: 280-82795-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-82795-3	**TW-4**					
Depth to water		88.70			ft	Field Sampling
Field pH		7.20			SU	Field Sampling
Field Conductivity		1385			umhos/cm	Field Sampling
Field Temperature		15.3			Degrees C	Field Sampling
Field Turbidity		15.9			NTU	Field Sampling
Field Dissolved Oxygen		10.6			mg/L	Field Sampling
Field EH/ORP		-15.5			millivolts	Field Sampling
Chloride		8.2		0.50	mg/L	300.0
Sulfate		550		5.0	mg/L	300.0
Total Alkalinity		310	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		310		10	mg/L	SM 2320B
Dissolved						
Calcium		160000		5000	ug/L	6010B
Magnesium		97000		5000	ug/L	6010B
Potassium		5100		5000	ug/L	6010B
Sodium		34000		5000	ug/L	6010B
280-82795-4	**TW-5**					
Depth to water		37.89			ft	Field Sampling
Field pH		7.77			SU	Field Sampling
Field Conductivity		800			umhos/cm	Field Sampling
Field Temperature		14.4			Degrees C	Field Sampling
Field Turbidity		324.0			NTU	Field Sampling
Field Dissolved Oxygen		13.6			mg/L	Field Sampling
Field EH/ORP		57.7			millivolts	Field Sampling
Chloride		50		0.50	mg/L	300.0
Sulfate		190		5.0	mg/L	300.0
Total Alkalinity		180	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		180		10	mg/L	SM 2320B
Dissolved						
Calcium		43000		5000	ug/L	6010B
Magnesium		53000		5000	ug/L	6010B
Sodium		58000		5000	ug/L	6010B

EXECUTIVE SUMMARY - Detections

Client: Waste Management Job Number: 280-82795-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-82795-5	**TW-6**					
Chloroform		6.4		5.0	ug/L	8260B
Depth to water		50.59			ft	Field Sampling
Field pH		8.25			SU	Field Sampling
Field Conductivity		454			umhos/cm	Field Sampling
Field Temperature		16.8			Degrees C	Field Sampling
Field Turbidity		108.0			NTU	Field Sampling
Field Dissolved Oxygen		7.4			mg/L	Field Sampling
Field EH/ORP		-37.7			millivolts	Field Sampling
Chloride		11		0.50	mg/L	300.0
Sulfate		120		5.0	mg/L	300.0
Total Alkalinity		140	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		140		10	mg/L	SM 2320B
Dissolved						
Calcium		50000		5000	ug/L	6010B
Magnesium		25000		5000	ug/L	6010B
Potassium		5800		5000	ug/L	6010B
Sodium		29000		5000	ug/L	6010B
280-82795-6	**TW-8**					
Depth to water		45.76			ft	Field Sampling
Field pH		6.88			SU	Field Sampling
Field Conductivity		1426			umhos/cm	Field Sampling
Field Temperature		16.8			Degrees C	Field Sampling
Field Turbidity		416.0			NTU	Field Sampling
Field Dissolved Oxygen		9.2			mg/L	Field Sampling
Field EH/ORP		45.3			millivolts	Field Sampling
Chloride		11		0.50	mg/L	300.0
Sulfate		290		5.0	mg/L	300.0
Total Alkalinity		520	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		520		10	mg/L	SM 2320B
Dissolved						
Calcium		160000		5000	ug/L	6010B
Magnesium		68000		5000	ug/L	6010B
Potassium		7500		5000	ug/L	6010B
Sodium		77000		5000	ug/L	6010B

EXECUTIVE SUMMARY - Detections

Client: Waste Management Job Number: 280-82795-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-82795-7	**TW-9**					
Depth to water		42.58			ft	Field Sampling
Field pH		7.11			SU	Field Sampling
Field Conductivity		2202			umhos/cm	Field Sampling
Field Temperature		15.9			Degrees C	Field Sampling
Field Turbidity		39.5			NTU	Field Sampling
Field Dissolved Oxygen		15.3			mg/L	Field Sampling
Field EH/ORP		18.8			millivolts	Field Sampling
Chloride		64		0.50	mg/L	300.0
Sulfate		340		5.0	mg/L	300.0
Total Alkalinity		310	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		310		10	mg/L	SM 2320B
Dissolved						
Calcium		190000		5000	ug/L	6010B
Magnesium		120000		5000	ug/L	6010B
Potassium		9300		5000	ug/L	6010B
Sodium		89000		5000	ug/L	6010B
280-82795-8	**TW-10**					
Depth to water		56.33			ft	Field Sampling
Field pH		6.31			SU	Field Sampling
Field Conductivity		4081			umhos/cm	Field Sampling
Field Temperature		18.8			Degrees C	Field Sampling
Field Turbidity		999.0			NTU	Field Sampling
Field Dissolved Oxygen		6.8			mg/L	Field Sampling
Field EH/ORP		-17.0			millivolts	Field Sampling
Chloride		24		0.50	mg/L	300.0
Sulfate		2100		5.0	mg/L	300.0
Total Alkalinity		830	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		830		10	mg/L	SM 2320B
Dissolved						
Calcium		560000		5000	ug/L	6010B
Magnesium		280000		5000	ug/L	6010B
Potassium		13000		5000	ug/L	6010B
Sodium		160000		5000	ug/L	6010B

EXECUTIVE SUMMARY - Detections

Client: Waste Management Job Number: 280-82795-1

Lab Sample ID / Analyte	Client Sample ID	Result	Qualifier	Reporting Limit	Units	Method
280-82795-9	**TW-D**					
Chloride		8.3		0.50	mg/L	300.0
Sulfate		530		5.0	mg/L	300.0
Total Alkalinity		310	*	10	mg/L	SM 2320B
Bicarbonate Alkalinity		310		10	mg/L	SM 2320B
Dissolved						
Calcium		150000		5000	ug/L	6010B
Magnesium		94000		5000	ug/L	6010B
Potassium		5000		5000	ug/L	6010B
Sodium		33000		5000	ug/L	6010B

METHOD SUMMARY

Client: Waste Management Job Number: 280-82795-1

Description	Lab Location	Method	Preparation Method
Matrix: Water			
Volatile Organic Compounds (GC/MS)	TAL DEN	SW846 8260B	
Purge and Trap	TAL DEN		SW846 5030B
Metals (ICP)	TAL DEN	SW846 6010B	
Preparation, Total Recoverable or Dissolved Metals	TAL DEN		SW846 3005A
Sample Filtration, Field			FIELD_FLTRD
Anions, Ion Chromatography	TAL DEN	MCAWW 300.0	
Alkalinity	TAL DEN	SM SM 2320B	
Field Sampling	TAL DEN	EPA Field Sampling	

Lab References:

TAL DEN = TestAmerica Denver

Method References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SM = "Standard Methods For The Examination Of Water And Wastewater"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

METHOD / ANALYST SUMMARY

Client: Waste Management

Job Number: 280-82795-1

Method	Analyst	Analyst ID
SW846 8260B	Lines, Jeremy N	JNL
SW846 6010B	Scott, Samantha J	SJS
EPA Field Sampling	Saetia, Kriangsak 1	K1S
MCAWW 300.0	Benson, Alex F	AFB
SM SM 2320B	Uge, Ikem E	IEU

SAMPLE SUMMARY

Client: Waste Management Job Number: 280-82795-1

Lab Sample ID	Client Sample ID	Client Matrix	Date/Time Sampled	Date/Time Received
280-82795-1	TW-1	Water	05/04/2016 0815	05/05/2016 1300
280-82795-2	TW-2	Water	05/03/2016 1325	05/05/2016 1300
280-82795-3	TW-4	Water	05/03/2016 1510	05/05/2016 1300
280-82795-4	TW-5	Water	05/03/2016 1800	05/05/2016 1300
280-82795-5	TW-6	Water	05/03/2016 1705	05/05/2016 1300
280-82795-6	TW-8	Water	05/04/2016 0955	05/05/2016 1300
280-82795-7	TW-9	Water	05/04/2016 1640	05/05/2016 1300
280-82795-8	TW-10	Water	05/04/2016 1540	05/05/2016 1300
280-82795-9	TW-D	Water	05/03/2016 1100	05/05/2016 1300
280-82795-10	TRIP BLANK	Water	05/03/2016 1000	05/05/2016 1300

SAMPLE RESULTS

Client Sample ID: **TW-1**

Lab Sample ID: 280-82795-1 Date Sampled: 05/04/2016 0815
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4722.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0138			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0138				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	5.8		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-1

Lab Sample ID: 280-82795-1 Date Sampled: 05/04/2016 0815
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4722.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0138			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0138				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	117		70 - 127
4-Bromofluorobenzene (Surr)	103		78 - 120
Dibromofluoromethane (Surr)	110		77 - 120
Toluene-d8 (Surr)	103		80 - 125

Client: Waste Management | Job Number: 280-82795-1

Client Sample ID: **TW-2**

Lab Sample ID: 280-82795-2 | Date Sampled: 05/03/2016 1325
Client Matrix: Water | Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4723.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0159			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0159				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-2

Lab Sample ID: 280-82795-2 Date Sampled: 05/03/2016 1325
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4723.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0159			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0159				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	118		70 - 127
4-Bromofluorobenzene (Surr)	100		78 - 120
Dibromofluoromethane (Surr)	108		77 - 120
Toluene-d8 (Surr)	101		80 - 125

Client Sample ID: **TW-4**

Lab Sample ID: 280-82795-3 Date Sampled: 05/03/2016 1510
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4724.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0220			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0220				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-4

Lab Sample ID: 280-82795-3 Date Sampled: 05/03/2016 1510
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4724.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0220			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0220				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	114		70 - 127
4-Bromofluorobenzene (Surr)	100		78 - 120
Dibromofluoromethane (Surr)	106		77 - 120
Toluene-d8 (Surr)	102		80 - 125

Client: Waste Management | Job Number: 280-82795-1

Client Sample ID: **TW-5**

Lab Sample ID: 280-82795-4 | Date Sampled: 05/03/2016 1800
Client Matrix: Water | Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4725.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0516			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0516				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-5

Lab Sample ID: 280-82795-4 Date Sampled: 05/03/2016 1800
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4725.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0516			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0516				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	129	X	70 - 127
4-Bromofluorobenzene (Surr)	104		78 - 120
Dibromofluoromethane (Surr)	113		77 - 120
Toluene-d8 (Surr)	102		80 - 125

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-6

Lab Sample ID: 280-82795-5 Date Sampled: 05/03/2016 1705
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4726.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0537			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0537				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	6.4		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-6

Lab Sample ID: 280-82795-5 Date Sampled: 05/03/2016 1705
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4726.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0537			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0537				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	121		70 - 127
4-Bromofluorobenzene (Surr)	102		78 - 120
Dibromofluoromethane (Surr)	113		77 - 120
Toluene-d8 (Surr)	104		80 - 125

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-8

Lab Sample ID: 280-82795-6 Date Sampled: 05/04/2016 0955
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4727.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0558			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0558				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-8

Lab Sample ID: 280-82795-6 Date Sampled: 05/04/2016 0955
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4727.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0558			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0558				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	116		70 - 127
4-Bromofluorobenzene (Surr)	96		78 - 120
Dibromofluoromethane (Surr)	107		77 - 120
Toluene-d8 (Surr)	97		80 - 125

Client Sample ID: **TW-9**

Lab Sample ID: 280-82795-7 Date Sampled: 05/04/2016 1640
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4728.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0619			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0619				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-9

Lab Sample ID: 280-82795-7 Date Sampled: 05/04/2016 1640
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4728.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0619			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0619				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	121		70 - 127
4-Bromofluorobenzene (Surr)	97		78 - 120
Dibromofluoromethane (Surr)	112		77 - 120
Toluene-d8 (Surr)	100		80 - 125

Client Sample ID: **TW-10**

Lab Sample ID: 280-82795-8 Date Sampled: 05/04/2016 1540
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4729.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0640			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0640				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-10

Lab Sample ID: 280-82795-8 Date Sampled: 05/04/2016 1540
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4729.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0640			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0640				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	127		70 - 127
4-Bromofluorobenzene (Surr)	102		78 - 120
Dibromofluoromethane (Surr)	119		77 - 120
Toluene-d8 (Surr)	106		80 - 125

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-D

Lab Sample ID: 280-82795-9 Date Sampled: 05/03/2016 1100
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4730.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0701			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0701				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TW-D

Lab Sample ID: 280-82795-9 Date Sampled: 05/03/2016 1100
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	MS9_4730.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/14/2016 0701			Final Weight/Volume:	20 mL
Prep Date:	05/14/2016 0701				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	130	X	70 - 127
4-Bromofluorobenzene (Surr)	103		78 - 120
Dibromofluoromethane (Surr)	116		77 - 120
Toluene-d8 (Surr)	106		80 - 125

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TRIP BLANK

Lab Sample ID: 280-82795-10 Date Sampled: 05/03/2016 1000
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325349	Instrument ID:	VMS_R1
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	R2692.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/15/2016 2137			Final Weight/Volume:	20 mL
Prep Date:	05/15/2016 2137				

Analyte	Result (ug/L)	Qualifier	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Client: Waste Management Job Number: 280-82795-1

Client Sample ID: TRIP BLANK

Lab Sample ID: 280-82795-10 Date Sampled: 05/03/2016 1000
Client Matrix: Water Date Received: 05/05/2016 1300

8260B Volatile Organic Compounds (GC/MS)

Analysis Method:	8260B	Analysis Batch:	280-325349	Instrument ID:	VMS_R1
Prep Method:	5030B	Prep Batch:	N/A	Lab File ID:	R2692.D
Dilution:	1.0			Initial Weight/Volume:	20 mL
Analysis Date:	05/15/2016 2137			Final Weight/Volume:	20 mL
Prep Date:	05/15/2016 2137				

Surrogate	%Rec	Qualifier	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	104		70 - 127
4-Bromofluorobenzene (Surr)	86		78 - 120
Dibromofluoromethane (Surr)	106		77 - 120
Toluene-d8 (Surr)	100		80 - 125

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-1**

Lab Sample ID: 280-82795-1
Client Matrix: Water

Date Sampled: 05/04/2016 0815
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/09/2016 2337			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	180000		5000
Magnesium	430000		5000
Potassium	ND		5000
Sodium	160000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-2**

Lab Sample ID: 280-82795-2
Client Matrix: Water

Date Sampled: 05/03/2016 1325
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/09/2016 2348			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	390000		5000
Magnesium	240000		5000
Potassium	11000		5000
Sodium	220000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-4**

Lab Sample ID: 280-82795-3
Client Matrix: Water

Date Sampled: 05/03/2016 1510
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0002			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	160000		5000
Magnesium	97000		5000
Potassium	5100		5000
Sodium	34000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: TW-5

Lab Sample ID: 280-82795-4
Client Matrix: Water

Date Sampled: 05/03/2016 1800
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0005			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	43000		5000
Magnesium	53000		5000
Potassium	ND		5000
Sodium	58000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-6**

Lab Sample ID: 280-82795-5
Client Matrix: Water

Date Sampled: 05/03/2016 1705
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0007			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	50000		5000
Magnesium	25000		5000
Potassium	5800		5000
Sodium	29000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-8**

Lab Sample ID: 280-82795-6
Client Matrix: Water

Date Sampled: 05/04/2016 0955
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0010			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	160000		5000
Magnesium	68000		5000
Potassium	7500		5000
Sodium	77000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-9**

Lab Sample ID: 280-82795-7
Client Matrix: Water

Date Sampled: 05/04/2016 1640
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0013			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	190000		5000
Magnesium	120000		5000
Potassium	9300		5000
Sodium	89000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-10**

Lab Sample ID: 280-82795-8
Client Matrix: Water

Date Sampled: 05/04/2016 1540
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0016			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	560000		5000
Magnesium	280000		5000
Potassium	13000		5000
Sodium	160000		5000

Client: Waste Management

Job Number: 280-82795-1

Client Sample ID: **TW-D**

Lab Sample ID: 280-82795-9
Client Matrix: Water

Date Sampled: 05/03/2016 1100
Date Received: 05/05/2016 1300

6010B Metals (ICP)-Dissolved

Analysis Method:	6010B	Analysis Batch:	280-324565	Instrument ID:	MT_026
Prep Method:	3005A	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0			Initial Weight/Volume:	50 mL
Analysis Date:	05/10/2016 0019			Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				

Analyte	Result (ug/L)	Qualifier	RL
Calcium	150000		5000
Magnesium	94000		5000
Potassium	5000		5000
Sodium	33000		5000

General Chemistry

Client Sample ID: TW-1

Lab Sample ID: 280-82795-1 Date Sampled: 05/04/2016 0815
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	160		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1506					
Sulfate	1000		mg/L	5.0	10	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 2313					
Total Alkalinity	1200	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1752					
Bicarbonate Alkalinity	1200		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1752					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1752					

General Chemistry

Client Sample ID: **TW-2**

Lab Sample ID: 280-82795-2 Date Sampled: 05/03/2016 1325
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	11		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1523					
Sulfate	1900		mg/L	5.0	20	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 2331					
Total Alkalinity	530	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1758					
Bicarbonate Alkalinity	530		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1758					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1758					

General Chemistry

Client Sample ID: TW-4

Lab Sample ID: 280-82795-3 Date Sampled: 05/03/2016 1510
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	8.2		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1541					
Sulfate	550		mg/L	5.0	10	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 2348					
Total Alkalinity	310	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1803					
Bicarbonate Alkalinity	310		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1803					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1803					

General Chemistry

Client Sample ID: TW-5

Lab Sample ID: 280-82795-4 Date Sampled: 05/03/2016 1800
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	50		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1559					
Sulfate	190		mg/L	5.0	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1559					
Total Alkalinity	180	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1808					
Bicarbonate Alkalinity	180		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1808					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1808					

General Chemistry

Client Sample ID: TW-6

Lab Sample ID: 280-82795-5 Date Sampled: 05/03/2016 1705
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	11		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1616					
Sulfate	120		mg/L	5.0	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1616					
Total Alkalinity	140	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1813					
Bicarbonate Alkalinity	140		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1813					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1813					

General Chemistry

Client Sample ID: TW-8

Lab Sample ID: 280-82795-6 Date Sampled: 05/04/2016 0955
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	11		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1710					
Sulfate	290		mg/L	5.0	5.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/11/2016 0006					
Total Alkalinity	520	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1827					
Bicarbonate Alkalinity	520		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1827					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1827					

General Chemistry

Client Sample ID: TW-9

Lab Sample ID: 280-82795-7 Date Sampled: 05/04/2016 1640
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	64		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1820					
Sulfate	340		mg/L	5.0	5.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/11/2016 0152					
Total Alkalinity	310	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1831					
Bicarbonate Alkalinity	310		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1831					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1831					

General Chemistry

Client Sample ID: TW-10

Lab Sample ID: 280-82795-8 Date Sampled: 05/04/2016 1540
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	24		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1838					
Sulfate	2100		mg/L	5.0	20	300.0
Analysis Batch: 280-324600	Analysis Date: 05/11/2016 0210					
Total Alkalinity	830	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1837					
Bicarbonate Alkalinity	830		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1837					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1837					

General Chemistry

Client Sample ID: TW-D

Lab Sample ID: 280-82795-9 Date Sampled: 05/03/2016 1100
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	RL	Dil	Method
Chloride	8.3		mg/L	0.50	1.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/10/2016 1856					
Sulfate	530		mg/L	5.0	5.0	300.0
Analysis Batch: 280-324600	Analysis Date: 05/11/2016 0228					
Total Alkalinity	310	*	mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1842					
Bicarbonate Alkalinity	310		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1842					
Carbonate Alkalinity	ND		mg/L	10	1.0	SM 2320B
Analysis Batch: 280-324592	Analysis Date: 05/09/2016 1842					

Field Service / Mobile Lab

Client Sample ID: **TW-1**

Lab Sample ID: 280-82795-1 Date Sampled: 05/04/2016 0815
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	47.76		ft	1.0	Field Sampling	280-324348	05/04/2016 0815
Field pH	6.72		SU	1.0	Field Sampling	280-324348	05/04/2016 0815
Field Conductivity	3856		umhos/cm	1.0	Field Sampling	280-324348	05/04/2016 0815
Field Temperature	13.1		Degrees C	1.0	Field Sampling	280-324348	05/04/2016 0815
Field Turbidity	286.0		NTU	1.0	Field Sampling	280-324348	05/04/2016 0815
Field Dissolved Oxygen	30.0		mg/L	1.0	Field Sampling	280-324348	05/04/2016 0815
Field EH/ORP	179.0		millivolts	1.0	Field Sampling	280-324348	05/04/2016 0815

Field Service / Mobile Lab

Client Sample ID: **TW-2**

Lab Sample ID: 280-82795-2 Date Sampled: 05/03/2016 1325
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	128.04		ft	1.0	Field Sampling	280-324348	05/03/2016 1325
Field pH	7.00		SU	1.0	Field Sampling	280-324348	05/03/2016 1325
Field Conductivity	3521		umhos/cm	1.0	Field Sampling	280-324348	05/03/2016 1325
Field Temperature	14.9		Degrees C	1.0	Field Sampling	280-324348	05/03/2016 1325
Field Turbidity	24.9		NTU	1.0	Field Sampling	280-324348	05/03/2016 1325
Field Dissolved Oxygen	13.9		mg/L	1.0	Field Sampling	280-324348	05/03/2016 1325
Field EH/ORP	70.5		millivolts	1.0	Field Sampling	280-324348	05/03/2016 1325

Field Service / Mobile Lab

Client Sample ID: **TW-4**

Lab Sample ID: 280-82795-3 Date Sampled: 05/03/2016 1510
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	88.70		ft	1.0	Field Sampling	280-324348	05/03/2016 1510
Field pH	7.20		SU	1.0	Field Sampling	280-324348	05/03/2016 1510
Field Conductivity	1385		umhos/cm	1.0	Field Sampling	280-324348	05/03/2016 1510
Field Temperature	15.3		Degrees C	1.0	Field Sampling	280-324348	05/03/2016 1510
Field Turbidity	15.9		NTU	1.0	Field Sampling	280-324348	05/03/2016 1510
Field Dissolved Oxygen	10.6		mg/L	1.0	Field Sampling	280-324348	05/03/2016 1510
Field EH/ORP	-15.5		millivolts	1.0	Field Sampling	280-324348	05/03/2016 1510

Field Service / Mobile Lab

Client Sample ID: **TW-5**

Lab Sample ID: 280-82795-4 Date Sampled: 05/03/2016 1800
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	37.89		ft	1.0	Field Sampling	280-324348	05/03/2016 1800
Field pH	7.77		SU	1.0	Field Sampling	280-324348	05/03/2016 1800
Field Conductivity	800		umhos/cm	1.0	Field Sampling	280-324348	05/03/2016 1800
Field Temperature	14.4		Degrees C	1.0	Field Sampling	280-324348	05/03/2016 1800
Field Turbidity	324.0		NTU	1.0	Field Sampling	280-324348	05/03/2016 1800
Field Dissolved Oxygen	13.6		mg/L	1.0	Field Sampling	280-324348	05/03/2016 1800
Field EH/ORP	57.7		millivolts	1.0	Field Sampling	280-324348	05/03/2016 1800

Field Service / Mobile Lab

Client Sample ID: **TW-6**

Lab Sample ID: 280-82795-5 Date Sampled: 05/03/2016 1705
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	50.59		ft	1.0	Field Sampling	280-324348	05/03/2016 1705
Field pH	8.25		SU	1.0	Field Sampling	280-324348	05/03/2016 1705
Field Conductivity	454		umhos/cm	1.0	Field Sampling	280-324348	05/03/2016 1705
Field Temperature	16.8		Degrees C	1.0	Field Sampling	280-324348	05/03/2016 1705
Field Turbidity	108.0		NTU	1.0	Field Sampling	280-324348	05/03/2016 1705
Field Dissolved Oxygen	7.4		mg/L	1.0	Field Sampling	280-324348	05/03/2016 1705
Field EH/ORP	-37.7		millivolts	1.0	Field Sampling	280-324348	05/03/2016 1705

Field Service / Mobile Lab

Client Sample ID: **TW-8**

Lab Sample ID: 280-82795-6 Date Sampled: 05/04/2016 0955
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	45.76		ft	1.0	Field Sampling	280-324348	05/04/2016 0955
Field pH	6.88		SU	1.0	Field Sampling	280-324348	05/04/2016 0955
Field Conductivity	1426		umhos/cm	1.0	Field Sampling	280-324348	05/04/2016 0955
Field Temperature	16.8		Degrees C	1.0	Field Sampling	280-324348	05/04/2016 0955
Field Turbidity	416.0		NTU	1.0	Field Sampling	280-324348	05/04/2016 0955
Field Dissolved Oxygen	9.2		mg/L	1.0	Field Sampling	280-324348	05/04/2016 0955
Field EH/ORP	45.3		millivolts	1.0	Field Sampling	280-324348	05/04/2016 0955

Field Service / Mobile Lab

Client Sample ID: **TW-9**

Lab Sample ID: 280-82795-7 Date Sampled: 05/04/2016 1640
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	42.58		ft	1.0	Field Sampling	280-324348	05/04/2016 1640
Field pH	7.11		SU	1.0	Field Sampling	280-324348	05/04/2016 1640
Field Conductivity	2202		umhos/cm	1.0	Field Sampling	280-324348	05/04/2016 1640
Field Temperature	15.9		Degrees C	1.0	Field Sampling	280-324348	05/04/2016 1640
Field Turbidity	39.5		NTU	1.0	Field Sampling	280-324348	05/04/2016 1640
Field Dissolved Oxygen	15.3		mg/L	1.0	Field Sampling	280-324348	05/04/2016 1640
Field EH/ORP	18.8		millivolts	1.0	Field Sampling	280-324348	05/04/2016 1640

Field Service / Mobile Lab

Client Sample ID: **TW-10**

Lab Sample ID: 280-82795-8 Date Sampled: 05/04/2016 1540
Client Matrix: Water Date Received: 05/05/2016 1300

Analyte	Result	Qual	Units	Dil	Method	Analysis Batch	Date Analyzed Date Prepared
Depth to water	56.33		ft	1.0	Field Sampling	280-324348	05/04/2016 1540
Field pH	6.31		SU	1.0	Field Sampling	280-324348	05/04/2016 1540
Field Conductivity	4081		umhos/cm	1.0	Field Sampling	280-324348	05/04/2016 1540
Field Temperature	18.8		Degrees C	1.0	Field Sampling	280-324348	05/04/2016 1540
Field Turbidity	999.0		NTU	1.0	Field Sampling	280-324348	05/04/2016 1540
Field Dissolved Oxygen	6.8		mg/L	1.0	Field Sampling	280-324348	05/04/2016 1540
Field EH/ORP	-17.0		millivolts	1.0	Field Sampling	280-324348	05/04/2016 1540

DATA REPORTING QUALIFIERS

Client: Waste Management Job Number: 280-82795-1

Lab Section	Qualifier	Description
GC/MS VOA		
	J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
	X	Surrogate is outside control limits
Metals		
	4	MS, MSD: The analyte present in the original sample is greater than 4 times the matrix spike concentration; therefore, control limits are not applicable.
General Chemistry		
	*	RPD of the LCS and LCSD exceeds the control limits

QUALITY CONTROL RESULTS

Client: Waste Management Job Number: 280-82795-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
GC/MS VOA					
Analysis Batch:280-325289					
LCS 280-325289/4	Lab Control Sample	T	Water	8260B	
MB 280-325289/6	Method Blank	T	Water	8260B	
280-82718-X-1 MS	Matrix Spike	T	Water	8260B	
280-82718-X-1 MSD	Matrix Spike Duplicate	T	Water	8260B	
280-82795-1	TW-1	T	Water	8260B	
280-82795-2	TW-2	T	Water	8260B	
280-82795-3	TW-4	T	Water	8260B	
280-82795-4	TW-5	T	Water	8260B	
280-82795-5	TW-6	T	Water	8260B	
280-82795-6	TW-8	T	Water	8260B	
280-82795-7	TW-9	T	Water	8260B	
280-82795-8	TW-10	T	Water	8260B	
280-82795-9	TW-D	T	Water	8260B	
Analysis Batch:280-325349					
LCS 280-325349/4	Lab Control Sample	T	Water	8260B	
MB 280-325349/6	Method Blank	T	Water	8260B	
280-82795-10	TRIP BLANK	T	Water	8260B	
280-82923-Y-3 MS	Matrix Spike	T	Water	8260B	
280-82923-Y-3 MSD	Matrix Spike Duplicate	T	Water	8260B	

Report Basis
T = Total

Client: Waste Management Job Number: 280-82795-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
Metals					
Prep Batch: 280-324196					
LCS 280-324196/2-A	Lab Control Sample	R	Water	3005A	
MB 280-324196/1-A	Method Blank	R	Water	3005A	
280-82795-1	TW-1	D	Water	3005A	
280-82795-1MS	Matrix Spike	D	Water	3005A	
280-82795-1MSD	Matrix Spike Duplicate	D	Water	3005A	
280-82795-2	TW-2	D	Water	3005A	
280-82795-3	TW-4	D	Water	3005A	
280-82795-4	TW-5	D	Water	3005A	
280-82795-5	TW-6	D	Water	3005A	
280-82795-6	TW-8	D	Water	3005A	
280-82795-7	TW-9	D	Water	3005A	
280-82795-8	TW-10	D	Water	3005A	
280-82795-9	TW-D	D	Water	3005A	
Analysis Batch:280-324565					
LCS 280-324196/2-A	Lab Control Sample	R	Water	6010B	280-324196
MB 280-324196/1-A	Method Blank	R	Water	6010B	280-324196
280-82795-1	TW-1	D	Water	6010B	280-324196
280-82795-1MS	Matrix Spike	D	Water	6010B	280-324196
280-82795-1MSD	Matrix Spike Duplicate	D	Water	6010B	280-324196
280-82795-2	TW-2	D	Water	6010B	280-324196
280-82795-3	TW-4	D	Water	6010B	280-324196
280-82795-4	TW-5	D	Water	6010B	280-324196
280-82795-5	TW-6	D	Water	6010B	280-324196
280-82795-6	TW-8	D	Water	6010B	280-324196
280-82795-7	TW-9	D	Water	6010B	280-324196
280-82795-8	TW-10	D	Water	6010B	280-324196
280-82795-9	TW-D	D	Water	6010B	280-324196

Report Basis
D = Dissolved
R = Total Recoverable

Client: Waste Management Job Number: 280-82795-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
Field Service / Mobile Lab					
Analysis Batch:280-324348					
280-82795-1	TW-1	T	Water	Field Sampling	
280-82795-2	TW-2	T	Water	Field Sampling	
280-82795-3	TW-4	T	Water	Field Sampling	
280-82795-4	TW-5	T	Water	Field Sampling	
280-82795-5	TW-6	T	Water	Field Sampling	
280-82795-6	TW-8	T	Water	Field Sampling	
280-82795-7	TW-9	T	Water	Field Sampling	
280-82795-8	TW-10	T	Water	Field Sampling	

Report Basis
T = Total

Client: Waste Management Job Number: 280-82795-1

QC Association Summary

Lab Sample ID	Client Sample ID	Report Basis	Client Matrix	Method	Prep Batch
General Chemistry					
Analysis Batch:280-324592					
LCS 280-324592/4	Lab Control Sample	T	Water	SM 2320B	
LCSD 280-324592/5	Lab Control Sample Duplicate	T	Water	SM 2320B	
MB 280-324592/6	Method Blank	T	Water	SM 2320B	
280-82458-A-26 DU	Duplicate	T	Water	SM 2320B	
280-82795-1	TW-1	T	Water	SM 2320B	
280-82795-2	TW-2	T	Water	SM 2320B	
280-82795-3	TW-4	T	Water	SM 2320B	
280-82795-4	TW-5	T	Water	SM 2320B	
280-82795-5	TW-6	T	Water	SM 2320B	
280-82795-6	TW-8	T	Water	SM 2320B	
280-82795-7	TW-9	T	Water	SM 2320B	
280-82795-8	TW-10	T	Water	SM 2320B	
280-82795-9	TW-D	T	Water	SM 2320B	
Analysis Batch:280-324600					
LCS 280-324600/4	Lab Control Sample	T	Water	300.0	
LCSD 280-324600/5	Lab Control Sample Duplicate	T	Water	300.0	
MB 280-324600/6	Method Blank	T	Water	300.0	
280-82795-1	TW-1	T	Water	300.0	
280-82795-2	TW-2	T	Water	300.0	
280-82795-3	TW-4	T	Water	300.0	
280-82795-4	TW-5	T	Water	300.0	
280-82795-5	TW-6	T	Water	300.0	
280-82795-6	TW-8	T	Water	300.0	
280-82795-6DU	Duplicate	T	Water	300.0	
280-82795-6MS	Matrix Spike	T	Water	300.0	
280-82795-6MSD	Matrix Spike Duplicate	T	Water	300.0	
280-82795-7	TW-9	T	Water	300.0	
280-82795-8	TW-10	T	Water	300.0	
280-82795-9	TW-D	T	Water	300.0	

Report Basis
T = Total

Surrogate Recovery Report

8260B Volatile Organic Compounds (GC/MS)

Client Matrix: Water

Lab Sample ID	Client Sample ID	DCA %Rec	BFB %Rec	DBFM %Rec	TOL %Rec
280-82795-1	TW-1	117	103	110	103
280-82795-2	TW-2	118	100	108	101
280-82795-3	TW-4	114	100	106	102
280-82795-4	TW-5	129X	104	113	102
280-82795-5	TW-6	121	102	113	104
280-82795-6	TW-8	116	96	107	97
280-82795-7	TW-9	121	97	112	100
280-82795-8	TW-10	127	102	119	106
280-82795-9	TW-D	130X	103	116	106
280-82795-10	TRIP BLANK	104	86	106	100
MB 280-325289/6		100	96	98	98
MB 280-325349/6		102	101	102	102
LCS 280-325289/4		100	101	101	107
LCS 280-325349/4		106	100	107	113
280-82718-X-1 MS		94	94	97	97
280-82923-Y-3 MS		91	87	93	100
280-82718-X-1 MSD		101	96	101	100
280-82923-Y-3 MSD		96	88	97	100

Surrogate	Acceptance Limits
DCA = 1,2-Dichloroethane-d4 (Surr)	70-127
BFB = 4-Bromofluorobenzene (Surr)	78-120
DBFM = Dibromofluoromethane (Surr)	77-120
TOL = Toluene-d8 (Surr)	80-125

Method Blank - Batch: 280-325289

Method: 8260B
Preparation: 5030B

Lab Sample ID:	MB 280-325289/6	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	MS9_4709.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/13/2016 2103	Units:	ug/L	Final Weight/Volume:	20 mL
Prep Date:	05/13/2016 2103				
Leach Date:	N/A				

Analyte	Result	Qual	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Surrogate	% Rec	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	100	70 - 127
4-Bromofluorobenzene (Surr)	96	78 - 120
Dibromofluoromethane (Surr)	98	77 - 120
Toluene-d8 (Surr)	98	80 - 125

Lab Control Sample - Batch: 280-325289

Method: 8260B
Preparation: 5030B

Lab Sample ID:	LCS 280-325289/4	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	MS9_4708.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/13/2016 2042	Units:	ug/L	Final Weight/Volume:	20 mL
Prep Date:	05/13/2016 2042				
Leach Date:	N/A				

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
1,1,1-Trichloroethane	5.00	5.20	104	65 - 135	
1,1-Dichloroethane	5.00	4.89	98	65 - 135	J
1,1-Dichloroethene	5.00	4.56	91	65 - 136	J
1,2-Dichloropropane	5.00	5.17	103	64 - 135	
1,3-Dichlorobenzene	5.00	4.47	89	65 - 135	
Benzene	5.00	5.02	100	65 - 135	
Bromodichloromethane	5.00	4.98	100	65 - 135	J
Carbon tetrachloride	5.00	5.13	103	65 - 135	
Chlorobenzene	5.00	4.61	92	65 - 135	J
Chloroform	5.00	4.96	99	65 - 135	J
Ethylbenzene	5.00	4.89	98	65 - 135	J
Methylene Chloride	5.00	4.30	86	54 - 141	J
Tetrachloroethene	5.00	5.16	103	65 - 135	
Toluene	5.00	5.45	109	65 - 135	
trans-1,2-Dichloroethene	5.00	4.93	99	65 - 135	J
Trichloroethene	5.00	5.35	107	65 - 135	

Surrogate	% Rec	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	100	70 - 127
4-Bromofluorobenzene (Surr)	101	78 - 120
Dibromofluoromethane (Surr)	101	77 - 120
Toluene-d8 (Surr)	107	80 - 125

Client: Waste Management

Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-325289

Method: 8260B
Preparation: 5030B

MS Lab Sample ID:	280-82718-X-1 MS	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	MS9_4711.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/13/2016 2148			Final Weight/Volume:	20 mL
Prep Date:	05/13/2016 2148				20 mL
Leach Date:	N/A				

MSD Lab Sample ID:	280-82718-X-1 MSD	Analysis Batch:	280-325289	Instrument ID:	VMS_MS9
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	MS9_4712.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/13/2016 2209			Final Weight/Volume:	20 mL
Prep Date:	05/13/2016 2209				20 mL
Leach Date:	N/A				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
1,1,1-Trichloroethane	99	109	65 - 135	9	20		
1,1-Dichloroethane	92	99	65 - 135	8	21		
1,1-Dichloroethene	95	99	65 - 136	4	20		
1,2-Dichloropropane	94	102	64 - 135	9	20		
1,3-Dichlorobenzene	80	88	65 - 135	9	20		
Benzene	91	100	65 - 135	9	20		
Bromodichloromethane	90	101	65 - 135	12	20		
Carbon tetrachloride	96	103	65 - 135	7	21		
Chlorobenzene	83	91	65 - 135	9	20		
Chloroform	93	102	65 - 135	9	20		
Ethylbenzene	87	95	65 - 135	9	20		
Methylene Chloride	69	77	54 - 141	10	26		
Tetrachloroethene	91	99	65 - 135	9	20		
Toluene	99	109	65 - 135	9	20		
trans-1,2-Dichloroethene	93	100	65 - 135	7	24		
Trichloroethene	97	104	65 - 135	7	20		

Surrogate	MS % Rec	MSD % Rec	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	94	101	70 - 127
4-Bromofluorobenzene (Surr)	94	96	78 - 120
Dibromofluoromethane (Surr)	97	101	77 - 120
Toluene-d8 (Surr)	97	100	80 - 125

Client: Waste Management

Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-325289

Method: 8260B
Preparation: 5030B

MS Lab Sample ID:	280-82718-X-1 MS	Units: ug/L	MSD Lab Sample ID:	280-82718-X-1 MSD	
Client Matrix:	Water		Client Matrix:	Water	
Dilution:	1.0		Dilution:	1.0	
Analysis Date:	05/13/2016 2148		Analysis Date:	05/13/2016 2209	
Prep Date:	05/13/2016 2148		Prep Date:	05/13/2016 2209	
Leach Date:	N/A		Leach Date:	N/A	

Analyte	Sample Result/Qual	MS Spike Amount	MSD Spike Amount	MS Result/Qual	MSD Result/Qual
1,1,1-Trichloroethane	ND	5.00	5.00	ND	5.43
1,1-Dichloroethane	ND	5.00	5.00	ND	ND
1,1-Dichloroethene	ND	5.00	5.00	ND	ND
1,2-Dichloropropane	ND	5.00	5.00	ND	5.12
1,3-Dichlorobenzene	ND	5.00	5.00	4.02	4.42
Benzene	ND	5.00	5.00	ND	5.02
Bromodichloromethane	ND	5.00	5.00	ND	5.07
Carbon tetrachloride	ND	5.00	5.00	ND	5.16
Chlorobenzene	ND	5.00	5.00	ND	ND
Chloroform	ND	5.00	5.00	ND	5.08
Ethylbenzene	ND	5.00	5.00	ND	ND
Methylene Chloride	ND	5.00	5.00	ND	ND
Tetrachloroethene	ND	5.00	5.00	ND	ND
Toluene	ND	5.00	5.00	ND	5.45
trans-1,2-Dichloroethene	ND	5.00	5.00	ND	ND
Trichloroethene	ND	5.00	5.00	ND	5.20

Client: Waste Management

Job Number: 280-82795-1

Method Blank - Batch: 280-325349

Method: 8260B
Preparation: 5030B

Lab Sample ID:	MB 280-325349/6	Analysis Batch:	280-325349	Instrument ID:	VMS_R1
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	R2665.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/15/2016 1251	Units:	ug/L	Final Weight/Volume:	20 mL
Prep Date:	05/15/2016 1251				
Leach Date:	N/A				

Analyte	Result	Qual	RL
1,1,1,2-Tetrachloroethane	ND		5.0
1,1,1-Trichloroethane	ND		5.0
1,1,2,2-Tetrachloroethane	ND		5.0
1,1,2-Trichloroethane	ND		5.0
1,1-Dichloroethane	ND		5.0
1,1-Dichloroethene	ND		5.0
1,2,3-Trichloropropane	ND		10
1,2-Dichlorobenzene	ND		10
1,2-Dichloroethane	ND		5.0
1,2-Dichloropropane	ND		5.0
1,4-Dichlorobenzene	ND		10
2-Butanone (MEK)	ND		50
2-Hexanone	ND		10
4-Methyl-2-pentanone (MIBK)	ND		10
Acetone	ND		34
Acrylonitrile	ND		100
Benzene	ND		5.0
Bromochloromethane	ND		10
Bromodichloromethane	ND		5.0
Bromoform	ND		5.0
Bromomethane	ND		10
Carbon disulfide	ND		5.0
Carbon tetrachloride	ND		5.0
Chlorobenzene	ND		5.0
Chlorodibromomethane	ND		5.0
Chloroethane	ND		10
Chloroform	ND		5.0
Chloromethane	ND		10
cis-1,2-Dichloroethene	ND		10
cis-1,3-Dichloropropene	ND		5.0
Dibromomethane	ND		10
Ethylbenzene	ND		5.0
Iodomethane	ND		10
Methylene Chloride	ND		5.0
Styrene	ND		5.0
Tetrachloroethene	ND		5.0
Toluene	ND		5.0
trans-1,2-Dichloroethene	ND		10
trans-1,3-Dichloropropene	ND		5.0
trans-1,4-Dichloro-2-butene	ND		10
Trichloroethene	ND		5.0
Trichlorofluoromethane	ND		10
Vinyl acetate	ND		10
Vinyl chloride	ND		1.0
Xylenes (total)	ND		10

Surrogate	% Rec	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	102	70 - 127
4-Bromofluorobenzene (Surr)	101	78 - 120
Dibromofluoromethane (Surr)	102	77 - 120
Toluene-d8 (Surr)	102	80 - 125

Lab Control Sample - Batch: 280-325349

Method: 8260B
Preparation: 5030B

Lab Sample ID:	LCS 280-325349/4	Analysis Batch:	280-325349	Instrument ID:	VMS_R1
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	R2664.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/15/2016 1231	Units:	ug/L	Final Weight/Volume:	20 mL
Prep Date:	05/15/2016 1231				
Leach Date:	N/A				

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
1,1,1-Trichloroethane	5.00	5.43	109	65 - 135	
1,1-Dichloroethane	5.00	4.69	94	65 - 135	J
1,1-Dichloroethene	5.00	4.33	87	65 - 136	J
1,2-Dichloropropane	5.00	5.15	103	64 - 135	
1,3-Dichlorobenzene	5.00	5.34	107	65 - 135	
Benzene	5.00	5.05	101	65 - 135	
Bromodichloromethane	5.00	5.20	104	65 - 135	
Carbon tetrachloride	5.00	5.72	114	65 - 135	
Chlorobenzene	5.00	5.25	105	65 - 135	
Chloroform	5.00	5.37	107	65 - 135	
Ethylbenzene	5.00	5.52	110	65 - 135	
Methylene Chloride	5.00	4.36	87	54 - 141	J
Tetrachloroethene	5.00	5.77	115	65 - 135	
Toluene	5.00	5.63	113	65 - 135	
trans-1,2-Dichloroethene	5.00	5.06	101	65 - 135	J
Trichloroethene	5.00	5.25	105	65 - 135	

Surrogate	% Rec	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	106	70 - 127
4-Bromofluorobenzene (Surr)	100	78 - 120
Dibromofluoromethane (Surr)	107	77 - 120
Toluene-d8 (Surr)	113	80 - 125

Client: Waste Management

Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-325349

Method: 8260B
Preparation: 5030B

MS Lab Sample ID:	280-82923-Y-3 MS	Analysis Batch:	280-325349	Instrument ID:	VMS_R1
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	R2667.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/15/2016 1330			Final Weight/Volume:	20 mL
Prep Date:	05/15/2016 1330				20 mL
Leach Date:	N/A				

MSD Lab Sample ID:	280-82923-Y-3 MSD	Analysis Batch:	280-325349	Instrument ID:	VMS_R1
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	R2668.D
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	20 mL
Analysis Date:	05/15/2016 1349			Final Weight/Volume:	20 mL
Prep Date:	05/15/2016 1349				20 mL
Leach Date:	N/A				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
1,1,1-Trichloroethane	105	103	65 - 135	1	20		
1,1-Dichloroethane	90	95	65 - 135	5	21		
1,1-Dichloroethene	82	83	65 - 136	0	20		
1,2-Dichloropropane	97	101	64 - 135	4	20		
1,3-Dichlorobenzene	104	104	65 - 135	0	20		
Benzene	97	98	65 - 135	1	20		
Bromodichloromethane	100	105	65 - 135	5	20		
Carbon tetrachloride	110	108	65 - 135	2	21		
Chlorobenzene	102	102	65 - 135	0	20		
Chloroform	103	104	65 - 135	1	20		
Ethylbenzene	108	105	65 - 135	2	20		
Methylene Chloride	75	80	54 - 141	6	26		
Tetrachloroethene	111	109	65 - 135	3	20		
Toluene	109	111	65 - 135	2	20		
trans-1,2-Dichloroethene	97	98	65 - 135	1	24		
Trichloroethene	102	101	65 - 135	1	20		

Surrogate	MS % Rec	MSD % Rec	Acceptance Limits
1,2-Dichloroethane-d4 (Surr)	91	96	70 - 127
4-Bromofluorobenzene (Surr)	87	88	78 - 120
Dibromofluoromethane (Surr)	93	97	77 - 120
Toluene-d8 (Surr)	100	100	80 - 125

Client: Waste Management

Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-325349

Method: 8260B
Preparation: 5030B

MS Lab Sample ID:	280-82923-Y-3 MS	Units: ug/L	MSD Lab Sample ID:	280-82923-Y-3 MSD	
Client Matrix:	Water		Client Matrix:	Water	
Dilution:	1.0		Dilution:	1.0	
Analysis Date:	05/15/2016 1330		Analysis Date:	05/15/2016 1349	
Prep Date:	05/15/2016 1330		Prep Date:	05/15/2016 1349	
Leach Date:	N/A		Leach Date:	N/A	

Analyte	Sample Result/Qual	MS Spike Amount	MSD Spike Amount	MS Result/Qual	MSD Result/Qual
1,1,1-Trichloroethane	ND	5.00	5.00	5.24	5.16
1,1-Dichloroethane	ND	5.00	5.00	ND	ND
1,1-Dichloroethene	ND	5.00	5.00	ND	ND
1,2-Dichloropropane	ND	5.00	5.00	ND	5.05
1,3-Dichlorobenzene	ND	5.00	5.00	5.18	5.18
Benzene	ND	5.00	5.00	ND	ND
Bromodichloromethane	ND	5.00	5.00	5.01	5.26
Carbon tetrachloride	ND	5.00	5.00	5.51	5.42
Chlorobenzene	ND	5.00	5.00	5.08	5.11
Chloroform	ND	5.00	5.00	7.02	7.09
Ethylbenzene	ND	5.00	5.00	5.38	5.27
Methylene Chloride	ND	5.00	5.00	ND	ND
Tetrachloroethene	ND	5.00	5.00	5.57	5.43
Toluene	ND	5.00	5.00	5.44	5.55
trans-1,2-Dichloroethene	ND	5.00	5.00	ND	ND
Trichloroethene	ND	5.00	5.00	5.09	5.06

Client: Waste Management

Job Number: 280-82795-1

Method Blank - Batch: 280-324196

Method: 6010B
Preparation: 3005A
Total Recoverable

Lab Sample ID:	MB 280-324196/1-A	Analysis Batch:	280-324565	Instrument ID:	MT_026
Client Matrix:	Water	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	50 mL
Analysis Date:	05/09/2016 2331	Units:	ug/L	Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				
Leach Date:	N/A				

Analyte	Result	Qual	RL
Calcium	ND		5000
Magnesium	ND		5000
Potassium	ND		5000
Sodium	ND		5000

Lab Control Sample - Batch: 280-324196

Method: 6010B
Preparation: 3005A
Total Recoverable

Lab Sample ID:	LCS 280-324196/2-A	Analysis Batch:	280-324565	Instrument ID:	MT_026
Client Matrix:	Water	Prep Batch:	280-324196	Lab File ID:	26a050916c.asc
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	50 mL
Analysis Date:	05/09/2016 2334	Units:	ug/L	Final Weight/Volume:	50 mL
Prep Date:	05/09/2016 0805				
Leach Date:	N/A				

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Calcium	50000	49600	99	90 - 111	
Magnesium	50000	49100	98	90 - 113	
Potassium	50000	49700	99	89 - 114	
Sodium	50000	51900	104	90 - 115	

Client: Waste Management Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-324196

Method: 6010B
Preparation: 3005A
Dissolved

MS Lab Sample ID: 280-82795-1
Client Matrix: Water
Dilution: 1.0
Analysis Date: 05/09/2016 2342
Prep Date: 05/09/2016 0805
Leach Date: N/A

Analysis Batch: 280-324565
Prep Batch: 280-324196
Leach Batch: N/A

Instrument ID: MT_026
Lab File ID: 26a050916c.asc
Initial Weight/Volume: 50 mL
Final Weight/Volume: 50 mL

MSD Lab Sample ID: 280-82795-1
Client Matrix: Water
Dilution: 1.0
Analysis Date: 05/09/2016 2345
Prep Date: 05/09/2016 0805
Leach Date: N/A

Analysis Batch: 280-324565
Prep Batch: 280-324196
Leach Batch: N/A

Instrument ID: MT_026
Lab File ID: 26a050916c.asc
Initial Weight/Volume: 50 mL
Final Weight/Volume: 50 mL

Analyte	% Rec. MS	% Rec. MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Calcium	98	106	48 - 153	2	20		
Magnesium	81	109	62 - 146	3	20	4	4
Potassium	104	104	76 - 132	0	20		
Sodium	109	116	70 - 203	2	20		

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-324196

Method: 6010B
Preparation: 3005A
Dissolved

MS Lab Sample ID: 280-82795-1
Client Matrix: Water
Dilution: 1.0
Analysis Date: 05/09/2016 2342
Prep Date: 05/09/2016 0805
Leach Date: N/A

Units: ug/L

MSD Lab Sample ID: 280-82795-1
Client Matrix: Water
Dilution: 1.0
Analysis Date: 05/09/2016 2345
Prep Date: 05/09/2016 0805
Leach Date: N/A

Analyte	Sample Result/Qual	MS Spike Amount	MSD Spike Amount	MS Result/Qual	MSD Result/Qual
Calcium	180000	50000	50000	227000	231000
Magnesium	430000	50000	50000	466000 4	480000 4
Potassium	ND	50000	50000	55700	55600
Sodium	160000	50000	50000	217000	220000

Client: Waste Management Job Number: 280-82795-1

Method Blank - Batch: 280-324600

Method: 300.0
Preparation: N/A

Lab Sample ID:	MB 280-324600/6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	06.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1124	Units:	mg/L	Final Weight/Volume:	5 mL
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Result	Qual	RL
Chloride	ND		0.50
Sulfate	ND		5.0

Method Reporting Limit Check - Batch: 280-324600

Method: 300.0
Preparation: N/A

Lab Sample ID:	MRL 280-324600/3	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	03.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1031	Units:	mg/L	Final Weight/Volume:	5 mL
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Spike Amount	Result	% Rec.	Limit	Qual
Chloride	2.50	ND	103	50 - 150	
Sulfate	2.50	ND	104	50 - 150	

Lab Control Sample/
Lab Control Sample Duplicate Recovery Report - Batch: 280-324600

Method: 300.0
Preparation: N/A

LCS Lab Sample ID:	LCS 280-324600/4	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	04.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1049	Units:	mg/L	Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

LCSD Lab Sample ID:	LCSD 280-324600/5	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	05.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1107	Units:	mg/L	Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Chloride	101	101	90 - 110	0	10		
Sulfate	101	101	90 - 110	0	10		

Client: Waste Management

Job Number: 280-82795-1

Laboratory Control/
Laboratory Duplicate Data Report - Batch: 280-324600

Method: 300.0
Preparation: N/A

LCS Lab Sample ID:	LCS 280-324600/4	Units: mg/L		LCSD Lab Sample ID:	LCSD 280-324600/5
Client Matrix:	Water			Client Matrix:	Water
Dilution:	1.0			Dilution:	1.0
Analysis Date:	05/10/2016 1049			Analysis Date:	05/10/2016 1107
Prep Date:	N/A			Prep Date:	N/A
Leach Date:	N/A			Leach Date:	N/A

Analyte	LCS Spike Amount	LCSD Spike Amount	LCS Result/Qual	LCSD Result/Qual
Chloride	100	100	101	101
Sulfate	100	100	101	101

Client: Waste Management

Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-324600

Method: 300.0
Preparation: N/A

MS Lab Sample ID:	280-82795-6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	21.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1745			Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

MSD Lab Sample ID:	280-82795-6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	22.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1803			Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Chloride	108	108	80 - 120	0	20		

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-324600

Method: 300.0
Preparation: N/A

MS Lab Sample ID:	280-82795-6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	39.0000.d
Dilution:	5.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/11/2016 0042			Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

MSD Lab Sample ID:	280-82795-6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	40.0000.d
Dilution:	5.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/11/2016 0059			Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

	% Rec.						
Analyte	MS	MSD	Limit	RPD	RPD Limit	MS Qual	MSD Qual
Sulfate	96	96	80 - 120	0	20		

Client: Waste Management

Job Number: 280-82795-1

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-324600

Method: 300.0
Preparation: N/A

MS Lab Sample ID:	280-82795-6	Units: mg/L	
Client Matrix:	Water		
Dilution:	1.0		
Analysis Date:	05/10/2016 1745		
Prep Date:	N/A		
Leach Date:	N/A		

MSD Lab Sample ID:	280-82795-6
Client Matrix:	Water
Dilution:	1.0
Analysis Date:	05/10/2016 1803
Prep Date:	N/A
Leach Date:	N/A

Analyte	Sample Result/Qual	MS Spike Amount	MSD Spike Amount	MS Result/Qual	MSD Result/Qual
Chloride	11	25.0	25.0	37.9	37.9

Matrix Spike/
Matrix Spike Duplicate Recovery Report - Batch: 280-324600

Method: 300.0
Preparation: N/A

MS Lab Sample ID:	280-82795-6	Units: mg/L	
Client Matrix:	Water		
Dilution:	5.0		
Analysis Date:	05/11/2016 0042		
Prep Date:	N/A		
Leach Date:	N/A		

MSD Lab Sample ID:	280-82795-6
Client Matrix:	Water
Dilution:	5.0
Analysis Date:	05/11/2016 0059
Prep Date:	N/A
Leach Date:	N/A

Analyte	Sample Result/Qual	MS Spike Amount	MSD Spike Amount	MS Result/Qual	MSD Result/Qual
Sulfate	290	125	125	409	409

Duplicate - Batch: 280-324600 **Method: 300.0**
Preparation: N/A

Lab Sample ID:	280-82795-6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	20.0000.d
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/10/2016 1727	Units:	mg/L	Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
Chloride	11	10.8	0.06	15	

Duplicate - Batch: 280-324600 **Method: 300.0**
Preparation: N/A

Lab Sample ID:	280-82795-6	Analysis Batch:	280-324600	Instrument ID:	WC_IonChrom6
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	38.0000.d
Dilution:	5.0	Leach Batch:	N/A	Initial Weight/Volume:	5 mL
Analysis Date:	05/11/2016 0024	Units:	mg/L	Final Weight/Volume:	5 mL
Prep Date:	N/A				25 uL
Leach Date:	N/A				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
Sulfate	290	288	0	15	

Client: Waste Management Job Number: 280-82795-1

Method Blank - Batch: 280-324592

Method: SM 2320B
Preparation: N/A

Lab Sample ID:	MB 280-324592/6	Analysis Batch:	280-324592	Instrument ID:	WC-AT3
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	050916 alk.txt
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	05/09/2016 1723	Units:	mg/L	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Result	Qual	RL
Total Alkalinity	ND		10
Bicarbonate Alkalinity	ND		10
Carbonate Alkalinity	ND		10

Lab Control Sample/
Lab Control Sample Duplicate Recovery Report - Batch: 280-324592

Method: SM 2320B
Preparation: N/A

LCS Lab Sample ID:	LCS 280-324592/4	Analysis Batch:	280-324592	Instrument ID:	WC-AT3
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	050916 alk.txt
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	05/09/2016 1713	Units:	mg/L	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

LCSD Lab Sample ID:	LCSD 280-324592/5	Analysis Batch:	280-324592	Instrument ID:	WC-AT3
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	050916 alk.txt
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	05/09/2016 1718	Units:	mg/L	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

	% Rec.						
Analyte	LCS	LCSD	Limit	RPD	RPD Limit	LCS Qual	LCSD Qual
Total Alkalinity	90	105	90 - 110	16	10		*

Laboratory Control/
Laboratory Duplicate Data Report - Batch: 280-324592

Method: SM 2320B
Preparation: N/A

LCS Lab Sample ID:	LCS 280-324592/4	Units:	mg/L	LCSD Lab Sample ID:	LCSD 280-324592/5
Client Matrix:	Water			Client Matrix:	Water
Dilution:	1.0			Dilution:	1.0
Analysis Date:	05/09/2016 1713			Analysis Date:	05/09/2016 1718
Prep Date:	N/A			Prep Date:	N/A
Leach Date:	N/A			Leach Date:	N/A

Analyte	LCS Spike Amount	LCSD Spike Amount	LCS Result/Qual	LCSD Result/Qual	
Total Alkalinity	200	200	180	210	*

Client: Waste Management

Job Number: 280-82795-1

Duplicate - Batch: 280-324592

Method: SM 2320B
Preparation: N/A

Lab Sample ID:	280-82458-A-26 DU	Analysis Batch:	280-324592	Instrument ID:	WC-AT3
Client Matrix:	Water	Prep Batch:	N/A	Lab File ID:	050916 alk.txt
Dilution:	1.0	Leach Batch:	N/A	Initial Weight/Volume:	
Analysis Date:	05/09/2016 1732	Units:	mg/L	Final Weight/Volume:	
Prep Date:	N/A				
Leach Date:	N/A				

Analyte	Sample Result/Qual	Result	RPD	Limit	Qual
Total Alkalinity	170	168	0.2	10	*

Client: Waste Management Job Number: 280-82795-1

Laboratory Chronicle

Lab ID: 280-82795-1 **Client ID: TW-1**

Sample Date/Time: 05/04/2016 08:15 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-1		280-325289		05/14/2016 01:38	1	TAL DEN	JNL
A:8260B	280-82795-E-1		280-325289		05/14/2016 01:38	1	TAL DEN	JNL
P:3005A	280-82795-B-1-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-1-A		280-324565	280-324196	05/09/2016 23:37	1	TAL DEN	SJS
A:300.0	280-82795-A-1		280-324600		05/10/2016 15:06	1	TAL DEN	AFB
A:300.0	280-82795-A-1		280-324600		05/10/2016 23:13	10	TAL DEN	AFB
A:SM 2320B	280-82795-A-1		280-324592		05/09/2016 17:52	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-1		280-324348		05/04/2016 08:15	1	TAL DEN	K1S

Lab ID: 280-82795-1 MS **Client ID: TW-1**

Sample Date/Time: 05/04/2016 08:15 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:3005A	280-82795-B-1-B MS		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-1-B MS		280-324565	280-324196	05/09/2016 23:42	1	TAL DEN	SJS

Lab ID: 280-82795-1 MSD **Client ID: TW-1**

Sample Date/Time: 05/04/2016 08:15 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:3005A	280-82795-B-1-C MSD		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-1-C MSD		280-324565	280-324196	05/09/2016 23:45	1	TAL DEN	SJS

Lab ID: 280-82795-2 **Client ID: TW-2**

Sample Date/Time: 05/03/2016 13:25 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-2		280-325289		05/14/2016 01:59	1	TAL DEN	JNL
A:8260B	280-82795-E-2		280-325289		05/14/2016 01:59	1	TAL DEN	JNL
P:3005A	280-82795-B-2-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-2-A		280-324565	280-324196	05/09/2016 23:48	1	TAL DEN	SJS
A:300.0	280-82795-A-2		280-324600		05/10/2016 15:23	1	TAL DEN	AFB
A:300.0	280-82795-A-2		280-324600		05/10/2016 23:31	20	TAL DEN	AFB
A:SM 2320B	280-82795-A-2		280-324592		05/09/2016 17:58	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-2		280-324348		05/03/2016 13:25	1	TAL DEN	K1S

Client: Waste Management Job Number: 280-82795-1

Laboratory Chronicle

Lab ID: 280-82795-3 **Client ID: TW-4**

Sample Date/Time: 05/03/2016 15:10 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-3		280-325289		05/14/2016 02:20	1	TAL DEN	JNL
A:8260B	280-82795-E-3		280-325289		05/14/2016 02:20	1	TAL DEN	JNL
P:3005A	280-82795-B-3-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-3-A		280-324565	280-324196	05/10/2016 00:02	1	TAL DEN	SJS
A:300.0	280-82795-A-3		280-324600		05/10/2016 15:41	1	TAL DEN	AFB
A:300.0	280-82795-A-3		280-324600		05/10/2016 23:48	10	TAL DEN	AFB
A:SM 2320B	280-82795-A-3		280-324592		05/09/2016 18:03	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-3		280-324348		05/03/2016 15:10	1	TAL DEN	K1S

Lab ID: 280-82795-4 **Client ID: TW-5**

Sample Date/Time: 05/03/2016 18:00 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-D-4		280-325289		05/14/2016 05:16	1	TAL DEN	JNL
A:8260B	280-82795-D-4		280-325289		05/14/2016 05:16	1	TAL DEN	JNL
P:3005A	280-82795-B-4-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-4-A		280-324565	280-324196	05/10/2016 00:05	1	TAL DEN	SJS
A:300.0	280-82795-A-4		280-324600		05/10/2016 15:59	1	TAL DEN	AFB
A:SM 2320B	280-82795-A-4		280-324592		05/09/2016 18:08	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-4		280-324348		05/03/2016 18:00	1	TAL DEN	K1S

Lab ID: 280-82795-5 **Client ID: TW-6**

Sample Date/Time: 05/03/2016 17:05 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-5		280-325289		05/14/2016 05:37	1	TAL DEN	JNL
A:8260B	280-82795-E-5		280-325289		05/14/2016 05:37	1	TAL DEN	JNL
P:3005A	280-82795-B-5-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-5-A		280-324565	280-324196	05/10/2016 00:07	1	TAL DEN	SJS
A:300.0	280-82795-A-5		280-324600		05/10/2016 16:16	1	TAL DEN	AFB
A:SM 2320B	280-82795-A-5		280-324592		05/09/2016 18:13	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-5		280-324348		05/03/2016 17:05	1	TAL DEN	K1S

Client: Waste Management Job Number: 280-82795-1

Laboratory Chronicle

Lab ID: 280-82795-6 **Client ID: TW-8**

Sample Date/Time: 05/04/2016 09:55 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-6		280-325289		05/14/2016 05:58	1	TAL DEN	JNL
A:8260B	280-82795-E-6		280-325289		05/14/2016 05:58	1	TAL DEN	JNL
P:3005A	280-82795-B-6-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-6-A		280-324565	280-324196	05/10/2016 00:10	1	TAL DEN	SJS
A:300.0	280-82795-A-6		280-324600		05/10/2016 17:10	1	TAL DEN	AFB
A:300.0	280-82795-A-6		280-324600		05/11/2016 00:06	5	TAL DEN	AFB
A:SM 2320B	280-82795-A-6		280-324592		05/09/2016 18:27	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-6		280-324348		05/04/2016 09:55	1	TAL DEN	K1S

Lab ID: 280-82795-6 MS **Client ID: TW-8**

Sample Date/Time: 05/04/2016 09:55 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:300.0	280-82795-A-6 MS		280-324600		05/10/2016 17:45	1	TAL DEN	AFB
A:300.0	280-82795-A-6 MS		280-324600		05/11/2016 00:42	5	TAL DEN	AFB

Lab ID: 280-82795-6 MSD **Client ID: TW-8**

Sample Date/Time: 05/04/2016 09:55 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:300.0	280-82795-A-6 MSD		280-324600		05/10/2016 18:03	1	TAL DEN	AFB
A:300.0	280-82795-A-6 MSD		280-324600		05/11/2016 00:59	5	TAL DEN	AFB

Lab ID: 280-82795-6 DU **Client ID: TW-8**

Sample Date/Time: 05/04/2016 09:55 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:300.0	280-82795-A-6 DU		280-324600		05/10/2016 17:27	1	TAL DEN	AFB
A:300.0	280-82795-A-6 DU		280-324600		05/11/2016 00:24	5	TAL DEN	AFB

Client: Waste Management Job Number: 280-82795-1

Laboratory Chronicle

Lab ID: 280-82795-7 **Client ID: TW-9**

Sample Date/Time: 05/04/2016 16:40 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-7		280-325289		05/14/2016 06:19	1	TAL DEN	JNL
A:8260B	280-82795-E-7		280-325289		05/14/2016 06:19	1	TAL DEN	JNL
P:3005A	280-82795-B-7-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-7-A		280-324565	280-324196	05/10/2016 00:13	1	TAL DEN	SJS
A:300.0	280-82795-A-7		280-324600		05/10/2016 18:20	1	TAL DEN	AFB
A:300.0	280-82795-A-7		280-324600		05/11/2016 01:52	5	TAL DEN	AFB
A:SM 2320B	280-82795-A-7		280-324592		05/09/2016 18:31	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-7		280-324348		05/04/2016 16:40	1	TAL DEN	K1S

Lab ID: 280-82795-8 **Client ID: TW-10**

Sample Date/Time: 05/04/2016 15:40 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-8		280-325289		05/14/2016 06:40	1	TAL DEN	JNL
A:8260B	280-82795-E-8		280-325289		05/14/2016 06:40	1	TAL DEN	JNL
P:3005A	280-82795-B-8-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-8-A		280-324565	280-324196	05/10/2016 00:16	1	TAL DEN	SJS
A:300.0	280-82795-A-8		280-324600		05/10/2016 18:38	1	TAL DEN	AFB
A:300.0	280-82795-A-8		280-324600		05/11/2016 02:10	20	TAL DEN	AFB
A:SM 2320B	280-82795-A-8		280-324592		05/09/2016 18:37	1	TAL DEN	IEU
A:Field Sampling	280-82795-A-8		280-324348		05/04/2016 15:40	1	TAL DEN	K1S

Lab ID: 280-82795-9 **Client ID: TW-D**

Sample Date/Time: 05/03/2016 11:00 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-E-9		280-325289		05/14/2016 07:01	1	TAL DEN	JNL
A:8260B	280-82795-E-9		280-325289		05/14/2016 07:01	1	TAL DEN	JNL
P:3005A	280-82795-B-9-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	280-82795-B-9-A		280-324565	280-324196	05/10/2016 00:19	1	TAL DEN	SJS
A:300.0	280-82795-A-9		280-324600		05/10/2016 18:56	1	TAL DEN	AFB
A:300.0	280-82795-A-9		280-324600		05/11/2016 02:28	5	TAL DEN	AFB
A:SM 2320B	280-82795-A-9		280-324592		05/09/2016 18:42	1	TAL DEN	IEU

Lab ID: 280-82795-10 **Client ID: TRIP BLANK**

Sample Date/Time: 05/03/2016 10:00 Received Date/Time: 05/05/2016 13:00

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82795-B-10		280-325349		05/15/2016 21:37	1	TAL DEN	JNL
A:8260B	280-82795-B-10		280-325349		05/15/2016 21:37	1	TAL DEN	JNL

Client: Waste Management Job Number: 280-82795-1

Laboratory Chronicle

Lab ID: MB **Client ID: N/A**

Sample Date/Time: N/A Received Date/Time: N/A

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	MB 280-325289/6		280-325289		05/13/2016 21:03	1	TAL DEN	JNL
A:8260B	MB 280-325289/6		280-325289		05/13/2016 21:03	1	TAL DEN	JNL
P:5030B	MB 280-325349/6		280-325349		05/15/2016 12:51	1	TAL DEN	JNL
A:8260B	MB 280-325349/6		280-325349		05/15/2016 12:51	1	TAL DEN	JNL
P:3005A	MB 280-324196/1-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	MB 280-324196/1-A		280-324565	280-324196	05/09/2016 23:31	1	TAL DEN	SJS
A:300.0	MB 280-324600/6		280-324600		05/10/2016 11:24	1	TAL DEN	AFB
A:SM 2320B	MB 280-324592/6		280-324592		05/09/2016 17:23	1	TAL DEN	IEU

Lab ID: LCS **Client ID: N/A**

Sample Date/Time: N/A Received Date/Time: N/A

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	LCS 280-325289/4		280-325289		05/13/2016 20:42	1	TAL DEN	JNL
A:8260B	LCS 280-325289/4		280-325289		05/13/2016 20:42	1	TAL DEN	JNL
P:5030B	LCS 280-325349/4		280-325349		05/15/2016 12:31	1	TAL DEN	JNL
A:8260B	LCS 280-325349/4		280-325349		05/15/2016 12:31	1	TAL DEN	JNL
P:3005A	LCS 280-324196/2-A		280-324565	280-324196	05/09/2016 08:05	1	TAL DEN	TEB
A:6010B	LCS 280-324196/2-A		280-324565	280-324196	05/09/2016 23:34	1	TAL DEN	SJS
A:300.0	LCS 280-324600/4		280-324600		05/10/2016 10:49	1	TAL DEN	AFB
A:SM 2320B	LCS 280-324592/4		280-324592		05/09/2016 17:13	1	TAL DEN	IEU

Lab ID: LCSD **Client ID: N/A**

Sample Date/Time: N/A Received Date/Time: N/A

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:300.0	LCSD 280-324600/5		280-324600		05/10/2016 11:07	1	TAL DEN	AFB
A:SM 2320B	LCSD 280-324592/5		280-324592		05/09/2016 17:18	1	TAL DEN	IEU

Lab ID: MRL **Client ID: N/A**

Sample Date/Time: N/A Received Date/Time: N/A

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:300.0	MRL 280-324600/3		280-324600		05/10/2016 10:31	1	TAL DEN	AFB

Client: Waste Management Job Number: 280-82795-1

Laboratory Chronicle

Lab ID: MS **Client ID: N/A**

Sample Date/Time: 05/03/2016 07:40 Received Date/Time: 05/04/2016 09:25

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82718-X-1 MS		280-325289		05/13/2016 21:48	1	TAL DEN	JNL
A:8260B	280-82718-X-1 MS		280-325289		05/13/2016 21:48	1	TAL DEN	JNL
P:5030B	280-82923-Y-3 MS		280-325349		05/15/2016 13:30	1	TAL DEN	JNL
A:8260B	280-82923-Y-3 MS		280-325349		05/15/2016 13:30	1	TAL DEN	JNL

Lab ID: MSD **Client ID: N/A**

Sample Date/Time: 05/03/2016 07:40 Received Date/Time: 05/04/2016 09:25

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
P:5030B	280-82718-X-1 MSD		280-325289		05/13/2016 22:09	1	TAL DEN	JNL
A:8260B	280-82718-X-1 MSD		280-325289		05/13/2016 22:09	1	TAL DEN	JNL
P:5030B	280-82923-Y-3 MSD		280-325349		05/15/2016 13:49	1	TAL DEN	JNL
A:8260B	280-82923-Y-3 MSD		280-325349		05/15/2016 13:49	1	TAL DEN	JNL

Lab ID: DU **Client ID: N/A**

Sample Date/Time: 04/25/2016 10:58 Received Date/Time: 04/27/2016 09:40

Method	Bottle ID	Run	Analysis Batch	Prep Batch	Date Prepared / Analyzed	Dil	Lab	Analyst
A:SM 2320B	280-82458-A-26 DU		280-324592		05/09/2016 17:32	1	TAL DEN	IEU

Lab References:
TAL DEN = TestAmerica Denver

TestAmerica Denver
4955 Yarrow Street
Arvada, CO 80002
Phone (303) 736-0100 Fax (303) 431-7171

Chain of Custody Record

SWIFT RIVER

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information	Sampler: ~~REECE SLATER~~	Lab PM: Sara, Betsy A	Carrier Tracking No(s):	COC No: 280-51948-18774.1
Client Contact: Mr. Tom Schweitzer	Phone: 303 695-4660	E-Mail: betsy.sara@testamericainc.com		Page:
Company: Waste Management				Job #:
Address: 2400 West Union Avenue	Due Date Requested:	Analysis Requested		Preservation Codes: A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA, M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - ph 4-5, Z - other (specify)
City: Englewood	TAT Requested (days): 7 DAY			
State, Zip: CO, 80110	PO #: Purchase Order Requested			
Phone: 303-914-1445(Tel) 303-914-1588(Fax)	WO #:			
Email: TSchweitzer@wm.com	Project #: 28003044 - log everything in "2Q16"			
Project Name: 588|North Weld	SSOW#:			
Site: Colorado				Other:

280-82795 Chain of Custody

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	Cl/SO4/Alks	Dissolved Metals	8260B - VOA	Total Number of containers	Special Instructions/Note:
			Preservation Code:								
TW-1	05/04/16	815	G	W	Y		N	D	N		
TW-2	05/03/16	1325	G	W	Y		N	D	N		
TW-4	05/03/16	1510	G	W	Y		N	D	N		
TW-5	05/03/16	1800	G	W	Y		N	D	N		
TW-6	05/03/16	1705	G	W	Y		N	D	N		
TW-8	05/04/16	955	G	W	Y		N	D	N		
TW-9	05/04/16	1640	G	W	Y		N	D	N		
TW-10	05/04/16	1540	G	W	Y		N	D	N		
TW-D	05/03/16	1100	G	W	Y		N	D	N		
TRIP BLANK	05/03/16	1000	G	W					N		

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements: RESULTS TO WM AND SWIFT RIVER

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
[signature]	5/5/16 1300	SWIFT RIVER	[signature]	5/5/16 1300	DAI
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks: 4.6 +-0.1 IR#5 transfered by ST 05/05/16

05/16/2016

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF EXPANSION

Site No.: | | | |

Sample Point: TW-01 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID: _____

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:min)	WATER VOL IN ~~CASING~~ TUBING (~~Gallons~~) L	ACTUAL VOL PURGED (~~Gallons~~) L	WELL VOLs PURGED
05/04/16	7:55	:20	.04	2.0	.5

Note: For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged. Mark changes, record field data, below

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment . . . Dedicated: [Y] or [N]

Purging Device: C — A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

Sampling Device: C

X-Other:

Filter Device: [Y] or [N] — 0.45 µ or [ ] µ (circle or fill in)

Filter Type: A — A-In-line Disposable, B-Pressure, C-Vacuum, X-Other

Sample Tube Type: D — A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:

WELL DATA

Well Elevation (at TOC): (ft/msl)

Depth to Water (DTW) (from TOC): 47.76 (ft)

Groundwater Elevation (site datum, from TOC): (ft/msl)

Total Well Depth (from TOC): 52.3 (ft)

Stick Up (from ground elevation): 3.0 (ft)

Casing ID: 2 (in)

Casing Material: PVC

Note: Total Well Depth, Stick Up, Casing Id. etc. are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit	pH (std)	Conductance (SC/EC) (µmhos/cm@25°C)	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1st 8:01	0	6.74	3.912	13.1	9990	6.44	1820	
2nd 8:04	0.5	6.74	3.889	13.1	9990	2.97	1615	
3rd 8:07	1.0	6.74	3.886	13.1	9990	2.53	1629	
4th 8:10	1.5	6.73	3.867	13.1	4970	2.57	1710	
8:13	2.0	6.72	3.856	13.1	2860	3.00	1790	
Suggested range for 3 consec. readings or note Permit/State requirements:		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site.* ***If more fields above are needed, use separate sheet or form.***

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE µmhos/cm @ 25°C	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05/04/16	6.72	3.856	13.1	2860	3.00	1790	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site*

FIELD COMMENTS

Sample Appearance: CLEAR Odor: NONE Color: CLEAR Other:

Weather Conditions (required daily, or as conditions change): Direction/Speed: W 2 MPH Outlook: SUNNY Precipitation: Y or (N)

Specific Comments (including purge/well volume calculations if required): SAMPLE 815

50 PSI, 2 CYCLES/MIN 18 REFILL 12 DISCHARGE

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
5/4/16	PETE ZLATEV		SWIAT RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF EXPANSION

Site No.:

Sample Point: TW-02 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:min)	WATER VOL IN ~~CASING~~ TUBING (~~Gallons~~) L	ACTUAL VOL PURGED (~~Gallons~~) L	WELL VOLs PURGED
05/03/16	13:05	:25	07	1.5	0.5 2+1

Note: For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged. Mark changes, record field data, below.

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment . . . Dedicated: Y or (N)

Purging Device: C — A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

Sampling Device: C

X-Other:

Filter Device: (Y) or N — (0.45 µ) or _____ µ (circle or fill in)

Filter Type: A — A-In-line Disposable, B-Pressure, C-Vacuum, X-Other

Sample Tube Type: D — A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:

WELL DATA

Well Elevation (at TOC): _____ (ft/msl)

Depth to Water (DTW) (from TOC): 128.04 (ft)

Groundwater Elevation (site datum, from TOC): _____ (ft/msl)

Total Well Depth (from TOC): 132.3 (ft)

Stick Up (from ground elevation): 3.56 (ft)

Casing ID: 2 (in)

Casing Material: PVC

Note: Total Well Depth, Stick Up, Casing Id. etc are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current.

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit L	pH (std)	Conductance (SC/EC) (umhos/cm@25°C)	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1305	0 1st	6.97 1st	3.575 1st	1.55	1610	2.22	80.4	
1312	0.6 2nd	6.96 2nd	3.547 2nd	1.49	828	1.66	57.2	
1317	1.0 3rd	6.99 3rd	3.532 3rd	1.50	466	1.46	58.5	
1322	1.5 4th	7.00 4th	3.521 4th	1.49	249	1.39	70.5	
Suggested range for 3 consec. readings or note Permit/State requirements:		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site* ***If more fields above are needed, use separate sheet or form.***

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE (umhos/cm @ 25°C)	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05/03/16	7.00	3.521	1.49	2.49	1.39	70.5	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site.*

FIELD COMMENTS

Sample Appearance: CLEAR Odor: NO Color: CLEAR Other:

Weather Conditions (required daily, or as conditions change): Direction/Speed: N 10MPH Outlook: SUNNY Precipitation: Y or (N)

Specific Comments (including purge/well volume calculations if required): TIME 13:25

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
5/3/16	PETE ZLATEV		SWIFT RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLR EXPANSION

Site No.:

Sample Point: TW-04 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:min)	WATER VOL IN ~~CASING~~ TUBING ~~(Gallons)~~ L	ACTUAL VOL PURGED ~~(Gallons)~~ L	WELL VOLs PURGED
05 03 16	14:45	1:25	06	20	3.3

Note: For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged Mark changes, record field data, below

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment . . . Dedicated: Y or (N)

Purging Device: C — A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

Sampling Device: C

X-Other:

Filter Device: (Y) or N — (0.45 µ) or ____ µ (circle or fill in)

Filter Type: A — A-In-line Disposable, B-Pressure, C-Vacuum, X-Other

Sample Tube Type: D — A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:

WELL DATA

Well Elevation (at TOC): ____ (ft/msl)

Depth to Water (DTW) (from TOC): 88.70 (ft)

Groundwater Elevation (site datum, from TOC): ____ (ft/msl)

Total Well Depth (from TOC): 106.6 (ft)

Stick Up (from ground elevation): 3.17 (ft)

Casing ID: 2 (in)

Casing Material: PVC

Note Total Well Depth, Stick Up, Casing Id. etc. are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current.

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit	pH (std)	Conductance (SC/EC) ~~Mmhos~~/cm@25°C	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1454	0 1st	7.27 1st	1.312 1st	16.5	7530	—	-115	
1456	0.5 2nd	7.23 2nd	1.309 2nd	15.6	4901	3.72	-144	
1459	1.0 3rd	7.21 3rd	1.344 3rd	15.0	3490	2.42	-107	
1502	1.5 4th	7.19 4th	1.384 4th	15.1	2210	1.48	-126	
1507	2.0	7.20	1.385	15.3	1590	1.06	-155	
Suggested range for 3 consec. readings or note Permit/State requirements:		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site. If more fileds above are needed, use separate sheet or form.*

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE ~~µmhos~~/cm @ 25°C	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05 03 16	7.20	1.385	15.3	1.59	1.06	-155	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site.*

FIELD COMMENTS

Sample Appearance: SL CLOUDY — Odor: NONE — Color: SL CLOUDY — Other:

Weather Conditions (required daily, or as conditions change): Direction/Speed: 10 NW — Outlook: SUNNY — Precipitation: Y or (N)

Specific Comments (including purge/well volume calculations if required): SAMPLE 1510

2 CYCLES 15 REPLACEMENT DISCHARGE

75 PSI

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
5/3/16	PETE ZLATEV		SMALL RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF EXPANSION
Site No.:
Sample Point: TW-05 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs.min)	WATER VOL IN ~~CASING~~ TUBING (~~Gallons~~) L	ACTUAL VOL PURGED (~~Gallons~~) L	WELL VOLs PURGED
05/03/16	1740	:20	0.4	1.5	3.8

Note. For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged Mark changes, record field data, below.

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment . . . Dedicated: Y or (N)
Purging Device: C
Sampling Device: C
A-Submersible Pump B-Peristaltic Pump C-QED Bladder Pump D-Bailer E-Piston Pump F-Dipper/Bottle
X-Other:

Filter Device: (Y) or N (0.45 µ) or ____ µ (circle or fill in)
Filter Type: A (A-In-line Disposable B-Pressure C-Vacuum X-Other)
Sample Tube Type: D (A-Teflon B-Stainless Steel C-PVC D-Polypropylene X-Other:)

WELL DATA

Well Elevation (at TOC): (ft/msl)
Depth to Water (DTW) (from TOC): 37.89 (ft)
Groundwater Elevation (site datum, from TOC): (ft/msl)
Total Well Depth (from TOC): 51.9 (ft)
Stick Up (from ground elevation): 3.19 (ft)
Casing ID: (in)
Casing Material:

Note: Total Well Depth, Stick Up, Casing Id. etc are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current.

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit L	pH (std)	Conductance (SC/EC) ~~µ~~mhos/cm@25°C	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1746	0 1st	7.82 1st	0.780 1st	15.8	6400	5.13	589	
1749	0.5 2nd	7.79 2nd	0.787 2nd	14.9	5680	2.20	592	
1752	1.0 3rd	7.80 3rd	0.792 3rd	14.6	4460	1.70	575	
1756	1.5 4th	7.77 4th	0.800 4th	14.4	3240	1.36	577	
Suggested range for 3 consec. readings or note Permit/State requirements:		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site If more fields above are needed, use separate sheet or form.*

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE ~~µ~~mhos/cm @ 25°C)	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05/03/16	7.77	0.800	14.4	3240	1.36	577	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site*

FIELD COMMENTS

Sample Appearance: SL CLOUDY Odor: NONE Color: CLEAR Other:

Weather Conditions (required daily, or as conditions change): Direction/Speed: N 10 MPH Outlook: SUNNY Precipitation: Y or (N)

Specific Comments (including purge/well volume calculations if required): SAMPLE TIME 1800

2 CYCLES 15 SEC REGEN / 15 SEC DISCHARGE

50 PSI

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
05/03/16	PETE SLATER		SWCA ENV

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF EXPANSION
Site No.:
Sample Point: TW-06 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:min)	WATER VOL IN ~~CASING~~ TUBING ~~(Gallons)~~ L	ACTUAL VOL PURGED ~~(Gallons)~~ L	WELL VOLs PURGED
05 03 16	16:47	:18	07	20	2.9

Note: For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged. Mark changes, record field data, below

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment . . . Dedicated: Y or (N)

Purging Device: C
Sampling Device: C
X-Other:

A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

Filter Device: (Y) or N — (0.45) or ____ µ (circle or fill in)
Filter Type: A (A-In-line Disposable, B-Pressure, C-Vacuum, X-Other)
Sample Tube Type: D (A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:)

WELL DATA

Well Elevation (at TOC): ____ (ft/msl)
Depth to Water (DTW) (from TOC): 56.79 (ft)
Groundwater Elevation (site datum, from TOC): ____ (ft/msl)
Total Well Depth (from TOC): 112.1 (ft)
Stick Up (from ground elevation): 3.33 (ft)
Casing ID: 2 (in)
Casing Material: PVC

Note: Total Well Depth, Stick Up, Casing Id etc are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current

STABILIZATION DATA (Optional)

	Sample Time (2400 Hr Clock)	Rate/Unit	pH (std)	Conductance (SC/EC) µmhos/cm@25°C	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1st	1650	0	8.38	0.433	18.4	929	5.80	-324	
2nd	1653	0.5	8.37	0.433	16.6	1040	2.30	-372	
3rd	1656	1.0	8.32	0.435	17.0	1020	1.21	-357	
4th	1659	1.5	8.30	0.444	17.0	1050	.89	-368	
	1702	2	8.25	0.454	16.8	1080	.74	-377	
Suggested range for 3 consec readings or note Permit/State requirements:			+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site. If more fields above are needed, use separate sheet or form.*

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE µmhos/cm @ 25°C	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05 03 16	8.25	0.454	16.8	X1080	7.4	-377	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site.*

FIELD COMMENTS

Sample Appearance: SL CLOUDY
Odor: NONE
Color: CLEAR
Other:

Weather Conditions (required daily, or as conditions change):
Direction/Speed: N 10 MPH
Outlook: SUNNY
Precipitation: Y or (N)

Specific Comments (including purge/well volume calculations if required): SAMPLE 17:05

SAMPLED AT 70 PSI, 15 SEC REFILL 15 SEC DISCHARGE

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
5/3/16	PETE SLATEN		SWIFT RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF - EXPANSION

Site No.:

Sample Point: TW-08 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:mm)	WATER VOL IN ~~CASING~~ TUBING (~~Gallons~~ L)	ACTUAL VOL PURGED (~~Gallons~~ L)	WELL VOLs PURGED
05 04 16	9:34	:21	06	25	4-2

Note: For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged Mark changes, record field data, below

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment... Dedicated: Y or (N)

Purging Device: C — A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

Sampling Device: C

X-Other:

Filter Device: (Y) or N — (0.45 µ) or ____ µ (circle or fill in)

Filter Type: A — A-In-line Disposable, B-Pressure, C-Vacuum, X-Other

Sample Tube Type: D — A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:

WELL DATA

Well Elevation (at TOC): ____ (ft/msl)

Depth to Water (DTW) (from TOC): 457.6 (ft)

Groundwater Elevation (site datum, from TOC): ____ (ft/msl)

Total Well Depth (from TOC): 959 (ft)

Stick Up (from ground elevation): 3.00 (ft)

Casing ID: 2 (in)

Casing Material: PVC

Note Total Well Depth, Stick Up, Casing Id etc are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current.

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit L	pH (std)	Conductance (SC/EC) µmhos/cm@25°C	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
9:36	0 1st	6.90 1st	1.147	16.7	277.0	6.20	836	
9:38	0.5 2nd	6.88 2nd	1.427	16.1	647.0	2.30	618	
9:42	1.0 3rd	6.88 3rd	1.425	15.9	697.0	1.26	587	
9:47	1.5 4th	6.88 4th	1.425	17.3	637.0	.98	501	
9:50	2.0	6.88	1.428	16.2	612.0	.98	475	
9:53	2.5	6.88	1.426	16.8	416.0	.92	453	
Suggested range for 3 consec. readings or note Permit/State requirements.		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site. If more fields above are needed, use separate sheet or form.*

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE µmhos/cm @ 25°C	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05 04 16	6.88	1.426	16.8	416	9.2	453	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site.*

FIELD COMMENTS

Sample Appearance: SL CLOUDY Odor: NONE Color: GRAY-BRN Other:

Weather Conditions (required daily, or as conditions change): Direction/Speed: S 2 MPH Outlook: SUNNY Precipitation: Y or N

Specific Comments (including purge/well volume calculations if required): SAMPLE TIME 9:55

2 GPM 18 REMM 12 DISCHARGE @ 60 PSI

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
05/04/16	PETE SLATER		SWIFT RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF EXPANSION
Site No.:
Sample Point: TW-09 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:min)	WATER VOL IN ~~CASING~~ (Gallons)	ACTUAL VOL PURGED (~~Gallons~~)	WELL VOLs PURGED
05 04 16	1621	:19	04 (30 Blank) L	20 L	5

Note For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged. Mark changes, record field data, below

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment . . . Dedicated: Y or (N)

Purging Device: C
Sampling Device: C
X-Other:

A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

Filter Device: (Y) or N — (0.45 µ) or _____ µ (circle or fill in)
Filter Type: A — A-In-line Disposable, B-Pressure, C-Vacuum, X-Other
Sample Tube Type: D — A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:

WELL DATA

Well Elevation (at TOC): (ft/msl)
Depth to Water (DTW) (from TOC): 42.58 (ft)
Groundwater Elevation (site datum, from TOC): (ft/msl)
Total Well Depth (from TOC): 50.6 (ft)
Stick Up (from ground elevation): 2.67 (ft)
Casing ID: 2 (in)
Casing Material: PVC

Note: Total Well Depth, Stick Up, Casing Id etc. are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit L	pH (std)	Conductance (SC/EC) (µmhos/cm@25°C)	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1623	0 1st	7.05 1st	2.294	16.6	87.1	4.06	98.3	
1627	0.5 2nd	7.05 2nd	2.280	15.6	66.5	1.42	60.2	
1629	1.0 3rd	7.06 3rd	2.268	15.1	49.7	1.15	43.7	
1635	1.5 4th	7.09 4th	2.212	15.7	45.2	1.10	22.5	
1638	2.0	7.11	2.202	15.9	39.5	1.53	18.8	
Suggested range for 3 consec. readings or note Permit/State requirements:		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e complete stabilization readings for parameters required by WM, Site, or State). These fields can be used where four (4) field measurements are required by State/Permit/Site. If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site. If more fields above are needed, use separate sheet or form.*

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE (µmhos/cm @ 25°C)	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05 04 16	7.11	2.202	15.9	39.5	1.53	18.8	

Final Field Readings are required *(i.e record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site*

FIELD COMMENTS

Sample Appearance: _____ Odor: _____ Color: _____ Other: _____

Weather Conditions (required daily, or as conditions change): Direction/Speed: _____ Outlook: _____ Precipitation: Y or N

Specific Comments (including purge/well volume calculations if required): SAMPLE TIME 1640
2 GPM 20 REPLN 10 DISCHARGE @ 30 PSI

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
5/4/16	PETE SLATER		SWIFT RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client, PINK - Field Copy

FIELD INFORMATION FORM

WASTE MANAGEMENT

Site Name: NWLF EXPANSION

Site No.:

Sample Point: TW-10 (Sample ID)

This Waste Management Field Information Form is Required
This form is to be completed, in addition to any State Forms. The Field Form is submitted along with the Chain of Custody Forms that accompany the sample containers (i.e. with the cooler that is returned to the laboratory).

Laboratory Use Only/Lab ID:

PURGE INFO

PURGE DATE (MM DD YY)	PURGE TIME (2400 Hr Clock)	ELAPSED HRS (hrs:min)	WATER VOL IN ~~CASING~~ TUBING (~~Gallons~~) L	ACTUAL VOL PURGED (~~Gallons~~) L	WELL VOLs PURGED
05 04 16	1522	0:18	0.6	2.0	3.3

Note: For Passive Sampling, replace "Water Vol in Casing" and "Well Vols Purged" w/ Water Vol in Tubing/Flow Cell and Tubing/Flow Cell Vols Purged Mark changes, record field data, below

PURGE/SAMPLE EQUIPMENT

Purging and Sampling Equipment... Dedicated: Y or (N)

Purging Device: C — Sampling Device: C

A-Submersible Pump, B-Peristaltic Pump, C-QED Bladder Pump, D-Bailer, E-Piston Pump, F-Dipper/Bottle

X-Other:

Filter Device: (Y) or N — (0.45 µ) or _____ µ (circle or fill in)

Filter Type: A — A-In-line Disposable, B-Pressure, C-Vacuum, X-Other

Sample Tube Type: D — A-Teflon, B-Stainless Steel, C-PVC, D-Polypropylene, X-Other:

WELL DATA

Well Elevation (at TOC) (ft/msl)	Depth to Water (DTW) (from TOC) (ft)	Groundwater Elevation (site datum, from TOC) (ft/msl)
	56.33	

Total Well Depth (from TOC) (ft)	Stick Up (from ground elevation) (ft)	Casing ID (in)	Casing Material
109	2.50	2	PVC

Note Total Well Depth, Stick Up, Casing Id. etc. are optional and can be from historical data, unless required by Site/Permit. Well Elevation, DTW, and Groundwater Elevation must be current

STABILIZATION DATA (Optional)

Sample Time (2400 Hr Clock)	Rate/Unit	pH (std)	Conductance (SC/EC) (µmhos/cm@25°C)	Temp. (°C)	Turbidity (ntu)	D.O. (mg/L - ppm)	eH/ORP (mV)	DTW (ft)
1525	1.0 1st	6.33 1st	4.202 1st	19.3	999	6.7	-247	
1529	0.5 2nd	6.27 2nd	4.129 2nd	17.7	999	17.2	-227	
1532	1.0 3rd	6.29 3rd	4.091 3rd	17.7	999	8.4	-209	
1536	1.5 4th	6.31 4th	4.075 4th	18.4	999	7.2	-184	
1539	2.0	6.31	4.081	18.8	999	6.8	-170	
Suggested range for 3 consec. readings or note Permit/State requirements:		+/- 0.2	+/- 3%	--	--	+/- 10%	+/- 25 mV	Stabilize

Stabilization Data Fields are Optional *(i.e. complete stabilization readings for parameters required by WM, Site, or State) These fields can be used where four (4) field measurements are required by State/Permit/Site If a Data Logger or other Electronic format is used, fill in final readings below and submit electronic data separately to Site. If more fields above are needed, use separate sheet or form.*

FIELD DATA

SAMPLE DATE (MM DD YY)	pH (std)	CONDUCTANCE (µmhos/cm @ 25°C)	TEMP. (°C)	TURBIDITY (ntu)	DO (mg/L-ppm)	eH/ORP (mV)	Other: Units
05 04 16	6.31	4.081	18.8	999	6.8	-170	

Final Field Readings are required *(i.e. record field measurements, final stabilized readings, passive sample readings before sampling for all field parameters required by State/Permit/Site*

FIELD COMMENTS

Sample Appearance: CLOUDY Odor: NONE Color: GRAY-BRN Other:

Weather Conditions (required daily, or as conditions change): Direction/Speed: SE 5MPH Outlook: SUNNY Precipitation: Y or N

Specific Comments (including purge/well volume calculations if required): SAMPLE TIME 1540

2 GPM 20 REGAL 10 DISCHARGE @ 50 PSI

I certify that sampling procedures were in accordance with applicable EPA, State, and WM protocols (if more than one sampler, all should sign):

Date	Name	Signature	Company
05/04/16	PETE SLATER		SWIFT RIVER

DISTRIBUTION: WHITE/ORIGINAL - Stays with Sample, YELLOW - Returned to Client. PINK - Field Copy

Login Sample Receipt Checklist

Client: Waste Management

Job Number: 280-82795-1

Login Number: 82795

List Source: TestAmerica Denver

List Number: 1

Creator: True, Joshua A

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	N/A	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time (Excluding tests with immediate HTs)..	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Sampling Company provided.	True	
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	True	
Chlorine Residual checked.	N/A	

Rig Water Results

March 2, 2016

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING



ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Denver
4955 Yarrow Street
Arvada, CO 80002
Tel: (303)736-0100

TestAmerica Job ID: 280-80430-1
Client Project/Site: Swift River Environmental Services, LLC

For:
Swift River Environmental Services, LLC
26 West Dry Creek Circle
Suite 470
Littleton, Colorado 80120

Attn: Mr. Steve Wampler

Betsy Sara

Authorized for release by:
3/18/2016 4:56:49 PM

Betsy Sara, Project Manager II
(303)736-0189
betsy.sara@testamericainc.com

LINKS

Review your project results through TotalAccess

Have a Question? Ask The Expert

Visit us at: www.testamericainc.com

The test results in this report meet all 2003 NELAC and 2009 TNI requirements for accredited parameters, exceptions are noted in this report. This report may not be reproduced except in full, and with written approval from the laboratory. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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Definitions/Glossary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
X	Surrogate is outside control limits

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 280-80430-1

Laboratory: TestAmerica Denver

Narrative

CASE NARRATIVE

Client: Swift River Environmental Services, LLC

Project: Swift River Environmental Services, LLC

Report Number: 280-80430-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

Sample Receiving

The samples were received on 03/04/2016; the samples arrived in good condition, properly preserved and on ice. The temperature of the cooler at receipt was 0.2 C.

Holding Times

All holding times were met.

Method Blanks

The Method 8260B surrogate recoveries of 1,2-Dichloroethane-d4, 4-Bromofluorobenzene, Dibromofluoromethane and Toluene-d8 were above control limits for the Method Blank. Because the data are considered to be biased high and all target analytes in the Method Blank were non-detect above the reporting limits, corrective action was deemed unnecessary.

All other Method Blanks were within established control limits.

Laboratory Control Samples (LCS)

All Laboratory Control Samples were within established control limits.

Matrix Spike (MS) and Matrix Spike Duplicate (MSD)

All MS and MSD samples were within established control limits.

Organics

The Method 8260B surrogate recovery of Dibromofluoromethane was below control limits during the analysis of sample RIG TANK. Because the chromatograms exhibited clear evidence of matrix interference and all other quality control samples met acceptance criteria, corrective action was deemed unnecessary.

Detection Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Client Sample ID: RIG TANK — Lab Sample ID: 280-80430-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Acetone	2.7	J	10	1.9	ug/L	1		8260B	Total/NA
Chlorodibromomethane	0.22	J	1.0	0.17	ug/L	1		8260B	Total/NA
Chloroform	18		1.0	0.16	ug/L	1		8260B	Total/NA
Dichlorobromomethane	1.6		1.0	0.17	ug/L	1		8260B	Total/NA

Client Sample ID: BAILER BLANK — Lab Sample ID: 280-80430-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Toluene	0.23	J	1.0	0.17	ug/L	1		8260B	Total/NA

This Detection Summary does not include radiochemical test results.

Method Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Method	Method Description	Protocol	Laboratory
8260B	Volatile Organic Compounds (GC/MS)	SW846	TAL DEN

Protocol References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

Sample Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
280-80430-1	RIG TANK	Water	03/02/16 13:45	03/04/16 09:56
280-80430-2	BAILER BLANK	Water	03/02/16 10:40	03/04/16 09:56

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Client Sample ID: RIG TANK
Date Collected: 03/02/16 13:45
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80430-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	ND		1.0	0.21	ug/L			03/14/16 12:48	1
1,1,1-Trichloroethane	ND		1.0	0.16	ug/L			03/14/16 12:48	1
1,1,2,2-Tetrachloroethane	ND		1.0	0.21	ug/L			03/14/16 12:48	1
1,1,2-Trichloroethane	ND		1.0	0.27	ug/L			03/14/16 12:48	1
1,1-Dichloroethane	ND		1.0	0.22	ug/L			03/14/16 12:48	1
1,1-Dichloroethene	ND		1.0	0.23	ug/L			03/14/16 12:48	1
1,1-Dichloropropene	ND		1.0	0.19	ug/L			03/14/16 12:48	1
1,2,3-Trichlorobenzene	ND		1.0	0.21	ug/L			03/14/16 12:48	1
1,2,3-Trichloropropane	ND		2.5	0.33	ug/L			03/14/16 12:48	1
1,2,4-Trichlorobenzene	ND		1.0	0.21	ug/L			03/14/16 12:48	1
1,2,4-Trimethylbenzene	ND		1.0	0.15	ug/L			03/14/16 12:48	1
1,2-Dibromo-3-Chloropropane	ND		5.0	0.47	ug/L			03/14/16 12:48	1
1,2-Dibromoethane	ND		1.0	0.18	ug/L			03/14/16 12:48	1
1,2-Dichlorobenzene	ND		1.0	0.15	ug/L			03/14/16 12:48	1
1,2-Dichloroethane	ND		1.0	0.13	ug/L			03/14/16 12:48	1
1,2-Dichloroethene, Total	ND		1.0	0.24	ug/L			03/14/16 12:48	1
1,2-Dichloropropane	ND		1.0	0.18	ug/L			03/14/16 12:48	1
1,3,5-Trimethylbenzene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
1,3-Dichlorobenzene	ND		1.0	0.13	ug/L			03/14/16 12:48	1
1,3-Dichloropropane	ND		1.0	0.22	ug/L			03/14/16 12:48	1
1,4-Dichlorobenzene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
2,2-Dichloropropane	ND		1.0	0.18	ug/L			03/14/16 12:48	1
2-Butanone (MEK)	ND		6.0	2.0	ug/L			03/14/16 12:48	1
2-Chlorotoluene	ND		1.0	0.17	ug/L			03/14/16 12:48	1
2-Hexanone	ND		5.0	1.7	ug/L			03/14/16 12:48	1
4-Chlorotoluene	ND		1.0	0.21	ug/L			03/14/16 12:48	1
4-Isopropyltoluene	ND		1.0	0.20	ug/L			03/14/16 12:48	1
4-Methyl-2-pentanone (MIBK)	ND		5.0	0.98	ug/L			03/14/16 12:48	1
Acetone	**2.7**	**J**	10	1.9	ug/L			03/14/16 12:48	1
Benzene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
Bromobenzene	ND		1.0	0.17	ug/L			03/14/16 12:48	1
Bromoform	ND		1.0	0.19	ug/L			03/14/16 12:48	1
Bromomethane	ND		2.0	0.21	ug/L			03/14/16 12:48	1
Carbon tetrachloride	ND		1.0	0.19	ug/L			03/14/16 12:48	1
Chlorobenzene	ND		1.0	0.17	ug/L			03/14/16 12:48	1
Chlorobromomethane	ND		1.0	0.10	ug/L			03/14/16 12:48	1
Chlorodibromomethane	**0.22**	**J**	1.0	0.17	ug/L			03/14/16 12:48	1
Chloroethane	ND		2.0	0.41	ug/L			03/14/16 12:48	1
Chloroform	**18**		1.0	0.16	ug/L			03/14/16 12:48	1
Chloromethane	ND		2.0	0.30	ug/L			03/14/16 12:48	1
cis-1,2-Dichloroethene	ND		1.0	0.15	ug/L			03/14/16 12:48	1
cis-1,3-Dichloropropene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
Dibromomethane	ND		1.0	0.17	ug/L			03/14/16 12:48	1
Dichlorobromomethane	**1.6**		1.0	0.17	ug/L			03/14/16 12:48	1
Dichlorodifluoromethane	ND		2.0	0.31	ug/L			03/14/16 12:48	1
Ethylbenzene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
Hexachlorobutadiene	ND		1.0	0.36	ug/L			03/14/16 12:48	1
Isopropylbenzene	ND		1.0	0.19	ug/L			03/14/16 12:48	1
Methyl tert-butyl ether	ND		5.0	0.25	ug/L			03/14/16 12:48	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Client Sample ID: RIG TANK
Date Collected: 03/02/16 13:45
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80430-1
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Methylene Chloride	ND		2.0	0.32	ug/L			03/14/16 12:48	1
m-Xylene & p-Xylene	ND		2.0	0.34	ug/L			03/14/16 12:48	1
Naphthalene	ND		1.0	0.22	ug/L			03/14/16 12:48	1
n-Butylbenzene	ND		1.0	0.32	ug/L			03/14/16 12:48	1
N-Propylbenzene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
o-Xylene	ND		1.0	0.19	ug/L			03/14/16 12:48	1
sec-Butylbenzene	ND		1.0	0.17	ug/L			03/14/16 12:48	1
Styrene	ND		1.0	0.17	ug/L			03/14/16 12:48	1
tert-Butylbenzene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
Tetrachloroethene	ND		1.0	0.20	ug/L			03/14/16 12:48	1
Toluene	ND		1.0	0.17	ug/L			03/14/16 12:48	1
trans-1,2-Dichloroethene	ND		1.0	0.15	ug/L			03/14/16 12:48	1
trans-1,3-Dichloropropene	ND		3.0	0.19	ug/L			03/14/16 12:48	1
Trichloroethene	ND		1.0	0.16	ug/L			03/14/16 12:48	1
Trichlorofluoromethane	ND		2.0	0.29	ug/L			03/14/16 12:48	1
Vinyl chloride	ND		1.0	0.10	ug/L			03/14/16 12:48	1
Xylenes, Total	ND		2.0	0.19	ug/L			03/14/16 12:48	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*120*		*70 - 127*		*03/14/16 12:48*	*1*
4-Bromofluorobenzene (Surr)	*100*		*78 - 120*		*03/14/16 12:48*	*1*
Dibromofluoromethane (Surr)	*14*	*X*	*77 - 120*		*03/14/16 12:48*	*1*
Toluene-d8 (Surr)	*104*		*80 - 125*		*03/14/16 12:48*	*1*

Client Sample ID: BAILER BLANK
Date Collected: 03/02/16 10:40
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80430-2
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	ND		1.0	0.21	ug/L			03/14/16 13:07	1
1,1,1-Trichloroethane	ND		1.0	0.16	ug/L			03/14/16 13:07	1
1,1,2,2-Tetrachloroethane	ND		1.0	0.21	ug/L			03/14/16 13:07	1
1,1,2-Trichloroethane	ND		1.0	0.27	ug/L			03/14/16 13:07	1
1,1-Dichloroethane	ND		1.0	0.22	ug/L			03/14/16 13:07	1
1,1-Dichloroethene	ND		1.0	0.23	ug/L			03/14/16 13:07	1
1,1-Dichloropropene	ND		1.0	0.19	ug/L			03/14/16 13:07	1
1,2,3-Trichlorobenzene	ND		1.0	0.21	ug/L			03/14/16 13:07	1
1,2,3-Trichloropropane	ND		2.5	0.33	ug/L			03/14/16 13:07	1
1,2,4-Trichlorobenzene	ND		1.0	0.21	ug/L			03/14/16 13:07	1
1,2,4-Trimethylbenzene	ND		1.0	0.15	ug/L			03/14/16 13:07	1
1,2-Dibromo-3-Chloropropane	ND		5.0	0.47	ug/L			03/14/16 13:07	1
1,2-Dibromoethane	ND		1.0	0.18	ug/L			03/14/16 13:07	1
1,2-Dichlorobenzene	ND		1.0	0.15	ug/L			03/14/16 13:07	1
1,2-Dichloroethane	ND		1.0	0.13	ug/L			03/14/16 13:07	1
1,2-Dichloroethene, Total	ND		1.0	0.24	ug/L			03/14/16 13:07	1
1,2-Dichloropropane	ND		1.0	0.18	ug/L			03/14/16 13:07	1
1,3,5-Trimethylbenzene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
1,3-Dichlorobenzene	ND		1.0	0.13	ug/L			03/14/16 13:07	1
1,3-Dichloropropane	ND		1.0	0.22	ug/L			03/14/16 13:07	1
1,4-Dichlorobenzene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
2,2-Dichloropropane	ND		1.0	0.18	ug/L			03/14/16 13:07	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Client Sample ID: BAILER BLANK
Date Collected: 03/02/16 10:40
Date Received: 03/04/16 09:56

Lab Sample ID: 280-80430-2
Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2-Butanone (MEK)	ND		6.0	2.0	ug/L			03/14/16 13:07	1
2-Chlorotoluene	ND		1.0	0.17	ug/L			03/14/16 13:07	1
2-Hexanone	ND		5.0	1.7	ug/L			03/14/16 13:07	1
4-Chlorotoluene	ND		1.0	0.21	ug/L			03/14/16 13:07	1
4-Isopropyltoluene	ND		1.0	0.20	ug/L			03/14/16 13:07	1
4-Methyl-2-pentanone (MIBK)	ND		5.0	0.98	ug/L			03/14/16 13:07	1
Acetone	ND		10	1.9	ug/L			03/14/16 13:07	1
Benzene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
Bromobenzene	ND		1.0	0.17	ug/L			03/14/16 13:07	1
Bromoform	ND		1.0	0.19	ug/L			03/14/16 13:07	1
Bromomethane	ND		2.0	0.21	ug/L			03/14/16 13:07	1
Carbon tetrachloride	ND		1.0	0.19	ug/L			03/14/16 13:07	1
Chlorobenzene	ND		1.0	0.17	ug/L			03/14/16 13:07	1
Chlorobromomethane	ND		1.0	0.10	ug/L			03/14/16 13:07	1
Chlorodibromomethane	ND		1.0	0.17	ug/L			03/14/16 13:07	1
Chloroethane	ND		2.0	0.41	ug/L			03/14/16 13:07	1
Chloroform	ND		1.0	0.16	ug/L			03/14/16 13:07	1
Chloromethane	ND		2.0	0.30	ug/L			03/14/16 13:07	1
cis-1,2-Dichloroethene	ND		1.0	0.15	ug/L			03/14/16 13:07	1
cis-1,3-Dichloropropene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
Dibromomethane	ND		1.0	0.17	ug/L			03/14/16 13:07	1
Dichlorobromomethane	ND		1.0	0.17	ug/L			03/14/16 13:07	1
Dichlorodifluoromethane	ND		2.0	0.31	ug/L			03/14/16 13:07	1
Ethylbenzene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
Hexachlorobutadiene	ND		1.0	0.36	ug/L			03/14/16 13:07	1
Isopropylbenzene	ND		1.0	0.19	ug/L			03/14/16 13:07	1
Methyl tert-butyl ether	ND		5.0	0.25	ug/L			03/14/16 13:07	1
Methylene Chloride	ND		2.0	0.32	ug/L			03/14/16 13:07	1
m-Xylene & p-Xylene	ND		2.0	0.34	ug/L			03/14/16 13:07	1
Naphthalene	ND		1.0	0.22	ug/L			03/14/16 13:07	1
n-Butylbenzene	ND		1.0	0.32	ug/L			03/14/16 13:07	1
N-Propylbenzene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
o-Xylene	ND		1.0	0.19	ug/L			03/14/16 13:07	1
sec-Butylbenzene	ND		1.0	0.17	ug/L			03/14/16 13:07	1
Styrene	ND		1.0	0.17	ug/L			03/14/16 13:07	1
tert-Butylbenzene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
Tetrachloroethene	ND		1.0	0.20	ug/L			03/14/16 13:07	1
Toluene	**0.23**	**J**	1.0	0.17	ug/L			03/14/16 13:07	1
trans-1,2-Dichloroethene	ND		1.0	0.15	ug/L			03/14/16 13:07	1
trans-1,3-Dichloropropene	ND		3.0	0.19	ug/L			03/14/16 13:07	1
Trichloroethene	ND		1.0	0.16	ug/L			03/14/16 13:07	1
Trichlorofluoromethane	ND		2.0	0.29	ug/L			03/14/16 13:07	1
Vinyl chloride	ND		1.0	0.10	ug/L			03/14/16 13:07	1
Xylenes, Total	ND		2.0	0.19	ug/L			03/14/16 13:07	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*120*		*70 - 127*		*03/14/16 13:07*	*1*
4-Bromofluorobenzene (Surr)	*100*		*78 - 120*		*03/14/16 13:07*	*1*
Dibromofluoromethane (Surr)	*109*		*77 - 120*		*03/14/16 13:07*	*1*
Toluene-d8 (Surr)	*104*		*80 - 125*		*03/14/16 13:07*	*1*

Surrogate Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Method: 8260B - Volatile Organic Compounds (GC/MS)

Matrix: Water

Prep Type: Total/NA

		Percent Surrogate Recovery (Acceptance Limits)			
		12DCE	BFB	DBFM	TOL
Lab Sample ID	Client Sample ID	(70-127)	(78-120)	(77-120)	(80-125)
280-80430-1	RIG TANK	120	100	14 X	104
280-80430-2	BAILER BLANK	120	100	109	104
280-80447-C-3 MS	Matrix Spike	116	96	101	96
280-80447-C-3 MSD	Matrix Spike Duplicate	115	95	100	95
LCS 280-316699/4	Lab Control Sample	97	96	92	97
MB 280-316699/5	Method Blank	147 X	136 X	137 X	140 X

Surrogate Legend

12DCE = 1,2-Dichloroethane-d4 (Surr)
BFB = 4-Bromofluorobenzene (Surr)
DBFM = Dibromofluoromethane (Surr)
TOL = Toluene-d8 (Surr)

Method: 8260B - Volatile Organic Compounds (GC/MS)

Lab Sample ID: MB 280-316699/5
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1,2-Tetrachloroethane	ND		1.0	0.21	ug/L			03/14/16 08:19	1
1,1,1-Trichloroethane	ND		1.0	0.16	ug/L			03/14/16 08:19	1
1,1,2,2-Tetrachloroethane	ND		1.0	0.21	ug/L			03/14/16 08:19	1
1,1,2-Trichloroethane	ND		1.0	0.27	ug/L			03/14/16 08:19	1
1,1-Dichloroethane	ND		1.0	0.22	ug/L			03/14/16 08:19	1
1,1-Dichloroethene	ND		1.0	0.23	ug/L			03/14/16 08:19	1
1,1-Dichloropropene	ND		1.0	0.19	ug/L			03/14/16 08:19	1
1,2,3-Trichlorobenzene	ND		1.0	0.21	ug/L			03/14/16 08:19	1
1,2,3-Trichloropropane	ND		2.5	0.33	ug/L			03/14/16 08:19	1
1,2,4-Trichlorobenzene	ND		1.0	0.21	ug/L			03/14/16 08:19	1
1,2,4-Trimethylbenzene	ND		1.0	0.15	ug/L			03/14/16 08:19	1
1,2-Dibromo-3-Chloropropane	ND		5.0	0.47	ug/L			03/14/16 08:19	1
1,2-Dibromoethane	ND		1.0	0.18	ug/L			03/14/16 08:19	1
1,2-Dichlorobenzene	ND		1.0	0.15	ug/L			03/14/16 08:19	1
1,2-Dichloroethane	ND		1.0	0.13	ug/L			03/14/16 08:19	1
1,2-Dichloroethene, Total	ND		1.0	0.24	ug/L			03/14/16 08:19	1
1,2-Dichloropropane	ND		1.0	0.18	ug/L			03/14/16 08:19	1
1,3,5-Trimethylbenzene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
1,3-Dichlorobenzene	ND		1.0	0.13	ug/L			03/14/16 08:19	1
1,3-Dichloropropane	ND		1.0	0.22	ug/L			03/14/16 08:19	1
1,4-Dichlorobenzene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
2,2-Dichloropropane	ND		1.0	0.18	ug/L			03/14/16 08:19	1
2-Butanone (MEK)	ND		6.0	2.0	ug/L			03/14/16 08:19	1
2-Chlorotoluene	ND		1.0	0.17	ug/L			03/14/16 08:19	1
2-Hexanone	ND		5.0	1.7	ug/L			03/14/16 08:19	1
4-Chlorotoluene	ND		1.0	0.21	ug/L			03/14/16 08:19	1
4-Isopropyltoluene	ND		1.0	0.20	ug/L			03/14/16 08:19	1
4-Methyl-2-pentanone (MIBK)	ND		5.0	0.98	ug/L			03/14/16 08:19	1
Acetone	ND		10	1.9	ug/L			03/14/16 08:19	1
Benzene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
Bromobenzene	ND		1.0	0.17	ug/L			03/14/16 08:19	1
Bromoform	ND		1.0	0.19	ug/L			03/14/16 08:19	1
Bromomethane	ND		2.0	0.21	ug/L			03/14/16 08:19	1
Carbon tetrachloride	ND		1.0	0.19	ug/L			03/14/16 08:19	1
Chlorobenzene	ND		1.0	0.17	ug/L			03/14/16 08:19	1
Chlorobromomethane	ND		1.0	0.10	ug/L			03/14/16 08:19	1
Chlorodibromomethane	ND		1.0	0.17	ug/L			03/14/16 08:19	1
Chloroethane	ND		2.0	0.41	ug/L			03/14/16 08:19	1
Chloroform	ND		1.0	0.16	ug/L			03/14/16 08:19	1
Chloromethane	ND		2.0	0.30	ug/L			03/14/16 08:19	1
cis-1,2-Dichloroethene	ND		1.0	0.15	ug/L			03/14/16 08:19	1
cis-1,3-Dichloropropene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
Dibromomethane	ND		1.0	0.17	ug/L			03/14/16 08:19	1
Dichlorobromomethane	ND		1.0	0.17	ug/L			03/14/16 08:19	1
Dichlorodifluoromethane	ND		2.0	0.31	ug/L			03/14/16 08:19	1
Ethylbenzene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
Hexachlorobutadiene	ND		1.0	0.36	ug/L			03/14/16 08:19	1
Isopropylbenzene	ND		1.0	0.19	ug/L			03/14/16 08:19	1

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 280-316699/5
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Methyl tert-butyl ether	ND		5.0	0.25	ug/L			03/14/16 08:19	1
Methylene Chloride	ND		2.0	0.32	ug/L			03/14/16 08:19	1
m-Xylene & p-Xylene	ND		2.0	0.34	ug/L			03/14/16 08:19	1
Naphthalene	ND		1.0	0.22	ug/L			03/14/16 08:19	1
n-Butylbenzene	ND		1.0	0.32	ug/L			03/14/16 08:19	1
N-Propylbenzene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
o-Xylene	ND		1.0	0.19	ug/L			03/14/16 08:19	1
sec-Butylbenzene	ND		1.0	0.17	ug/L			03/14/16 08:19	1
Styrene	ND		1.0	0.17	ug/L			03/14/16 08:19	1
tert-Butylbenzene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
Tetrachloroethene	ND		1.0	0.20	ug/L			03/14/16 08:19	1
Toluene	ND		1.0	0.17	ug/L			03/14/16 08:19	1
trans-1,2-Dichloroethene	ND		1.0	0.15	ug/L			03/14/16 08:19	1
trans-1,3-Dichloropropene	ND		3.0	0.19	ug/L			03/14/16 08:19	1
Trichloroethene	ND		1.0	0.16	ug/L			03/14/16 08:19	1
Trichlorofluoromethane	ND		2.0	0.29	ug/L			03/14/16 08:19	1
Vinyl chloride	ND		1.0	0.10	ug/L			03/14/16 08:19	1
Xylenes, Total	ND		2.0	0.19	ug/L			03/14/16 08:19	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*147*	*X*	*70 - 127*		*03/14/16 08:19*	*1*
4-Bromofluorobenzene (Surr)	*136*	*X*	*78 - 120*		*03/14/16 08:19*	*1*
Dibromofluoromethane (Surr)	*137*	*X*	*77 - 120*		*03/14/16 08:19*	*1*
Toluene-d8 (Surr)	*140*	*X*	*80 - 125*		*03/14/16 08:19*	*1*

Lab Sample ID: LCS 280-316699/4
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1-Trichloroethane	5.00	5.09		ug/L		102	65 - 135
1,1-Dichloroethane	5.00	5.06		ug/L		101	65 - 135
1,1-Dichloroethene	5.00	4.83		ug/L		97	65 - 136
1,2-Dichloropropane	5.00	5.20		ug/L		104	64 - 135
1,3-Dichlorobenzene	5.00	4.85		ug/L		97	65 - 135
Benzene	5.00	5.23		ug/L		105	65 - 135
Carbon tetrachloride	5.00	5.26		ug/L		105	65 - 135
Chlorobenzene	5.00	4.92		ug/L		98	65 - 135
Chloroform	5.00	5.12		ug/L		102	65 - 135
Dichlorobromomethane	5.00	4.85		ug/L		97	65 - 135
Ethylbenzene	5.00	5.00		ug/L		100	65 - 135
Methylene Chloride	5.00	4.52		ug/L		90	54 - 141
Tetrachloroethene	5.00	4.90		ug/L		98	65 - 135
Toluene	5.00	5.80		ug/L		116	65 - 135
trans-1,2-Dichloroethene	5.00	5.11		ug/L		102	65 - 135
Trichloroethene	5.00	4.93		ug/L		99	65 - 135

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 280-316699/4
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Surrogate	LCS %Recovery	LCS Qualifier	Limits
1,2-Dichloroethane-d4 (Surr)	97		70 - 127
4-Bromofluorobenzene (Surr)	96		78 - 120
Dibromofluoromethane (Surr)	92		77 - 120
Toluene-d8 (Surr)	97		80 - 125

Lab Sample ID: 280-80447-C-3 MS
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1-Trichloroethane	ND		5.00	4.63		ug/L		93	65 - 135
1,1-Dichloroethane	4.9		5.00	8.56		ug/L		73	65 - 135
1,1-Dichloroethene	ND		5.00	4.16		ug/L		83	65 - 136
1,2-Dichloropropane	ND		5.00	4.70		ug/L		94	64 - 135
1,3-Dichlorobenzene	0.53	J	5.00	4.35		ug/L		76	65 - 135
Benzene	0.39	J	5.00	4.95		ug/L		91	65 - 135
Carbon tetrachloride	ND		5.00	4.65		ug/L		93	65 - 135
Chlorobenzene	1.9		5.00	5.68		ug/L		76	65 - 135
Chloroform	ND		5.00	4.82		ug/L		96	65 - 135
Dichlorobromomethane	ND		5.00	4.63		ug/L		93	65 - 135
Ethylbenzene	ND		5.00	3.98		ug/L		80	65 - 135
Methylene Chloride	ND		5.00	4.37		ug/L		87	54 - 141
Tetrachloroethene	ND		5.00	3.93		ug/L		79	65 - 135
Toluene	ND		5.00	5.05		ug/L		101	65 - 135
trans-1,2-Dichloroethene	ND		5.00	4.54		ug/L		91	65 - 135
Trichloroethene	0.28	J	5.00	4.40		ug/L		82	65 - 135

Surrogate	MS %Recovery	MS Qualifier	Limits
1,2-Dichloroethane-d4 (Surr)	116		70 - 127
4-Bromofluorobenzene (Surr)	96		78 - 120
Dibromofluoromethane (Surr)	101		77 - 120
Toluene-d8 (Surr)	96		80 - 125

Lab Sample ID: 280-80447-C-3 MSD
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1,1-Trichloroethane	ND		5.00	5.05		ug/L		101	65 - 135	9	20
1,1-Dichloroethane	4.9		5.00	8.84		ug/L		79	65 - 135	3	21
1,1-Dichloroethene	ND		5.00	4.67		ug/L		93	65 - 136	12	20
1,2-Dichloropropane	ND		5.00	5.17		ug/L		103	64 - 135	10	20
1,3-Dichlorobenzene	0.53	J	5.00	4.69		ug/L		83	65 - 135	8	20
Benzene	0.39	J	5.00	5.40		ug/L		100	65 - 135	9	20
Carbon tetrachloride	ND		5.00	5.03		ug/L		101	65 - 135	8	21
Chlorobenzene	1.9		5.00	5.97		ug/L		82	65 - 135	5	20
Chloroform	ND		5.00	5.24		ug/L		105	65 - 135	8	20
Dichlorobromomethane	ND		5.00	5.05		ug/L		101	65 - 135	9	20

Method: 8260B - Volatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 280-80447-C-3 MSD
Matrix: Water
Analysis Batch: 316699

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Ethylbenzene	ND		5.00	4.34		ug/L		87	65 - 135	9	20
Methylene Chloride	ND		5.00	4.93		ug/L		99	54 - 141	12	26
Tetrachloroethene	ND		5.00	4.25		ug/L		85	65 - 135	8	20
Toluene	ND		5.00	5.45		ug/L		109	65 - 135	8	20
trans-1,2-Dichloroethene	ND		5.00	5.02		ug/L		100	65 - 135	10	24
Trichloroethene	0.28	J	5.00	4.84		ug/L		91	65 - 135	10	20

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*115*		*70 - 127*
4-Bromofluorobenzene (Surr)	*95*		*78 - 120*
Dibromofluoromethane (Surr)	*100*		*77 - 120*
Toluene-d8 (Surr)	*95*		*80 - 125*

QC Association Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

GC/MS VOA

Analysis Batch: 316699

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-80430-1	RIG TANK	Total/NA	Water	8260B	
280-80430-2	BAILER BLANK	Total/NA	Water	8260B	
280-80447-C-3 MS	Matrix Spike	Total/NA	Water	8260B	
280-80447-C-3 MSD	Matrix Spike Duplicate	Total/NA	Water	8260B	
LCS 280-316699/4	Lab Control Sample	Total/NA	Water	8260B	
MB 280-316699/5	Method Blank	Total/NA	Water	8260B	

Lab Chronicle

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Client Sample ID: RIG TANK

Lab Sample ID: 280-80430-1

Date Collected: 03/02/16 13:45

Matrix: Water

Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	20 mL	20 mL	316699	03/14/16 12:48	DPI	TAL DEN

Client Sample ID: BAILER BLANK

Lab Sample ID: 280-80430-2

Date Collected: 03/02/16 10:40

Matrix: Water

Date Received: 03/04/16 09:56

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	8260B		1	20 mL	20 mL	316699	03/14/16 13:07	DPI	TAL DEN

Laboratory References:

TAL DEN = TestAmerica Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

Certification Summary

Client: Swift River Environmental Services, LLC
Project/Site: Swift River Environmental Services, LLC

TestAmerica Job ID: 280-80430-1

Laboratory: TestAmerica Denver

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
A2LA	DoD ELAP		2907.01	10-31-17
A2LA	ISO/IEC 17025		2907.01	10-31-17
Alabama	State Program	4	40730	09-30-12 *
Alaska (UST)	State Program	10	UST-30	04-05-16
Arizona	State Program	9	AZ0713	12-19-16
Arkansas DEQ	State Program	6	88-0687	06-01-16
California	State Program	9	2513	08-31-16
Connecticut	State Program	1	PH-0686	09-30-16
Florida	NELAP	4	E87667	06-30-16
Georgia	State Program	4	N/A	01-09-17
Illinois	NELAP	5	200017	04-30-16
Iowa	State Program	7	370	11-30-16
Kansas	NELAP	7	E-10166	04-30-16
Louisiana	NELAP	6	02096	06-30-16
Maine	State Program	1	CO0002	03-03-17
Minnesota	NELAP	5	8-999-405	12-31-16
Nevada	State Program	9	CO0026	07-31-16
New Hampshire	NELAP	1	205310	04-28-16
New Jersey	NELAP	2	CO004	06-30-16
New York	NELAP	2	11964	04-01-16
North Carolina (WW/SW)	State Program	4	358	12-31-16
North Dakota	State Program	8	R-034	01-09-16 *
Oklahoma	State Program	6	8614	08-31-16
Oregon	NELAP	10	4025	01-09-17
Pennsylvania	NELAP	3	68-00664	07-31-16
South Carolina	State Program	4	72002001	01-09-16 *
Texas	NELAP	6	T104704183-15-11	09-30-16
USDA	Federal		P330-13-00202	07-02-16
Utah	NELAP	8	CO00026	07-31-16
Virginia	NELAP	3	460232	06-14-16
Washington	State Program	10	C583	08-03-16
West Virginia DEP	State Program	3	354	11-30-16
Wisconsin	State Program	5	999615430	08-31-16
Wyoming (UST)	A2LA	8	2907.01	10-31-17

* Certification renewal pending - certification considered valid.

Chain of Custody Record

Sampler ID _____

Temperature on Receipt _____

Drinking Water? Yes ☐ No ☐

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124-280 (0508)

Client	Project Manager	Date	Chain of Custody Number
SWIFT RIVER ENVIRONMENTAL	PETE ZLATEV	3/3/2016	184226
Address	**Telephone Number (Area Code)/Fax Number**	**Lab Number**	**Page ____ of ____**
26 W DRY CREEK CIRCLE	303 695-4660 x 106		
City / **State** / **Zip Code**	**Site Contact** / **Lab Contact**		
LITTLETON / CO / 80120			
Project Name and Location (State)	**Carrier/Waybill Number**		
NW LANDFILL EXPANSION			
Contract/Purchase Order/Quote No.			

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH	Analysis: 8260B	Special Instructions/ Conditions of Receipt
RIG TANK	3/2/16	1345		X			X						X	
BAILER BLANK	3/3/16	1040		X			X						X	

280-80430 Chain of Custody

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months
(A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other _____

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By	3/4/16	0917	1. Received By	3/4/16	09117
2. Relinquished By	3/4/16	0956	2. Received By	3/4/16	0956
3. Relinquished By			3. Received By		

Comments

0.4 IR #7 - 0.2 Transferred by RP 3-4-16

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Login Sample Receipt Checklist

Client: Swift River Environmental Services, LLC

Job Number: 280-80430-1

Login Number: 80430
List Number: 1
Creator: Pottruff, Reed W

List Source: TestAmerica Denver

Question	Answer	Comment
Radioactivity either was not measured or, if measured, is at or below background	N/A	
The cooler's custody seal, if present, is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	NA: Not requested on COC
There are no discrepancies between the sample IDs on the containers and the COC.	True	
Samples are received within Holding Time (Excluding tests with immediate HTs)..	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
VOA sample vials do not have headspace or bubble is <6mm (1/4") in diameter.	True	
If necessary, staff have been informed of any short hold time or quick TAT needs	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Sampling Company provided.	True	
Samples received within 48 hours of sampling.	True	
Samples requiring field filtration have been filtered in the field.	True	
Chlorine Residual checked.	N/A	

APPENDIX E

LABORATORY PERMEABILITY RESULTS

Permeability Testing

Back Pressure Saturated – Flow Pump

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-12	TEST STARTED	03/30/2016	By: CAL
DEPTH	--	TEST FINISHED	04/07/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	5P	
LOCATION	--	PERMEANT	Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	514.64	601.25
Wt. Wet Soil & Pan - (g)	528.80	615.41
Wt. Dry Soil & Pan - (g)	476.76	476.76
Wt. Lost Moisture - (g)	52.04	138.65
Wt. of Pan Only - (g)	14.16	14.16
Wt. of Dry Soil - (g)	462.60	462.60
Moisture Content - (%)	11.2	30.0
Wet Density - (pcf)	100.3	123.1
Dry Density - (pcf)	90.1	94.7
Init. Diameter - (in)	2.761	
Init. Area - (sq in)	5.987	
Init. Height - (in)	3.266	
Vol. Bef. Consol. - (cu ft)	0.01132	
Vol. After Consol. - (cu ft)	0.01077	
Porosity - (%)	45.46	

FLOW PUMP CALCULATIONS

Pump Setting (gear number)	1
Percentage of Pump Setting	100
Q - (cc/s)	1.09E-01
Height - (in)	2.857
Diameter - (in)	2.880
Pressure - (psi)	0.128
Area after consol. - (sq cm)	42.017
Gradient	1.240
Permeability k - (cm/s)	2.1E-03
Permeability k - (m/s)	2.1E-05
Back Pressure - (psi)	78.0
Cell Pressure - (psi)	83.0
Ave. Effective Stress - (psi)	4.936
Average temperature degree - (c°)	22.2

Data entry by:	CKP	Date:	04/08/2016
Checked by:	CAL	Date:	04/11/2016

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-12	TEST STARTED	03/30/2016	By: CAL
DEPTH	--	TEST FINISHED	04/07/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	5P	
LOCATION	--	PERMEANT	Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	6.6	26.0				
50.0	48.0	27.1	28.3	38.7	46.1	7.4	0.74
60.0	58.0	28.4	29.3	48.7	56.9	8.2	0.82
70.0	68.0	29.5	30.3	58.7	67.8	9.1	0.91
80.0	78.0	30.4	31.1	68.7	78.1	9.4	0.94
90.0		31.3	31.4	78.7	88.3	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	0.00	0.00
0.25	0.50	1.30	-1.30
0.5	0.71	1.35	-1.35
1	1.00	1.40	-1.40
2	1.41	1.50	-1.50
4	2.00	1.50	-1.50
9	3.00	1.60	-1.60
16	4.00	1.60	-1.60
30	5.48	1.70	-1.70
60	7.75	1.70	-1.70
120	10.95	1.85	-1.85
240	15.49	1.90	-1.90
360	18.97	1.90	-1.90

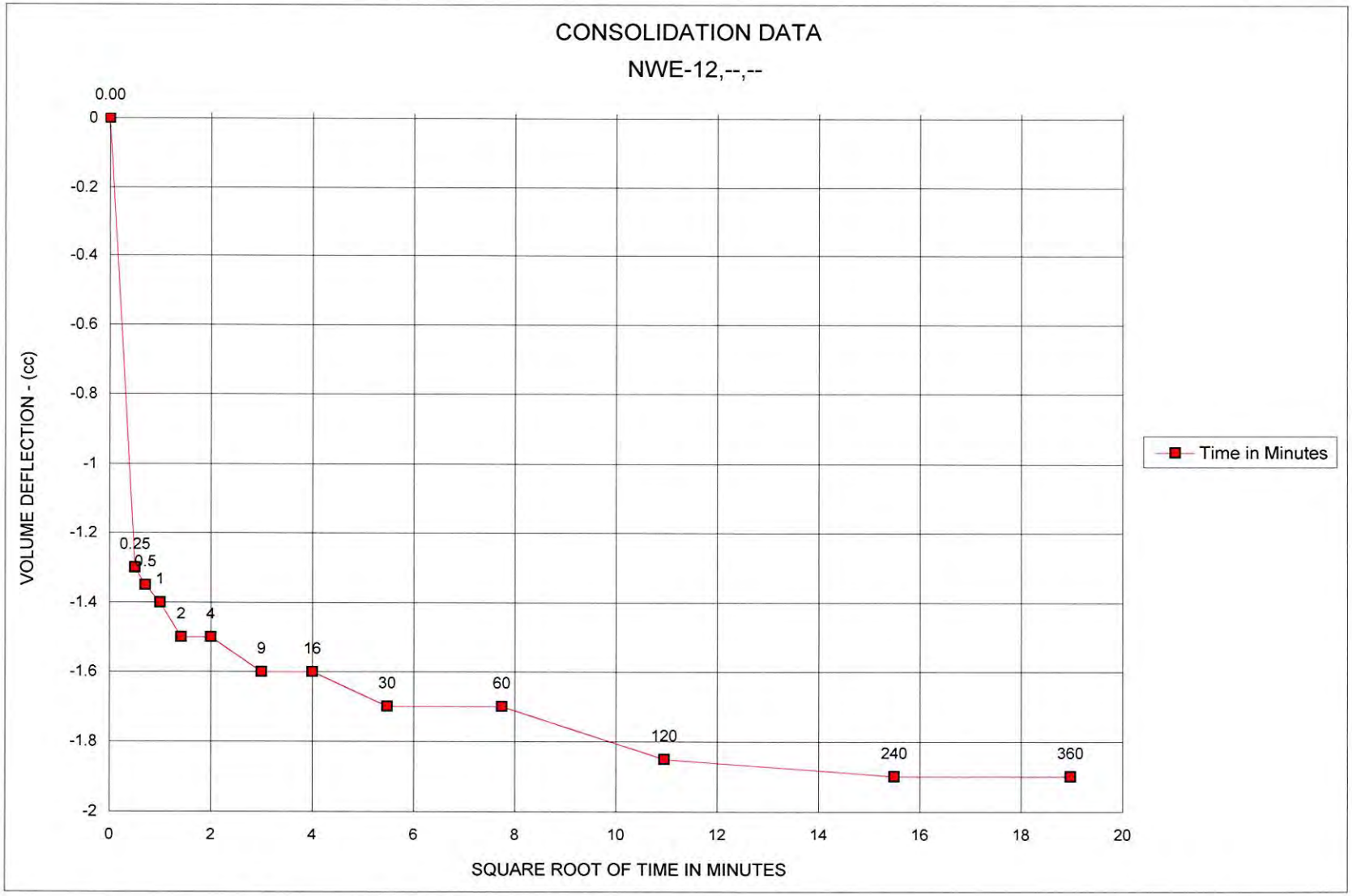
Initial Height - (in)	3.266	Init. Vol. - (cc)	320.49
Height Change - (in)	0.409	Vol. Change - (cc)	28.10
Ht. After Cons. - (in)	2.857	Cell Exp. - (cc)	12.57
Initial Area - (sq in)	5.987	Net Change - (cc)	15.53
Area After Cons. - sq in	6.513	Cons. Vol. - (cc)	304.96

ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO.	2952-2

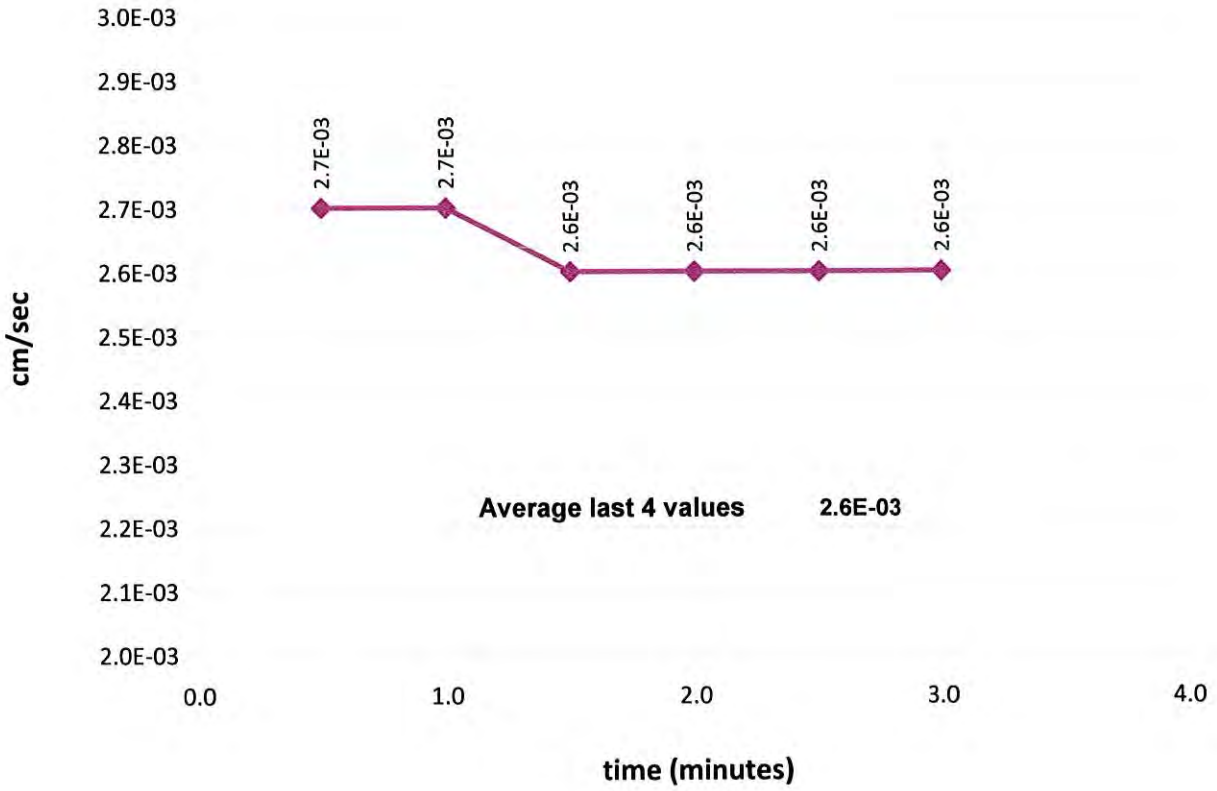


FileName: 2952_2_HarvardFlowPump-Perm-ASTMD-5084-R3_0.xls

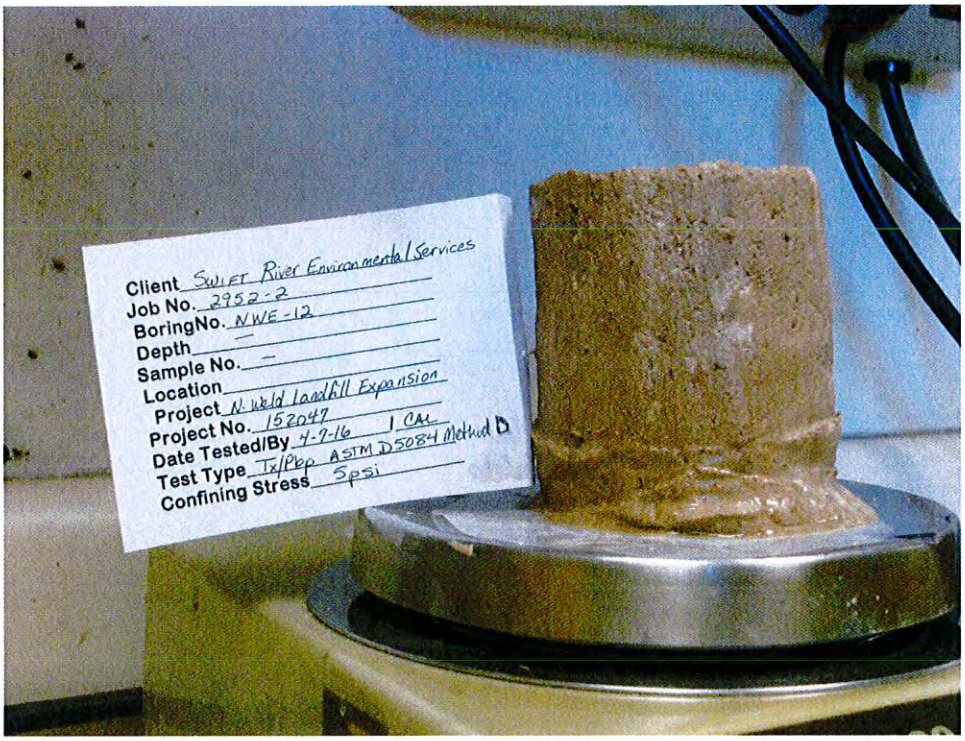
ADVANCED TERRA TESTING

Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	NWE-12		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/7/2016	Technician:	CAL



Data Entered By:	CAL		
Date:	4/7/2016	Checked By:	CKP
File Name:	2952_2_PrelimPerm_ASTMD-5084-methodD-R1_0.xls	Date:	4/8/16



Q:\Client Data File\2952\2\PICTURE\DSCF6170.JPG

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services	JOB NO.	2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-7	TEST STARTED	3/30/2016	By: CAL
DEPTH	--	TEST FINISHED	4/12/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	12P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

MOISTURE / DENSITY DATA	BEFORE TEST	AFTER TEST
Wt. Soil + Moisture - (g)	575.98	674.95
Wt. Wet Soil & Pan - (g)	590.22	689.19
Wt. Dry Soil & Pan - (g)	534.17	534.17
Wt. Lost Moisture - (g)	56.05	155.02
Wt. of Pan Only - (g)	14.24	14.24
Wt. of Dry Soil - (g)	519.93	519.93
Moisture Content - (%)	10.8	29.8
Wet Density - (pcf)	101.1	124.1
Dry Density - (pcf)	91.3	95.6
Init. Diameter - (in)	2.822	
Init. Area - (sq in)	6.255	
Init. Height - (in)	3.470	
Vol. Bef. Consol. - (cu ft)	0.01256	
Vol. After Consol. - (cu ft)	0.01199	
Porosity - (%)	45.67	

FLOW PUMP CALCULATIONS	
Pump Setting (gear number)	1
Percentage of Pump Setting	100
Q - (cc/s)	1.09E-01
Height - (in)	3.455
Diameter - (in)	2.763
Pressure - (psi)	0.068
Area after consol. - (sq cm)	38.675
Gradient	0.545
Permeability k - (cm/s)	5.2E-03
Permeability k - (m/s)	5.2E-05
Back Pressure - (psi)	98.0
Cell Pressure - (psi)	103.0
Ave. Effective Stress - (psi)	4.966
Average temperature degree - (c°)	21.5

Data entry by: NN	Date: 04/13/2016
Checked by: CAL	Date: 04/13/2016

ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

CLIENT	Swift River Environmental Services		JOB NO. 2952-2

PROJECT	North Weld Landfill Expansion			
PROJECT NO.	152047	SAMPLED	--	By: --
BORING NO.	NWE-7	TEST STARTED	3/30/2016	By: CAL
DEPTH	--	TEST FINISHED	4/12/2016	By: CAL
SAMPLE NO.	--	CELL NUMBER	12P	
LOCATION	--	PERMEANT	Tap Water	
SAMPLE TYPE	Shelby Tube	CONF. PRES. - (psf)	720	

SATURATION DATA

Cell Press.	Back Press.	Burette Reading (cc)		Pore Press. (psi)			
(psi)	(psi)	Close	Open	Close	Open	Change	B
40.0	38.0	5.4	26.5				
50.0	48.0	28.4	29.6	38.7	43.7	5.0	0.50
60.0	58.0	29.5	30.6	48.6	55.2	6.6	0.66
70.0	68.0	30.7	31.7	58.6	66.4	7.8	0.78
80.0	78.0	31.5	32.4	68.7	77.0	8.3	0.83
90.0	88.0	32.6	33.4	78.7	87.7	9.0	0.90
100.0	98.0	33.4	34.1	88.8	97.9	9.1	0.91
110.0		34.4	34.6	98.7	108.3	9.6	0.96

CONSOLIDATION DATA

Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (cc)	Volume Defl. (cc)
0.00	0.00	0.50	0.00
0.25	0.50	1.60	-1.10
0.5	0.71	1.65	-1.15
1	1.00	1.65	-1.15
2	1.41	1.70	-1.20
4	2.00	1.75	-1.25
9	3.00	1.80	-1.30
16	4.00	1.80	-1.30
30	5.48	1.80	-1.30
60	7.75	1.85	-1.35
120	10.95	1.90	-1.40
240	15.49	1.95	-1.45
360	18.97	1.95	-1.45

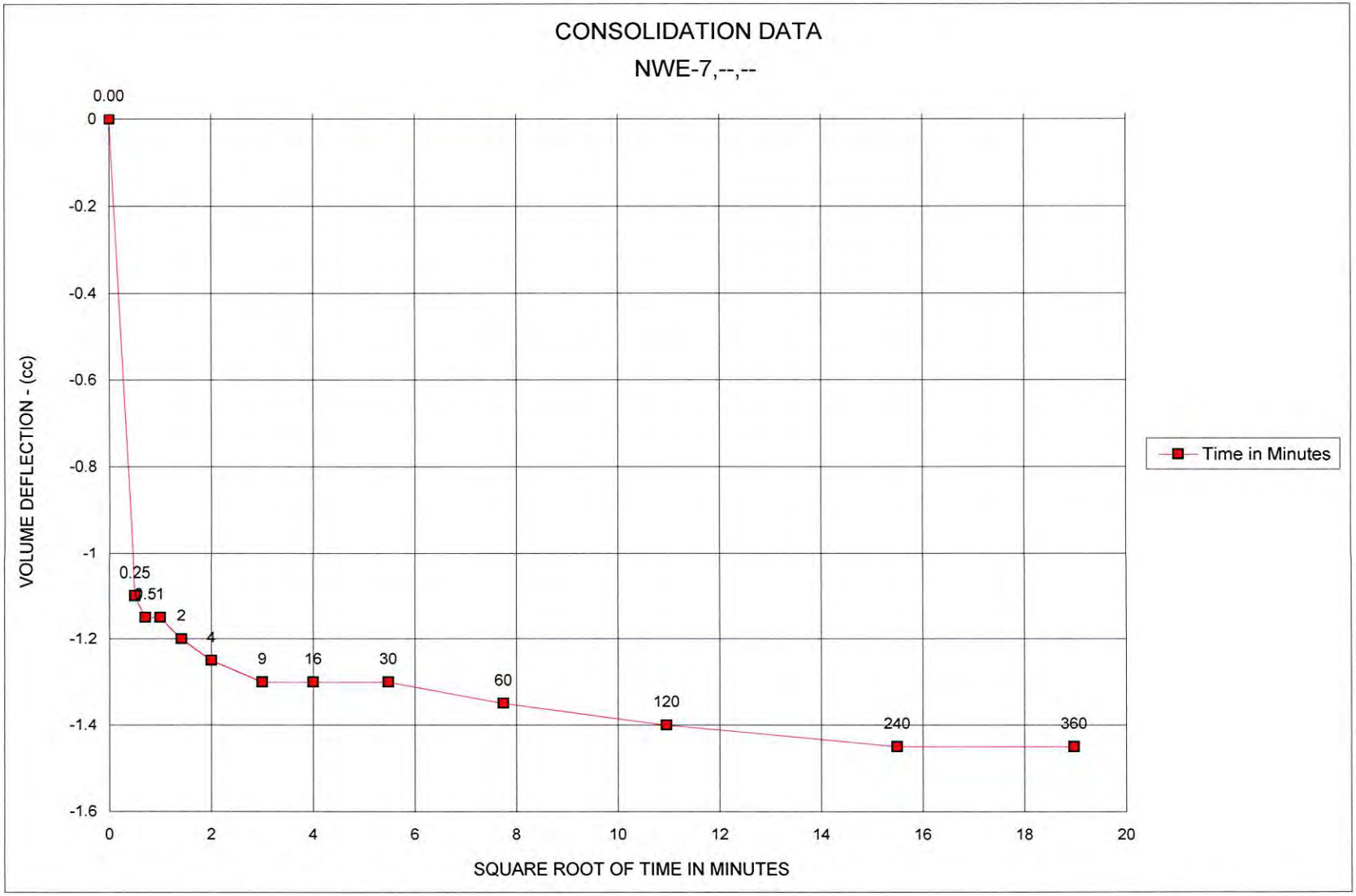
Initial Height - (in)	3.470	Init. Vol. - (cc)	355.72
Height Change - (in)	0.015	Vol. Change - (cc)	31.25
Ht. After Cons. - (in)	3.455	Cell Exp. - (cc)	14.99
Initial Area - (sq in)	6.255	Net Change - (cc)	16.26
Area After Cons. - sq in	5.995	Cons. Vol. - (cc)	339.46

ATT
ADVANCED TERRA TESTING

PERMEABILITY TEST - BACK PRESSURE SATURATED - FLOW PUMP METHOD

ASTM D5084 Method D

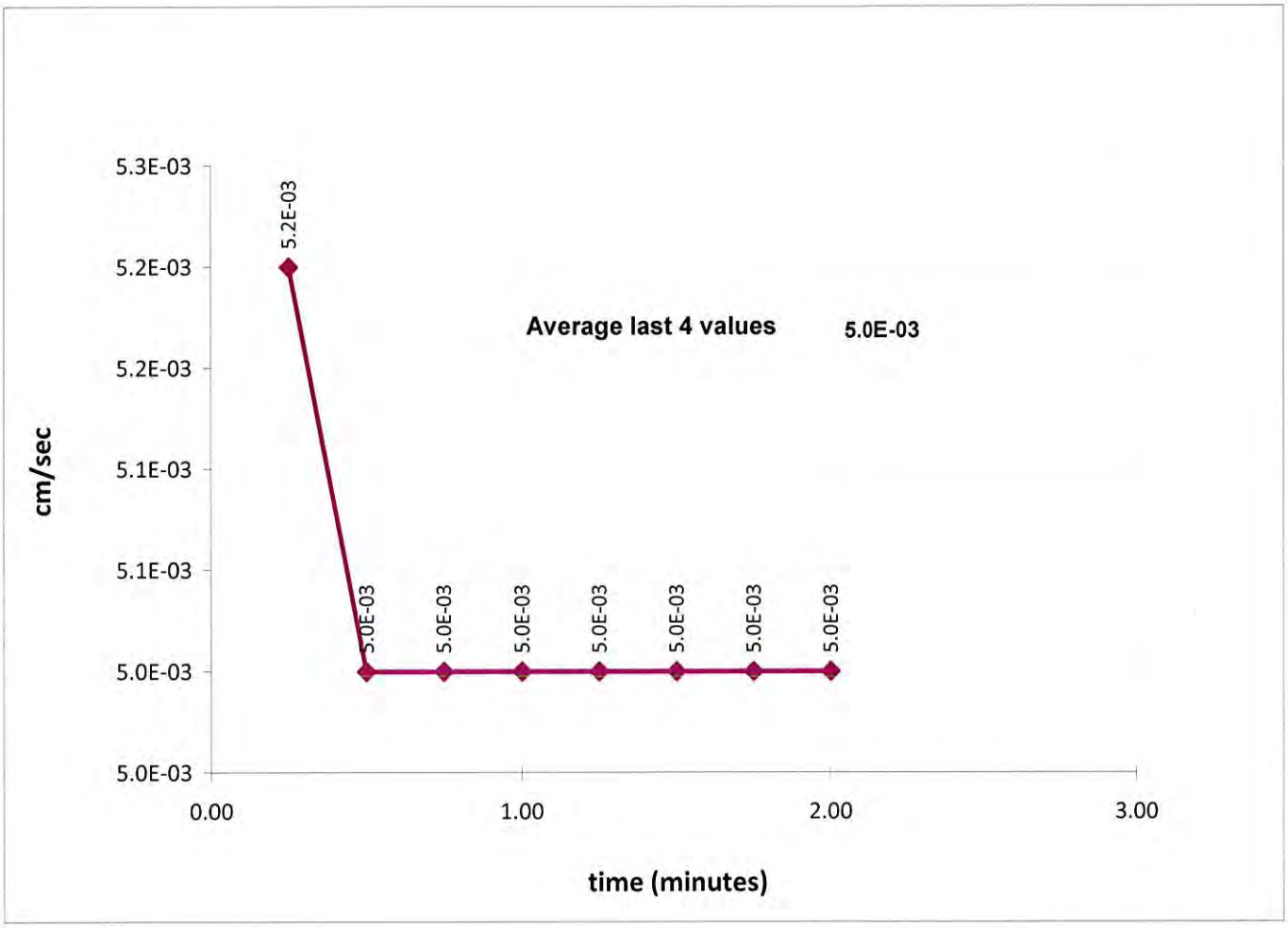
CLIENT	Swift River Environmental Services		JOB NO.	2952-2



ADVANCED TERRA TESTING

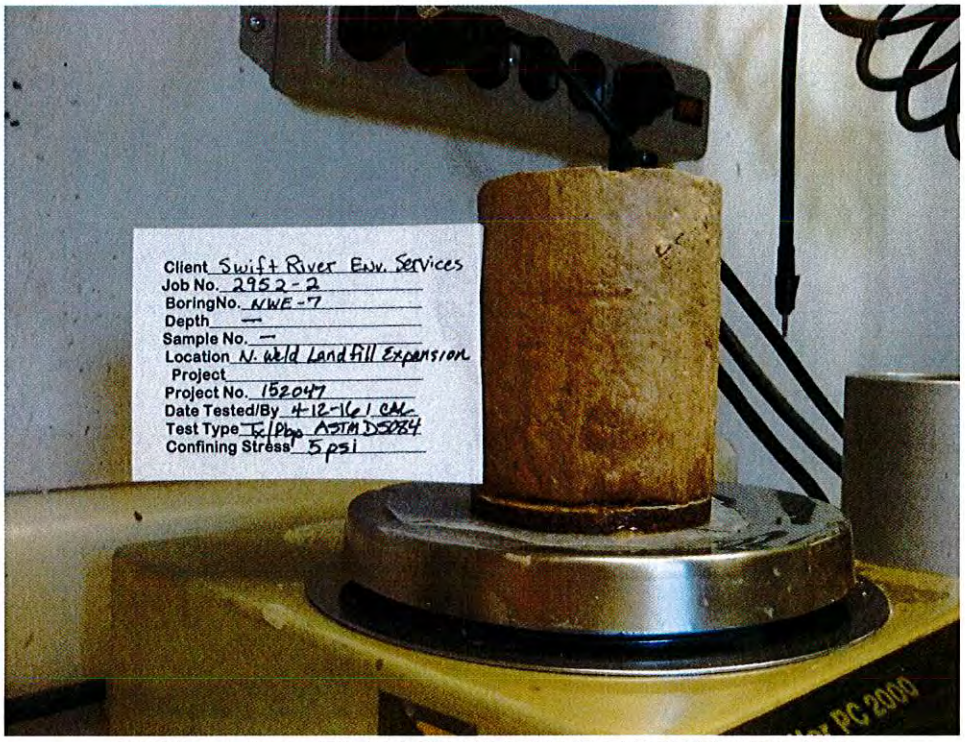
Preliminary Flow Pump Test Data
ASTM D5084

Client:	Swift River Environmental Services	Boring Number:	NWE-7		
Job Number:	2952-2	Depth:	--		
Project:	North Weld Landfill Expansion	Sample Number:	--		
Location:	--	Sampled Date:	--	Sampled By:	--
Project Number:	152047	Test Date:	4/12/2016	Technician:	CAL



Data Entered By: CAL
Date: 4/12/2016
File Name: 2952_2_PrelimPerm_ASTMD-5084-methodD-R1_1.xls

Checked By: DM
Date: 4/13/16



Q:\Client Data File\2952\2\PICTURE\DSCF6171.JPG

APPENDIX F

SLUG TEST DATA

SWIFT RIVER ENVIRONMENTAL SERVICES, LLC

... An Alaska Native Corporation ...

26 West Dry Creek Circle, Littleton, CO 80120 ◊ (303) 695-4660

CALCULATION SUMMARY SHEET

PROJECT NUMBER: 152047 Page 1 of 6

PROJECT NAME: NWLF Expansion

DATE: 5/25/16

CALCULATION NUMBER: Revision: 1

SUPERSEDED BY CALCULATION NUMBER: Revision:

DESCRIPTION OF CALCULATION:

Slug Test Analyses for Hydrogeologic Report

REFERENCES USED: Number of References Attached:

1)Data collected by PAZ and SLW (May 4 – 5, 2016)

2) AQTESOLV v 4.5

REVIEW COMMENTS:

CALCULATION MADE BY: PAZ DATE: 5/25/16

CALCULATION CHECKED BY: EMF DATE: 6/3/16

CALCULATION REVISED BY: PAZ DATE:

CALCULATION REVIEWED BY: SLW DATE: 6/6/16

FINAL DESTINATION: File

CALCULATION

Purpose

This calculation presents the test setup, analysis and results of slug testing performed in Test Wells installed at the North Weld Landfill Expansion.

Approach

A slug constructed of weighted PVC was used in the testing. The slug was constructed of 1 inch ID PVC, filled with sand and sealed with end caps. An eye bolt was fixed to one end of the slug to allow for the attachment of the lifting line. The slug dimensions were:

Outer diameter slug body 1.25 inches by 46 inches long: 

End caps diameter 1.5 inches in diameter by 1.375 inches long (2 end caps)

Volume = π*46*(1.25/2)^2+2*π*1.375*(1.5/2)^2 = 56.45+4.86=61.31 cu inches

During the testing, the slug was completely submerged or completely removed from the water within the well casing. The slug produced a theoretical rise or drop in the water level in the well equal to the volume displaced by the slug. This is calculated from the comparison of the slug volume to the well cross sectional area. Each of the tested wells was 2 inch inner diameter.

The well area is calculated as:

Area = π*(2/2)^2 =3.14 sq inches

The theoretical rise then is:

Rise = 61.31/3.14 = 19.5 inches = 1.63 feet

In the cases where the static water level was below the top of the screen, a correction factor must be applied to the theoretical H0. With a borehole diameter of 8.25 inches and an assumed filter pack porosity of 30 percent, the theoretical rise is:

Borehole Area = π*(8.25/2)^2 =53.46 sq inches

The open area (3.14+0.3*(53.64-3.14))=18.29

So the theoretical rise is:

Rise = 61.31/18.29 = 3.35 inches = 0.28 feet

An In-Situ Level Troll 700 15 psig vented transducer (Serial number 345480) was used for the tests. The transducer was connected by USB to a laptop PC in the field using 3 cables, each 50 feet in length. The software program WinSitu 5 was used to collect and store the data from the test. During the test, the data could be downloaded and graphed to observe test progress and to determine when the water table had returned to pre-test conditions.

The process for the test was to first measure the depth to water. The transducer was then lowered into the water table to a depth approximately 8 feet or more below the water table. This depth was selected to avoid possible contact between the lowered slug and the transducer during the test.

After the transducer was lowered, the data was reviewed on the screen to confirm the transducer was communicating with the PC. Next, the slug was lowered so the bottom of the slug was approximately 1 to 2 feet above the water table in preparation for the Slug In, or Falling Head test.

The slug test identification and test parameters, including sampling time interval was set up in the software, and the signal was given to smoothly and quickly lower the slug as the test was initiated. In general, the test data collection was initiated about 1 second before the slug was lowered into the water to ensure the peak rise in water level was recorded. Despite attempts to minimize splashing, some water level oscillation is observed in the test data. The test was continued until the water level had returned to about 0.05 feet of the pre-test water level. The test was then stopped, and a new test set up for the removal of the slug (Slug Out, or Rising Head Test). The test sequence was then to initiate the data collection about 1 second before the slug was quickly removed from the water. To reduce the chance of disturbing the transducer cable, the slug was only removed until it was clear of the water table, then tied off downhole until the test was completed.

Tests Performed

The testing was performed in 6 of the 8 wells installed in 2016 at the NWLF Expansion. Slug in and slug out testing was performed in wells TW-4, TW-5, TW-6, TW-8, TW-9 and TW-10. Two wells (TW-1 and TW-2) could not be tested because of insufficient water depth in the well, and wells TW-3 and TW-7 were not installed during the Hydrogeologic Investigation because shallow water was not encountered during drilling in those locations. A summary of the depth to water and well construction details are shown below.

Table 1: Depth to Water and Well Construction Details

Well Name	Depth Drilled ft bgs	Well Bottom ft bgs	Screen Bottom ft bgs	Screen Top ft bgs	Sand Pack Top ft bgs	Stick Up ft	DTW TOC ft	DTW BGS ft	Satd Thickness ft
TW-04	104	103.5	103.2	88.2	84.4	3.17	88.70	85.53	18.47
TW-05	49	49	48.7	28.7	25.5	3.19	37.89	34.70	14.30
TW-06	109	109	108.8	93.8	90.5	3.33	50.59	47.26	61.74
TW-08	104	92.3	92	72	69	3.00	45.76	42.76	61.24
TW-09	49	49	47	32	29	2.67	42.58	39.91	9.09
TW-10	98.5	97.8	97.5	77.5	73.8	2.50	56.33	53.83	44.67

Saturated thickness is water table to depth drilled.

Wells in which no tests were performed had insufficient water level to allow the transducer to be placed with a fully submerged slug.

Data

The data were downloaded from the transducer to Comma Separated Values files for analysis. The data sets are included in Appendix 1 of this calculation.

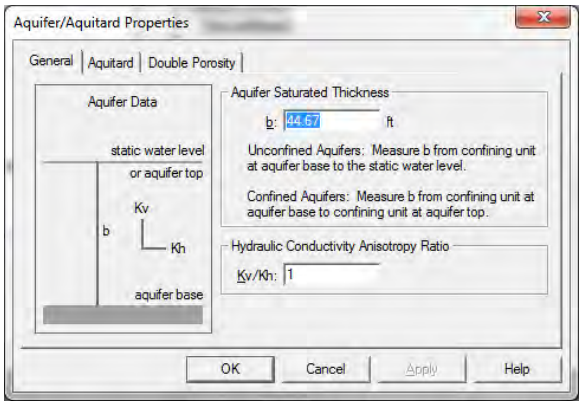
Boring logs of the wells are included in this calculation.

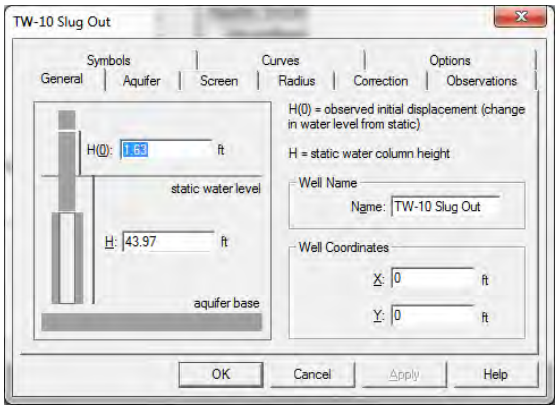
Analysis

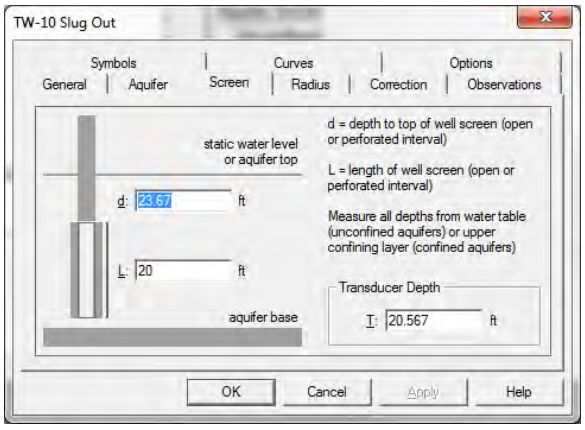
The data were analyzed using the Bouwer Rice method included in the AQTESOLV program. Well construction and aquifer properties are input to the program for each well tested. The transducer data is directly read into the program, and then adjusted by the depth of the transducer in the water column to show the rise or fall in water level developed by the insertion or removal of the slug. The aquifer and well construction details are input to AQTESOLV. A summary of the data is as follows where:

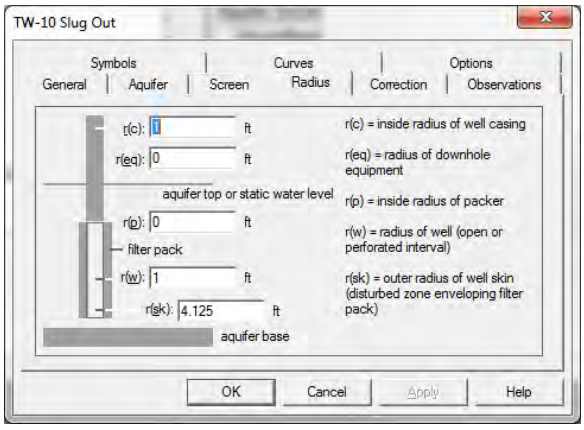
- H0 = The theoretical rise (or fall) from slug being immersed (or removed) from static water table (ft)
- d = The depth from static water table to screen top (ft). This value is 0 if water table is below top of screen (presented as negative value in Table 2 to show the wells with water level below top of screen and modified screen length calculation).
- L = Screen length if water table is above the top of the screen (ft)
- Modified L = The saturated length of screen if the water table is below the top of screen (ft)
- rc = casing radius, all wells were 2 inch diameter PVC, so rc = 1 in
- rw = well screen radius, all wells were 2 inch diameter PVC, so rw = 1 in
- rsk = borehole radius, the borehole was 8.25 inches, so rsk = 4.125 inches
- Correction H0* =not used in the Bouwer Rice corrections;
- ne = effective porosity of the filter pack (unitless)
- b=Aquifer thickness
- H = Static water column in well

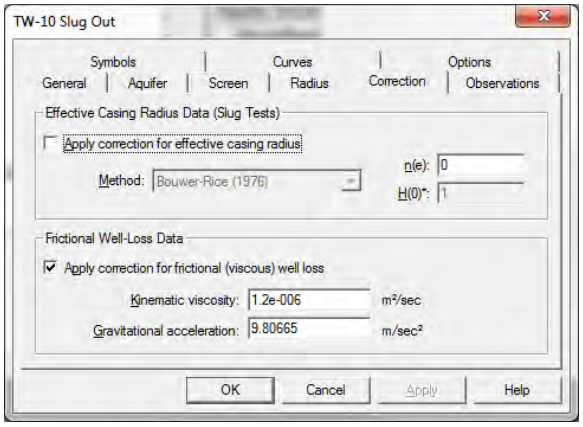
The definitions are shown in the attached figures from the AQTESOLV program.


Aquifer/Aquitard Properties
General
Aquitard
Double Porosity
Aquifer Data
static water level
or aquifer top
Kv
b
Kh
aquifer base
Aquifer Saturated Thickness
b: 44.67 ft
Unconfined Aquifers: Measure b from confining unit at aquifer base to the static water level.
Confined Aquifers: Measure b from confining unit at aquifer base to confining unit at aquifer top.
Hydraulic Conductivity Anisotropy Ratio
Kv/Kh: 1
OK
Cancel
Apply
Help


TW-10 Slug Out
Symbols
General
Aquifer
Curves
Screen
Radius
Options
Correction
Observations
H(0): 1.68 ft
static water level
H: 43.97 ft
aquifer base
H(0) = observed initial displacement (change in water level from static)
H = static water column height
Well Name
Name: TW-10 Slug Out
Well Coordinates
X: 0 ft
Y: 0 ft
OK
Cancel
Apply
Help


TW-10 Slug Out
Symbols
General
Aquifer
Curves
Screen
Radius
Options
Correction
Observations
static water level
or aquifer top
d: 23.67 ft
L: 20 ft
aquifer base
d = depth to top of well screen (open or perforated interval)
L = length of well screen (open or perforated interval)
Measure all depths from water table (unconfined aquifers) or upper confining layer (confined aquifers)
Transducer Depth
T: 20.567 ft
OK
Cancel
Apply
Help


TW-10 Slug Out
Symbols
General
Aquifer
Curves
Screen
Radius
Options
Correction
Observations
r(c): 1 ft
r(eq): 0 ft
aquifer top or static water level
r(p): 0 ft
filter pack
r(w): 1 ft
r(sk): 4.125 ft
aquifer base
r(c) = inside radius of well casing
r(eq) = radius of downhole equipment
r(p) = inside radius of packer
r(w) = radius of well (open or perforated interval)
r(sk) = outer radius of well skin (disturbed zone enveloping filter pack)
OK
Cancel
Apply
Help


TW-10 Slug Out
Symbols
General
Aquifer
Curves
Screen
Radius
Options
Correction
Observations
Effective Casing Radius Data (Slug Tests)
Apply correction for effective casing radius
Method: Bouwer-Rice (1976)
n(e): 0
H(0)*: 1
Frictional Well-Loss Data
Apply correction for frictional (viscous) well loss
Kinematic viscosity: 1.2e-006 m²/sec
Gravitational acceleration: 9.80665 m/sec²
OK
Cancel
Apply
Help

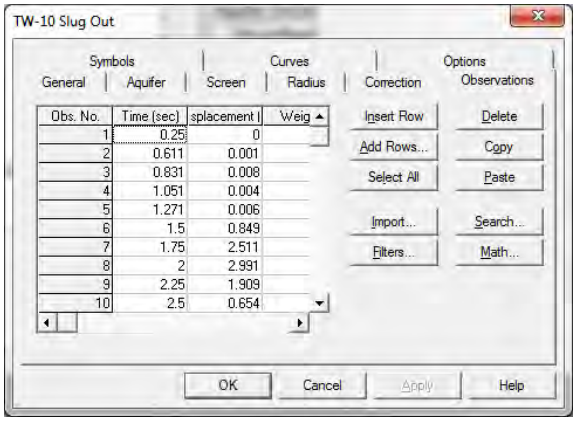

TW-10 Slug Out
Symbols
General
Aquifer
Curves
Screen
Radius
Options
Correction
Observations
Obs. No. | Time (sec) | splacement | Weig
1 0.25 0
2 0.611 0.001
3 0.831 0.008
4 1.051 0.004
5 1.271 0.006
6 1.5 0.849
7 1.75 2.511
8 2 2.991
9 2.25 1.909
10 2.5 0.654
Insert Row
Add Rows...
Select All
Import...
Filters...
Delete
Copy
Paste
Search...
Math...
OK
Cancel
Apply
Help

Table 2: AQTESOLV Input Data

	H0				modified				Correction	
Well	theoretical	H	d	L	L	rc	rw	rsk	H0*	ne
Name	ft	ft	ft	ft	ft	in	in	in		
TW-04	1.63	17.97	2.67	15	15.00	1	1	4.125	NA	NA
TW-05	1.63	14.30	-6.00	20	14.00	1	1	4.125	NA	0.3
TW-06	1.63	61.74	46.54	15	15.00	1	1	4.125	NA	NA
TW-08	1.63	49.54	29.24	20	20.00	1	1	4.125	NA	NA
TW-09	1.63	9.09	-7.91	15	7.09	1	1	4.125	NA	0.3
TW-10	1.63	43.97	23.67	20	20.00	1	1	4.125	NA	NA

H is water column in well

d is depth of water above screen (negative if water table in screen)

L is Screen length

Modified L is saturated screen length.

The output of the analysis includes a graph of the data and the analytical results. The hydraulic conductivity values are summarized:

Table 3: Results

Well	Test	Hydraulic Conductivity (cm/sec)	Notes
TW-4	Slug In	6.15E-3	Screened in Fox Hills Fm
TW-4	Slug Out	7.54E-3	Screened in Fox Hills Fm
TW-5	Slug In	1.90E-2	Screened in Laramie Fm
TW-5	Slug Out	5.13E-3	Screened in Laramie Fm
TW-6	Slug In	2.06E-2	Screened in Fox Hills Fm
TW-6	Slug Out	1.88E-2	Screened in Fox Hills Fm
TW-8	Slug In	2.54E-3	Screened in Laramie Fm
TW-8	Slug Out	2.13E-3	Screened in Laramie Fm
TW-9	Slug In	2.02E-1	Screened in alluvium and Laramie Fm. Data noisy, sparse, suspect beginning of test was missed
TW-9	Slug Out	1.38E-1	Screened in alluvium and Laramie Fm.
TW-10	Slug In	1.68E-3	Screened in Laramie Fm
TW-10	Slug Out	1.89E-3	Screened in Laramie Fm

Summary

The results of the testing showed relatively high permeability material, greater than previous tests performed at the site. A review of the well logs show relatively long screen lengths through sandy materials (SM and SP), with interspersed clay layers.

APPENDIX B-3

NATIONAL RESOURCES CONSERVATION SERVICE (NRCS) WEB SOIL SURVEY (WSS)
CUSTOM SOIL RESOURCE REPORT FOR WELD COUNTY COLORADO,
SOUTHERN PART, NORTH WELD LANDFILL

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Weld County, Colorado, Southern Part

North Weld Landfill



August 17, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:12,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Southern Part
Survey Area Data: Version 14, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 22, 2011—Oct 19, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Weld County, Colorado, Southern Part (CO618)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
4	Aquolls and Aquepts, flooded	2.8	0.4%
32	Kim loam, 1 to 3 percent slopes	51.1	7.7%
33	Kim loam, 3 to 5 percent slopes	5.2	0.8%
47	Olney fine sandy loam, 1 to 3 percent slopes	291.9	43.9%
48	Olney fine sandy loam, 3 to 5 percent slopes	312.7	47.0%
52	Otero sandy loam, 3 to 5 percent slopes	1.0	0.1%
Totals for Area of Interest		**664.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Weld County, Colorado, Southern Part

4—Aquolls and Aquepts, flooded

Map Unit Setting

National map unit symbol: 362l
Elevation: 3,600 to 4,700 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Aquolls and similar soils: 55 percent
Aquepts, flooded, and similar soils: 25 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aquolls

Setting

Landform: Depressions, drainageways, plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Recent alluvium

Typical profile

H1 - 0 to 8 inches: variable
H2 - 8 to 60 inches: stratified sandy loam to clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 6.00 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: Salt Meadow (R067BY035CO)
Hydric soil rating: Yes

Description of Aquepts, Flooded

Setting

Landform: Stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Recent alluvium

Typical profile

H1 - 0 to 8 inches: variable
H2 - 8 to 60 inches: stratified sandy loam to clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 6.00 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: Wet Meadow (R067BY038CO)
Hydric soil rating: Yes

Minor Components

Thedalund

Percent of map unit: 10 percent
Hydric soil rating: No

Haverson

Percent of map unit: 10 percent
Hydric soil rating: No

32—Kim loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 362b
Elevation: 4,900 to 5,250 feet

Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 125 to 150 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Kim and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kim

Setting

Landform: Alluvial fans, plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed eolian deposits derived from sedimentary rock

Typical profile

H1 - 0 to 12 inches: loam
H2 - 12 to 40 inches: loam
H3 - 40 to 60 inches: fine sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Otero

Percent of map unit: 10 percent
Hydric soil rating: No

33—Kim loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 362c
Elevation: 4,900 to 5,250 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 125 to 150 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kim and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kim

Setting

Landform: Alluvial fans, plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed eolian deposits derived from sedimentary rock

Typical profile

H1 - 0 to 12 inches: loam
H2 - 12 to 40 inches: loam
H3 - 40 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Otero

Percent of map unit: 10 percent
Hydric soil rating: No

47—Olney fine sandy loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 362v
Elevation: 4,600 to 5,200 feet
Mean annual precipitation: 11 to 15 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 125 to 175 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Olney and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Olney

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed deposit outwash

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 20 inches: sandy clay loam
H3 - 20 to 25 inches: sandy clay loam
H4 - 25 to 60 inches: fine sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Plains (R067BY024CO)
Hydric soil rating: No

Minor Components

Zigweid

Percent of map unit: 10 percent
Hydric soil rating: No

Vona

Percent of map unit: 5 percent
Hydric soil rating: No

48—Olney fine sandy loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 362w
Elevation: 4,600 to 5,200 feet
Mean annual precipitation: 11 to 15 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 125 to 175 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Olney and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Olney

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed deposit outwash

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 20 inches: sandy clay loam
H3 - 20 to 25 inches: sandy clay loam
H4 - 25 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Plains (R067BY024CO)
Hydric soil rating: No

Minor Components

Zigweid
Percent of map unit: 9 percent
Hydric soil rating: No

Vona
Percent of map unit: 6 percent
Hydric soil rating: No

52—Otero sandy loam, 3 to 5 percent slopes

Map Unit Setting
National map unit symbol: 3631
Elevation: 4,700 to 5,250 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 130 to 180 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Otero and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Otero

Setting
Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits and/or mixed outwash

Typical profile
H1 - 0 to 12 inches: sandy loam

H2 - 12 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Sandy Plains (R067BY024CO)
Hydric soil rating: No

Minor Components

Kim

Percent of map unit: 12 percent
Hydric soil rating: No

Vona

Percent of map unit: 3 percent
Hydric soil rating: No

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APPENDIX C
ENGINEERING CALCULATIONS

APPENDIX C-1
LEACHATE HEAD ON LINER CALCULATIONS (HELP ANALYSIS)

CALCULATIONS

Date:	November 18, 2016	**Made by:**	ALB
Project No.:	1538880	**Checked by:**	DVS DS
Site Name:	North Weld Landfill Unit 2 EDOP Weld County, Colorado	**Reviewed by:**	JAR
Subject:	**APPENDIX C-1: LEACHATE HEAD ON LINER CALCULATIONS (HELP MODEL ANALYSIS)**		

1.0 OBJECTIVES

Perform hydrological modeling of Unit 2 of North Weld Landfill (NWLF) to model leachate generation and corresponding hydrologic performance of the alternative liner system. Estimate maximum leachate head buildup on the alternative liner system and maximum impingement rates through the alternative liner system. Confirm that the proposed drainage layer will result in less than 12 inches of head on the alternative liner system at all times.

2.0 METHODOLOGY

Use the Hydrologic Evaluation of Landfill Performance (HELP) Model, version 3.07 (USACE 1997), to model the hydrologic performance of the alternative liner system and leachate collection system within the Unit 2 expansion. Model various waste depth and cover configurations assumed to represent the most critical typical operational scenarios anticipated to occur throughout the life of the landfill from a leachate-generation standpoint. Evaluate the sensitivity of the HELP model results to changes in operational input parameters.

3.0 INPUT PARAMETERS

3.1 Operational Scenarios

The following waste depths and cover configurations were initially modeled to identify the most critical operational scenarios from a leachate-generation standpoint:

- Scenario 1: 6 feet of waste with daily cover (1 year weather generation);
- Scenario 2: 70 feet of waste with daily cover (1 year of weather generation);
- Scenario 3: 70 feet of waste with intermediate cover (10 years of weather generation); and
- Scenario 4: 154 feet of waste with final cover (30 years of weather generation representative of post-closure period)

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Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill, Unit 2 EDOP	Checked by:	DVS DS
Date:	November 18, 2016	Reviewed by:	JAR

3.2 Meteorological Data

Meteorological data for the Landfill site was synthetically generated using the synthetic weather generator (WGEN) developed by the United States Department of Agriculture (USDA) Agricultural Research Service (ARS) and built into the HELP model. Statistical characteristics for synthetic weather data generation were adopted from Cheyenne, Wyoming, the nearest city to the site with published values in the program's default database. Default average monthly precipitation and temperature data for Cheyenne, Wyoming, was used for the synthetic generation of daily data. Daily solar radiation and evapotranspiration data were synthetically generated based on the latitude for Ault, Colorado (40.59° N).

3.3 Alternative Liner System

3.3.1 General Design Inputs

The following is a list of the general input parameters used in the HELP analysis:

- The length and slope of the landfill floor was modeled at 845 feet and 2.64%, based on the maximum leachate flow path length within the leachate collection drainage layer and considering the maximum estimated consolidation of foundation soils;
- The compacted cohesive soil liner consists of 24 inches of on-site low-permeability soil;
- The granular leachate collection drainage layer consists of six inches of coarse-grained sand;
- Daily and intermediate cover soils consist of on-site eolian deposit material (sandy clay loam) encountered within the proposed excavation depth for the development of the Unit 2 subgrade;
- 100% of the waste area was allowed to have runoff, with an SCS runoff curve number (CN) of 85;
- The waste surface was assumed to be bare ground (i.e., Leaf Area Index of 0); and
- The evaporative zone depth was limited to the thickness of the cover material modelled.

3.3.2 HELP Material Layers

Material properties were referenced from site-specific geotechnical data from the Report of Geotechnical Investigation (Swift River 2016) and correlated to default HELP model soil textures, with user-defined properties input to reflect specific material requirements, where appropriate. Material properties used in the HELP analysis are listed below from bottom of the alternative liner system to top of the daily, intermediate, or final cover:

- The 24-inch-thick compacted cohesive soil liner (all scenarios) was modeled as a barrier soil liner, with user-defined soil properties referenced from recent NWLF CQA data from Unit 1 cell construction projects and a hydraulic conductivity of 1 x 10^{-7} cm/sec
- The granular leachate collection drainage layer (all scenarios) was modeled as a lateral drainage layer, HELP Default Soil Type 1 (SP in USCS, CoS in USDA), with a hydraulic conductivity of 1 x 10^{-2} cm/sec

Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill, Unit 2 EDOP	Checked by:	DVS
Date:	November 18, 2016	Reviewed by:	JAR

- The waste mass (all scenarios, varying thickness) was modeled as a vertical percolation layer, HELP default soil type 18 (municipal solid waste), with a hydraulic conductivity of 1×10^{-3} cm/sec
- Daily and intermediate cover (all scenarios) were modeled as a vertical percolation layer with user-defined soil properties from site-specific laboratory test data (Swift River 2016a) and a default hydraulic conductivity of 1.9×10^{-4} cm/sec for HELP Default Soil Type 10 (SC in USCS, SCL in USDA)
- The 30-inch-thick water balance final cover (Scenario 4) was modeled as a vertical percolation layer with user-defined soil properties from site-specific laboratory test data (Swift River 2016a) and a default hydraulic conductivity of 1.9×10^{-4} cm/sec for HELP Default Soil Type 10 (SC in USCS, SCL in USDA)

4.0 CONCLUSIONS/RESULTS

The results of the initial HELP Model analysis are summarized in Table 1 below:

Table 1: Initial Leachate Generation Analysis HELP Model Results

Scenario	Waste and Cover Configuration	Model Duration (yrs)	Peak Daily Head on Liner (inches)	Average Annual Liner Impingement (in/yr)
1	6 feet of waste with daily cover	1	4.28	0.9720
2	70 feet of waste with daily cover	1	4.28	0.9739
3	70 feet of waste with intermediate cover	10	8.10	0.4306
4	154 feet of waste with final cover	30	8.06	0.0826

The HELP Model output reports from the initial analysis are provided in Attachment 1.

The results of the initial analysis indicate that the peak daily head on liner is estimated to be greatest during intermediate and final cover conditions. This is to be expected as these operational scenarios are anticipated to have the longest durations. For each operational scenario and duration modelled, the calculated peak daily head on the alternative liner system is expected to be less than 12 inches throughout all open/daily cover, intermediate cover, and closed conditions of Unit 2.

The results of the initial analysis also indicated that the operational conditions modeled under both Scenarios 1 and 2 result in very similar critical leachate generation and impingement (i.e., leakage) rates through the alternative liner system. Since the HELP model is limited to a quasi-two-dimensional input model of a single geometrically-defined waste mass, the operational input parameters for Scenario 2 (i.e., the waste height, slope length) were further varied to evaluate the sensitivity of the impingement rate to changes in these parameters. The results of the sensitivity analysis are summarized in Table 2 below:

Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill, Unit 2 EDOP	Checked by:	DVS DS
Date:	November 18, 2016	Reviewed by:	JAR

Table 2: HELP Model Sensitivity Analysis Results

Scenario	Waste Thickness (ft)	Slope Length (ft)	Model Duration (yrs)	Average Annual Liner Impingement (in/yr)
2	70	845	1	0.9739
2A	80	845	1	0.9731
2B	90	845	1	0.9731
2C	60	845	1	0.9739
2D	70	800	1	0.9607
2E	70	700	1	0.9286
2F	70	500	1	0.8518

The HELP Model output report from the sensitivity analysis is provided in Attachment 2.

The results of the sensitivity analysis indicated that the base operational conditions modeled as Operational Scenario 2 (i.e., slope length of 845 feet and floor slope of 2.64%) result in the most critical leachate impingement rate of 0.9739 inches per year. This rate was used as the source infiltration rate input parameter to the MULTIMED model for the alternative liner performance demonstration.

5.0 ATTACHMENTS

Attachment 1: Operational Scenario HELP Model Results

Attachment 2: Sensitivity Analysis HELP Model Results

6.0 REFERENCES

Swift River Environmental Services, LLC (Swift River). 2016. Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development. June.

United States Army Corps of Engineers (USACE). 1997. Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.07. Waterways Experiment Station for USEPA Risk Reduction Engineering Laboratory. November 1.

ATTACHMENT 1

OPERATIONAL SCENARIO

HELP MODEL OUTPUT

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**
 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_1.D10
 OUTPUT DATA FILE:           C:\NW_OUT_1.OUT


 TIME:  11:42     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 1:6' WASTE WITH DAILY COVER
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	72.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0713	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.1630	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	33.235	INCHES
TOTAL INITIAL WATER	=	33.235	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0142	0.0012	0.0000	0.0000	0.0113	0.0933
FROM LAYER 3	0.1077	0.0877	0.0776	0.0595	0.0499	0.0397
PERCOLATION/LEAKAGE THROUGH	0.1066	0.0465	0.0015	0.0013	0.0469	0.1095
LAYER 4	0.1141	0.1125	0.1083	0.1102	0.1060	0.1086

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.259	0.023	0.000	0.000	0.207	1.756
TOP OF LAYER 4	1.962	1.599	1.461	1.085	0.940	0.724
STD. DEVIATION OF DAILY	0.095	0.034	0.000	0.000	0.291	0.331
HEAD ON TOP OF LAYER 4	0.210	0.156	0.113	0.134	0.051	0.117

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5421	1967.939	4.81
PERC./LEAKAGE THROUGH LAYER 4	0.971989	3528.322	8.62
AVG. HEAD ON TOP OF LAYER 4	0.8347		
CHANGE IN WATER STORAGE	0.019	70.123	0.17
SOIL WATER AT START OF YEAR	33.235	120643.547	
SOIL WATER AT END OF YEAR	33.254	120713.672	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0142	0.0012	0.0000	0.0000	0.0113	0.0933
	0.1077	0.0877	0.0776	0.0595	0.0499	0.0397
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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     TOTALS                  0.1066   0.0465   0.0015   0.0013   0.0469
0.1095
                             0.1141   0.1125   0.1083   0.1102   0.1060
0.1086

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.2592   0.0232   0.0000   0.0000   0.2068
1.7564
                             1.9624   1.5986   1.4610   1.0849   0.9403
0.7240

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
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  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
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EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.54213	(0.00000)	1967.939	4.80613
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.97199	(0.00000)	3528.322	8.61693
AVERAGE HEAD ON TOP OF LAYER 4	0.835	(0.000)		
CHANGE IN WATER STORAGE	0.019	(0.0000)	70.12	0.171

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00400	14.53152
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003722	13.51113
AVERAGE HEAD ON TOP OF LAYER 4	2.262	
MAXIMUM HEAD ON TOP OF LAYER 4	4.283	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	44.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	21.0239	0.2920
3	0.4666	0.0778
4	10.6800	0.4450
SNOW WATER	0.000	

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 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_2.D10
 OUTPUT DATA FILE:           C:\NW_OUT_2.OUT


 TIME:  11:43     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 2: 70'WASTE WITH DAILY COVER
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	840.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	257.494	INCHES
TOTAL INITIAL WATER	=	257.494	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0146	0.0013	0.0000	0.0000	0.0111	0.0919
FROM LAYER 3	0.1078	0.0879	0.0777	0.0597	0.0501	0.0399
PERCOLATION/LEAKAGE THROUGH	0.1066	0.0485	0.0015	0.0013	0.0468	0.1094
LAYER 4	0.1141	0.1125	0.1083	0.1102	0.1061	0.1086

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.265	0.026	0.000	0.000	0.202	1.730
TOP OF LAYER 4	1.965	1.603	1.463	1.088	0.943	0.726
STD. DEVIATION OF DAILY	0.095	0.036	0.000	0.000	0.288	0.349
HEAD ON TOP OF LAYER 4	0.209	0.156	0.113	0.134	0.051	0.117

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5419	1966.929	4.80
PERC./LEAKAGE THROUGH LAYER 4	0.973931	3535.370	8.63
AVG. HEAD ON TOP OF LAYER 4	0.8343		
CHANGE IN WATER STORAGE	0.018	64.030	0.16
SOIL WATER AT START OF YEAR	257.494	934701.875	
SOIL WATER AT END OF YEAR	257.511	934765.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.049	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0146	0.0013	0.0000	0.0000	0.0111	0.0919
	0.1078	0.0879	0.0777	0.0597	0.0501	0.0399
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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     TOTALS                  0.1066   0.0485   0.0015   0.0013   0.0468
0.1094
                             0.1141   0.1125   0.1083   0.1102   0.1061
0.1086

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.2653   0.0258   0.0000   0.0000   0.2020
1.7300
                             1.9647   1.6028   1.4633   1.0881   0.9431
0.7263

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
------
  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
```

EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.54185	(0.00000)	1966.929	4.80367
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.97393	(0.00000)	3535.370	8.63414
AVERAGE HEAD ON TOP OF LAYER 4	0.834	(0.000)		
CHANGE IN WATER STORAGE	0.018	(0.0000)	64.03	0.156

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                PEAK DAILY VALUES FOR YEARS    1 THROUGH    1
    ------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   ------------
       PRECIPITATION                               0.64          2323.200

       RUNOFF                                      0.117          423.7645

       DRAINAGE COLLECTED FROM LAYER  3            0.00400
14.52650

       PERCOLATION/LEAKAGE THROUGH LAYER  4        0.003722
13.51072

       AVERAGE HEAD ON TOP OF LAYER  4             2.261

       MAXIMUM HEAD ON TOP OF LAYER  4             4.281

       LOCATION OF MAXIMUM HEAD IN LAYER  3
             (DISTANCE FROM DRAIN)                44.4 FEET

       SNOW WATER                                  0.41          1476.5393


       MAXIMUM VEG. SOIL WATER (VOL/VOL)                  0.2614

       MINIMUM VEG. SOIL WATER (VOL/VOL)                  0.1330


        ***  Maximum heads are computed using McEnroe's equations.  ***

             Reference:  Maximum Saturated Depth over Landfill Liner
                         by Bruce M. McEnroe, University of Kansas
                         ASCE Journal of Environmental Engineering
                         Vol. 119, No. 2, March 1993, pp. 262-270.


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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	245.2799	0.2920
3	0.4674	0.0779
4	10.6800	0.4450
SNOW WATER	0.000	

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**
 **   HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **   HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)
**
 **   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **   USAE WATERWAYS EXPERIMENT STATION
**
 **   FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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PRECIPITATION DATA FILE: C:\NWPREC1.D4
TEMPERATURE DATA FILE: C:\NWTEMP1.D7
SOLAR RADIATION DATA FILE: C:\NWRAD1.D13
EVAPOTRANSPIRATION DATA: C:\NWEVAP12.D11
SOIL AND DESIGN DATA FILE: C:\NW_SD_3.D10
OUTPUT DATA FILE: C:\NW_OUT_3.OUT

TIME: 11:44   DATE: 11/16/2016

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      TITLE: NORTH WELD LANDFILL SCENARIO 3: 70'WASTE WITH INT COVER

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1774	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	840.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.129	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.716	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.596	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	258.359	INCHES
TOTAL INITIAL WATER	=	258.359	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39
0.11					
RUNOFF	0.000	0.000	0.117	0.000	0.000
0.000					
	0.000	0.000	0.000	0.000	0.000
0.000					
EVAPOTRANSPIRATION	0.146	0.241	0.757	0.500	1.714
0.927					
	2.635	0.666	1.633	0.533	1.400
0.189					
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0007
0.0232					
FROM LAYER 3	0.0079	0.0000	0.0000	0.0000	0.0000
0.0000					
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0003	0.0001	0.0001	0.0145
0.1039					
LAYER 4	0.1041	0.0000	0.0002	0.0011	0.0017
0.0051					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.012
0.437					
TOP OF LAYER 4	0.144	0.000	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.043
0.071					
HEAD ON TOP OF LAYER 4	0.089	0.000	0.000	0.000	0.000
0.002					

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	11.340	41165.992	100.54
DRAINAGE COLLECTED FROM LAYER 3	0.0318	115.507	0.28
PERC./LEAKAGE THROUGH LAYER 4	0.231000	838.529	2.05
AVG. HEAD ON TOP OF LAYER 4	0.0495		
CHANGE IN WATER STORAGE	-0.440	-1597.430	-3.90
SOIL WATER AT START OF YEAR	258.359	937843.187	
SOIL WATER AT END OF YEAR	257.919	936245.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.78	0.84	0.62	1.52	3.26	4.29
	1.89	0.54	1.27	0.12	0.30	0.90
RUNOFF	0.005	0.014	0.057	0.000	0.022	0.013
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.574	0.739	0.330	1.353	2.961	3.897
	1.457	1.093	0.730	0.360	0.441	0.603
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0253	0.0349
FROM LAYER 3	0.1122	0.0891	0.0601	0.0390	0.0185	0.0032
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0817	0.1048
LAYER 4	0.1144	0.1126	0.1069	0.1086	0.1035	0.0666

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.462	0.657
TOP OF LAYER 4	2.044	1.625	1.132	0.710	0.349	0.059
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.409	0.085
HEAD ON TOP OF LAYER 4	0.322	0.159	0.131	0.116	0.096	0.063

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.33	59277.898	100.00
RUNOFF	0.111	402.739	0.68
EVAPOTRANSPIRATION	14.538	52771.543	89.02
DRAINAGE COLLECTED FROM LAYER 3	0.3823	1387.847	2.34
PERC./LEAKAGE THROUGH LAYER 4	0.799071	2900.628	4.89
AVG. HEAD ON TOP OF LAYER 4	0.5864		
CHANGE IN WATER STORAGE	0.500	1815.111	3.06
SOIL WATER AT START OF YEAR	257.919	936245.750	
SOIL WATER AT END OF YEAR	258.419	938060.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.22	0.22	1.29	2.48	1.42	1.28
	0.86	0.51	1.78	1.43	0.28	0.47
RUNOFF	0.000	0.000	0.236	0.285	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.005
EVAPOTRANSPIRATION	0.220	0.135	0.460	2.704	1.428	1.774
	0.393	0.409	1.544	1.057	0.927	0.373
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0095	0.0198	0.0038
FROM LAYER 3	0.0000	0.0000	0.0003	0.0001	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0501	0.1070	0.0722
LAYER 4	0.0000	0.0001	0.0243	0.0224	0.0137	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.179	0.361	0.072
TOP OF LAYER 4	0.000	0.000	0.006	0.001	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.233	0.094	0.069

HEAD ON TOP OF LAYER 4	0.000	0.000	0.014	0.002	0.001	0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.24	44431.207	100.00
RUNOFF	0.526	1908.257	4.29
EVAPOTRANSPIRATION	11.423	41466.527	93.33
DRAINAGE COLLECTED FROM LAYER 3	0.0335	121.783	0.27
PERC./LEAKAGE THROUGH LAYER 4	0.289900	1052.336	2.37
AVG. HEAD ON TOP OF LAYER 4	0.0516		
CHANGE IN WATER STORAGE	-0.032	-117.647	-0.26
SOIL WATER AT START OF YEAR	258.419	938060.875	
SOIL WATER AT END OF YEAR	258.387	937943.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.049	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.17	0.59	0.59	0.77	1.97	1.30
	1.46	1.41	0.99	0.74	1.20	0.53
RUNOFF	0.000	0.000	0.004	0.001	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
EVAPOTRANSPIRATION	0.188	0.564	0.508	0.296	1.949	1.876
	0.757	1.483	1.366	0.586	0.639	0.654
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0010	0.0395
FROM LAYER 3	0.0238	0.0061	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0010	0.0000	0.0000	0.0342	0.1052
LAYER 4	0.1073	0.0911	0.0004	0.0017	0.0001	0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.019
0.743					
TOP OF LAYER 4	0.433	0.111	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.042
0.146					
HEAD ON TOP OF LAYER 4	0.103	0.084	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.72	42543.613	100.00
RUNOFF	0.006	20.514	0.05
EVAPOTRANSPIRATION	10.865	39440.527	92.71
DRAINAGE COLLECTED FROM LAYER 3	0.0703	255.221	0.60
PERC./LEAKAGE THROUGH LAYER 4	0.341309	1238.951	2.91
AVG. HEAD ON TOP OF LAYER 4	0.1088		
CHANGE IN WATER STORAGE	0.438	1588.347	3.73
SOIL WATER AT START OF YEAR	258.387	937943.250	
SOIL WATER AT END OF YEAR	258.824	939531.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.055	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.66	0.05	1.17	1.00	1.59	0.80
	1.51	2.03	2.55	1.00	0.68	0.08
RUNOFF	0.136	0.000	0.000	0.030	0.000	0.000
	0.004	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.330	0.494	0.790	1.606	1.992	0.406
	1.288	1.840	2.453	0.881	1.107	0.488
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0003	0.0001	0.0160	0.0075	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0025	0.0047	0.0010	0.0000
LAYER 4	0.0179	0.0201	0.0996	0.1009	0.0018	0.0003

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.006	0.002	0.302	0.136	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.015	0.004	0.172	0.089	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.12	47625.602	100.00
RUNOFF	0.171	619.090	1.30
EVAPOTRANSPIRATION	13.675	49639.984	104.23
DRAINAGE COLLECTED FROM LAYER 3	0.0239	86.869	0.18
PERC./LEAKAGE THROUGH LAYER 4	0.248775	903.053	1.90
AVG. HEAD ON TOP OF LAYER 4	0.0372		
CHANGE IN WATER STORAGE	-0.998	-3623.353	-7.61

SOIL WATER AT START OF YEAR	258.824	939531.562
SOIL WATER AT END OF YEAR	257.826	935908.250
SNOW WATER AT START OF YEAR	0.000	0.000
SNOW WATER AT END OF YEAR	0.000	0.000
ANNUAL WATER BUDGET BALANCE	0.0000	-0.039

0.00

0.00

0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 6

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.13	0.58	1.30	0.90	6.33	2.22
	1.94	0.79	2.02	0.05	0.04	0.41
RUNOFF	0.000	0.009	0.115	0.000	0.379	0.003
	0.000	0.000	0.008	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.130	0.186	0.671	0.631	4.629	2.868
	1.136	0.908	2.002	0.415	0.040	0.327
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0531	0.2137

FROM LAYER 3	0.1759	0.1357	0.1291	0.1174	0.0834	0.0595
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0017	0.0801	0.1192
LAYER 4	0.1195	0.1163	0.1124	0.1149	0.1087	0.1102

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.968	4.024
TOP OF LAYER 4	3.206	2.473	2.432	2.140	1.571	1.085
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	1.210	0.240
HEAD ON TOP OF LAYER 4	0.233	0.198	0.291	0.183	0.152	0.134

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.71	60657.316	100.00
RUNOFF	0.513	1862.365	3.07
EVAPOTRANSPIRATION	13.943	50611.609	83.44
DRAINAGE COLLECTED FROM LAYER 3	0.9680	3513.711	5.79

PERC./LEAKAGE THROUGH LAYER 4	0.882966	3205.167	5.28
AVG. HEAD ON TOP OF LAYER 4	1.4917		
CHANGE IN WATER STORAGE	0.403	1464.402	2.41
SOIL WATER AT START OF YEAR	257.826	935908.250	
SOIL WATER AT END OF YEAR	258.161	937123.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.069	249.380	0.41
ANNUAL WATER BUDGET BALANCE	0.0000	0.064	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 7

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.57	0.45	1.75	2.18	1.23	3.28
	0.86	1.55	0.29	0.68	0.28	0.39
RUNOFF	0.020	0.018	0.000	0.320	0.000	0.006
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	0.287	0.190	1.329	1.781	1.486
3.230					
	0.737	1.568	0.808	0.227	0.487
0.383					
LATERAL DRAINAGE COLLECTED	0.0364	0.0158	0.0040	0.0048	0.0098
0.0020					
FROM LAYER 3	0.0000	0.0014	0.0052	0.0000	0.0000
0.0000					
PERCOLATION/LEAKAGE THROUGH	0.1084	0.0965	0.1047	0.0575	0.1062
0.0878					
LAYER 4	0.0047	0.0218	0.0879	0.0000	0.0001
0.0000					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.663	0.319	0.073	0.091	0.178
0.038					
TOP OF LAYER 4	0.000	0.026	0.097	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.114	0.089	0.046	0.127	0.060
0.024					
HEAD ON TOP OF LAYER 4	0.002	0.067	0.070	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.51	49041.297	100.00

RUNOFF	0.364	1320.325	2.69
EVAPOTRANSPIRATION	12.514	45425.711	92.63
DRAINAGE COLLECTED FROM LAYER 3	0.0793	288.018	0.59
PERC./LEAKAGE THROUGH LAYER 4	0.675639	2452.569	5.00
AVG. HEAD ON TOP OF LAYER 4	0.1237		
CHANGE IN WATER STORAGE	-0.123	-445.348	-0.91
SOIL WATER AT START OF YEAR	258.161	937123.250	
SOIL WATER AT END OF YEAR	258.107	936927.312	
SNOW WATER AT START OF YEAR	0.069	249.380	0.51
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.024	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 8

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.30	0.21	0.55	1.42	0.76	2.50

	1.80	2.02	0.57	0.62	0.17	0.22
RUNOFF	0.244	0.000	0.000	0.000	0.000	0.006
	0.000	0.005	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.387	0.263	0.470	1.823	0.618	2.337
	1.967	1.030	1.665	0.482	0.321	0.233
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0007	0.0000	0.0005
FROM LAYER 3	0.0236	0.0072	0.0023	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0002	0.0387	0.0041	0.0175
LAYER 4	0.1073	0.1001	0.0724	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.012	0.000	0.009
TOP OF LAYER 4	0.431	0.132	0.044	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.020	0.001	0.031
HEAD ON TOP OF LAYER 4	0.096	0.086	0.041	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.14	44068.203	100.00
RUNOFF	0.255	924.705	2.10
EVAPOTRANSPIRATION	11.596	42092.566	95.52
DRAINAGE COLLECTED FROM LAYER 3	0.0343	124.621	0.28
PERC./LEAKAGE THROUGH LAYER 4	0.340391	1235.619	2.80
AVG. HEAD ON TOP OF LAYER 4	0.0523		
CHANGE IN WATER STORAGE	-0.085	-309.294	-0.70
SOIL WATER AT START OF YEAR	258.107	936927.312	
SOIL WATER AT END OF YEAR	258.021	936618.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.011	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 9

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.25	0.19	1.76	1.12	2.13	0.87
	1.99	1.02	1.03	0.58	0.23	0.07
RUNOFF	0.000	0.000	0.061	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.178	0.282	0.432	1.936	1.886	1.545
	1.566	0.897	1.514	0.608	0.393	0.070
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0535	0.0084	0.0010
LAYER 4	0.0008	0.0000	0.0020	0.0008	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.015	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.020	0.001	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.24	40801.203	100.00
RUNOFF	0.061	222.202	0.54
EVAPOTRANSPIRATION	11.307	41044.742	100.60
DRAINAGE COLLECTED FROM LAYER 3	0.0008	2.989	0.01
PERC./LEAKAGE THROUGH LAYER 4	0.066407	241.056	0.59
AVG. HEAD ON TOP OF LAYER 4	0.0013		
CHANGE IN WATER STORAGE	-0.196	-709.760	-1.74
SOIL WATER AT START OF YEAR	258.021	936618.000	
SOIL WATER AT END OF YEAR	257.826	935908.250	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.027	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.48	0.68	0.25	2.55	0.82	2.44
	2.82	1.86	1.20	1.00	0.03	0.53
RUNOFF	0.002	0.000	0.000	0.000	0.000	0.000
	0.001	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.406	0.457	0.227	1.982	0.846	1.950
	3.445	1.253	1.441	0.953	0.364	0.204
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0030	0.0515	0.0297	0.0126	0.0006	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0001	0.0008	0.0033	0.0112
LAYER 4	0.0660	0.1096	0.1044	0.1065	0.0291	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.055	0.939	0.559	0.230	0.011	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000

HEAD ON TOP OF LAYER 4 0.111 0.120 0.103 0.091 0.022
0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.66	53215.805	100.00
RUNOFF	0.002	7.818	0.01
EVAPOTRANSPIRATION	13.529	49110.027	92.28
DRAINAGE COLLECTED FROM LAYER 3	0.0975	353.839	0.66
PERC./LEAKAGE THROUGH LAYER 4	0.430907	1564.192	2.94
AVG. HEAD ON TOP OF LAYER 4	0.1496		
CHANGE IN WATER STORAGE	0.601	2179.863	4.10
SOIL WATER AT START OF YEAR	257.826	935908.250	
SOIL WATER AT END OF YEAR	258.061	936761.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.366	1326.977	2.49
ANNUAL WATER BUDGET BALANCE	0.0000	0.066	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.46	0.39	1.04	1.44	2.15	1.99
	1.76	1.27	1.34	0.72	0.36	0.37
STD. DEVIATIONS	0.38	0.28	0.52	0.73	1.64	1.17
	0.63	0.59	0.68	0.42	0.35	0.26
RUNOFF						
TOTALS	0.041	0.004	0.059	0.064	0.040	0.003
	0.001	0.001	0.001	0.000	0.000	0.001
STD. DEVIATIONS	0.083	0.007	0.078	0.126	0.119	0.004
	0.001	0.002	0.003	0.000	0.000	0.001
EVAPOTRANSPIRATION						
TOTALS	0.285	0.355	0.597	1.461	1.951	2.081
	1.538	1.115	1.516	0.610	0.612	0.352
STD. DEVIATIONS	0.141	0.198	0.313	0.766	1.142	1.048

	0.932	0.433	0.505	0.271	0.413	0.188

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0036	0.0016	0.0004	0.0016	0.0110	0.0318
	0.0347	0.0291	0.0243	0.0177	0.0103	0.0063
STD. DEVIATIONS	0.0115	0.0050	0.0013	0.0032	0.0175	0.0657
	0.0603	0.0479	0.0416	0.0371	0.0264	0.0187

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0108	0.0098	0.0108	0.0207	0.0441	0.0623
	0.0642	0.0572	0.0610	0.0457	0.0259	0.0182
STD. DEVIATIONS	0.0343	0.0305	0.0330	0.0256	0.0446	0.0490
	0.0524	0.0524	0.0485	0.0539	0.0433	0.0384

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0663	0.0319	0.0073	0.0298	0.2001	0.5981
	0.6321	0.5305	0.4572	0.3217	0.1932	0.1144
STD. DEVIATIONS	0.2097	0.1008	0.0230	0.0595	0.3186	1.2382
	1.0986	0.8724	0.7832	0.6766	0.4963	0.3415

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.30 (2.001)	48260.9	100.00
RUNOFF	0.212 (0.1956)	771.18	1.598
EVAPOTRANSPIRATION	12.473 (1.3368)	45276.92	93.817
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.17219 (0.30024)	625.040	1.29513
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.43064 (0.26706)	1563.210	3.23908
AVERAGE HEAD ON TOP OF LAYER 4	0.265 (0.462)		
CHANGE IN WATER STORAGE	0.007 (0.4962)	24.49	0.051

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 10

	(INCHES)	(CU. FT.)
PRECIPITATION	1.96	7114.800
RUNOFF	0.379	1374.9197
DRAINAGE COLLECTED FROM LAYER 3	0.00783	28.41975
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.004028	14.62322
AVERAGE HEAD ON TOP OF LAYER 4	4.423	
MAXIMUM HEAD ON TOP OF LAYER 4	8.103	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	70.5 FEET	
SNOW WATER	0.64	2324.3435

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2936
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 10

LAYER	(INCHES)	(VOL/VOL)
1	1.8310	0.1526
2	245.2799	0.2920
3	0.2700	0.0450
4	10.6800	0.4450
SNOW WATER	0.366	

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 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP12.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_4.D10
 OUTPUT DATA FILE:           C:\NW_OUT_4.OUT


 TIME:  11:46     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 4: 156' WASTE WITH FINAL COVER
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	30.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2468	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1876.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.129	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	4.716	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.596	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	566.146	INCHES
TOTAL INITIAL WATER	=	566.146	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	12.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.146	0.241	0.757	0.500	1.714	0.927
	2.635	0.666	1.633	0.533	1.400	0.189
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0014	0.0227
FROM LAYER 3	0.0074	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0003	0.0001	0.0001	0.0180	0.1039
LAYER 4	0.1010	0.0000	0.0002	0.0011	0.0017	0.0051

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.025	0.427
TOP OF LAYER 4	0.136	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.068	0.070
HEAD ON TOP OF LAYER 4	0.088	0.000	0.000	0.000	0.000	0.002

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	11.340	41165.992	100.54
DRAINAGE COLLECTED FROM LAYER 3	0.0315	114.335	0.28
PERC./LEAKAGE THROUGH LAYER 4	0.231322	839.701	2.05
AVG. HEAD ON TOP OF LAYER 4	0.0490		
CHANGE IN WATER STORAGE	-0.440	-1597.209	-3.90
SOIL WATER AT START OF YEAR	566.146	2055110.620	
SOIL WATER AT END OF YEAR	565.706	2053513.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.179	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.78	0.84	0.62	1.52	3.26	4.29
	1.89	0.54	1.27	0.12	0.30	0.90
RUNOFF	0.005	0.014	0.057	0.000	0.022	0.013
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.574	0.739	0.330	1.353	2.961	3.897
	1.457	1.093	0.730	0.360	0.441	0.603
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0255	0.0361
FROM LAYER 3	0.1100	0.0890	0.0600	0.0389	0.0184	0.0032
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0834	0.1049
LAYER 4	0.1143	0.1126	0.1069	0.1086	0.1035	0.0662

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.464	0.680
TOP OF LAYER 4	2.004	1.623	1.130	0.709	0.347	0.058
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.389	0.127
HEAD ON TOP OF LAYER 4	0.344	0.159	0.131	0.116	0.096	0.063

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.33	59277.898	100.00
RUNOFF	0.111	402.739	0.68
EVAPOTRANSPIRATION	14.538	52771.543	89.02
DRAINAGE COLLECTED FROM LAYER 3	0.3811	1383.335	2.33
PERC./LEAKAGE THROUGH LAYER 4	0.800314	2905.139	4.90
AVG. HEAD ON TOP OF LAYER 4	0.5846		
CHANGE IN WATER STORAGE	0.500	1815.000	3.06
SOIL WATER AT START OF YEAR	565.706	2053513.370	
SOIL WATER AT END OF YEAR	566.206	2055328.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.144	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 3

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.22	0.22	1.29	2.48	1.42	1.28
	0.86	0.51	1.78	1.43	0.28	0.47
RUNOFF	0.000	0.000	0.236	0.285	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.005
EVAPOTRANSPIRATION	0.220	0.135	0.460	2.704	1.428	1.774
	0.393	0.409	1.544	1.057	0.927	0.373
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0100	0.0197	0.0038
FROM LAYER 3	0.0000	0.0000	0.0003	0.0001	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0501	0.1070	0.0718
LAYER 4	0.0000	0.0001	0.0243	0.0224	0.0137	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.188	0.360	0.071
TOP OF LAYER 4	0.000	0.000	0.006	0.001	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.240	0.094	0.069

HEAD ON TOP OF LAYER 4 0.000 0.000 0.014 0.002 0.001
0.000

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.24	44431.207	100.00
RUNOFF	0.526	1908.257	4.29
EVAPOTRANSPIRATION	11.423	41466.527	93.33
DRAINAGE COLLECTED FROM LAYER 3	0.0339	123.143	0.28
PERC./LEAKAGE THROUGH LAYER 4	0.289525	1050.976	2.37
AVG. HEAD ON TOP OF LAYER 4	0.0522		
CHANGE IN WATER STORAGE	-0.032	-117.647	-0.26
SOIL WATER AT START OF YEAR	566.206	2055328.370	
SOIL WATER AT END OF YEAR	566.174	2055210.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.049	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 4

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.17	0.59	0.59	0.77	1.97	1.30
	1.46	1.41	0.99	0.74	1.20	0.53
RUNOFF	0.000	0.000	0.004	0.001	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.001
EVAPOTRANSPIRATION	0.188	0.564	0.508	0.296	1.949	1.876
	0.757	1.483	1.366	0.586	0.639	0.654
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0013	0.0389
FROM LAYER 3	0.0238	0.0061	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0010	0.0000	0.0000	0.0343	0.1052
LAYER 4	0.1074	0.0913	0.0004	0.0017	0.0001	0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.024
0.733					
TOP OF LAYER 4	0.434	0.111	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.059
0.148					
HEAD ON TOP OF LAYER 4	0.103	0.084	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.72	42543.613	100.00
RUNOFF	0.006	20.514	0.05
EVAPOTRANSPIRATION	10.865	39440.527	92.71
DRAINAGE COLLECTED FROM LAYER 3	0.0701	254.559	0.60
PERC./LEAKAGE THROUGH LAYER 4	0.341491	1239.613	2.91
AVG. HEAD ON TOP OF LAYER 4	0.1085		
CHANGE IN WATER STORAGE	0.438	1588.347	3.73
SOIL WATER AT START OF YEAR	566.174	2055210.750	
SOIL WATER AT END OF YEAR	566.611	2056799.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.055	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.66	0.05	1.17	1.00	1.59	0.80
	1.51	2.03	2.55	1.00	0.68	0.08
RUNOFF	0.136	0.000	0.000	0.030	0.000	0.000
	0.004	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.330	0.494	0.790	1.606	1.992	0.406
	1.288	1.840	2.453	0.881	1.107	0.488
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0003	0.0001	0.0159	0.0075	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0025	0.0047	0.0010	0.0000
LAYER 4	0.0179	0.0201	0.0996	0.1009	0.0018	0.0003

 ---------- MONTHLY SUMMARIES FOR DAILY HEADS (INCHES) ----------

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.006	0.002	0.300	0.136	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000
HEAD ON TOP OF LAYER 4	0.015	0.004	0.171	0.089	0.000	0.000

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.12	47625.602	100.00
RUNOFF	0.171	619.090	1.30
EVAPOTRANSPIRATION	13.675	49639.984	104.23
DRAINAGE COLLECTED FROM LAYER 3	0.0239	86.637	0.18
PERC./LEAKAGE THROUGH LAYER 4	0.248839	903.285	1.90
AVG. HEAD ON TOP OF LAYER 4	0.0371		
CHANGE IN WATER STORAGE	-0.998	-3623.353	-7.61

SOIL WATER AT START OF YEAR	566.611	2056799.120
SOIL WATER AT END OF YEAR	565.613	2053175.750
SNOW WATER AT START OF YEAR	0.000	0.000
SNOW WATER AT END OF YEAR	0.000	0.000
ANNUAL WATER BUDGET BALANCE	0.0000	-0.039

0.00

0.00

0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 6

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.13	0.58	1.30	0.90	6.33	2.22
	1.94	0.79	2.02	0.05	0.04	0.41
RUNOFF	0.000	0.009	0.115	0.000	0.379	0.003
	0.000	0.000	0.008	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.130	0.186	0.671	0.631	4.629	2.868
	1.136	0.908	2.002	0.415	0.040	0.327
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0438	0.2120

FROM LAYER 3	0.1774	0.1369	0.1301	0.1183	0.0842	0.0602
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0017	0.0807	0.1190
LAYER 4	0.1197	0.1164	0.1125	0.1149	0.1088	0.1103

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.799	3.992
TOP OF LAYER 4	3.233	2.495	2.450	2.157	1.586	1.097
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	1.024	0.257
HEAD ON TOP OF LAYER 4	0.234	0.199	0.270	0.184	0.152	0.134

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.71	60657.316	100.00
RUNOFF	0.513	1862.365	3.07
EVAPOTRANSPIRATION	13.943	50611.609	83.44
DRAINAGE COLLECTED FROM LAYER 3	0.9629	3495.366	5.76

PERC./LEAKAGE THROUGH LAYER 4	0.883829	3208.299	5.29
AVG. HEAD ON TOP OF LAYER 4	1.4840		
CHANGE IN WATER STORAGE	0.408	1479.689	2.44
SOIL WATER AT START OF YEAR	565.613	2053175.750	
SOIL WATER AT END OF YEAR	565.952	2054406.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.069	249.380	0.41
ANNUAL WATER BUDGET BALANCE	0.0000	-0.011	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 7

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.57	0.45	1.75	2.18	1.23	3.28
	0.86	1.55	0.29	0.68	0.28	0.39
RUNOFF	0.020	0.018	0.000	0.320	0.000	0.006
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	0.287	0.190	1.329	1.781	1.486
3.230					
	0.737	1.568	0.808	0.227	0.487
0.383					
LATERAL DRAINAGE COLLECTED	0.0369	0.0162	0.0044	0.0048	0.0098
0.0020					
FROM LAYER 3	0.0000	0.0014	0.0051	0.0000	0.0000
0.0000					
PERCOLATION/LEAKAGE THROUGH	0.1084	0.0965	0.1058	0.0591	0.1062
0.0879					
LAYER 4	0.0047	0.0226	0.0872	0.0000	0.0001
0.0000					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.673	0.328	0.080	0.090	0.178
0.038					
TOP OF LAYER 4	0.000	0.026	0.095	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.115	0.089	0.046	0.124	0.060
0.024					
HEAD ON TOP OF LAYER 4	0.002	0.069	0.069	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.51	49041.297	100.00

RUNOFF	0.364	1320.325	2.69
EVAPOTRANSPIRATION	12.514	45425.711	92.63
DRAINAGE COLLECTED FROM LAYER 3	0.0806	292.724	0.60
PERC./LEAKAGE THROUGH LAYER 4	0.678533	2463.076	5.02
AVG. HEAD ON TOP OF LAYER 4	0.1257		
CHANGE IN WATER STORAGE	-0.127	-460.746	-0.94
SOIL WATER AT START OF YEAR	565.952	2054406.120	
SOIL WATER AT END OF YEAR	565.894	2054194.750	
SNOW WATER AT START OF YEAR	0.069	249.380	0.51
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0001	0.210	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 8

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.30	0.21	0.55	1.42	0.76	2.50

	1.80	2.02	0.57	0.62	0.17	0.22
RUNOFF	0.244	0.000	0.000	0.000	0.000	0.006
	0.000	0.005	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.387	0.263	0.470	1.823	0.618	2.337
	1.967	1.030	1.665	0.482	0.321	0.233
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0007	0.0000	0.0011
FROM LAYER 3	0.0233	0.0071	0.0023	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0002	0.0387	0.0041	0.0184
LAYER 4	0.1073	0.0991	0.0724	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.012	0.000	0.021
TOP OF LAYER 4	0.425	0.129	0.044	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.020	0.001	0.060
HEAD ON TOP OF LAYER 4	0.095	0.086	0.041	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.14	44068.203	100.00
RUNOFF	0.255	924.705	2.10
EVAPOTRANSPIRATION	11.596	42092.566	95.52
DRAINAGE COLLECTED FROM LAYER 3	0.0345	125.103	0.28
PERC./LEAKAGE THROUGH LAYER 4	0.340258	1235.138	2.80
AVG. HEAD ON TOP OF LAYER 4	0.0526		
CHANGE IN WATER STORAGE	-0.085	-309.294	-0.70
SOIL WATER AT START OF YEAR	565.894	2054194.750	
SOIL WATER AT END OF YEAR	565.809	2053885.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.012	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 9

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.25	0.19	1.76	1.12	2.13	0.87
	1.99	1.02	1.03	0.58	0.23	0.07
RUNOFF	0.000	0.000	0.061	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.178	0.282	0.432	1.936	1.886	1.545
	1.566	0.897	1.514	0.608	0.393	0.070
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0535	0.0084	0.0010
LAYER 4	0.0008	0.0000	0.0020	0.0008	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.015	0.000	0.000
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.020	0.001	0.000
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.24	40801.203	100.00
RUNOFF	0.061	222.202	0.54
EVAPOTRANSPIRATION	11.307	41044.742	100.60
DRAINAGE COLLECTED FROM LAYER 3	0.0008	2.988	0.01
PERC./LEAKAGE THROUGH LAYER 4	0.066407	241.057	0.59
AVG. HEAD ON TOP OF LAYER 4	0.0013		
CHANGE IN WATER STORAGE	-0.195	-709.649	-1.74
SOIL WATER AT START OF YEAR	565.809	2053885.370	
SOIL WATER AT END OF YEAR	565.613	2053175.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.138	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 10

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.48	0.68	0.25	2.55	0.82	2.44
	2.82	1.86	1.20	1.00	0.03	0.53
RUNOFF	0.002	0.000	0.000	0.000	0.000	0.000
	0.001	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.406	0.457	0.227	1.982	0.846	1.950
	3.445	1.253	1.441	0.953	0.364	0.204
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
FROM LAYER 3	0.0030	0.0502	0.0296	0.0125	0.0006	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0001	0.0008	0.0033	0.0112
LAYER 4	0.0686	0.1095	0.1044	0.1064	0.0283	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.000
TOP OF LAYER 4	0.055	0.915	0.557	0.228	0.011	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.000

HEAD ON TOP OF LAYER 4 0.088 0.134 0.103 0.091 0.021
0.000

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.66	53215.805	100.00
RUNOFF	0.002	7.818	0.01
EVAPOTRANSPIRATION	13.529	49110.027	92.28
DRAINAGE COLLECTED FROM LAYER 3	0.0959	347.957	0.65
PERC./LEAKAGE THROUGH LAYER 4	0.432527	1570.074	2.95
AVG. HEAD ON TOP OF LAYER 4	0.1471		
CHANGE IN WATER STORAGE	0.600	2179.752	4.10
SOIL WATER AT START OF YEAR	565.613	2053175.750	
SOIL WATER AT END OF YEAR	565.848	2054028.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.366	1326.977	2.49
ANNUAL WATER BUDGET BALANCE	0.0000	0.177	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 11

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.16	0.47	0.75	0.78	1.74	1.48
	1.41	1.54	0.95	0.65	1.20	0.55
RUNOFF	0.018	0.000	0.014	0.000	0.017	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.315	0.470	0.563	0.516	2.211	1.760
	0.411	1.612	1.408	0.850	0.609	0.534
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0028	0.0014
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0002	0.0377	0.0562
LAYER 4	0.0001	0.0003	0.0019	0.0004	0.0013	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.051
0.027					
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.075
0.038					
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.68	42398.414	100.00
RUNOFF	0.048	175.457	0.41
EVAPOTRANSPIRATION	11.257	40861.559	96.38
DRAINAGE COLLECTED FROM LAYER 3	0.0042	15.334	0.04
PERC./LEAKAGE THROUGH LAYER 4	0.098163	356.330	0.84
AVG. HEAD ON TOP OF LAYER 4	0.0065		
CHANGE IN WATER STORAGE	0.273	989.851	2.33
SOIL WATER AT START OF YEAR	565.848	2054028.500	
SOIL WATER AT END OF YEAR	566.486	2056345.370	
SNOW WATER AT START OF YEAR	0.366	1326.977	3.13

SNOW WATER AT END OF YEAR	0.000	0.000
0.00		
ANNUAL WATER BUDGET BALANCE	0.0000	-0.117
0.00		

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MONTHLY TOTALS (IN INCHES) FOR YEAR 12

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.47	0.18	0.58	1.56	1.75	1.43
	1.39	1.23	1.29	0.23	0.89	0.53
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.470	0.215	0.564	1.506	1.935	1.287
	1.793	0.833	1.445	0.742	0.450	0.494
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000
FROM LAYER 3	0.0012	0.0010	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0007	0.0474	0.0065
LAYER 4	0.0354	0.0414	0.0082	0.0007	0.0018	0.0001

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                     MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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 AVERAGE DAILY HEAD ON            0.000   0.000   0.000   0.000   0.013
0.000
   TOP OF LAYER  4                0.021   0.019   0.000   0.000   0.000
0.000

 STD. DEVIATION OF DAILY          0.000   0.000   0.000   0.000   0.016
0.001
   HEAD ON TOP OF LAYER  4        0.044   0.031   0.000   0.000   0.000
0.000

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                             ANNUAL TOTALS FOR YEAR   12
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                                          INCHES          CU. FEET
PERCENT
                                        --------        ----------    --
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   PRECIPITATION                          11.53          41853.914
100.00

   RUNOFF                                  0.000             0.000
0.00

   EVAPOTRANSPIRATION                     11.734          42593.227
101.77

   DRAINAGE COLLECTED FROM LAYER  3        0.0029           10.619
0.03

   PERC./LEAKAGE THROUGH LAYER  4          0.142245        516.351
1.23

   AVG. HEAD ON TOP OF LAYER  4            0.0045

   CHANGE IN WATER STORAGE                -0.349          -1266.313     -
3.03
```

SOIL WATER AT START OF YEAR	566.486	2056345.370
SOIL WATER AT END OF YEAR	566.040	2054725.120
SNOW WATER AT START OF YEAR	0.000	0.000
SNOW WATER AT END OF YEAR	0.098	353.937
ANNUAL WATER BUDGET BALANCE	0.0000	0.030

0.00

0.85

0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 13

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.00	0.16	0.64	0.86	3.64	1.42
	1.39	0.99	1.24	0.24	0.60	0.00
RUNOFF	0.000	0.000	0.000	0.000	0.009	0.001
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.098	0.112	0.490	0.714	3.166	1.181
	1.852	0.712	1.665	0.512	0.343	0.073
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0091	0.0570

FROM LAYER 3	0.0367	0.0174	0.0022	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0001	0.0433	0.1066
LAYER 4	0.1084	0.1068	0.0564	0.0000	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.165	1.074
TOP OF LAYER 4	0.670	0.316	0.042	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.251	0.122
HEAD ON TOP OF LAYER 4	0.110	0.098	0.051	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.18	40583.410	100.00
RUNOFF	0.009	34.127	0.08
EVAPOTRANSPIRATION	10.918	39632.270	97.66
DRAINAGE COLLECTED FROM LAYER 3	0.1225	444.573	1.10

PERC./LEAKAGE THROUGH LAYER 4	0.421707	1530.797	3.77
AVG. HEAD ON TOP OF LAYER 4	0.1890		
CHANGE IN WATER STORAGE	-0.292	-1058.491	-2.61
SOIL WATER AT START OF YEAR	566.040	2054725.120	
SOIL WATER AT END OF YEAR	565.846	2054020.620	
SNOW WATER AT START OF YEAR	0.098	353.937	0.87
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.137	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 14

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.42	0.10	0.93	0.77	2.34	1.35
	0.94	1.72	2.54	0.93	0.15	0.08
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	0.420	0.118	0.385	0.508	2.703	0.770
	1.241	1.726	2.461	0.881	0.363	0.333
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000
FROM LAYER 3	0.0000	0.0000	0.0011	0.0023	0.0001	0.0002
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0007	0.0887	0.0094
LAYER 4	0.0009	0.0056	0.0284	0.0585	0.0159	0.0300

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.029	0.001
TOP OF LAYER 4	0.000	0.000	0.020	0.043	0.001	0.004
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.023	0.003
HEAD ON TOP OF LAYER 4	0.000	0.000	0.045	0.050	0.003	0.008

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.27	44540.113	100.00

RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	11.910	43234.539	97.07
DRAINAGE COLLECTED FROM LAYER 3	0.0053	19.406	0.04
PERC./LEAKAGE THROUGH LAYER 4	0.238129	864.406	1.94
AVG. HEAD ON TOP OF LAYER 4	0.0082		
CHANGE IN WATER STORAGE	0.116	421.846	0.95
SOIL WATER AT START OF YEAR	565.846	2054020.620	
SOIL WATER AT END OF YEAR	565.962	2054442.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.085	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.42	0.00	0.66	2.16	1.41	2.00

	1.42	0.32	0.72	0.71	0.49	0.51
RUNOFF	0.008	0.000	0.036	0.000	0.000	0.004
	0.000	0.000	0.000	0.000	0.000	0.005
EVAPOTRANSPIRATION	0.291	0.000	0.301	2.295	1.752	1.418
	1.209	0.700	0.521	1.294	0.325	0.251
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0007	0.0002	0.0009
FROM LAYER 3	0.0234	0.0070	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0006	0.0337	0.0252	0.0208
LAYER 4	0.1073	0.1049	0.0006	0.0064	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.013	0.005	0.017
TOP OF LAYER 4	0.427	0.127	0.000	0.001	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.023	0.010	0.053
HEAD ON TOP OF LAYER 4	0.095	0.084	0.000	0.002	0.000	0.000

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.82	39276.605	100.00
RUNOFF	0.053	193.125	0.49
EVAPOTRANSPIRATION	10.357	37594.523	95.72
DRAINAGE COLLECTED FROM LAYER 3	0.0323	117.143	0.30
PERC./LEAKAGE THROUGH LAYER 4	0.299463	1087.050	2.77
AVG. HEAD ON TOP OF LAYER 4	0.0491		
CHANGE IN WATER STORAGE	0.078	284.662	0.72
SOIL WATER AT START OF YEAR	565.962	2054442.370	
SOIL WATER AT END OF YEAR	565.908	2054246.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.132	480.298	1.22
ANNUAL WATER BUDGET BALANCE	0.0000	0.103	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 16

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.25	0.44	0.66	1.04	3.59	0.86
	2.86	0.42	0.96	0.91	0.36	0.07
RUNOFF	0.000	0.014	0.013	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.382	0.299	0.575	0.474	3.070	1.577
	2.511	1.075	0.395	0.947	0.725	0.265
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0163	0.0111
FROM LAYER 3	0.0004	0.0000	0.0000	0.0001	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0823	0.1029
LAYER 4	0.0242	0.0000	0.0000	0.0119	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.297	0.208
TOP OF LAYER 4	0.007	0.000	0.000	0.001	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.210	0.089
HEAD ON TOP OF LAYER 4	0.015	0.000	0.000	0.003	0.000	0.000

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                            ANNUAL TOTALS FOR YEAR   16
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                                              INCHES          CU. FEET
PERCENT
                                             --------        ----------    --
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   PRECIPITATION                              12.42          45084.613
100.00

   RUNOFF                                      0.028            100.937
0.22

   EVAPOTRANSPIRATION                         12.295          44632.457
99.00

   DRAINAGE COLLECTED FROM LAYER  3            0.0278           100.937
0.22

   PERC./LEAKAGE THROUGH LAYER  4              0.221356         803.524
1.78

   AVG. HEAD ON TOP OF LAYER  4                0.0428

   CHANGE IN WATER STORAGE                    -0.152           -553.190     -
1.23

   SOIL WATER AT START OF YEAR               565.908        2054246.750

   SOIL WATER AT END OF YEAR                 565.888        2054173.870

   SNOW WATER AT START OF YEAR                 0.132            480.298
1.07

   SNOW WATER AT END OF YEAR                   0.000              0.000
0.00

   ANNUAL WATER BUDGET BALANCE                 0.0000            -0.051
0.00


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MONTHLY TOTALS (IN INCHES) FOR YEAR 17

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.62	0.06	1.13	1.55	2.81	2.70
	1.25	1.59	1.63	1.20	0.24	0.67
RUNOFF	0.000	0.005	0.189	0.000	0.000	0.000
	0.000	0.001	0.000	0.000	0.000	0.008
EVAPOTRANSPIRATION	0.259	0.362	0.367	1.634	2.587	3.124
	0.643	1.673	1.701	1.405	0.475	0.446
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0017	0.0037	0.0230
FROM LAYER 3	0.0112	0.0011	0.0004	0.0015	0.0001	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0038	0.0326	0.0595	0.1039
LAYER 4	0.1063	0.0392	0.0285	0.0458	0.0150	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.032	0.068	0.434
TOP OF LAYER 4	0.204	0.020	0.008	0.028	0.002	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.052	0.127	0.046

HEAD ON TOP OF LAYER 4 0.087 0.033 0.018 0.039 0.004
0.000

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	15.45	56083.512	100.00
RUNOFF	0.202	734.802	1.31
EVAPOTRANSPIRATION	14.676	53275.406	94.99
DRAINAGE COLLECTED FROM LAYER 3	0.0428	155.243	0.28
PERC./LEAKAGE THROUGH LAYER 4	0.434551	1577.422	2.81
AVG. HEAD ON TOP OF LAYER 4	0.0662		
CHANGE IN WATER STORAGE	0.094	340.571	0.61
SOIL WATER AT START OF YEAR	565.888	2054173.870	
SOIL WATER AT END OF YEAR	565.936	2054349.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.045	165.098	0.29
ANNUAL WATER BUDGET BALANCE	0.0000	0.071	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 18

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.45	0.22	0.79	2.08	1.10	1.61
	0.92	1.08	0.40	0.11	0.54	0.00
RUNOFF	0.033	0.000	0.008	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.295	0.220	0.639	1.326	1.830	1.865
	0.508	0.864	0.325	0.261	0.337	0.115
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0039	0.0294	0.0106
FROM LAYER 3	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0269	0.1078	0.1029
LAYER 4	0.0184	0.0002	0.0000	0.0001	0.0003	0.0005

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.074	0.536
0.200					
TOP OF LAYER 4	0.004	0.000	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.169	0.108
0.090					
HEAD ON TOP OF LAYER 4	0.012	0.000	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.30	33759.008	100.00
RUNOFF	0.041	148.641	0.44
EVAPOTRANSPIRATION	8.584	31160.176	92.30
DRAINAGE COLLECTED FROM LAYER 3	0.0442	160.315	0.47
PERC./LEAKAGE THROUGH LAYER 4	0.256957	932.755	2.76
AVG. HEAD ON TOP OF LAYER 4	0.0678		
CHANGE IN WATER STORAGE	0.374	1357.225	4.02
SOIL WATER AT START OF YEAR	565.936	2054349.370	
SOIL WATER AT END OF YEAR	566.356	2055871.620	
SNOW WATER AT START OF YEAR	0.045	165.098	0.49

SNOW WATER AT END OF YEAR	0.000	0.000
0.00		
ANNUAL WATER BUDGET BALANCE	0.0000	-0.104
0.00		

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MONTHLY TOTALS (IN INCHES) FOR YEAR 19

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.14	1.19	0.69	0.71	2.19	1.31
	1.48	2.50	1.89	0.64	0.92	0.80
RUNOFF	0.000	0.000	0.010	0.000	0.000	0.000
	0.000	0.000	0.010	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.140	0.436	1.259	1.036	2.120	1.376
	1.110	2.541	2.167	0.418	0.696	0.484
LATERAL DRAINAGE COLLECTED	0.0000	0.0004	0.0027	0.0007	0.0103	0.0122
FROM LAYER 3	0.0006	0.0000	0.0218	0.0218	0.0046	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0251	0.0419	0.0369	0.0591	0.1030
LAYER 4	0.0281	0.0027	0.0789	0.1072	0.0796	0.0000

 ---------- MONTHLY SUMMARIES FOR DAILY HEADS (INCHES) ----------

AVERAGE DAILY HEAD ON	0.000	0.008	0.049	0.014	0.187	0.229
TOP OF LAYER 4	0.010	0.000	0.410	0.397	0.087	0.000
STD. DEVIATION OF DAILY	0.000	0.017	0.066	0.025	0.209	0.090
HEAD ON TOP OF LAYER 4	0.021	0.000	0.312	0.102	0.075	0.000

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.46	52489.809	100.00
RUNOFF	0.020	73.772	0.14
EVAPOTRANSPIRATION	13.783	50030.992	95.32
DRAINAGE COLLECTED FROM LAYER 3	0.0750	272.093	0.52
PERC./LEAKAGE THROUGH LAYER 4	0.562604	2042.252	3.89
AVG. HEAD ON TOP OF LAYER 4	0.1159		
CHANGE IN WATER STORAGE	0.019	70.677	0.13

SOIL WATER AT START OF YEAR	566.356	2055871.620
SOIL WATER AT END OF YEAR	566.375	2055942.370
SNOW WATER AT START OF YEAR	0.000	0.000
SNOW WATER AT END OF YEAR	0.000	0.000
ANNUAL WATER BUDGET BALANCE	0.0000	0.021

0.00

0.00

0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.19	1.88	1.13	2.01	2.60
	2.65	0.81	1.63	0.36	0.58	0.38
RUNOFF	0.000	0.000	0.537	0.308	0.000	0.000
	0.000	0.000	0.012	0.000	0.000	0.027
EVAPOTRANSPIRATION	0.080	0.190	0.676	1.689	1.696	2.397
	2.983	0.966	1.680	0.426	0.499	0.408
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000

FROM LAYER 3	0.0003	0.0000	0.0081	0.0114	0.0004	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0249	0.0125	0.0168
LAYER 4	0.0259	0.0057	0.0543	0.1064	0.0224	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.008	0.000	0.000
TOP OF LAYER 4	0.005	0.000	0.153	0.208	0.007	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.016	0.001	0.000
HEAD ON TOP OF LAYER 4	0.010	0.000	0.167	0.081	0.016	0.000

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.30	51909.008	100.00
RUNOFF	0.884	3208.853	6.18
EVAPOTRANSPIRATION	13.692	49700.336	95.75
DRAINAGE COLLECTED FROM LAYER 3	0.0206	74.806	0.14

PERC./LEAKAGE THROUGH LAYER 4	0.268820	975.816	1.88
AVG. HEAD ON TOP OF LAYER 4	0.0318		
CHANGE IN WATER STORAGE	-0.565	-2050.737	-3.95
SOIL WATER AT START OF YEAR	566.375	2055942.370	
SOIL WATER AT END OF YEAR	565.810	2053891.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.068	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 21

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.81	0.07	0.75	1.27	2.20	2.38
	0.75	0.36	1.13	0.67	0.35	0.61
RUNOFF	0.000	0.000	0.012	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION	0.558	0.442	0.559	0.370	2.177	2.768
	0.850	0.419	0.465	1.013	0.755	0.269
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0211	0.0181
FROM LAYER 3	0.0033	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0001	0.0839	0.1035
LAYER 4	0.0697	0.0004	0.0001	0.0028	0.0000	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.385	0.341
TOP OF LAYER 4	0.060	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.277	0.093
HEAD ON TOP OF LAYER 4	0.064	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.35	41200.504	100.00

RUNOFF	0.012	43.086	0.10
EVAPOTRANSPIRATION	10.644	38638.992	93.78
DRAINAGE COLLECTED FROM LAYER 3	0.0425	154.264	0.37
PERC./LEAKAGE THROUGH LAYER 4	0.260509	945.648	2.30
AVG. HEAD ON TOP OF LAYER 4	0.0655		
CHANGE IN WATER STORAGE	0.391	1418.412	3.44
SOIL WATER AT START OF YEAR	565.810	2053891.620	
SOIL WATER AT END OF YEAR	566.201	2055310.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.104	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 22

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.52	0.34	1.40	2.15	2.74	3.31

	1.75	0.98	1.02	0.85	0.43	0.59
RUNOFF	0.000	0.007	0.384	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.503	0.192	0.915	2.211	2.925	2.184
	2.804	0.745	0.990	0.884	0.596	0.693
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0013	0.0091	0.0001
FROM LAYER 3	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0001	0.0213	0.1062	0.0129
LAYER 4	0.0401	0.0012	0.0044	0.0005	0.0002	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.024	0.166	0.002
TOP OF LAYER 4	0.015	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.070	0.073	0.007
HEAD ON TOP OF LAYER 4	0.023	0.000	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.08	58370.406	100.00
RUNOFF	0.392	1421.850	2.44
EVAPOTRANSPIRATION	15.642	56780.402	97.28
DRAINAGE COLLECTED FROM LAYER 3	0.0113	41.152	0.07
PERC./LEAKAGE THROUGH LAYER 4	0.187004	678.826	1.16
AVG. HEAD ON TOP OF LAYER 4	0.0173		
CHANGE IN WATER STORAGE	-0.152	-551.900	-0.95
SOIL WATER AT START OF YEAR	566.201	2055310.000	
SOIL WATER AT END OF YEAR	566.049	2054758.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.076	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 23

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.38	0.32	0.87	0.93	1.97	4.40
	1.59	1.72	0.59	0.39	0.93	0.25
RUNOFF	0.000	0.000	0.000	0.050	0.000	0.065
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.368	0.417	0.683	0.606	2.128	4.004
	1.484	1.106	1.638	0.303	0.369	0.352
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0000	0.0188
FROM LAYER 3	0.0698	0.0452	0.0246	0.0093	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0009	0.0000	0.0000	0.0003	0.0514
LAYER 4	0.1110	0.1091	0.1040	0.1062	0.0063	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.000	0.353
TOP OF LAYER 4	1.273	0.823	0.463	0.169	0.001	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.000	0.560
HEAD ON TOP OF LAYER 4	0.143	0.122	0.085	0.091	0.003	0.000

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                            ANNUAL TOTALS FOR YEAR   23
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                                              INCHES          CU. FEET
PERCENT
                                             --------        ----------    --
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   PRECIPITATION                              14.34          52054.199
100.00

   RUNOFF                                      0.115           417.081
0.80

   EVAPOTRANSPIRATION                         13.459         48855.297
93.85

   DRAINAGE COLLECTED FROM LAYER  3            0.1677          608.577
1.17

   PERC./LEAKAGE THROUGH LAYER  4              0.489177       1775.711
3.41

   AVG. HEAD ON TOP OF LAYER  4                0.2568

   CHANGE IN WATER STORAGE                     0.110           397.499
0.76

   SOIL WATER AT START OF YEAR               566.049       2054758.120

   SOIL WATER AT END OF YEAR                 566.139       2055083.620

   SNOW WATER AT START OF YEAR                 0.000             0.000
0.00

   SNOW WATER AT END OF YEAR                   0.020            72.031
0.14

   ANNUAL WATER BUDGET BALANCE                 0.0000            0.036
0.00


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MONTHLY TOTALS (IN INCHES) FOR YEAR 24

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.31	1.14	0.98	1.13	2.75	1.45
	1.81	1.02	0.86	0.44	1.35	0.48
RUNOFF	0.000	0.105	0.053	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.020
EVAPOTRANSPIRATION	0.220	0.649	0.706	0.759	3.257	1.833
	0.999	1.287	1.570	0.537	0.607	0.276
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0017	0.0213	0.0167
FROM LAYER 3	0.0063	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0445	0.1072	0.1034
LAYER 4	0.1008	0.0013	0.0006	0.0000	0.0001	0.0000

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.031	0.388	0.315
TOP OF LAYER 4	0.116	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.046	0.093	0.073

HEAD ON TOP OF LAYER 4 0.067 0.000 0.000 0.000 0.000
0.000

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ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.72	49803.617	100.00
RUNOFF	0.178	646.745	1.30
EVAPOTRANSPIRATION	12.701	46105.707	92.58
DRAINAGE COLLECTED FROM LAYER 3	0.0460	167.039	0.34
PERC./LEAKAGE THROUGH LAYER 4	0.357816	1298.873	2.61
AVG. HEAD ON TOP OF LAYER 4	0.0708		
CHANGE IN WATER STORAGE	0.437	1585.220	3.18
SOIL WATER AT START OF YEAR	566.139	2055083.620	
SOIL WATER AT END OF YEAR	566.595	2056740.870	
SNOW WATER AT START OF YEAR	0.020	72.031	0.14
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.035	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 25

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.11	0.32	0.73	0.78	3.40	1.81
	0.39	1.43	0.14	0.97	0.87	0.19
RUNOFF	0.000	0.003	0.007	0.035	0.015	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.182	0.118	0.785	0.791	3.045	2.139
	0.512	1.463	0.516	0.591	0.640	0.188
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0048	0.0085
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0004	0.0019	0.0670	0.1027
LAYER 4	0.0107	0.0029	0.0022	0.0001	0.0010	0.0005

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.088
0.160					
TOP OF LAYER 4	0.001	0.000	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.115
0.079					
HEAD ON TOP OF LAYER 4	0.003	0.000	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.14	40438.199	100.00
RUNOFF	0.061	219.939	0.54
EVAPOTRANSPIRATION	10.969	39817.973	98.47
DRAINAGE COLLECTED FROM LAYER 3	0.0134	48.510	0.12
PERC./LEAKAGE THROUGH LAYER 4	0.189297	687.148	1.70
AVG. HEAD ON TOP OF LAYER 4	0.0207		
CHANGE IN WATER STORAGE	-0.092	-335.217	-0.83
SOIL WATER AT START OF YEAR	566.595	2056740.870	
SOIL WATER AT END OF YEAR	566.503	2056405.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00		
ANNUAL WATER BUDGET BALANCE	0.0000	-0.154	0.00		

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MONTHLY TOTALS (IN INCHES) FOR YEAR 26

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.87	0.45	0.68	1.17	1.01	2.83
	2.98	0.66	1.03	0.13	0.54	0.52
RUNOFF	0.033	0.023	0.034	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.640	1.144	0.634	0.759	0.543	3.493
	2.659	0.727	1.387	0.562	0.213	0.406
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0041	0.0403	0.0001	0.0001	0.0026
LAYER 4	0.0006	0.0071	0.0064	0.0005	0.0000	0.0000

 ---------- MONTHLY SUMMARIES FOR DAILY HEADS (INCHES) ----------

AVERAGE DAILY HEAD ON	0.000	0.000	0.016	0.000	0.000
0.000					
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.025	0.000	0.000
0.000					
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.87	46718.098	100.00
RUNOFF	0.090	326.133	0.70
EVAPOTRANSPIRATION	13.167	47795.246	102.31
DRAINAGE COLLECTED FROM LAYER 3	0.0009	3.270	0.01
PERC./LEAKAGE THROUGH LAYER 4	0.061782	224.268	0.48
AVG. HEAD ON TOP OF LAYER 4	0.0014		
CHANGE IN WATER STORAGE	-0.449	-1630.886	-3.49

SOIL WATER AT START OF YEAR	566.503	2056405.620
SOIL WATER AT END OF YEAR	566.054	2054774.750
SNOW WATER AT START OF YEAR	0.000	0.000
SNOW WATER AT END OF YEAR	0.000	0.000
ANNUAL WATER BUDGET BALANCE	0.0000	0.067

0.00

0.00

0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 27

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.75	0.38	0.81	0.29	2.52	4.17
	1.42	0.37	0.87	2.42	0.69	0.41
RUNOFF	0.013	0.006	0.004	0.000	0.000	0.000
	0.000	0.000	0.000	0.008	0.000	0.000
EVAPOTRANSPIRATION	0.392	0.252	0.611	0.298	2.076	4.090
	1.925	0.501	0.529	2.327	0.898	0.627
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0049	0.0101

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   FROM LAYER  3                 0.0027  0.0000  0.0000  0.0286  0.0327
0.0147

 PERCOLATION/LEAKAGE THROUGH     0.0000  0.0000  0.0000  0.0087  0.0850
0.1029
   LAYER  4                      0.0725  0.0135  0.0072  0.0839  0.1047
0.1066


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                     MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)
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 AVERAGE DAILY HEAD ON           0.000   0.000   0.000   0.000   0.089
0.190
   TOP OF LAYER  4               0.050   0.000   0.000   0.521   0.615
0.268

 STD. DEVIATION OF DAILY         0.000   0.000   0.000   0.000   0.084
0.056
   HEAD ON TOP OF LAYER  4       0.053   0.001   0.000   0.396   0.108
0.096


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                            ANNUAL TOTALS FOR YEAR   27
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                                          INCHES          CU. FEET
PERCENT
                                        --------        ----------    --
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   PRECIPITATION                          15.10          54813.020
100.00

   RUNOFF                                  0.030            110.184
0.20

   EVAPOTRANSPIRATION                     14.527          52732.148
96.20

   DRAINAGE COLLECTED FROM LAYER  3        0.0937           340.227
0.62
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PERC./LEAKAGE THROUGH LAYER 4	0.585121	2123.990	3.87
AVG. HEAD ON TOP OF LAYER 4	0.1445		
CHANGE IN WATER STORAGE	-0.136	-493.630	-0.90
SOIL WATER AT START OF YEAR	566.054	2054774.750	
SOIL WATER AT END OF YEAR	565.918	2054281.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.098	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 28

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.27	0.36	1.07	1.99	1.13	1.53
	0.58	2.15	0.49	1.36	0.13	0.42
RUNOFF	0.000	0.000	0.208	0.001	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.006

EVAPOTRANSPIRATION	0.345	0.237	0.575	1.044	1.884
2.199					
	0.555	1.504	0.610	0.812	1.124
0.238					
LATERAL DRAINAGE COLLECTED	0.0011	0.0000	0.0000	0.0000	0.0013
0.0000					
FROM LAYER 3	0.0000	0.0000	0.0000	0.0000	0.0000
0.0000					
PERCOLATION/LEAKAGE THROUGH	0.0390	0.0000	0.0000	0.0000	0.0443
0.0050					
LAYER 4	0.0001	0.0012	0.0002	0.0002	0.0013
0.0000					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.020	0.000	0.000	0.000	0.023
0.000					
TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.033	0.000	0.000	0.000	0.034
0.001					
HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.48	41672.414	100.00

RUNOFF	0.215	781.500	1.88
EVAPOTRANSPIRATION	11.126	40385.734	96.91
DRAINAGE COLLECTED FROM LAYER 3	0.0024	8.649	0.02
PERC./LEAKAGE THROUGH LAYER 4	0.091284	331.361	0.80
AVG. HEAD ON TOP OF LAYER 4	0.0036		
CHANGE IN WATER STORAGE	0.046	165.282	0.40
SOIL WATER AT START OF YEAR	565.918	2054281.120	
SOIL WATER AT END OF YEAR	565.963	2054446.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.114	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 29

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.66	0.15	0.74	1.25	2.01	1.26

	2.30	1.53	0.01	0.49	0.42
0.29					
RUNOFF	0.002	0.000	0.000	0.000	0.000
0.000					
	0.000	0.000	0.000	0.000	0.000
0.000					
EVAPOTRANSPIRATION	0.522	0.232	0.343	1.637	1.849
1.718					
	1.802	0.901	0.631	0.370	0.416
0.250					
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0000	0.0002
0.0001					
FROM LAYER 3	0.0003	0.0001	0.0000	0.0000	0.0000
0.0000					
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0003	0.0017	0.0153
0.0121					
LAYER 4	0.0128	0.0136	0.0252	0.0096	0.0015
0.0000					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.000	0.003
0.001					
TOP OF LAYER 4	0.005	0.002	0.001	0.000	0.000
0.000					
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.000	0.008
0.003					
HEAD ON TOP OF LAYER 4	0.013	0.005	0.001	0.000	0.000
0.000					

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ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.11	40329.301	100.00
RUNOFF	0.002	6.109	0.02
EVAPOTRANSPIRATION	10.672	38737.605	96.05
DRAINAGE COLLECTED FROM LAYER 3	0.0006	2.205	0.01
PERC./LEAKAGE THROUGH LAYER 4	0.092110	334.359	0.83
AVG. HEAD ON TOP OF LAYER 4	0.0009		
CHANGE IN WATER STORAGE	0.344	1248.920	3.10
SOIL WATER AT START OF YEAR	565.963	2054446.370	
SOIL WATER AT END OF YEAR	566.307	2055695.370	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.104	0.00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.24	0.66	0.68	1.56	3.08	1.83
	2.62	2.73	0.92	0.49	0.99	0.30
RUNOFF	0.000	0.005	0.033	0.000	0.000	0.000
	0.003	0.006	0.000	0.000	0.000	0.007
EVAPOTRANSPIRATION	0.201	0.563	0.522	1.651	3.019	1.896
	2.741	2.686	0.965	0.461	0.500	0.805
LATERAL DRAINAGE COLLECTED	0.0000	0.0000	0.0000	0.0043	0.0005	0.0000
FROM LAYER 3	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0703	0.0327	0.0043
LAYER 4	0.0595	0.0088	0.0014	0.0017	0.0005	0.0006

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.000	0.000	0.000	0.081	0.009	0.000
TOP OF LAYER 4	0.037	0.000	0.000	0.000	0.000	0.000
STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.066	0.015	0.001
HEAD ON TOP OF LAYER 4	0.046	0.001	0.000	0.000	0.000	0.000

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ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.10	58443.027	100.00
RUNOFF	0.055	200.533	0.34
EVAPOTRANSPIRATION	16.012	58122.187	99.45
DRAINAGE COLLECTED FROM LAYER 3	0.0069	24.871	0.04
PERC./LEAKAGE THROUGH LAYER 4	0.179916	653.096	1.12
AVG. HEAD ON TOP OF LAYER 4	0.0106		
CHANGE IN WATER STORAGE	-0.154	-557.661	-0.95
SOIL WATER AT START OF YEAR	566.307	2055695.370	
SOIL WATER AT END OF YEAR	566.154	2055137.620	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.005	0.00

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          AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH   30
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                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV
JUN/DEC
                          -------  -------  -------  -------  -------  --
-----
   PRECIPITATION
   -------------
     TOTALS                 0.42     0.37     0.93     1.32     2.23
2.05
                            1.65     1.26     1.12     0.71     0.54
0.38

     STD. DEVIATIONS        0.30     0.30     0.39     0.60     1.12
1.02
                            0.70     0.65     0.63     0.49     0.36
0.24

   RUNOFF
   ------
     TOTALS                 0.017    0.007    0.071    0.034    0.015
0.003
                            0.000    0.000    0.001    0.000    0.000
0.003

     STD. DEVIATIONS        0.050    0.019    0.126    0.092    0.069
0.012
                            0.001    0.001    0.003    0.001    0.000
0.006

   EVAPOTRANSPIRATION
   ------------------
     TOTALS                 0.318    0.341    0.604    1.215    2.183
2.130
                            1.533    1.173    1.274    0.723    0.569
0.368

     STD. DEVIATIONS        0.150    0.232    0.246    0.677    0.854
0.946
                            0.868    0.558    0.614    0.425    0.292
0.186

   LATERAL DRAINAGE COLLECTED FROM LAYER  3
   ---------------------------------------
     TOTALS                 0.0013   0.0006   0.0003   0.0010   0.0080
0.0168
                            0.0168   0.0121   0.0101   0.0084   0.0047
0.0026
```

STD. DEVIATIONS 0.0067 0.0030 0.0009 0.0022 0.0110
0.0394
0.0386 0.0307 0.0261 0.0228 0.0165
0.0112

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS 0.0049 0.0043 0.0065 0.0171 0.0517
0.0584
0.0525 0.0346 0.0340 0.0333 0.0170
0.0107

STD. DEVIATIONS 0.0208 0.0180 0.0214 0.0219 0.0380
0.0460
0.0452 0.0453 0.0413 0.0457 0.0338
0.0296

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES 0.0231 0.0112 0.0048 0.0195 0.1450
0.3172
0.3066 0.2203 0.1893 0.1533 0.0886
0.0476

STD. DEVIATIONS 0.1229 0.0598 0.0169 0.0406 0.2011
0.7425
0.7035 0.5591 0.4921 0.4162 0.3099
0.2044

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH
30

INCHES CU. FEET
PERCENT

PRECIPITATION	12.99	(1.958)	47147.7	100.00
RUNOFF	0.152	(0.2029)	551.82	1.170
EVAPOTRANSPIRATION	12.428	(1.7363)	45115.21	95.689
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.08260	(0.18195)	299.846	0.63597
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.32504	(0.21041)	1179.878	2.50252
AVERAGE HEAD ON TOP OF LAYER 4	0.127	(0.280)		
CHANGE IN WATER STORAGE	0.000	(0.3603)	0.90	0.002

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	1.96	7114.800
RUNOFF	0.379	1374.9197
DRAINAGE COLLECTED FROM LAYER 3	0.00779	28.26786
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.004025	14.61106
AVERAGE HEAD ON TOP OF LAYER 4	4.400	
MAXIMUM HEAD ON TOP OF LAYER 4	8.062	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	70.3 FEET	
SNOW WATER	1.00	3627.4089

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2936
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	7.4116	0.2471
2	547.7920	0.2920
3	0.2700	0.0450
4	10.6800	0.4450
SNOW WATER	0.000	

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ATTACHMENT 2

SENSITIVITY ANALYSIS

HELP MODEL OUTPUT

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**
 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                  HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                     DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                       USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_2A.D10
 OUTPUT DATA FILE:           C:\NW_OUT2A.OUT


 TIME:  11:51     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 2: 80'WASTE WITH DAILY COVER
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	960.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	292.534	INCHES
TOTAL INITIAL WATER	=	292.534	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39
0.11					
RUNOFF	0.000	0.000	0.117	0.000	0.000
0.000					
	0.000	0.000	0.000	0.000	0.000
0.000					
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378
0.513					
	2.292	0.802	2.007	0.299	0.494
0.201					
LATERAL DRAINAGE COLLECTED	0.0146	0.0013	0.0000	0.0000	0.0111
0.0920					
FROM LAYER 3	0.1079	0.0880	0.0778	0.0598	0.0501
0.0399					
PERCOLATION/LEAKAGE THROUGH	0.1066	0.0485	0.0015	0.0013	0.0460
0.1094					
LAYER 4	0.1141	0.1125	0.1083	0.1102	0.1061
0.1086					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.265	0.026	0.000	0.000	0.203
1.732					
TOP OF LAYER 4	1.966	1.604	1.465	1.089	0.944
0.727					
STD. DEVIATION OF DAILY	0.095	0.036	0.000	0.000	0.289
0.349					
HEAD ON TOP OF LAYER 4	0.209	0.156	0.113	0.134	0.051
0.117					

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5424	1968.891	4.81
PERC./LEAKAGE THROUGH LAYER 4	0.973135	3532.479	8.63
AVG. HEAD ON TOP OF LAYER 4	0.8351		
CHANGE IN WATER STORAGE	0.018	65.027	0.16
SOIL WATER AT START OF YEAR	292.534	1061897.000	
SOIL WATER AT END OF YEAR	292.552	1061962.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.019	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0146	0.0013	0.0000	0.0000	0.0111	0.0920
	0.1079	0.0880	0.0778	0.0598	0.0501	0.0399
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

```
     TOTALS                  0.1066   0.0485   0.0015   0.0013   0.0460
0.1094
                             0.1141   0.1125   0.1083   0.1102   0.1061
0.1086

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.2653   0.0258   0.0000   0.0000   0.2029
1.7318
                             1.9664   1.6043   1.4645   1.0891   0.9440
0.7271

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
 ---------------------------------------------------------------------------
-------
                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
------
  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
```

EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.54239	(0.00000)	1968.891	4.80846
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.97313	(0.00000)	3532.479	8.62708
AVERAGE HEAD ON TOP OF LAYER 4	0.835	(0.000)		
CHANGE IN WATER STORAGE	0.018	(0.0000)	65.03	0.159

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00400	14.53737
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003722	13.51159
AVERAGE HEAD ON TOP OF LAYER 4	2.263	
MAXIMUM HEAD ON TOP OF LAYER 4	4.284	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	44.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	280.3199	0.2920
3	0.4677	0.0779
4	10.6800	0.4450
SNOW WATER	0.000	

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**
 **   HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **   HELP MODEL VERSION 3.07 (1 NOVEMBER 1997)
**
 **   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **   USAE WATERWAYS EXPERIMENT STATION
**
 **   FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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PRECIPITATION DATA FILE: C:\NWPREC1.D4
TEMPERATURE DATA FILE: C:\NWTEMP1.D7
SOLAR RADIATION DATA FILE: C:\NWRAD1.D13
EVAPOTRANSPIRATION DATA: C:\NWEVAP.D11
SOIL AND DESIGN DATA FILE: C:\NW_SD_2B.D10
OUTPUT DATA FILE: C:\NW_OUT2B.OUT

TIME: 11:52   DATE: 11/16/2016

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      TITLE: NORTH WELD LANDFILL SCENARIO 2: 90'WASTE WITH DAILY COVER

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1080.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	327.574	INCHES
TOTAL INITIAL WATER	=	327.574	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39
0.11					
RUNOFF	0.000	0.000	0.117	0.000	0.000
0.000					
	0.000	0.000	0.000	0.000	0.000
0.000					
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378
0.513					
	2.292	0.802	2.007	0.299	0.494
0.201					
LATERAL DRAINAGE COLLECTED	0.0146	0.0013	0.0000	0.0000	0.0111
0.0920					
FROM LAYER 3	0.1079	0.0880	0.0778	0.0598	0.0501
0.0399					
PERCOLATION/LEAKAGE THROUGH	0.1066	0.0485	0.0015	0.0013	0.0460
0.1094					
LAYER 4	0.1141	0.1125	0.1083	0.1102	0.1061
0.1086					

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.265	0.026	0.000	0.000	0.203
1.732					
TOP OF LAYER 4	1.966	1.604	1.465	1.089	0.944
0.727					
STD. DEVIATION OF DAILY	0.095	0.036	0.000	0.000	0.289
0.349					
HEAD ON TOP OF LAYER 4	0.209	0.156	0.113	0.134	0.051
0.117					

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5424	1968.887	4.81
PERC./LEAKAGE THROUGH LAYER 4	0.973143	3532.509	8.63
AVG. HEAD ON TOP OF LAYER 4	0.8351		
CHANGE IN WATER STORAGE	0.018	64.916	0.16
SOIL WATER AT START OF YEAR	327.574	1189092.250	
SOIL WATER AT END OF YEAR	327.591	1189157.120	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.066	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0146	0.0013	0.0000	0.0000	0.0111	0.0920
	0.1079	0.0880	0.0778	0.0598	0.0501	0.0399
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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     TOTALS                  0.1066   0.0485   0.0015   0.0013   0.0460
0.1094
                             0.1141   0.1125   0.1083   0.1102   0.1061
0.1086

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.2654   0.0259   0.0000   0.0000   0.2028
1.7317
                             1.9664   1.6043   1.4645   1.0892   0.9440
0.7271

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
------
  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
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EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.54239	(0.00000)	1968.887	4.80845
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.97314	(0.00000)	3532.509	8.62715
AVERAGE HEAD ON TOP OF LAYER 4	0.835	(0.000)		
CHANGE IN WATER STORAGE	0.018	(0.0000)	64.92	0.159

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00400	14.53715
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003722	13.51158
AVERAGE HEAD ON TOP OF LAYER 4	2.263	
MAXIMUM HEAD ON TOP OF LAYER 4	4.284	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	44.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	315.3599	0.2920
3	0.4677	0.0779
4	10.6800	0.4450
SNOW WATER	0.000	

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 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_2C.D10
 OUTPUT DATA FILE:           C:\NW_OUT2C.OUT


 TIME:  11:54     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 2: 60'WASTE WITH DAILY COVER
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	720.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	222.454	INCHES
TOTAL INITIAL WATER	=	222.454	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0146	0.0013	0.0000	0.0000	0.0111	0.0919
FROM LAYER 3	0.1078	0.0879	0.0777	0.0597	0.0501	0.0399
PERCOLATION/LEAKAGE THROUGH	0.1066	0.0485	0.0015	0.0013	0.0468	0.1094
LAYER 4	0.1141	0.1125	0.1083	0.1102	0.1061	0.1086

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.265	0.026	0.000	0.000	0.202	1.730
TOP OF LAYER 4	1.965	1.603	1.463	1.088	0.943	0.726
STD. DEVIATION OF DAILY	0.095	0.036	0.000	0.000	0.288	0.349
HEAD ON TOP OF LAYER 4	0.209	0.156	0.113	0.134	0.051	0.117

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5419	1966.939	4.80
PERC./LEAKAGE THROUGH LAYER 4	0.973917	3535.319	8.63
AVG. HEAD ON TOP OF LAYER 4	0.8343		
CHANGE IN WATER STORAGE	0.018	64.141	0.16
SOIL WATER AT START OF YEAR	222.454	807506.500	
SOIL WATER AT END OF YEAR	222.471	807570.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.021	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0146	0.0013	0.0000	0.0000	0.0111	0.0919
	0.1078	0.0879	0.0777	0.0597	0.0501	0.0399
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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     TOTALS                  0.1066   0.0485   0.0015   0.0013   0.0468
0.1094
                             0.1141   0.1125   0.1083   0.1102   0.1061
0.1086

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.2653   0.0258   0.0000   0.0000   0.2020
1.7303
                             1.9646   1.6027   1.4633   1.0880   0.9430
0.7263

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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-------
                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
------
  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
```

EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.54186	(0.00000)	1966.939	4.80369
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.97392	(0.00000)	3535.319	8.63401
AVERAGE HEAD ON TOP OF LAYER 4	0.834	(0.000)		
CHANGE IN WATER STORAGE	0.018	(0.0000)	64.14	0.157

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00400	14.52689
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003722	13.51075
AVERAGE HEAD ON TOP OF LAYER 4	2.261	
MAXIMUM HEAD ON TOP OF LAYER 4	4.281	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	44.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	210.2399	0.2920
3	0.4674	0.0779
4	10.6800	0.4450
SNOW WATER	0.000	

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**
 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_2D.D10
 OUTPUT DATA FILE:           C:\NW_OUT2D.OUT


 TIME:  11:55     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 2: 70'WASTE WITH DC; 800'
SLOPE
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	= 6.00	INCHES
POROSITY	= 0.3930	VOL/VOL
FIELD CAPACITY	= 0.2990	VOL/VOL
WILTING POINT	= 0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	= 840.00	INCHES
POROSITY	= 0.6710	VOL/VOL
FIELD CAPACITY	= 0.2920	VOL/VOL
WILTING POINT	= 0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	= 6.00	INCHES
POROSITY	= 0.4170	VOL/VOL
FIELD CAPACITY	= 0.0450	VOL/VOL
WILTING POINT	= 0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	= 0.0694	VOL/VOL
EFFECTIVE SAT. HYD. COND.	= 0.999999978000E-02	CM/SEC
SLOPE	= 2.64	PERCENT
DRAINAGE LENGTH	= 800.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	257.479	INCHES
TOTAL INITIAL WATER	=	257.479	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0133	0.0007	0.0000	0.0000	0.0117	0.0966
FROM LAYER 3	0.1127	0.0911	0.0799	0.0606	0.0505	0.0396
PERCOLATION/LEAKAGE THROUGH	0.1065	0.0364	0.0015	0.0013	0.0468	0.1094
LAYER 4	0.1140	0.1124	0.1081	0.1100	0.1059	0.1084

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.229	0.013	0.000	0.000	0.202	1.722
TOP OF LAYER 4	1.944	1.571	1.425	1.046	0.900	0.683
STD. DEVIATION OF DAILY	0.094	0.023	0.000	0.000	0.288	0.347
HEAD ON TOP OF LAYER 4	0.208	0.159	0.113	0.135	0.051	0.116

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5566	2020.497	4.93
PERC./LEAKAGE THROUGH LAYER 4	0.960682	3487.275	8.52
AVG. HEAD ON TOP OF LAYER 4	0.8113		
CHANGE IN WATER STORAGE	0.016	58.491	0.14
SOIL WATER AT START OF YEAR	257.479	934650.437	
SOIL WATER AT END OF YEAR	257.496	934708.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.114	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0133	0.0007	0.0000	0.0000	0.0117	0.0966
	0.1127	0.0911	0.0799	0.0606	0.0505	0.0396
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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     TOTALS                  0.1065   0.0364   0.0015   0.0013   0.0468
0.1094
                             0.1140   0.1124   0.1081   0.1100   0.1059
0.1084

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.2290   0.0130   0.0000   0.0000   0.2017
1.7223
                             1.9441   1.5712   1.4252   1.0460   0.9001
0.6834

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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-------
                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
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  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
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EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26
85.371			
LATERAL DRAINAGE COLLECTED	0.55661	(0.00000)	2020.497
4.93449			
FROM LAYER 3			
PERCOLATION/LEAKAGE THROUGH	0.96068	(0.00000)	3487.275
8.51668			
LAYER 4			
AVERAGE HEAD ON TOP	0.811	(0.000)	
OF LAYER 4			
CHANGE IN WATER STORAGE	0.016	(0.0000)	58.49
0.143			

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00419	15.22011
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003719	13.50136
AVERAGE HEAD ON TOP OF LAYER 4	2.243	
MAXIMUM HEAD ON TOP OF LAYER 4	4.239	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	43.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	245.2799	0.2920
3	0.4518	0.0753
4	10.6800	0.4450
SNOW WATER	0.000	

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**
 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_2E.D10
 OUTPUT DATA FILE:           C:\NW_OUT2E.OUT


 TIME:  11:56     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 2: 70'WASTE WITH DC; 700'
SLOPE
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	840.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0637	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	700.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	257.445	INCHES
TOTAL INITIAL WATER	=	257.445	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0094	0.0000	0.0000	0.0000	0.0133	0.1091
FROM LAYER 3	0.1252	0.0987	0.0851	0.0623	0.0509	0.0383
PERCOLATION/LEAKAGE THROUGH	0.1061	0.0072	0.0015	0.0013	0.0468	0.1093
LAYER 4	0.1138	0.1120	0.1077	0.1096	0.1054	0.1080

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.143	0.000	0.000	0.000	0.201	1.702
TOP OF LAYER 4	1.890	1.490	1.328	0.941	0.794	0.579
STD. DEVIATION OF DAILY	0.091	0.001	0.000	0.000	0.287	0.344
HEAD ON TOP OF LAYER 4	0.204	0.164	0.114	0.136	0.051	0.115

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5924	2150.280	5.25
PERC./LEAKAGE THROUGH LAYER 4	0.928628	3370.921	8.23
AVG. HEAD ON TOP OF LAYER 4	0.7556		
CHANGE IN WATER STORAGE	0.012	45.087	0.11
SOIL WATER AT START OF YEAR	257.445	934526.812	
SOIL WATER AT END OF YEAR	257.458	934571.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.091	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0094	0.0000	0.0000	0.0000	0.0133	0.1091
	0.1252	0.0987	0.0851	0.0623	0.0509	0.0383
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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     TOTALS                  0.1061   0.0072   0.0015   0.0013   0.0468
0.1093
                             0.1138   0.1120   0.1077   0.1096   0.1054
0.1080

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.1426   0.0004   0.0000   0.0000   0.2010
1.7016
                             1.8900   1.4896   1.3283   0.9405   0.7938
0.5789

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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-------
                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
------
  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
```

EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.59236	(0.00000)	2150.280	5.25145
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.92863	(0.00000)	3370.921	8.23252
AVERAGE HEAD ON TOP OF LAYER 4	0.756	(0.000)		
CHANGE IN WATER STORAGE	0.012	(0.0000)	45.09	0.110

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00469	17.02342
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003713	13.47675
AVERAGE HEAD ON TOP OF LAYER 4	2.195	
MAXIMUM HEAD ON TOP OF LAYER 4	4.129	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	41.2 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	245.2799	0.2920
3	0.4140	0.0690
4	10.6800	0.4450
SNOW WATER	0.000	

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**
 **               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
**
 **                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)
**
 **                   DEVELOPED BY ENVIRONMENTAL LABORATORY
**
 **                     USAE WATERWAYS EXPERIMENT STATION
**
 **              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY
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 PRECIPITATION DATA FILE:    C:\NWPREC1.D4
 TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
 SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
 EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
 SOIL AND DESIGN DATA FILE:  C:\NW_SD_2F.D10
 OUTPUT DATA FILE:           C:\NW_OUT2F.OUT


 TIME:  11:56     DATE:  11/16/2016




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      TITLE:  NORTH WELD LANDFILL SCENARIO 2: 70'WASTE WITH DC; 500'
SLOPE
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	6.00	INCHES
POROSITY	=	0.3930	VOL/VOL
FIELD CAPACITY	=	0.2990	VOL/VOL
WILTING POINT	=	0.1330	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1839	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.119999997000E-03	CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	840.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0506	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	500.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	257.367	INCHES
TOTAL INITIAL WATER	=	257.367	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	=	40.59	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	138	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%

AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 50.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 51.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93

	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0013	0.0000	0.0000	0.0000	0.0184	0.1470
FROM LAYER 3	0.1603	0.1164	0.0953	0.0615	0.0474	0.0306
PERCOLATION/LEAKAGE THROUGH	0.0350	0.0080	0.0015	0.0013	0.0468	0.1090
LAYER 4	0.1130	0.1110	0.1066	0.1084	0.1043	0.1069

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.014	0.000	0.000	0.000	0.199	1.638
TOP OF LAYER 4	1.729	1.256	1.063	0.664	0.529	0.330
STD. DEVIATION OF DAILY	0.026	0.001	0.000	0.000	0.283	0.334
HEAD ON TOP OF LAYER 4	0.194	0.177	0.117	0.134	0.051	0.108

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.6784	2462.526	6.01
PERC./LEAKAGE THROUGH LAYER 4	0.851747	3091.840	7.55
AVG. HEAD ON TOP OF LAYER 4	0.6183		
CHANGE IN WATER STORAGE	0.003	11.964	0.03
SOIL WATER AT START OF YEAR	257.367	934242.125	
SOIL WATER AT END OF YEAR	257.370	934254.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.048	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0013	0.0000	0.0000	0.0000	0.0184	0.1470
	0.1603	0.1164	0.0953	0.0615	0.0474	0.0306
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						

```
     TOTALS                  0.0350   0.0080   0.0015   0.0013   0.0468
0.1090
                             0.1130   0.1110   0.1066   0.1084   0.1043
0.1069

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000


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                AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
 ---------------------------------------------------------------------------
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   DAILY AVERAGE HEAD ON TOP OF LAYER  4
   ------------------------------------
     AVERAGES                0.0141   0.0004   0.0000   0.0000   0.1989
1.6377
                             1.7287   1.2556   1.0625   0.6637   0.5286
0.3297

     STD. DEVIATIONS         0.0000   0.0000   0.0000   0.0000   0.0000
0.0000
                             0.0000   0.0000   0.0000   0.0000   0.0000
0.0000

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      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH
1
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-------
                                       INCHES            CU. FEET
PERCENT
                                  ------------------   -------------   ---
------
  PRECIPITATION                    11.28    (   0.000)      40946.4
100.00

  RUNOFF                            0.117   (  0.0000)        423.76
1.035
```

EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.67838	(0.00000)	2462.526	6.01402
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.85175	(0.00000)	3091.840	7.55094
AVERAGE HEAD ON TOP OF LAYER 4	0.618	(0.000)		
CHANGE IN WATER STORAGE	0.003	(0.0000)	11.96	0.029

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00614	22.27106
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003692	13.40275
AVERAGE HEAD ON TOP OF LAYER 4	2.051	
MAXIMUM HEAD ON TOP OF LAYER 4	3.809	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	35.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	245.2799	0.2920
3	0.3264	0.0544
4	10.6800	0.4450
SNOW WATER	0.000	

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APPENDIX C-2
LEACHATE TRAVEL TIME CALCULATIONS

CALCULATIONS

Date:	November 18, 2016	**Made by:**	ALB
Project No.:	1538880	**Checked by:**	JAR
Site Name:	North Weld Landfill, Unit 2 EDOP Weld County, Colorado	**Reviewed by:**	MEM
Subject:	**APPENDIX C-2: LEACHATE TRAVEL TIME CALCULATIONS**		

1.0 OBJECTIVES

Estimate the maximum travel time for leachate to report to a permanent leachate collection sump using the longest hydraulic leachate flow path within the leachate collection drainage layer and leachate drain lines for Unit 2 of North Weld Landfill (NWLF). Verify that the travel times through the longest flow paths are less than 365 days.

2.0 METHODOLOGY

Use Darcy's Law to calculate travel time through the leachate collection drainage layer and drain lines:

$$Q = k \times i \times A$$

where:

Q = Discharge
k = Hydraulic Conductivity
A = Area
i = Gradient

$$q = \frac{Q}{A} = k \times i$$

where:

q = Specific discharge

$$V_s = \frac{q}{n} = \frac{k \times i}{n}$$

where:

V_s = Average linear leachate velocity
n = Porosity

$$T = \frac{d}{V_s} = \frac{d \times n}{k \times i}$$

where:

T = Leachate travel time
d = Maximum leachate travel distance

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Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill, Unit 2 EDOP	Checked by:	JAR AR
Date:	November 18, 2016	Reviewed by:	MEM

3.0 ASSUMPTIONS AND DESIGN PARAMETERS

Leachate travel time calculations were based on the following assumptions and design parameters:

- It was assumed that leachate flow through the leachate collection drainage layer and drain lines follows Darcy's Law.
- It was assumed that the hydraulic gradient of the leachate is equivalent to the slope of the landfill floor.
- Leachate travel times were calculated for the following design slopes and conservative estimates of post-consolidation slopes:
  - Landfill floor slopes:
    - Design slope: 2.8%
    - Post-consolidation slope: 2.64% to 2.90%
  - Drain line slopes:
    - Design slope: 2.15%
    - Post-consolidation slope: 2.12% to 2.20%
- Material properties of the granular leachate collection drainage layer material and gravel drain line material are as follows:
  - Granular drainage layer:
    - Hydraulic conductivity (k): 0.01 cm/sec (EDOP minimum requirement)
    - Porosity: 0.3 (NAVFAC 1986)
  - Drain line gravel:
    - Hydraulic conductivity (k): 1 cm/sec (EDOP minimum requirement)
    - Porosity: 0.25 (Linsley, Kohler, and Paulhus 1982)

4.0 CALCULATIONS

Maximum leachate travel times were calculated for the longest hydraulic leachate flow paths within Phases 4 and 5 of Unit 2 as shown in the attached Figure 1. Calculations are summarized in Tables 1 and 2 below for design slopes and post-consolidation slopes, respectively:

Table 1: Leachate Travel Time – Design Slopes

Phase	Granular Drainage Layer				Drain Line				Total Travel Time (days)
	Slope (%)	Flow Length (ft)	Velocity (ft/sec)	Travel Time (days)	Slope	Flow Length (ft)	Velocity (ft/sec)	Travel Time (days)	
4	2.8	812	0.00003	307	2.15	3,104	0.02351	13	**320**
5	2.8	818	0.00003	309	2.15	2,321	0.00282	10	**319**

Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill, Unit 2 EDOP	Checked by:	JAR
Date:	November 18, 2016	Reviewed by:	MEM

Table 2: Leachate Travel Time – Post-Settlement Slopes

Phase	Granular Drainage Layer				Drain Line				Total Travel Time (days)
	Slope (%)	Flow Length (ft)	Velocity (ft/sec)	Travel Time (days)	Slope	Flow Length (ft)	Velocity (ft/sec)	Travel Time (days)	
4	2.64	845	0.00003	338	2.20	1,270	0.00289	5	**351**
					2.12	1,834	0.00278	8	
5	2.80	820	0.00003	299	2.17	1,149	0.00285	5	**309**
					2.19	1,172	0.00287	5	

5.0 CONCLUSIONS

The maximum leachate travel times calculated were approximately 320 days for design slopes in both Phases 4 and 5. Post-consolidation floor slopes in Phase 4 result in an increase in travel time to approximately 351 days. Post-consolidation floor slopes in Phase 5 actually result in an increase in floor slopes and a reduction in travel time to approximately 309 days. All calculated travel times were less than 12 months for design and post-consolidation conditions.

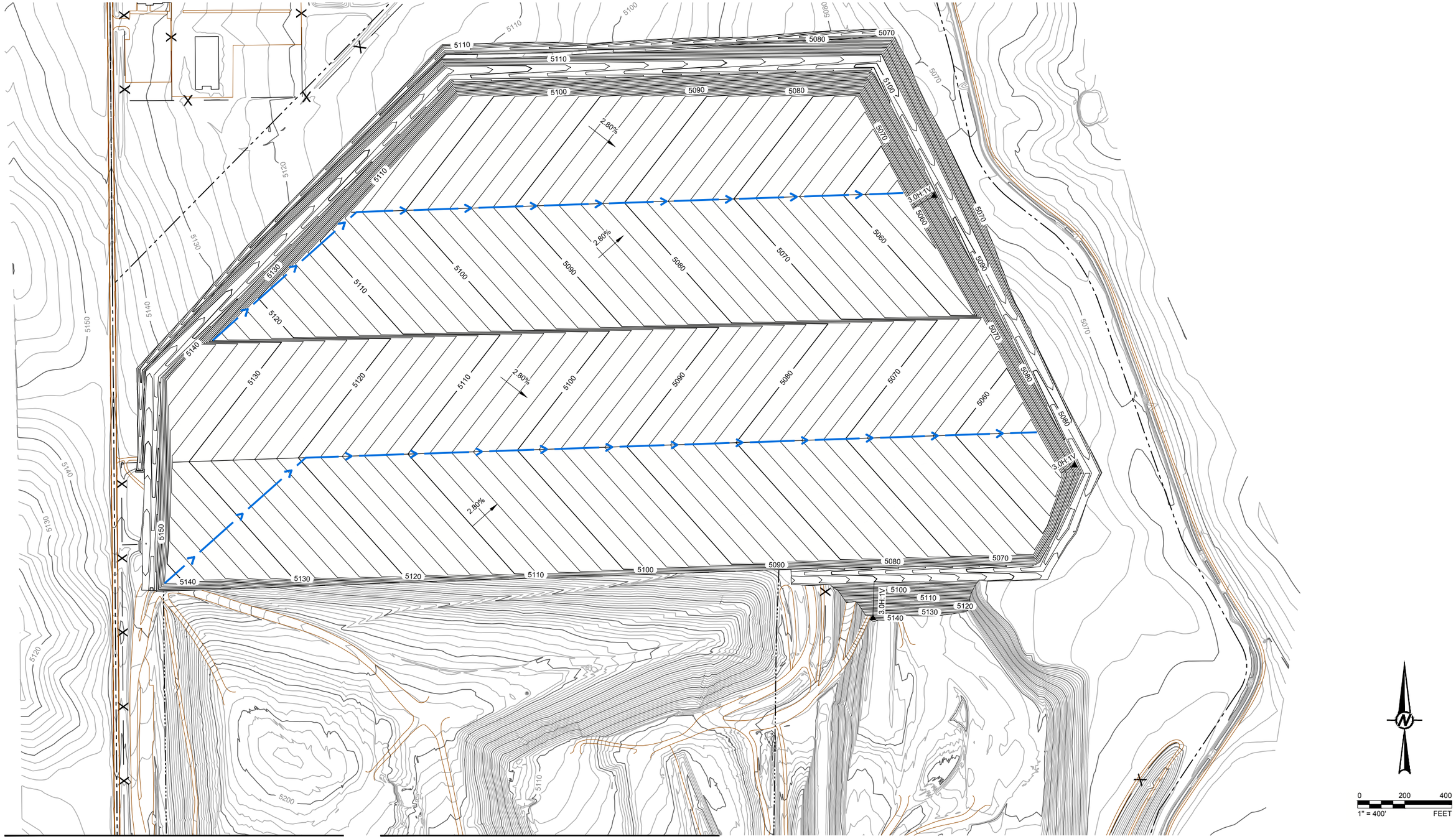
6.0 REFERENCES

Linsley, R.K. Jr., M.A. Kohler, and J.L.H. Paulhus. 1982. Hydrology for Engineers. Third Edition.

Naval Facilities Engineering Command (NAVFAC). 1986. Design Manual 7.01, Soil Mechanics. Revalidated September 1.

FIGURE 1

LEACHATE TRAVEL TIME



LEGEND

- 5280 EXISTING TOPOGRAPHY (SEE NOTE 1)
- 5280 PROPOSED LINER SUBGRADE
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- CRITICAL LEACHATE FLOW PATH

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-11-18
DESIGNED	ALB
PREPARED	ALB
REVIEWED	JAR
APPROVED	MEM

PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
CRITICAL LEACHATE FLOW PATHS

PROJECT NO.	CONTROL	REV.	FIGURE
1538880		A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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APPENDIX C-3
LEACHATE COLLECTION HEADER PIPE STRENGTH CALCULATIONS

Golder Associates	SUBJECT:	HDPE Leachate Collection Pipe - Structural Integrity Calculations			
	Job Number:	1538880	Made by:	ALB	Date: 11/18/2016
	Project:	North Weld Landfill Unit 2 EDOP	Checked:	DVS	
			Reviewed:	JAR	

PIPE STRUCTURAL DESIGN

OBJECTIVE: Check the structural integrity of the buried leachate collection pipe by evaluating the factors of safety against pipe crushing, wall buckling, and deflection.

REFERENCES:

1. PolyPipe Industries, Inc., Design and Engineering Guide for Polyethylene Piping. 2005
2. The Plastics Pipe Institute (PPI), Handbook of Polyethylene Pipe (2nd ed.)
3. McGrath, T.J. "Replacing E' with the Constrained Modulus in Buried Pipe Design." Proceedings of the Conference, Pipelines in the Constructed Environment, ASCE. 1998
4. Qian, X. Koerner, R.M., and Gray, D.H., Geotechnical Aspects of Landfill Design and Construction. 2002.
5. Bowles, J. Foundation Analysis and Design. 1988.
6. Goddard, J.B. ADS Technical Report 4.103. April, 2004.
7. ISCO Industries HDPE Pipe TyPical Physical Properties
8. FEMA Plastic Pipe Used in Embankment Dams, Best Practices for Design, Construction, Problem Identification and Evaluation, Inspection, Maintenance, Renovation, and Repair. November 2007.
9. Swift River Environmental Services, LLC. Report of Geotechnical Investigation: North Weld Landfill Unit 2 Permitting and Development. Draft Final Report. June 2016.

PIPE PROPERTIES:

Pipe type: 6-inch dia. perforated smooth wall PE pipe

SDR:		11		*(PolyPipe)*
wall thickness:	t =	0.602	inches	*(PolyPipe)*
inside diameter:	D_i =	5.350	inches	*(PolyPipe)*
outside diameter:	D_o =	6.625	inches	*(PolyPipe)*
mean diameter:	D_m =	5.952	inches	
mean radius:	R =	2.976	inches	
moment of intertia:	I =	0.018	in^4/in	

pipe modulus of elasticity (initial):	E_{p-i} =	100,000	psi	*(PolyPipe)*
pipe modulus of elasticity (long-term):	E_{p-lt} =	25,000	psi	*(PolyPipe)*
pipe compressive yield strength (initial):	P_{A-i} =	1,440	psi	*(ISCO)*

= 90% of solid pipe compressive strength to conservatively account for 10% perforated surface area (FEMA)

PIPE BEDDING PROPERTIES:

Bedding material: Gravel

deflection lag factor:	L_f =	1.0	*(Qian, Koerner, and Gray)*
bedding constant:	K =	0.083	*(Qian, Koerner, and Gray)*
modulus of soil reaction:	E_s =	4100	*(Qian, Koerner, and Gray)*
Stress-dependent constrained modulus	M_s =	see below	*(Roberts)*
Poisson's ratio	μ =	0.4	*(Bowles)*

Stress-dependent constrained modulus: $M_s = 1483\ (\sigma_1)^{0.34}$ *(Roberts)*

where: σ_1 = Vertical overburden stress

Golder Associates	SUBJECT:	HDPE Leachate Collection Pipe - Structural Integrity Calculations			
	Job Number:	1538880	Made by:	ALB	Date: 11/18/2016
	Project:	North Weld Landfill Unit 2 EDOP	Checked:	DVS	
			Reviewed:	JAR	

CALCULATIONS:

1. Calculate the maximum overburden stress acting on the pipe:

Waste	Thickness =	60	feet
	Density =	65.0	pcf
Drainage Media	Thickness =	2.5	feet
	Density	125	pcf
Final Cover	Thickness =	3	feet
	Density	120	pcf
Total Overburden Pressure (σ_{vo}) =		4,592	psf
Total Overburden Pressure (σ_{vo}) =		**31.9**	**psi**

2. Calculate the stress-dependent constrained modulus:

$$M_s = 1483\ (\sigma_1)^{0.34}$$ Ms = 4,812.8 psi

3. Calculate the vertical arching factor (VAF):

$$VAF = 0.88 - 0.71\frac{S_A - 1}{S_A + 2.5}$$ *(PPI)*

where: VAF = Vertical arching factor

S_A = Hoop thrust stiffness ratio

$$S_A = \frac{1.43\,M_S\,r_{CENT}}{EA}$$ *(PPI)*

where: M_s = One-dimensional modulus of soil (psi)

r_{cent} = Radius to centroidal axis of pipe (in.)

E = Apparent modulus of elasticity of pipe material (psi)

A = Profile wall average wall thickness (in.)

Hoop thrust stiffness ratio: S_A = 0.34

Vertical arching factor: VAF = 1.04

4. Calculate the maximum design load on the pipe:

$P_T = (\sigma_{vo}) \times (VAF)$ **P_T = 33.3 psi**

CRUSHING ANALYSIS:

1. Define the minimum acceptable factor of safety against pipe crushing:

Acceptable factor of safety = 2

Golder Associates	SUBJECT:	HDPE Leachate Collection Pipe - Structural Integrity Calculations				
	Job Number:	1538880	Made by:	ALB	Date:	11/18/2016
	Project:	North Weld Landfill Unit 2 EDOP	Checked: Reviewed:	DVS JAR		

CRUSHING ANALYSIS:

2. Calculate the maximum axial stress acting on the pipe (P_{SA})

$$S = \frac{(P_E + P_L)\,DR}{288} \quad \textit{(PPI)}$$

where:
- S = Critical crushing pressure
- P_E = Maximum axial stress (psf) from earth loading
- PL = Axial stress from live load (psf); neglected
- DR = Dimension ratio (D_0/t)

S =	183.4	psi

CRUSHING ANALYSIS [cont.]:

3. Calculate the factor of safety against pipe crushing:

Factor of Safety (P_A/P_{SA}) =	7.9	(OK)

BUCKLING ANALYSIS:

1. Define the minimum acceptable factor of safety against pipe buckling:

Acceptable factor of safety = 2

2. Calculate the critical buckling pressure, P_{cr}:

$$P_{CR} = \frac{2.4\,\varphi\,R_H}{D_M}(EI)^{\frac{1}{3}}(E_S^*)^{\frac{2}{3}} \quad \textit{(PPI)}$$

where:
- P_{cr} = Critical buckling pressure
- φ = Calibration factor (0.55 for granular soils)
- RH = Geometry factor (1.0 for deep burials in uniform soil)
- D_M = Mean pipe diameter (in.)
- E = Apparent modulus of elasticity of pipe (psi)
- I = Moment of intertia of pipe wall (in^4/in)
- E^*_s = Secant modulus of soil (psi)
- $E^*_s = E_s/(1-\mu)$

P_{cr} - Initial =	974.7 psi
P_{cr} - LongTerm =	614.0 psi

3. Calculate the factor of safety against pipe buckling:

Factor of Safety (P_{cr}/P_T) - Initial =	29.2	(OK)
Factor of Safety (P_{cr}/P_T) - Long-term =	18.4	(OK)

Golder Associates	SUBJECT:	HDPE Leachate Collection Pipe - Structural Integrity Calculations			
	Job Number:	1538880	Made by:	ALB	Date: 11/18/2016
	Project:	North Weld Landfill Unit 2 EDOP	Checked: Reviewed:	DVS JAR	

RING DEFLECTION ANALYSIS:

1. Define the allowable ring deflection:

Allowable ring deflection (SDR 11) = 3% *(Qian, Koerner, and Gray)*

2. Determine maximum pipe deflection, using the modified Iowa Equation:

$$\frac{\Delta Y}{D_m} = \frac{L_f K P_T R^3}{E_P I + 0.061 M_S R^3}$$ *(ADS)*

where:

ΔY = Vertical pipe deflection (in.)
D_m = Mean diameter of pipe
L_f = Deflection lag factor
K = Bedding constant
P_T = Maximum design load (psi)
R = Radius of pipe (in.)
E_p = Pipe modulus of elasticity (psi)
I = Moment of intertia of pipe wall (in^4/in)
M_s = Stress-dependent constrained modulus (psi)

Pipe Deflection ($\Delta Y/D_m$) - Initial =	**0.76%**	**(OK)**
Pipe Deflection ($\Delta Y/D_m$) - Long-term =	**0.89%**	**(OK)**

CONCLUSIONS: The 6-inch HDPE SDR-11 perforated leachate collection pipe will be able to withstand the proposed overburden stresses under the maximum waste height. Additionally, the maximum estimated pipe deflection was determined to be adequate. The following safety factors were computed for the leachate drainage pipe:

Wall Crushing Safety Factor:	**7.9**	>	2
Wall Buckling Safety Factor (Initial):	**29.2**	>	2
Wall Buckling Safety Factor (Long-term):	**18.4**	>	2
Maxmum pipe deflection (Initial):	**0.8%**	<	3%
Maxmum pipe deflection Long-term):	**0.9%**	<	3%

APPENDIX C-4
FOUNDATION CONSOLIDATION CALCULATIONS

Golder Associates	SUBJECT:	Foundation Soil Consolidation and Differential Settlement Calculations - Phase 4				
	Job Number:	1538880	Made by:	ALB	Date:	11/18/2016
	Project:	North Weld Landfill Unit 2 EDOP	Checked:	DVS	Page:	1 of 4
			Reviewed:	JAR		

OBJECTIVES:

1. Calculate potential primary and secondary consolidation settlement (total and differential) of the foundation soils in Phase 4 of the North Weld Landfill Unit 2 assuming maximum waste elevations and final cover conditions.
2. Estimate the maximum change in the slope of the landfill liner floor grades and in the leachate collection header trench as a result of differential foundation settlement.

REFERENCES:

1. Das, Braja M. Principles of Geotechnical Engineering. 5th ed, 2002.
2. Das, Braja M. *Principles of Foundation Engineering*. 5th ed, 2004.
3. Sharma, Hari D. and Anirban De. "Municipal Solid Waste Landfill Settlement: Postclosure Perspectives." *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 133, No. 6, June 2007.
4. *Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development*. Swift River Environmental Services, LLC. Draft Final, June 2016.
5. Advanced Terra Testing Consolidation Report (ASTM D2435 Method B) from Job No. 2952-1, Boring No. NWE-8, Sample No. 18'-20'. Dated 03/21/16.
6. Advanced Terra Testing Consolidation Report (ASTM D2435 Method B) from Job No. 2952-1, Boring No. NWE-16, Sample No. 14'-16'. Dated 03/25/16.

METHODOLOGY:

1. Apply Terzaghi's one-dimensional consolidation model to foundation soils to calculate primary and secondary
2. Calculate consolidation at three points along the leachate collection header trench and at two points on the landfill liner floor under varying overburden pressures from overlying waste. The locations of the survey points are shown in the
3. Calculate change in design grade along leachate collection header trench and on landfill liner floor resulting from differential settlement .

SITE DATA:

1. As presented in Swift River's *Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development* report, the subsurface conditions within the North Weld Landfill Unit 2 area generally consist unconsolidated eolian surficial deposits of clayey silt and very fine to fine-grained silty sand interbedded by alluival coarser-grained sand and fine gravel and overlying sedimentary rock from the Laramie Formation.
2. It was conservatively assumed that the entire subsurface strata through the top of the Laramie Formation consists of compressible material and that no significant deformation of the Laramie Formation rock will occur.
3. Consolidation parameters were derived from two consolidation tests run on undisturbed soil samples collected from soil borings NWE-16 (14'-16') and NWE-8 (18'-20'). It was assumed that the derived consolidation parameters are representative of the entire subsurface strata through the top of the Laramie Formation.
4. Primary settlement of MSW typically occurs within the first four months after load placement (Sharma and De, 2007). Therefore, primary settlement was assumed to be completed after four months. Secondary settlement was calculated at 50 years following the construction of Unit 2 to allow for a 20-year operational life and 30-year post-closure period.

ANALYSIS:

1. Define material properties:

			Reference
Waste Unit Weight (γ_{waste}) =	65	pcf	
Liner Thickness (H_L) =	2.0	ft	WMDSC NWLF EDOP
Liner Unit Weight (γ_L) =	130	pcf	Swift River, 2016
Final Cover Thickness (H_{FC}) =	2.5	ft	WMDSC NWLF EDOP
Final Cover Unit Weight (γ_{FC}) =	100	pcf	Swift River, 2016

1. Define material properties [cont.]:

Moist Unit Weight of Soil (γ) =	99	pcf	Swift River, 2016
C_c =	0.22		Swift River, 2016
C_r =	0.032		Swift River, 2016
C_α =	0.0029		Terra Testing, 2016
e_0 =	0.831		Terra Testing, 2016
e_p =	0.715		Terra Testing, 2016
OCR =	1.05		Swift River, 2016

2. Define settlement points:

Settlement Point	4-A	4-B	4-C	4-D	4-E
Existing Elev. (ft amsl)	5149.5	5109.9	5078.6	5120.8	5116.5
Bedrock Elev. (ft amsl)	5122.5	5080.0	5032.3	5102.0	5091.0
Subgrade Grade Elev. (ft amsl)	5131.5	5092.0	5052.5	5114.7	5113.6
Final Cover Elev. (ft amsl)	5164.3	5232.1	5103.6	5232.3	5240.7
Groundwater Elev. (ft amsl)	5032.0	5032.0	5032.0	5032.0	5032.0
Thickness of Soil Unit (H_0) (ft)	9.0	12.0	20.2	12.7	22.6
Top of Waste Elev. (ft)	5,161.8	5,229.6	5,101.1	5,229.8	5,238.2
Top of Liner (ft)	5,133.5	5,094.0	5,054.5	5,116.7	5,115.6
Waste Thickness (H_{waste}) (ft)	28	136	47	113	123
$H_0/2$ (ft)	4.5	6.0	10.1	6.4	11.3
$H_0/2$ Elev. (ft amsl)	5,127	5,086	5,042	5,108	5,102
Sat. Thickness above $H_0/2$ (ft)	0	0	0	0	0
Preconsol. Pressure (P'_P) (psf)	**2335**	**2484**	**3759**	**1293**	**1482**

3. Calculate the initial effective overburden stress:

The calculation of initial effective stress assumes that excavation to subgrade elevations has occurred prior to cell construction and pore pressure has equalized. The initial effective overburden stress is calculated at the midpoint of each compressible layer using the following equation:

$$P'_o = \sum \gamma_i H_i - u$$

where:

P'_0 = Initial Effective Overburden Stress (psf)
H_i = Layer Height (ft)
γ_i = Moist Unit Weight of Soil (pcf)
u = Pore Pressure (psf) (saturated thickness above soil layer midpoint x 62.4 pcf)

Settlement Point	4-A	4-B	4-C	4-D	4-E
u (psf)	0	0	0	0	0
P'_0 (psf)	**444.7**	**593.6**	**997.8**	**630.2**	**1116.0**

4. Calculate the effective stress increase due to the landfill:

$$\Delta p = \gamma_{FC} H_{FC} + \gamma_{waste} H_{waste} + \gamma_L H_L$$

where:

Δp = Effective Stress Increase, psf
γ_{FC} = Final Cover Unit Weight, pcf
H_{FC} = Final Cover Thickness, ft
γ_{waste} = Waste Unit Weight, pcf
H_{waste} = Waste Thickness, ft
γ_L = Liner Density, pcf
H_L = Liner System Thickness, ft

4. Calculate the effective stress increase due to the landfill [cont.]:

Settlement Point	4-A	4-B	4-C	4-D	4-E
Waste Pressure (psf)	1,840	8,815	3,030	7,347	7,969
Final Cover Pressure (psf)	250	250	250	250	250
Liner Pressure (psf)	260	260	260	260	260
Δp (psf)	**2,350**	**9,325**	**3,540**	**7,857**	**8,479**

5. Using Terzaghi's 1-D consolidation theory, primary consolidation is calculated using the following equations:

If **$P'_0 + \Delta p > P'_P$**, then:

$$S = C_r\left(\frac{H_0}{1+e_0}\right)\times\log\left(\frac{P'_p}{P'_o}\right)+C_c\left(\frac{H_0}{1+e_0}\right)\times\log\left(\frac{\Delta p+P'_o}{P'_p}\right)$$

If **$P'_0 + \Delta p < P'_P$**, then:

$$S = C_r\left(\frac{H_0}{1+e_0}\right)\times\log\left(\frac{P'_o+\Delta p}{P'_o}\right)$$

where:

- S = Primary consolidation settlement (ft)
- C_c = Compression Index
- C_r = Recompression Index
- H_0 = Thickness of Soil Unit (ft)
- e_0 = Initial void ratio
- Δp = Effective stress increase (psf)
- P'_0 = Initial effective stress (psf)
- P'_P = Preconsolidation Pressure (psf)

Settlement Point	4-A	4-B	4-C	4-D	4-E
H_0 (ft) =	9.0	12.0	20.2	12.7	22.6
$1+e_0$ =	1.8	1.8	1.8	1.8	1.8
$H_0/(1+e_0)$ =	4.9	6.6	11.0	7.0	12.3
P'_P (psf) =	2334.6	2483.7	3759.4	1293.1	1482.3
P'_0 (psf) =	444.7	593.6	997.8	630.2	1116.0
Δp (psf) =	2349.8	9324.6	3539.7	7857.2	8478.7
P'_P/P'_0 =	5.3	4.2	3.8	2.1	1.3
$\log(P'_P/P'_0)$ =	0.7	0.6	0.6	0.3	0.1
$\Delta p+P'_0$ =	2794.5	9918.1	4537.5	8487.4	9594.8
$(\Delta p+P'_0)/P'_P$ =	1.2	4.0	1.2	6.6	6.5
$\log((\Delta p+P'_0)/P'_P)$ =	0.08	0.60	0.08	0.82	0.81
$(\Delta p+P'_0)/P'_0$ =	6.3	16.7	4.5	13.5	8.6
$\log((\Delta p+P'_0)/P'_0)$	0.80	1.22	0.66	1.13	0.93
$S_{primary}$ (ft) =	**0.19**	**0.98**	**0.39**	**1.29**	**2.20**

6. Using Terzaghi's 1-D consolidation theory, secondary consolidation is calculated using the following equation:

$$S_s = C'_\alpha H \log\left(\frac{t_2}{t_1}\right)$$

where:

- S_s = Secondary consolidation settlement (ft)
- C_α = Secondary compression index
- H = Thickness of Soil Unit (ft)
- t_1, t_2 = Time

6. Using Terzaghi's 1-D consolidation theory, secondary consolidation is calculated using the following equation [cont.]:

Settlement Point	4-A	4-B	4-C	4-D	4-E
C'_α	0.002	0.002	0.002	0.002	0.002
H =	8.8	11.0	19.8	11.4	20.4
t_1 (yrs)=	0.33	0.33	0.33	0.33	0.33
t_2 (yrs) =	30	30	30	30	30
log (t_2/t_1)	1.95	1.95	1.95	1.95	1.95
S_s (ft) =	**0.03**	**0.04**	**0.06**	**0.04**	**0.07**

7. Sum the primary and secondary settlement to calculate total settlement:

Settlement Point	4-A	4-B	4-C	4-D	4-E
$S_{primary}$ (ft) =	0.19	0.98	0.39	1.29	2.20
$S_{secondary}$ (ft) =	0.03	0.04	0.06	0.04	0.07
S_{total} (ft) =	**0.22**	**1.01**	**0.46**	**1.33**	**2.26**

8. Calculate post settlement slope between settlement points:

Settlement Point	Design Liner Grade (ft amsl)	Total Settlement (ft)	Final Liner Grade (ft amsl)	Lateral Distance (ft)	Design Slope (%)	Final Slope (%)	Δslope (%)
4-A	5131.5	0.22	5131.3	1834.0	-2.15%	-2.20%	-0.04%
4-B	5092.0	1.01	5091.0				
4-B	5092.0	1.01	5091.0	1834.0	-2.15%	-2.12%	0.03%
4-C	5052.5	0.46	5052.0				
4-A	5131.5	0.22	5131.3	3668.0	-2.15%	-2.16%	-0.01%
4-C	5052.5	0.46	5052.0				
4-D	5114.7	1.33	5113.4	812.1	-2.80%	-2.76%	0.04%
4-B	5092.0	1.01	5091.0				
4-E	5113.6	2.26	5111.3	769.9	-2.80%	-2.64%	0.16%
4-B	5092.0	1.01	5091.0				

CONCLUSIONS:

1. For settlement analysis, the maximum final slope after differential settlement presents the critical slope for leachate flow after closure of the landfill. Differential settlement in the landfill results in an increase in the slope of the leachate collection trench of 0.03%, resulting in a maximum final slope of -2.12% between points 5-B and 5-C. Additionally, differential settlement along the floor grades results in an increase of 0.16%, resulting in a maximum final slope of -2.64% between points 4-E and 4-B.

Golder Associates	SUBJECT:	Foundation Soil Consolidation and Differential Settlement Calculations - Phase 5				
	Job Number:	1538880	Made by:	ALB	Date:	11/18/2016
	Project:	North Weld Landfill Unit 2 EDOP	Checked:	DVS DS	Page:	1 of 4
			Reviewed:	JAR AL		

OBJECTIVES:

1. Calculate potential primary and secondary consolidation settlement (total and differential) of the foundation soils in Phase 5 of the North Weld Landfill Unit 2 assuming maximum waste elevations and final cover conditions.
2. Estimate the maximum change in the slope of the landfill liner floor grades and in the leachate collection header trench as a result of differential foundation settlement.

REFERENCES:

1. Das, Braja M. Principles of Geotechnical Engineering. 5th ed, 2002.
2. Das, Braja M. *Principles of Foundation Engineering*. 5th ed, 2004.
3. Sharma, Hari D. and Anirban De. "Municipal Solid Waste Landfill Settlement: Postclosure Perspectives." *Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 133, No. 6, June 2007.
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METHODOLOGY:

1. Apply Terzaghi's one-dimensional consolidation model to foundation soils to calculate primary and secondary
2. Calculate consolidation at three points along the leachate collection header trench and at two points on the landfill liner floor under varying overburden pressures from overlying waste. The locations of the survey points are shown in the
3. Calculate change in design grade along leachate collection header trench and on landfill liner floor resulting from differential settlement .

SITE DATA:

1. As presented in Swift River's *Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development* report, the subsurface conditions within the North Weld Landfill Unit 2 area generally consist unconsolidated eolian surficial deposits of clayey silt and very fine to fine-grained silty sand interbedded by alluival coarser-grained sand and fine gravel and overlying sedimentary rock from the Laramie Formation.
2. It was conservatively assumed that the entire subsurface strata through the top of the Laramie Formation consists of compressible material and that no significant deformation of the Laramie Formation rock will occur.
3. Consolidation parameters were derived from two consolidation tests run on undisturbed soil samples collected from soil borings NWE-16 (14'-16') and NWE-8 (18'-20'). It was assumed that the derived consolidation parameters are representative of the entire subsurface strata through the top of the Laramie Formation.
4. Primary settlement of MSW typically occurs within the first four months after load placement (Sharma and De, 2007). Therefore, primary settlement was assumed to be completed after four months. Secondary settlement was calculated at 50 years following the construction of Unit 2 to allow for a 20-year operational life and 30-year post-closure period.

ANALYSIS:

1. Define material properties:

			Reference
Waste Unit Weight (γ_{waste}) =	65	pcf	
Liner Thickness (H_L) =	2.0	ft	WMDSC NWLF EDOP
Liner Unit Weight (γ_L) =	130	pcf	Swift River, 2016
Final Cover Thickness (H_{FC}) =	2.5	ft	WMDSC NWLF EDOP
Final Cover Unit Weight (γ_{FC}) =	100	pcf	Swift River, 2016

1. Define material properties [cont.]:

Moist Unit Weight of Soil (γ) =	99	pcf	Swift River, 2016
C_c =	0.22		Swift River, 2016
C_r =	0.032		Swift River, 2016
C_α =	0.0029		Terra Testing, 2016
e_0 =	0.831		Terra Testing, 2016
e_p =	0.609		Terra Testing, 2016
OCR =	1.05		Swift River, 2016

2. Define settlement points:

Settlement Point	5-A	5-B	5-C	5-D	5-E
Existing Elev. (ft amsl)	5116.6	5101.2	5079.1	5115.2	5108.3
Bedrock Elev. (ft amsl)	5084.2	5066.3	4996.0	5101.0	5071.8
Subgrade Grade Elev. (ft amsl)	5105.0	5079.7	5054.5	5102.7	5100.4
Final Cover Elev. (ft amsl)	5154.6	5223.0	5127.3	5243.0	5139.6
Groundwater Elev. (ft amsl)	5032.0	5032.0	5032.0	5032.0	5032.0
Thickness of Soil Unit (H_0) (ft)	20.8	13.4	58.5	1.7	28.6
Top of Waste Elev. (ft)	5,152.1	5,220.5	5,124.8	5,240.5	5,137.1
Top of Liner (ft)	5,107.0	5,081.7	5,056.5	5,104.7	5,102.4
Waste Thickness (H_{waste}) (ft)	45	139	68	136	35
$H_0/2$ (ft)	10.4	6.7	29.3	0.9	14.3
$H_0/2$ Elev. (ft amsl)	5,095	5,073	5,025	5,102	5,086
Sat. Thickness above $H_0/2$ (ft)	0	0	7	0	0
Preconsol. Pressure (P'_p) (psf)	**2286**	**2930**	**5599**	**1390**	**2311**

3. Calculate the initial effective overburden stress:

The calculation of initial effective stress assumes that excavation to subgrade elevations has occurred prior to cell construction and pore pressure has equalized. The initial effective overburden stress is calculated at the midpoint of each compressible layer using the following equation:

$$P'_o = \sum \gamma_i H_i - u$$

where:

P'_0 = Initial Effective Overburden Stress (psf)
H_i = Layer Height (ft)
γ_i = Moist Unit Weight of Soil (pcf)
u = Pore Pressure (psf) (saturated thickness above soil layer midpoint x 62.4 pcf)

Settlement Point	5-A	5-B	5-C	5-D	5-E
u (psf)	0	0	0	0	0
P'_0 (psf)	**1029.6**	**664.9**	**2894.8**	**84.4**	**1417.7**

4. Calculate the effective stress increase due to the landfill:

$$\Delta p = \gamma_{FC} H_{FC} + \gamma_{waste} H_{waste} + \gamma_L H_L$$

where:

Δp = Effective Stress Increase, psf
γ_{FC} = Final Cover Unit Weight, pcf
H_{FC} = Final Cover Thickness, ft
γ_{waste} = Waste Unit Weight, pcf
H_{waste} = Waste Thickness, ft
γ_L = Liner Density, pcf
H_L = Liner System Thickness, ft

4. Calculate the effective stress increase due to the landfill [cont.]:

Settlement Point	5-A	5-B	5-C	5-D	5-E
Waste Pressure (psf)	2,933	9,019	4,442	8,826	2,258
Final Cover Pressure (psf)	250	250	250	250	250
Liner Pressure (psf)	260	260	260	260	260
Δp (psf)	**3,443**	**9,529**	**4,952**	**9,336**	**2,768**

5. Using Terzaghi's 1-D consolidation theory, primary consolidation is calculated using the following equations:

If $P'_0 + \Delta p > P'_P$, then:

$$S = C_r\left(\frac{H_0}{1+e_0}\right)\times\log\left(\frac{P'_p}{P'_o}\right) + C_c\left(\frac{H_0}{1+e_0}\right)\times\log\left(\frac{\Delta p + P'_o}{P'_p}\right)$$

If $P'_0 + \Delta p < P'_P$, then:

$$S = C_r\left(\frac{H_0}{1+e_0}\right)\times\log\left(\frac{P'_o + \Delta p}{P'_o}\right)$$

where:

- S = Primary consolidation settlement (ft)
- C_c = Compression Index
- C_r = Recompression Index
- H_0 = Thickness of Soil Unit (ft)
- e_0 = Initial void ratio
- Δp = Effective stress increase (psf)
- P'_0 = Initial effective stress (psf)
- P'_P = Preconsolidation Pressure (psf)

Settlement Point	5-A	5-B	5-C	5-D	5-E
H_0 (ft) =	20.8	13.4	58.5	1.7	28.6
$1+e_0$ =	1.8	1.8	1.8	1.8	1.8
$H_0/(1+e_0)$ =	11.4	7.3	32.0	0.9	15.7
P'_P (psf) =	2286.5	2930.4	5599.4	1389.8	2311.0
P'_0 (psf) =	1029.6	664.9	2894.8	84.4	1417.7
Δp (psf) =	3443.1	9528.8	4952.1	9336.1	2768.4
P'_P/P'_0 =	2.2	4.4	1.9	16.5	1.6
$\log(P'_P/P'_0)$ =	0.3	0.6	0.3	1.2	0.2
$\Delta p+P'_0$ =	4472.6	10193.7	7846.9	9420.5	4186.1
$(\Delta p+P'_0)/P'_P$ =	2.0	3.5	1.4	6.8	1.8
$\log((\Delta p+P'_0)/P'_P)$ =	0.29	0.54	0.15	0.83	0.26
$(\Delta p+P'_0)/P'_0$ =	4.3	15.3	2.7	111.7	3.0
$\log((\Delta p+P'_0)/P'_0)$	0.64	1.19	0.43	2.05	0.47
$S_{primary}$ (ft) =	**0.84**	**1.00**	**1.30**	**0.20**	**0.97**

6. Using Terzaghi's 1-D consolidation theory, secondary consolidation is calculated using the following equation:

$$S_s = C'_\alpha H \log\left(\frac{t_2}{t_1}\right)$$

where:

- S_s = Secondary consolidation settlement (ft)
- C_α = Secondary compression index
- H = Thickness of Soil Unit (ft)
- t_1, t_2 = Time

6. Using Terzaghi's 1-D consolidation theory, secondary consolidation is calculated using the following equation [cont.]:

Settlement Point	5-A	5-B	5-C	5-D	5-E
C'_α	0.002	0.002	0.002	0.002	0.002
H =	20.0	12.4	57.2	1.5	27.7
t_1 (yrs)=	0.33	0.33	0.33	0.33	0.33
t_2 (yrs) =	30	30	30	30	30
log (t_2/t_1)	1.95	1.95	1.95	1.95	1.95
S_s (ft) =	**0.07**	**0.04**	**0.20**	**0.01**	**0.10**

7. Sum the primary and secondary settlement to calculate total settlement:

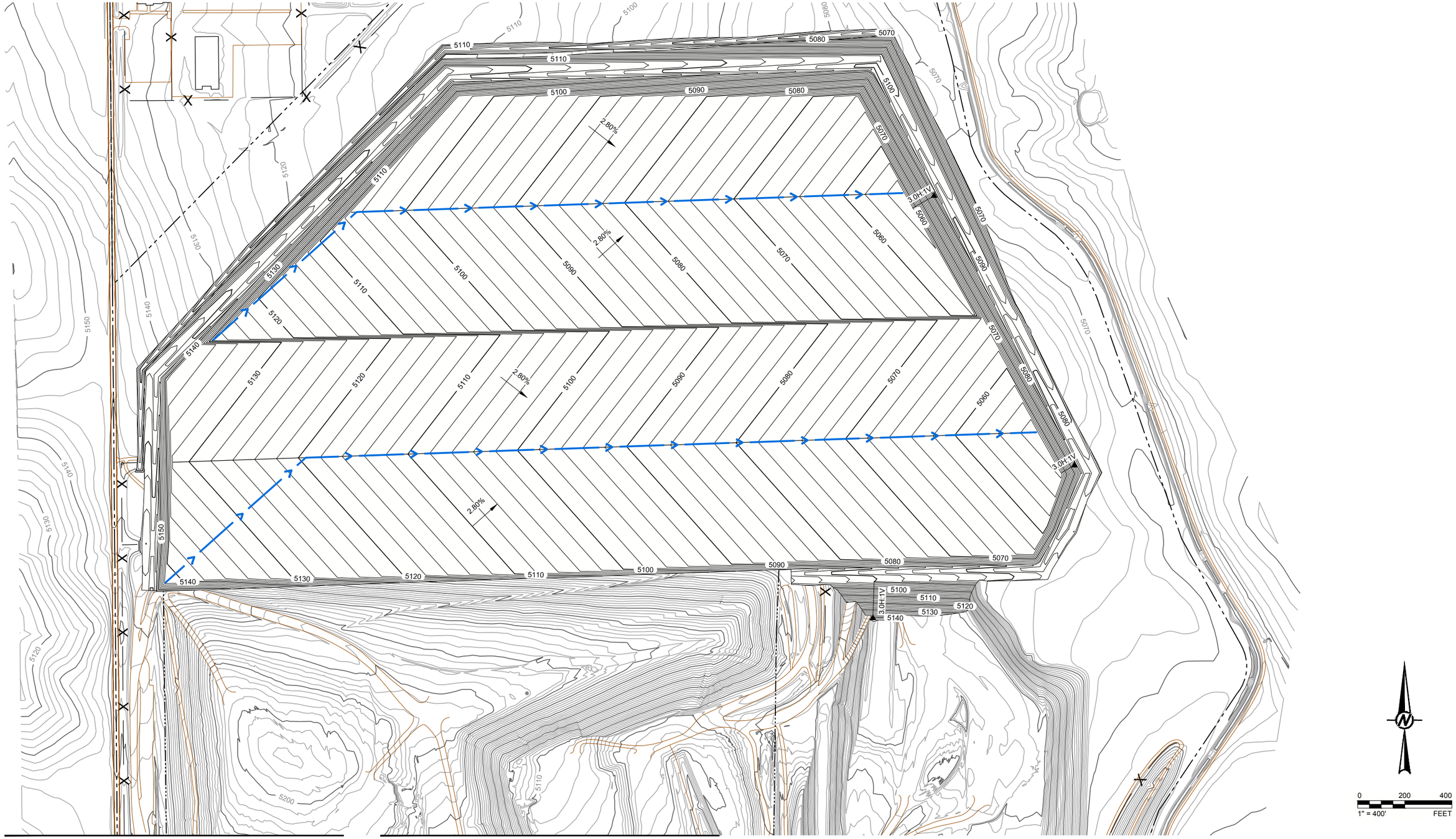
Settlement Point	5-A	5-B	5-C	5-D	5-E
$S_{primary}$ (ft) =	0.84	1.00	1.30	0.20	0.97
$S_{secondary}$ (ft) =	0.07	0.04	0.20	0.01	0.10
S_{total} (ft) =	**0.91**	**1.05**	**1.49**	**0.21**	**1.07**

8. Calculate post settlement slope between settlement points:

Settlement Point	Design Liner Grade (ft amsl)	Total Settlement (ft)	Final Liner Grade (ft amsl)	Lateral Distance (ft)	Design Slope (%)	Final Slope (%)	Δslope (%)
5-A	5105.0	0.91	5104.1	1171.9	-2.15%	-2.17%	-0.01%
5-B	5079.7	1.05	5078.7				
5-B	5079.7	1.05	5078.7	1171.9	-2.15%	-2.19%	-0.04%
5-C	5054.5	1.49	5053.0				
5-A	5105.0	0.91	5104.1	2343.9	-2.15%	-2.18%	-0.03%
5-C	5054.5	1.49	5053.0				
5-D	5102.7	0.21	5102.5	820.3	-2.80%	-2.90%	-0.10%
5-B	5079.7	1.05	5078.7				
5-E	5100.4	1.07	5099.3	737.9	-2.80%	-2.80%	0.00%
5-B	5079.7	1.05	5078.7				

CONCLUSIONS:

1. For settlement analysis, the maximum final slope after differential settlement presents the critical slope for leachate flow after closure of the landfill. Differential settlement in the landfill results in a decrease in the slope of the leachate collection trench of 0.02%, resulting in a maximum final slope of -2.17% between points 5-A and 5-B. Additionally, differential settlement along the floor grades yields no increase in the critical slope.



LEGEND

- 5280 EXISTING TOPOGRAPHY (SEE NOTE 1)
- 5280 PROPOSED LINER SUBGRADE
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- CRITICAL LEACHATE FLOW PATH

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-11-18
DESIGNED	ALB
PREPARED	ALB
REVIEWED	JAR
APPROVED	MEM

PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
CRITICAL LEACHATE FLOW PATHS

PROJECT NO.	CONTROL	REV.	FIGURE
1538880		A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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Path: \\Denver.golder.gds\acad\15\1538880\PRODUCTION\B - Figures\ | File Name: 1538880B003.dwg | Last Edited By: alebrown Date: 2016-11-17 Time:7:19:34 PM | Printed By: ALEBrown Date: 2016-11-18 Time:9:24:55 AM

APPENDIX C-5
SLOPE STABILITY ANALYSIS

CALCULATIONS

Date:	November 18, 2016	**Made by:**	ALB
Project No.:	1538880	**Checked by:**	JAR
Site Name:	North Weld Landfill Unit 2 EDOP	**Reviewed by:**	MEM
Subject	**APPENDIX C-5: GLOBAL SLOPE STABILITY ANALYSIS**		

1.0 OBJECTIVE

Evaluate the global stability of the proposed Unit 2 at North Weld Landfill (NWLF) at initial construction, intermediate development, and final closure conditions. Initial cell construction excavation slopes within Unit 2 are modeled at the maximum design slope of 3H:1V. The step in liner grades between Phases 4 and 5 of Unit 2 are modeled at the design slope of 2H:1V. Intermediate filling conditions are modeled at 3H:1V. Final closure conditions are modeled at the final design slopes of 4H:1V with a 5% crown slope.

2.0 METHODOLOGY

Five cross-sections representative of various operational conditions expected throughout the development of Unit 2 were evaluated for global slope stability analysis. These cross sections represent anticipated worst-case conditions from a slope stability perspective throughout the operational life of Unit 2. General limit equilibrium (GLE) slope stability analyses were performed using Spencer's method in Slide 7.0 (RocScience 2016), a slope stability modeling software platform commonly considered as the standard of practice for slope stability analyses of earthen structures such as landfills. Spencer's method considers both moment and force equilibrium for a range of interslice shear-normal force conditions. It is common geotechnical practice to analyze the stability of embankment slopes using limit equilibrium methods.

The NWLF is not located in a seismic impact zone defined in the Colorado Department of Public Health and Environment (CDPHE) "Regulations Pertaining to Solid Waste Sites and Facilities," 6 CCR 1007-2, Part 1 as amended November 17, 2015 (Regulations) as an area with a 10% percent or greater probability that the maximum horizontal acceleration in lithified earth material, expressed as a percentage of the earth's gravitational pull (g), will exceed 0.10g in 250 years. Therefore, slope stability analyses were only run for static conditions. For all five cross-sections, results from circular and block slip surfaces were compared to determine the failure mode and surface with the lowest factor of safety.

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Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill	Checked by:	JAR
Date:	November 18, 2016	Reviewed by:	MEM

2.1 Geometry

Five cross-sections were analyzed for global slope stability analyses, as shown in Figure 1 and summarized below:

- Section A: cross-section cut through the maximum depth of excavation (i.e., longest excavation slope) required for liner construction
- Section B: cross-section cut in a north-south alignment through an intermediate filling condition in Phase 4 that terminates at the 2H:1V step between the liner systems of Phases 4 and 5
- Section C: cross-section cut in an east-west alignment through an intermediate filling condition in Phase 4
- Section D: cross-section cut through the maximum thickness of waste (i.e., maximum driving force)
- Section E: cross-section cut through maximum permitted waste grades at the location of minimum height of the perimeter berm (i.e., minimum resisting force)

2.2 Assumptions

Slope stability analyses were based on the following assumptions:

- Factors of safety were computed using Spencer's Method of Slices (Spencer 1967).
- The critical slip surface for all conditions was assumed to be circular. Circular analysis slip surfaces were drawn using a random search routine to locate the critical failure surface (the failure surface yielding the lowest factor of safety).
- The search was restricted to slip surfaces that would result in a significant failure of the embankment (i.e., sloughing of the slopes was neglected).
- Material properties for in situ materials, liner system materials, and alternative final cover materials (including shear strength parameters and unit weights) were based on the results of consolidated undrained (CU) triaxial shear strength tests (ASTM D4767) and direct shear tests (ASTM D3080) performed on relatively undisturbed or recompacted soil samples collected during the site characterization field investigation.
- Groundwater elevations were based on maximum inferred elevations from temporary monitoring well readings collected by Swift River Environmental Services, LLC on May 3–4, 2016.
- Only groundwater elevations from temporary wells screened within shallow alluvial deposits of gravelly sands and sandstones encountered between the alluvium and the Laramie Formation and within the discontinuous water-bearing sands and lignite seams within the Laramie formation were considered in stability analyses. Groundwater elevations from the regional confined aquifer within the Fox Hills Formation were not considered due to depth (i.e., greater than 50 ft bgs).
- Minimum allowable factors of safety were defined as follows:
  - Short-term conditions (excavation and intermediate fill): 1.30
  - Long-term conditions (final closure): 1.50

Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill	Checked by:	JAR
Date:	November 18, 2016	Reviewed by:	MEM

2.3 Material Properties

Mohr-Coulomb drained shear strength parameters were derived for all materials as summarized in Table 1.

Table 1: Shear Strength Parameters

Material	Total Unit Weight (pcf)	Static Analysis	
		Friction Angle (°)	Cohesion (psf)
In Situ Material (Alluvium)	122	25	0
Engineered Fill	122	29	0
Compacted Cohesive Soil Liner	120	26	905
Granular Drainage Material	120	34	0
Protective Layer	122	25	0
Municipal Solid Waste	65	33	0
Daily and Intermediate Cover	122	25	0
Alternative Final Cover	120	29	157

Shear strength properties were based on the following geotechnical laboratory testing reported in the Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016):

- Shear strength properties for in-situ alluvial material, protective layer materials, and daily/intermediate cover materials were based on a 3-point isotropically consolidated undrained (CIU) triaxial shear strength test (ASTM D4767) of a relatively undisturbed soil sample collected from boring NWE-14 between 17 and 19 ft bgs.
- Shear strength parameters for engineered fill material were based on a direct shear test (ASTM D3080) of a bulk sample collected from test pit TP-3 between 3 and 5 ft bgs and remolded to 85% maximum dry density and 2.5% below optimum moisture content. No cohesion was assumed to maintain conservativeness.
- Shear strength properties for the compacted cohesive soil liner were based on a direct shear test (ASTM D3080) of a bulk sample collected from test pit TP-2 between 5 and 9 ft bgs and remolded to 97% maximum dry density and 2.5% below optimum moisture content.
- Shear strength properties for granular drainage material were referenced from typical soil characteristics (Lindeburg 2008).
- Shear strength properties for municipal solid waste (MSW) were referenced from published data (Kavazanjian et al 1995). The unit weight of MSW was based on commonly accepted values assuming good compaction and/or waste settlement.
- Shear strength parameters for alternative final cover material were based on a direct shear test (ASTM D3080) of a bulk sample collected from test pit TP-3 between 3 and 5 ft bgs and remolded to 85% maximum dry density and 2.5% below optimum moisture content.

Project No.:	1538880	Made by:	ALB
Site Name:	North Weld Landfill	Checked by:	JAR
Date:	November 18, 2016	Reviewed by:	MEM

3.0 RESULTS AND CONCLUSIONS

Results of the slope stability analyses are summarized in Table 2. The results are also illustrated graphically in the attached Slide output figures. The figures depict the most critical slip surfaces and computed minimum factors of safety for the cross-sections evaluated. For each section, circular slip surfaces yielded lower safety factors than block slip surfaces.

Table 2: Summary of Analyses and Computed Minimum Factors of Safety

Cross-Section	Operational Condition	Factor of Safety
Section A	Excavation	1.41
Section B	Intermediate Fill	1.95
Section C	Intermediate Fill	1.95
Section D	Final Closure	1.69
Section E	Final Closure	2.10

The minimum factors of safety calculated against static stability failure were found to be above the targeted factors of safety and are therefore considered stable for all cross sections and operational conditions evaluated.

4.0 REFERENCES

Colorado Department of Public Health and Environment (CDPHE). 2015. Hazardous Materials and Waste Management Division. Part 1 – Regulations Pertaining to Solid Waste Disposal Sites and Facilities, 6 CCR 1007-2. Amended November 17.

Kavazanjian, E. Jr., N. Matasovic, R. Bonaparte, and G.R. Schmertmann. 1995. Evaluation of MSW Properties for Seismic Analysis. ***Geoenvironment 2000*** 2:pp. 1126–1141.

Lindeburg, M.R. 2008. Civil Engineering Reference Manual for the PE Exam. 11th ed.

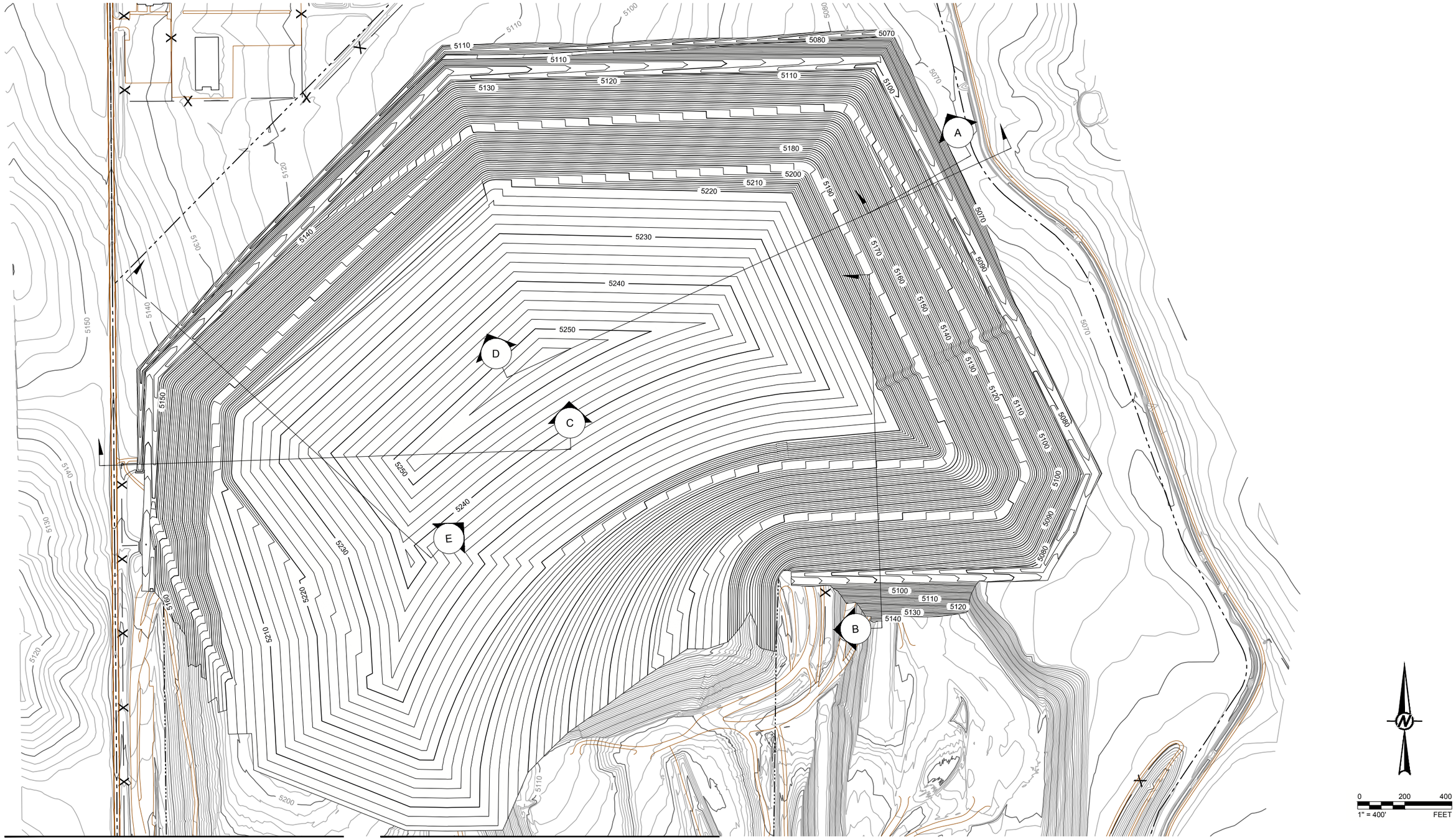
RocScience. 2016. Slide Version 7.020. Build date: October 27, 2016.

Spencer, E. 1967. A Method of Analysis of the Stability of Embankments Assuming Parallel Inter-Slice Forces. ***Geotechnique*** Vol. XVII, 1:pp. 11–26.

Swift River Environmental Services, LLC (Swift River). 2016. Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development. June.

United States Geological Survey (USGS). 2014. Interactive Fault Map. Available online: http://earthquake.usgs.gov/hazards/qfaults/map/#hazfaults2014 (accessed August 12, 2016).

FIGURES



LEGEND

- 5280 EXISTING TOPOGRAPHY (SEE NOTE 1)
- 5280 PROPOSED LINER SUBGRADE
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- EXISTING FENCE

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

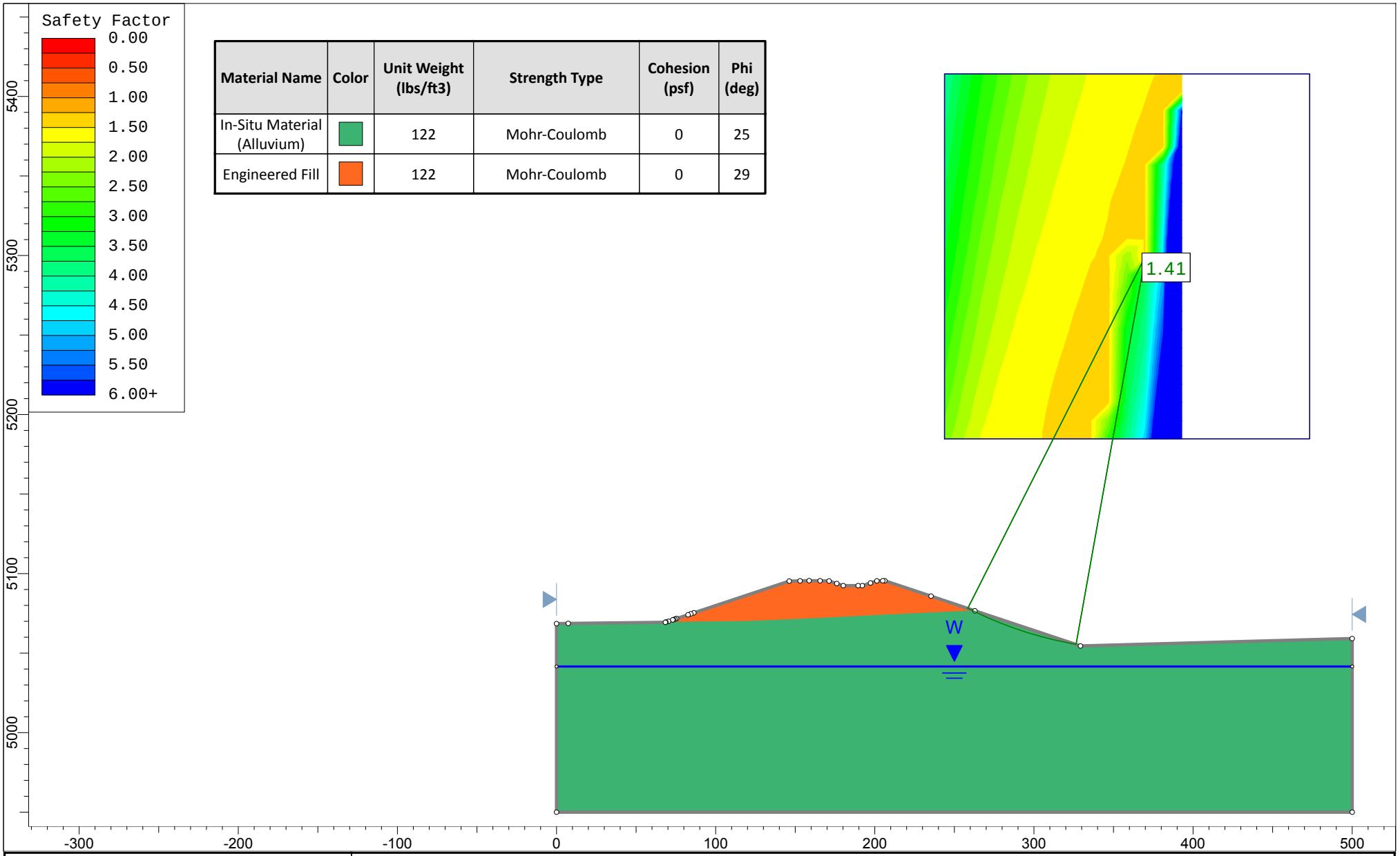
YYYY-MM-DD	2016-11-11
DESIGNED	ALB
PREPARED	ALB
REVIEWED	JAR
APPROVED	MEM

PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
SLOPE STABILITY SECTION MAP

PROJECT NO.	CONTROL	REV.	FIGURE
1538880		A	1

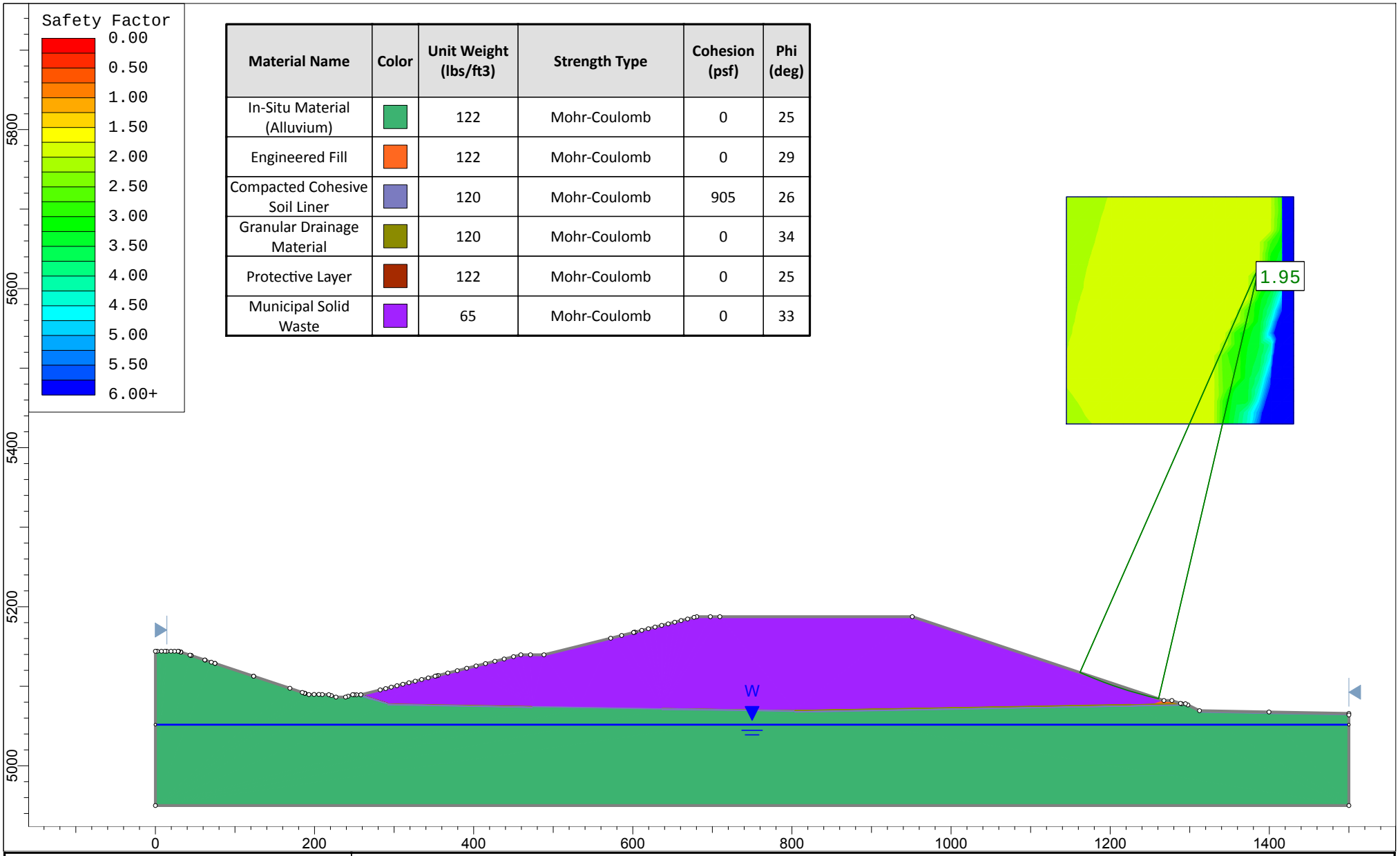
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Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
In-Situ Material (Alluvium)		122	Mohr-Coulomb	0	25
Engineered Fill		122	Mohr-Coulomb	0	29

SLIDEINTERPRET 7.020

Project	North Weld Landfill - Unit 2 Expansion		
Analysis Description	Slope Stability - Section A - Excavation		
Drawn By	ALB	Scale 1:1000	Company Golder Associates
Date	11/2/2016, 9:52:27 AM		File Name Excavation Section.slim

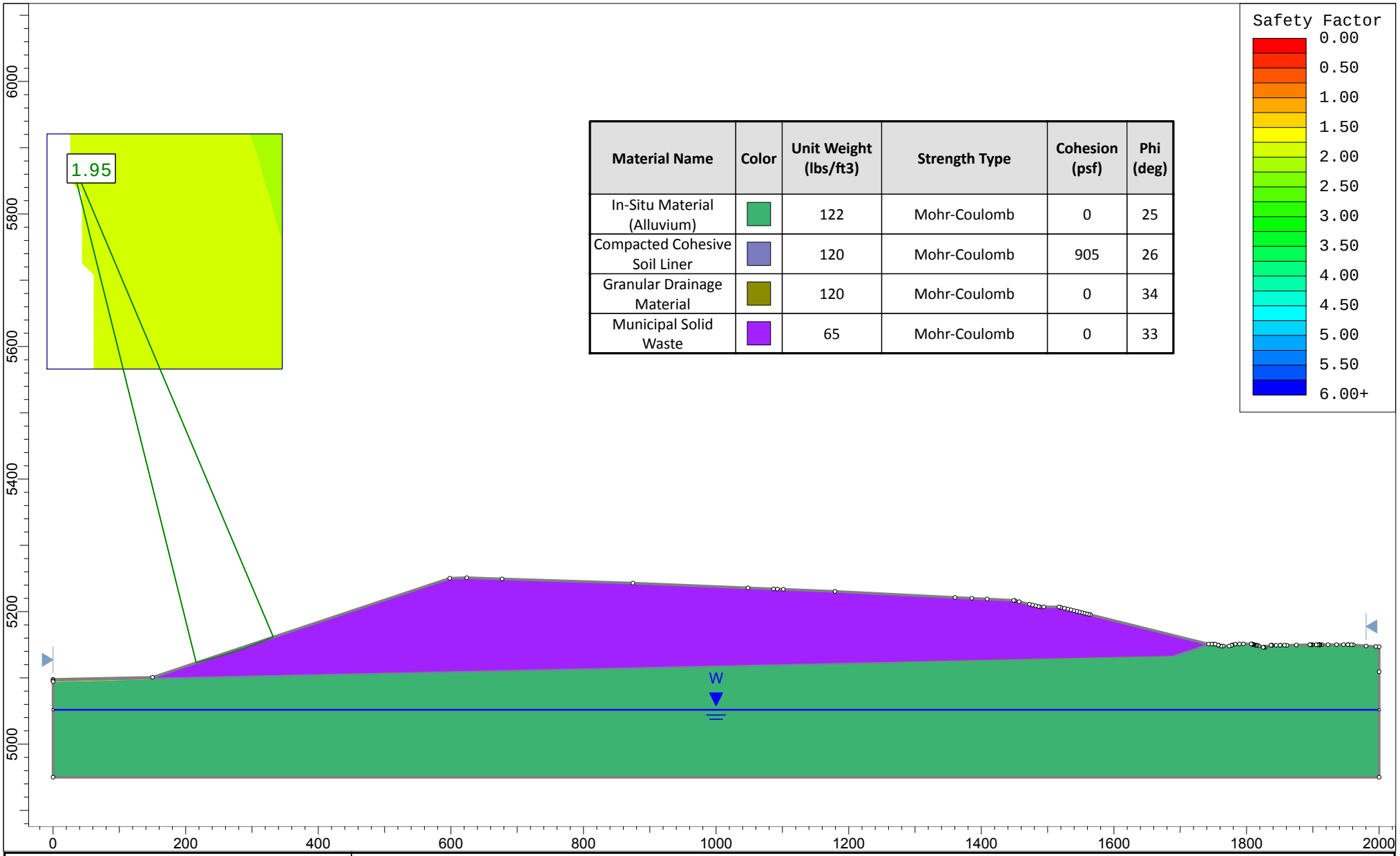


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
In-Situ Material (Alluvium)		122	Mohr-Coulomb	0	25
Engineered Fill		122	Mohr-Coulomb	0	29
Compacted Cohesive Soil Liner		120	Mohr-Coulomb	905	26
Granular Drainage Material		120	Mohr-Coulomb	0	34
Protective Layer		122	Mohr-Coulomb	0	25
Municipal Solid Waste		65	Mohr-Coulomb	0	33

rocscience

SLIDEINTERPRET 7.020

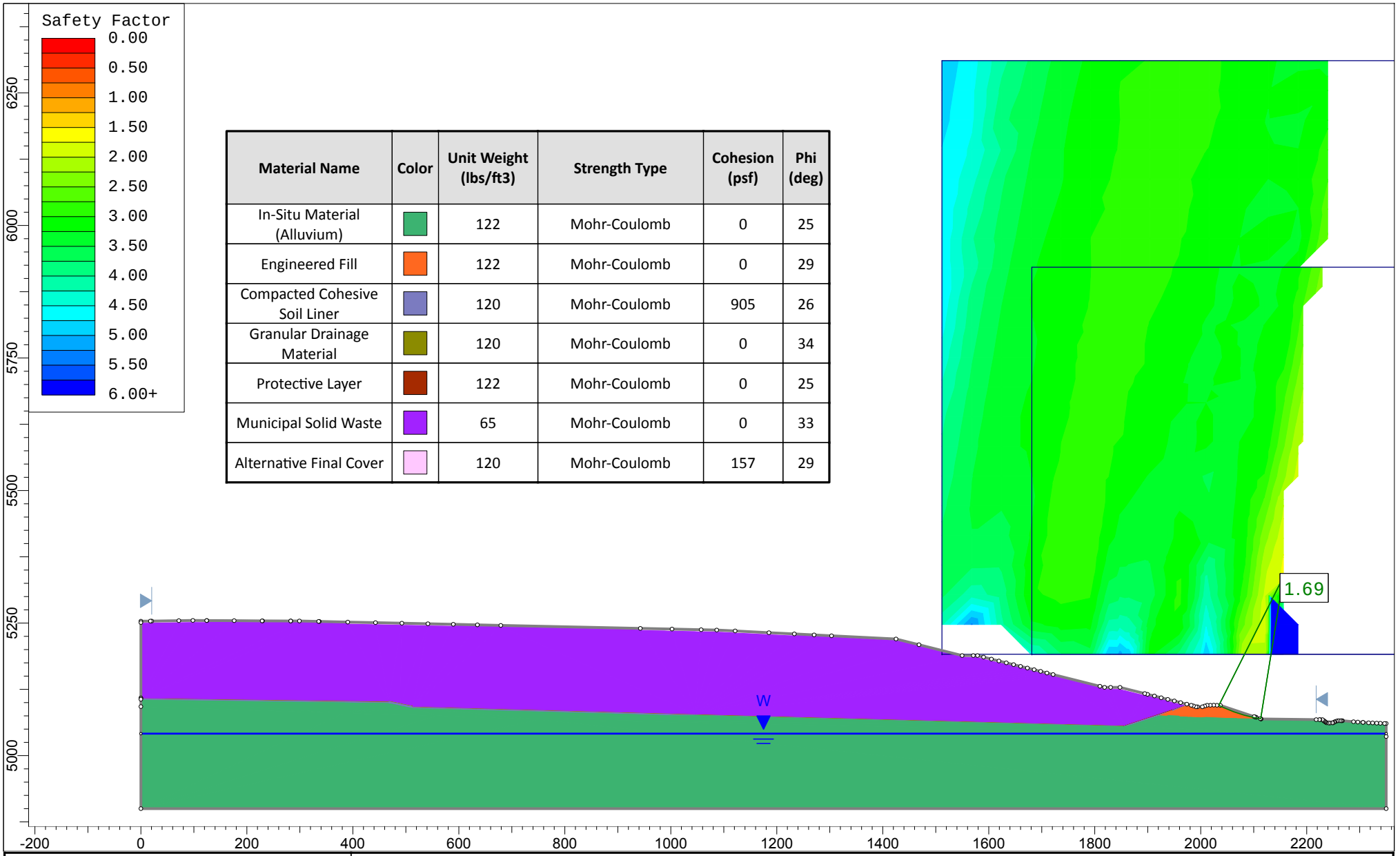
Project	North Weld Landfill - Unit 2 Expansion		
Analysis Description	Slope Stability - Section B - Intermediate Fill		
Drawn By	ALB	*Scale* 1:2000	*Company* Golder Associates
Date	11/2/2016, 9:52:27 AM	*File Name*	Intermediate Section B.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
In-Situ Material (Alluvium)		122	Mohr-Coulomb	0	25
Compacted Cohesive Soil Liner		120	Mohr-Coulomb	905	26
Granular Drainage Material		120	Mohr-Coulomb	0	34
Municipal Solid Waste		65	Mohr-Coulomb	0	33

Project	North Weld Landfill - Unit 2 Expansion		
Analysis Description	Slope Stability - Section C - Intermediate Fill		
Drawn By: ALB	Scale: 1:2400	Company: Golder Associates	
Date: 11/2/2016, 9:52:27 AM		File Name: Intermediate Section A.slim	

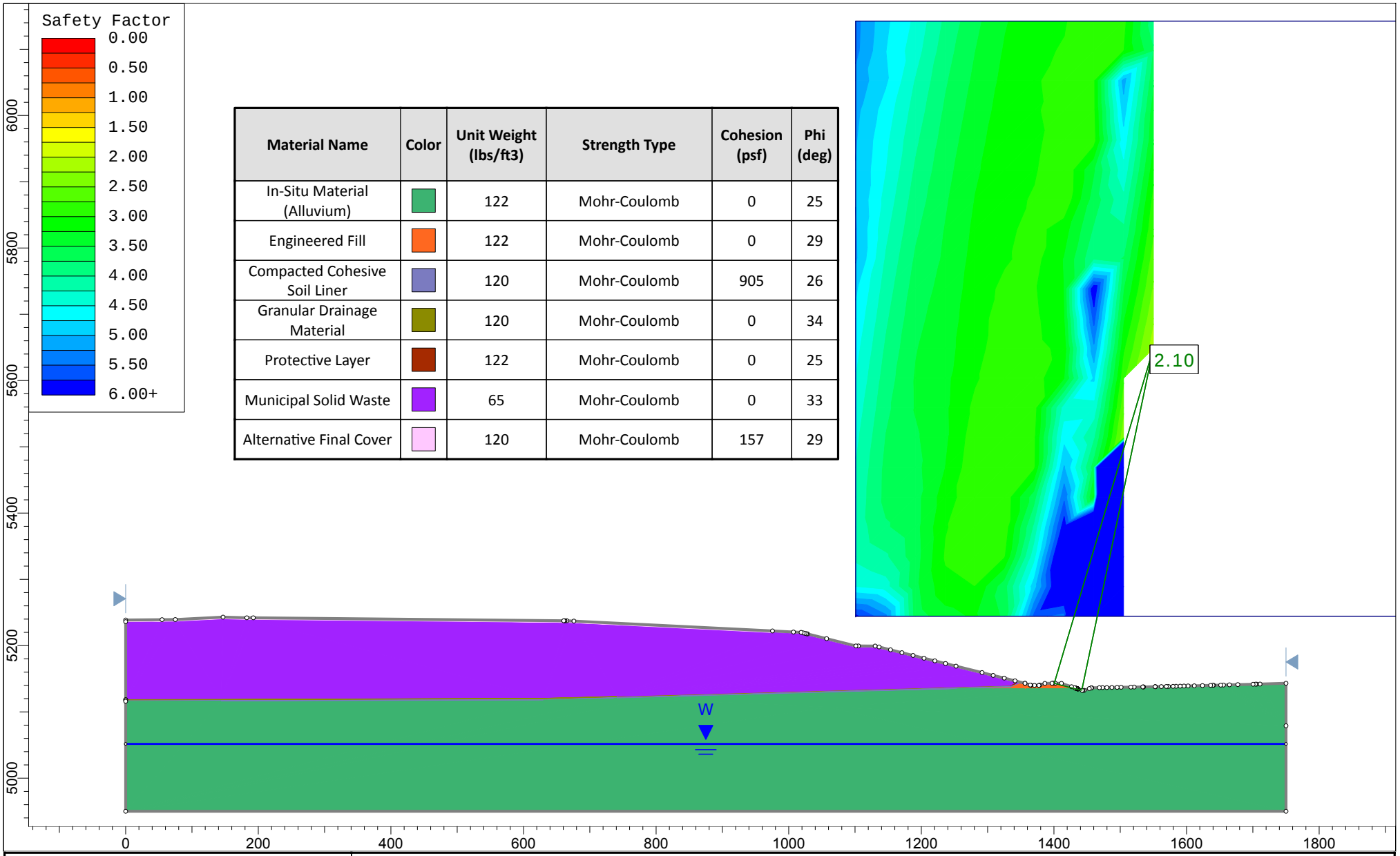
SLIDEINTERPRET 7.020



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
In-Situ Material (Alluvium)		122	Mohr-Coulomb	0	25
Engineered Fill		122	Mohr-Coulomb	0	29
Compacted Cohesive Soil Liner		120	Mohr-Coulomb	905	26
Granular Drainage Material		120	Mohr-Coulomb	0	34
Protective Layer		122	Mohr-Coulomb	0	25
Municipal Solid Waste		65	Mohr-Coulomb	0	33
Alternative Final Cover		120	Mohr-Coulomb	157	29

SLIDEINTERPRET 7.020

Project	North Weld Landfill - Unit 2 Expansion		
Analysis Description	Slope Stability - Section D - Final Closure: Maximum Waste		
Drawn By: ALB	Scale: 1:3000	Company: Golder Associates	
Date: 11/2/2016, 9:52:27 AM		File Name: Max Waste Section.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
In-Situ Material (Alluvium)		122	Mohr-Coulomb	0	25
Engineered Fill		122	Mohr-Coulomb	0	29
Compacted Cohesive Soil Liner		120	Mohr-Coulomb	905	26
Granular Drainage Material		120	Mohr-Coulomb	0	34
Protective Layer		122	Mohr-Coulomb	0	25
Municipal Solid Waste		65	Mohr-Coulomb	0	33
Alternative Final Cover		120	Mohr-Coulomb	157	29

SLIDEINTERPRET 7.020

Project	North Weld Landfill - Unit 2 Expansion		
Analysis Description	Slope Stability - Section E - Final Closure: Minimum Berm		
Drawn By	ALB	Scale 1:2400	Company Golder Associates
Date	11/2/2016, 9:52:27 AM		File Name Min Buttress Section.slim

APPENDIX C-6
SOIL EROSION POTENTIAL EVALUATION

Golder Associates

CALCULATIONS

Date:	November 18, 2016	**Made by:**	MBR
Project No.:	1538880	**Checked by:**	PDS TDS
Site Name:	North Weld Landfill Unit 2 EDOP Weld County, Colorado	**Reviewed by:**	JAR
Subject:	**APPENDIX C-6: EROSION POTENTIAL CALCULATION**		

1.0 OBJECTIVES

Estimate the average annual soil loss due to erosion for the alternative final cover design of Unit 2 of North Weld Landfill (NWLF). A maximum soil loss tolerance is not specified in the Colorado Department of Public Health and Environment (CDPHE) "Regulations Pertaining to Solid Waste Sites and Facilities," 6 CCR 1007-2, Part 1. Therefore, for the purposes of this calculation, a soil loss of 5.0 tons/acre/year due to erosion was considered an acceptable and conservative soil loss rate. This maximum soil loss rate is based on the regulatory soil loss tolerance for landfill final cover slopes in the state of Nebraska.

2.0 METHODOLOGY

Erosion was evaluated using the Revised Universal Soil Loss Equation, Version 2 (RUSLE2) erosion modeling software (USDA 2010). Two analyses were performed on a profile of the alternative final cover with the greatest slope length:

- Short-term analysis for the first year of vegetative growth to model how the water balance cover will respond during the first year of closure.
- Long-term analysis for a five-year period of vegetative growth on the water balance cover.

The profile of the final cover analyzed consisted of a 570-foot-long crown slope at a 5% grade, a 570-foot-long side slope at a 4H:1:V slope, and 2 mid-slope bench channels.

3.0 ASSUMPTIONS

The following is a list of general input parameters and assumptions used for the RUSLE analysis:

- The on-site soils to be used for the water balance final cover are expected to consist of surficial eolian deposits within the Unit 2 was footprint to be excavated and stockpiled during unit development. The Natural Resources Conservation Service (NRCS) Web Soil Survey (NRCS 2016, provided in Attachment 1) indicates that the soils within the Unit 2 waste disposal footprint predominantly consist of Olney fine sandy loam at varying slopes between 1 and 5%. The soil properties associated with Olney fine sandy loam, 0 to 6% slopes, Olney fine sandy loam 85%, were assumed in the RUSLE analysis.
- It was assumed that mulch will be applied to the final cover surface at a rate of 2 tons/acre at the time of seeding.

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Project No.:	1538880	Made by:	MBR
Site Name:	North Weld Landfill	Checked by:	PDS
Date:	November 18, 2016	Reviewed by:	JAR

- It was assumed that seeding will take place in April of the first year following final cover construction. Construction activities prior to seeding will include: bulldozer filling and leveling; soil disking, tandem light finishing; and spike tooth harrow.
- Weld County is located in Crop Management Zone (CMZ) 05. Vegetation for CMZ 05 is assumed to be modeled as a generic cool season grass mixture with a yield of 1.5 ton/acre.

4.0 CALCULATIONS

RUSLE2 computes average annual soil loss on the *ith* day as follows:

$$a_i = r_i \times k_i \times l_i \times S \times c_i i \times p_i$$

where:

a_i = *average annual soil loss for the ith day (tons/acre /year)*
r_i = *erosivity factor for the ith day*
k_i = *soil erodibility factor for the ith day*
l_i = *soil length factor for the ith day*
S = *steepness factor for the ith day*
c_i = *cover-management factor for the ith day*
p_i = *supporting practice factor for the ith day*

The average annual soil loss is computed as:

$$A = \frac{\sum ai}{m}$$

where:

a_i = *average annual soil loss for the ith day (tons/acre/year)*
m = *number of years in the analysis*
A = *average annual soil loss (tons/acre/year)*

5.0 CONCLUSIONS

The inputs and output files from the RUSLE2 software for the first-year analysis are presented in Attachment 2 and the long-term analysis is presented in Attachment 3. The predicted soil loss due to erosion in the first year is 2.9 tons/acre/year and long-term is 1.4 tons/acre/year. Since the predicted soil loss is less than the maximum soil loss tolerance (5.0 tons/acre/year) the design of the water balance final cover is considered adequate to prevent excessive erosion.

6.0 REFERENCES

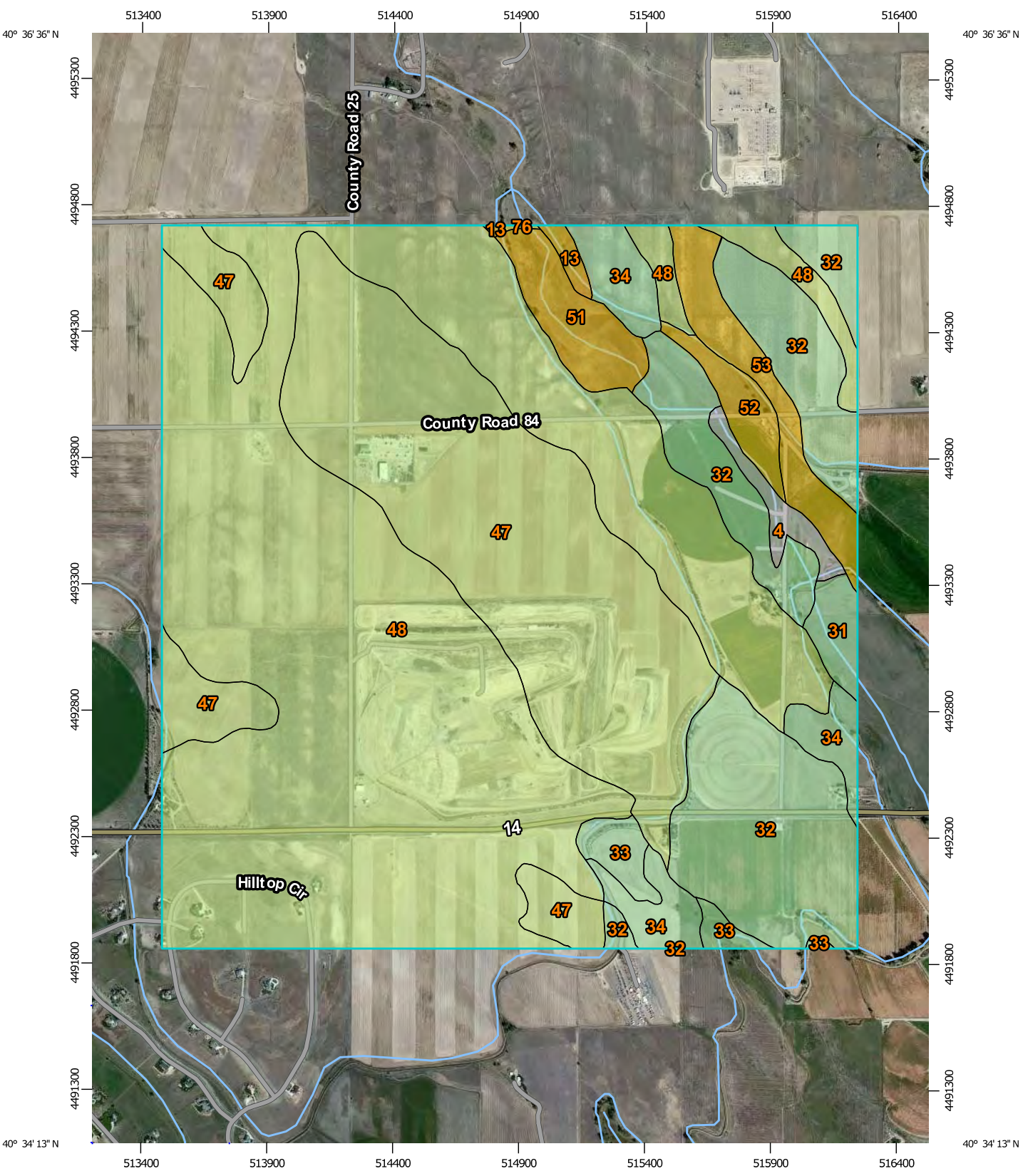
National Resource Conversation Survey (NRCS). 2016. Web Soil Survey of Weld County, Colorado. November 11.

United States Department of Agriculture (USDA). 2010. RUSLE2 Version 2.0.4.0

Colorado Department of Public Health and Environment (CDPHE). 2015. Hazardous Materials and Waste Management Division. Part 1 – Regulations Pertaining to Solid Waste Disposal Sites and Facilities, 6 CCR 1007-2. Amended November 17.

ATTACHMENT 1
NRCS SOIL MAP – WELD COUNTY, COLORADO

K Factor, Rock Free—Weld County, Colorado, Southern Part
(NWLF K Factor)



Map Scale: 1:21,400 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 300 600 1200 1800

Feet
0 1000 2000 4000 6000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Lines
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Soil Rating Points
- .02
- .05
- .10
- .15
- .17
- .20
- .24
- .28
- .32
- .37
- .43
- .49
- .55
- .64
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Southern Part
Survey Area Data: Version 14, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 22, 2011—Oct 19, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

K Factor, Rock Free

K Factor, Rock Free— Summary by Map Unit — Weld County, Colorado, Southern Part (CO618)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
4	Aquolls and Aquepts, flooded		16.3	0.8%
13	Cascajo gravelly sandy loam, 5 to 20 percent slopes	.15	6.5	0.3%
31	Kim loam, 0 to 1 percent slopes	.28	17.6	0.9%
32	Kim loam, 1 to 3 percent slopes	.28	282.2	14.4%
33	Kim loam, 3 to 5 percent slopes	.28	23.3	1.2%
34	Kim loam, 5 to 9 percent slopes	.28	64.2	3.3%
47	Olney fine sandy loam, 1 to 3 percent slopes	.24	465.7	23.8%
48	Olney fine sandy loam, 3 to 5 percent slopes	.24	968.2	49.4%
51	Otero sandy loam, 1 to 3 percent slopes	.15	42.4	2.2%
52	Otero sandy loam, 3 to 5 percent slopes	.15	23.0	1.2%
53	Otero sandy loam, 5 to 9 percent slopes	.15	50.3	2.6%
76	Vona sandy loam, 1 to 3 percent slopes	.20	0.5	0.0%
Totals for Area of Interest			**1,960.2**	**100.0%**

Description

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kf (rock free)" indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

ATTACHMENT 2
RUSLE2 EROSION CALCULATION RECORD
YEAR 1

RUSLE2 Profile Erosion Calculation Record

Info:

File: profiles\North Weld Year 1

Inputs:
Location: USA\Colorado\Weld County\CO_Weld_R_16-18
Soil: Weld County, Colorado, Northern Part\44 Olney fine sandy loam, 0 to 6 percent slopes\Olney Fine sandy loam 85%
Slope length (horiz): 1100 ft
Avg. slope steepness: 15 %

Management	*Vegetation*	*Yield units*	*# yield units, #/ac*
managements\CMZ 05\c.Other Local Mgt Records\North Weld check	Grass, cool season, spring seeded	ton	1.5

Contouring: b. absolute row grade 0.5 percent
Strips/barriers: (none)
Diversion/terrace, sediment basin: diversion/terrace system defined by user in profile
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
T value: 5.0 t/ac/yr
Soil loss erod portion: 3.3 t/ac/yr
Detachment on slope: 3.3 t/ac/yr
Soil loss for cons. plan: 2.9 t/ac/yr
Sediment delivery: 0.16 t/ac/yr

Crit. slope length: 700 ft
Surf. cover after planting: 90 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
4/1/0	Bulldozer, filling/leveling		0
4/21/0	Disk, tandem light finishing		0
4/21/0	Harrow, spike tooth		0
4/22/0	Drill or airseeder, double disk	Grass, cool season, spring seeded	90
4/22/0	Add mulch		90
4/22/0	Mulch crimper		90

ATTACHMENT 3
RUSLE2 EROSION CALCULATION RECORD
YEAR 5

RUSLE2 Profile Erosion Calculation Record

Info:

File: profiles\North Weld Long Term

Inputs:
Location: USA\Colorado\Weld County\CO_Weld_R_16-18
Soil: Weld County, Colorado, Northern Part\44 Olney fine sandy loam, 0 to 6 percent slopes\Olney Fine sandy loam 85%
Slope length (horiz): 1100 ft
Avg. slope steepness: 15 %

Management	*Vegetation*	*Yield units*	*# yield units, #/ac*
managements\CMZ 05\c.Other Local Mgt Records\North Weld Long Term	Grass, cool season, spring seeded	ton	1.5

Contouring: b. absolute row grade 0.5 percent
Strips/barriers: (none)
Diversion/terrace, sediment basin: diversion/terrace system defined by user in profile
Subsurface drainage: (none)
Adjust res. burial level: Normal res. burial

Outputs:
T value: 5.0 t/ac/yr
Soil loss erod.portion: 1.6 t/ac/yr
Detachment on slope: 1.6 t/ac/yr
Soil loss for cons. plan: 1.4 t/ac/yr
Sediment delivery: 0.061 t/ac/yr

Crit. slope length: 700 ft
Surf. cover after planting: 40 %

Date	*Operation*	*Vegetation*	*Surf. res. cov. after op, %*
4/22/0	Begin growth	Grass, cool season, spring seeded	40

APPENDIX D
DRAINAGE REPORT

DRAINAGE REPORT

DRAINAGE REPORT

North Weld Landfill, Unit 2
Weld County, Colorado

Prepared By: Golder Associates Inc.
4730 N. Oracle, Suite 210
Tucson, AZ 85705

Prepared For: Waste Management Disposal Services of Colorado, Inc.
North Weld Landfill
40000 Weld County Road 25
Ault, CO 80610

December 21, 2016

1538880

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Appendix B Unit 1 Surface Water Calculations

1.0 CERTIFICATION OF COMPLIANCE

The Weld County Certification of Compliance is included on the following page.

As discussed in this Drainage Report, Waste Management Disposal Services of Colorado, Inc. (WMDSC) is requesting a variance from Article XII, Section 23-12-30, Part D of the Weld County Code to allow on-site retention rather than detention of site runoff. A letter from the Pierce Lateral's attorney supporting this request is attached to the Certification of Compliance.

CERTIFICATION OF COMPLIANCE
ENGINEERING DESIGNED TO WELD COUNTY CODE STANDARDS AND CRITERIA

I Jeffrey Rusch, Consultant Engineer for Waste Management Disposal Services of Colorado, Inc. ("Applicant"), understand and acknowledge that Applicant is seeking land use approval of North Weld Landfill, Unit 2 ("Application") for the property described in the attached Exhibit "A." I have designed or reviewed the design ("Design") for the proposed land use set forth in the Application. I hereby certify, on behalf of Applicant that the Design will meet all applicable drainage requirements of the Weld County Code with the exception of variance(s) described below. This certification is not a guarantee or warranty either expressed or implied.

(Engineer's Stamp)



Engineer of Record Signature

VARIANCE REQUEST

1) Describe the Weld County Code criteria of which a variance is being requested.
2) Describe why it is not possible to meet the Weld County Code.
3) Describe the proposed alternative with engineering rational which supports the intent of the Weld County Code.

1) Requesting variance from Article XII, Section 23-12-30, Part D to allow on-site retention rather than detention of site runoff.

2) The NWLF site is geographically bounded by the manmade Pierce Lateral agricultural canal to the east and the Colorado State Highway 14 right-of-way to the south. During the development of Unit 1 at the NWLF site, these neighboring property owners informed WMDSC that were not amenable to receiving discharge from stormwater detention on the NWLF site. Consequently, the CDPHE and the WCDPHE approved the construction of a retention basin at the NWLF site to manage surface water runoff from the Unit 1 landform. Recently, WMDSC re-approached the Pierce Lateral Board of Directors on November 15, 2016, to update them on the Unit 2 development plans and re-gauge their willingness to accept detention discharge from the Unit 2 development. The Board of Directors communicated that they are not interested in receiving any discharge from the NWLF site. A letter from the Pierce Lateral's attorney summarizing their position is provided in this Drainage Report. Additionally, the concerns CDOT raised in their letter to NWLF dated August 9, 2000 about detention discharge to the State Highway 14 right-of-way are still applicable to and limit discharge options from Unit 2 detention.

3) The proposed stormwater management system for the Unit 2 development includes a new stormwater retention pond for Unit 2 runoff. The new stormwater retention pond will provide up to 77 acre-feet of storage capacity below 1 foot of freeboard (greater than 1.5 times the 24-hour, 100-year runoff volume from Unit 2), is designed to drain through the pond bottom in less than 72 hours, and includes an emergency spillway capable of conveying the peak discharge from Unit 2 resulting from the 100 year, 1 hour storm in accordance with Weld County Code requirements for retention facilities (Article XII, Section 23-12-90, Part B).

I understand and agree that the intention of the Code is to reduce impacts of development on neighboring downstream properties and the public. I understand if this variance request is approved it is not precedent setting and is based on site specific constraints.

Planning Director Approval indicated when signed by director or appointee:

Planning Director Name

Signature

Date of approval

TO BE REPLACED WITH LETTER FROM PIERCE LATERAL ATTORNEYS

2.0 INTRODUCTION

This Drainage Report is prepared on behalf of the applicant, WMDSC, in support of a Weld County Use by Special Review (USR) permit application for Unit 2 of the North Weld Landfill (NWLF). The design of the stormwater drainage controls presented herein satisfies applicable design criteria set forth by Section 23, Article XII of the Weld County Code and by Colorado Department of Public Health and Environment (CDPHE) "Regulations Pertaining to Solid Waste Sites and Facilities," 6 CCR 1007-2, Part 1 (Regulations) (CDPHE 2015).

WMDSC is proposing to develop Unit 2 of the NWLF facility, which will add an additional 155 acres of waste disposal area to the existing 122-acre waste disposal footprint at the site, hereinafter referred to as Unit 1. WMDSC owns a total of approximately 490 acres at the NWLF site, currently consisting of the Unit 1 waste disposal footprint, a Waste Management of Northern Colorado facility (WMNC) permitted under Weld County USR 1527, and adjoining buffer property. The Unit 2 waste disposal area will be located directly north of and contiguous to the existing Unit 1 waste disposal footprint in land that is currently undeveloped and leased for agricultural dry land farming.

The current facility infrastructure and support facilities in place for Unit 1 are envisioned to continue to serve the development and operation of Unit 2. No additional site access or operational infrastructure beyond maintenance of existing roadways and access lanes is anticipated as part of the development of Unit 2. Currently, impervious areas of the site comprise approximately 87,500 square feet of paved parking areas and roads. All stormwater runoff from impervious areas and facility structures is and will continue to be managed through existing Unit 1 stormwater management infrastructure. Following closure, the landfill will most likely serve as open space or some other end use strategy that is protective of human health and the environment for the long term; the final disposition of impervious areas and site structures will be determined in conjunction with the development of the end use and post-closure care plan.

3.0 GENERAL LOCATION AND DESCRIPTION

3.1 Location

The NWLF is located at 40,000 Weld County Road 25, near the intersection of Weld County Road 25 and Colorado State Highway 14 (co-signed with Weld County Road 82) within unincorporated Weld County, Colorado. The site is approximately nine miles east of Interstate Highway 25 (I-25) and 5 miles west of the Town of Ault. The Unit 1 and Unit 2 waste disposal areas at NWLF are located in Section 7, Township 7 North, Range 66 West of the Sixth Principal Meridian. Accessibility to NWLF from primary municipalities served by the facility is from Colorado State Highway 14.

The property, project site, and surrounding land are zoned (A) Agricultural, and are located in unincorporated Weld County. The site is in an urbanizing area pursuant to the Weld County Code as it is located within 0.25 miles of the annexed Belmont Farms subdivision by the Town of Severance. There are no lakes, streams, or water resource facilities within the property. The NWLF property is bounded by the manmade Pierce Lateral agricultural canal to the east.

Existing site access to the NWLF site is from Weld County Road 25 approximately 200 feet north of the intersection of Colorado State Highway 14. No changes or additional infrastructure to the existing site access is anticipated as part of the development of Unit 2.

3.2 Site History

Waste Services Corporation received a Certificate of Designation (CD) from the Weld County Board of County Commissioners on June 27, 1990, authorizing the development of the first four phases of NWLF (Unit 1, comprising Phases 1, 2, 3A, and 3B), which provided approximately 122 acres of waste disposal area. A USR permit (USR-895) for solid waste disposal within Unit 1 was adopted by the Weld County Board of County Commissioners on November 14, 1990.

Construction of the first disposal module of Unit 1 was completed in December 1991. Site civil improvements were completed in January 1992 and NWLF first received waste on February 3, 1992. Waste Services Corporation merged with an indirect subsidiary of Waste Management, Inc. on July 12, 1991, and changed its name to WMDSC in December 1993. WMDSC continues to be an indirect subsidiary of Waste Management, Inc.

In 2006, WMNC allocated approximately 28 acres in the northwest quarter of Section 7, Township 7 North, Range 66 West as a separate USR (USR-1527) for an administrative and maintenance facility for their commercial trucking operations. The CD and USR boundaries for the expanded NWLF facility will exclude the limits of USR-1527.

3.3 Description of Property

The NWLF site is approximately 490 acres in size and is owned by WMDSC. The site is topographically characterized as an upland area of relatively uniform slope toward the regional drainage feature (i.e., Coalbank Creek bed) located approximately 0.25 miles east of the NWLF property boundary. The area of the NWLF property where Unit 2 will be developed is topographically bounded by the Weld County Road 25 embankment to the west, a man-made stormwater runoff channel constructed along the USR-1527 boundary to the northwest, the Weld County Road 84 embankment to the north, the man-made Pierce Lateral agricultural canal to the east, and Unit 1 to the south.

Natural, pre-development topographic elevations within the Unit 2 area of the NWLF site range from a high of approximately 5,150 feet above mean sea level (ft AMSL) in the southwestern portion of the site to a low of 5,068 ft AMSL near the Pierce Lateral canal to the east. The existing topography within the Unit 2 area is crossed by a few very shallow drainage swales none of which include perennial surface water flow features. The total natural topographic relief across the Unit 2 area is approximately 80 feet, with natural topographic slopes between 1% and 5% and averaging approximately 1.5% to the east.

The United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) designates the surficial soil types at the NWLF site as predominantly Olney fine sandy loam (NRCS 2016) at varying slopes between 1% and 5%. Olney fine sandy loam soils are classified under Hydrologic Soil Group B and are generally well drained with moderately low runoff potential, and moderately high to high capacity to transmit water. The Custom Soil Resource Report for Weld County, Colorado, Southern Part is provided in Appendix A.

3.4 Description of Project

3.4.1 Existing Stormwater Controls for Unit 1

The existing stormwater management system design for Unit 1 is presented in the Updated Design and Operations (D&O) Plan for the North Weld Sanitary Landfill originally prepared by Rust Environment & Infrastructure, Inc. in January 1996 and later revised by WMDSC in November 1997. The hydrologic and hydraulic calculations have been subsequently revised several times to better accommodate site conditions. Design calculations for the stormwater controls for Unit 1 are provided in Appendix D of this Drainage Report to allow this report to encompass stormwater management for the full NWLF site.

Surface water runoff from final closure landfill slopes within Unit 1 and the surrounding run-on areas is collected by permanent perimeter channels and conveyed to a retention pond located in the southeastern corner of the property. The original stormwater management system for Unit 1 included a detention pond with an outlet structure. However, due to concern by the Colorado Department of Transportation (CDOT) regarding discharge of stormwater onto the Colorado State Highway 14 right-of-way, CPDHE requested

that the detention pond be converted to a retention pond. The modifications to the pond design to allow for stormwater retention are also provided in Appendix D of this Drainage Report for reference.

3.4.2 Development of Unit 2

The Unit 2 waste disposal area of the NWLF facility will consist of approximately 155 acres of waste disposal footprint located directly north of and contiguous to the existing Unit 1 waste disposal footprint. The waste disposal footprint of Unit 2 includes a minimum offset of 175 feet from the property boundary.

The proposed development of Unit 2 will include the 155-acre landfill, perimeter access roads, stormwater run-on control structures, temporary and permanent stormwater runoff structures, and an approximate 64-acre stormwater retention pond along the western property boundary. The stormwater controls for Unit 2 were designed to manage the runoff from Unit 2 completely separate from the existing Unit 1 structures.

Unit 2 will consist of two primary waste disposal phases, identified as Phases 4 and 5 and shown in Sheet 3 of the Site Development Plans provided in Appendix A of the EDOP. These phases will be further subdivided into modules to limit the area of exposed liner and active waste disposal area open at one time. Run-on and runoff controls will be established and maintained throughout the operation of each phase and module. Module development is expected to proceed from west to east with temporary leachate collection sumps constructed at the downgradient (i.e., east) end of modules until ultimate build-out of each phase when permanent leachate collection sumps will be constructed along the eastern boundary of each phase.

Wherever a module development area will terminate internal to the landfill footprint (i.e., not along the final perimeter), a temporary termination berm will be constructed along the leading edge for containment of waste and leachate and to facilitate tie-in of future cells. Phased construction will progress in this manner until the entire landfill footprint is developed. This method of phased development will limit the amount of active (open) cell area at any given point in the landfill development, minimize leachate generation, and minimize the area requiring stormwater management.

4.0 DRAINAGE BASINS AND SUB-BASINS

4.1 Major Basin Description

As previously discussed, the NWLF is located in a rural area of unincorporated Weld County. The surrounding area is generally used for agricultural farming, including feedlot and dairy operations. Historically, the average natural slope from northwest to southeast was approximately 3%. The site is situated near a topographic high, such that it receives very little if any surface water run-on from off-site locations.

Under current conditions, regional surface water is collected in small reservoirs and deflation basins for agricultural use and distribution through a network of manmade canals. The NWLF site is bounded by the Pierce Lateral agricultural canal, which flows to the south along on the eastern boundary of the NWLF and to the south side of Colorado State Highway 14.

The NWLF site is not located within a floodplain or flood hazard area defined by the Federal Emergency Management Agency (FEMA 2016). The nearest FEMA-mapped floodplain is a Zone A 100-year floodplain located approximately 300 feet (at its closest) to the northeast-east of the site along the Coalbank Creek drainage area.

4.2 Sub-basin Description

4.2.1 Run-on Basins

Historically and to the present day, existing stormwater flows across the Unit 2 footprint in a southeasterly direction following existing topographic features. Run-on basins up-gradient of the NWLF waste disposal footprint are bounded by the Weld County Road 25 embankment along the western property boundary, the Weld County Road 84 embankment along the northern property boundary, and a man-made stormwater runoff channel constructed along the boundary of USR-1527 to the northwest. These up-gradient basins are characterized by shallow sheet flow that impact the NWLF waste disposal footprint at several locations along the western and northern boundaries. Sub-basins for the run-on stormwater control design were delineated based on existing topography and ultimate buildout of Unit 2 (conservatively including runoff from the USR-1527 property) and are shown in Figure 2.

4.2.2 Runoff Basins

Sub-basins for final closure stormwater management were delineated based on the final closure design of the NWLF facility. Stormwater runoff from Unit 2 and the area where Unit 2 will piggyback over the existing Unit 1 waste footprint will be collected in a network of bench and perimeter channels. The bench channels will discharge to at a single downchute along the eastern side slope of Unit 2, where flow will converge with the perimeter channel flow and ultimately report to the Unit 2 retention pond. Sub-basins for the runoff stormwater control design are shown in Figure 3.

5.0 DRAINAGE DESIGN CRITERIA

The stormwater management system for Unit 2 of NWLF was prepared based on the storm drainage criteria presented in Section 23, Article XII of the Weld County Code and in CDPHE Regulations. The storm event used for the sizing of stormwater management controls was the 100-year frequency, 24-hour duration storm event (unless otherwise noted), required by CDPHE Regulations for permanent surface water diversion structures after closure.

5.1 Development Criteria Reference and Constraints

There is neither a project master plan nor a regional drainage master plan for the NWLF site. As previously discussed, the initial design of existing stormwater structures for Unit 1 was presented in the Updated Design and Operations (D&O) Plan for the North Weld Sanitary Landfill (revised by WMDSC 1997) and has been subsequently modified (Golder 2010, 2013, and 2016) to accommodate changes in operational development of the site. Historic design calculations for the Unit 1 stormwater controls are provided in Appendix B of this Drainage Report. No run-on diversion or runoff from Unit 2 will be directed to the existing Unit 1 drainage structures.

There are no known utilities that cross the NWLF site that are expected to limit the stormwater management system. The gently-sloping topography of the undeveloped NWLF site, with the absence of existing defined drainage features, was considered in preparing the stormwater management system design for Unit 2 and does not pose a significant design constraint.

5.2 Hydrologic Criteria

Design rainfall data was obtained from the National Oceanic and Atmospheric Administration's (NOAA) Precipitation Frequency Data Server website. The values, summarized in Table 1 below, were based on NOAA Atlas 14, Volume 8, Version 2.0 (NOAA 2013) and the latitude and longitude of the NWLF site:

Table 1: NWLF Site Rainfall Event Data

Storm Event	Depth (inches)
2-year, 24-hour	1.76
25-year, 24-hour	3.38
100-year, 1-hour	2.78
100-year, 24-hour	4.67

Times of concentration were calculated using the methodology described in TR-55 (NRCS 1986) for sheet flow and shallow concentrated flow and via Manning's equation for channel flow. HEC-HMS modeling software (USACE 2013) was used to determine the routing of surface runoff from the delineated drainage basins and the resulting estimated peak flows.

5.3 Hydraulic Criteria

Run-on from upstream drainage basins will be conveyed in an open channel along the western and northern boundaries of the Unit 2 waste disposal footprint. Peak flows from the 100-year, 24-hour storm event, calculated using HEC-HMS as described in Section 5.2, were used to size the run-on channel with 1 foot of freeboard, exceeding Weld County Code design requirements of conveying the 100-year, 1-hour storm event. The run-on channel was designed with three horizontal to one vertical (3H:1V) side slopes. The concentrated flow from the run-on channel will be returned to natural pre-development sheet flow patterns through a permanent riprap-lined dissipation basin in the northeast corner of the NWLF site and ultimately infiltrate into the surrounding natural soils.

Stormwater runoff from the closed landfill will be conveyed in open bench channels along the landfill side slopes or around the landfill perimeter and will be routed to the stormwater retention pond. Runoff bench and perimeter channels were sized for peak flows from a 100-year, 24-hour storm event, calculated using HEC-HMS as described in Section 5.2, with 1 foot of freeboard and 3H:1V (outboard) and 4H:1V (inboard) side slopes. A stilling basin was designed for the toe of the downchute along the eastern landfill side slope for energy dissipation. The retention pond was designed to store 1.5 times to volume of runoff from the 100-year, 24-hour storm event from the ultimate Unit 2 footprint plus 1 foot of freeboard in accordance with Weld County Code requirements.

A new access road will be provided near the southwest corner of Unit 2. This access road will cross over two existing drainage facilities within Unit 1 and new conveyance culverts will be provided at these locations. The culverts were designed in accordance with Weld County requirements, with regards to minimum pipe diameter requirements and limiting the design headwater to depth (HW/D) to 1.5 for the 100-year, 24-hour storm event.

There are no stormwater management manhole inlets or storm sewers at the NWLF site. Various stormwater management structures, such as culverts, check dams, and/or drop structures, may be required throughout the operational life of the facility to address changing conditions through the ongoing development of the site; such stormwater management structures will be designed on an as-needed basis in accordance with Weld County Code requirements.

6.0 DRAINAGE FACILITY DESIGN

6.1 General Concept

The general concept for management of stormwater for Unit 2 of NWLF is to manage the runoff completely separate from the existing Unit 1 structures and return flow to historic drainage patterns, to the extent practical. Additionally, the stormwater management system was designed to retain runoff on site from the developed footprint of the site in order to comply with the requests of the neighboring properties, specifically the Pierce Lateral agricultural canal to the east and CDOT to the south of the NWLF site.

Temporary and permanent surface water structures and erosion control measures will be constructed over the life of Unit 2 to manage stormwater run-on, runoff, and contact water (i.e., stormwater runoff that has contacted exposed waste (contact water). Design objectives for the stormwater controls include:

- Provide all-season trafficable roads;
- Prevent contact water runoff from leaving the active areas of the landfill;
- Divert surface water run-on from areas up-gradient of the landfill around the developed footprint and return to historic flow patterns;
- Prevent run-on to the active area of the landfill;
- Prevent discharge of contact water from the site; and
- Control and manage site runoff on site.

Components of the stormwater management system for the Unit 2 will include the following:

- Run-on diversion channels;
- Dissipation basin;
- Landfill perimeter and access road channels;
- Bench channels;
- Downchute channel with stilling basin;
- Culverts; and
- Retention pond.

The locations of the permanent stormwater management structures for Unit 2 are shown in Figure 4. Figures 5 and 6 provide details for the Unit 2 stormwater management structures. For reference, a site-wide site plan with stormwater management structures for the full NWLF site (Units 1 and 2) is shown in Sheet 4B of the Site Development Plans.

6.2 Specific Design Details and Compliance with Weld County Code

6.2.1 Temporary Surface Water Management

Surface water within the active landfill will be managed through a series of temporary berms and/or channels that will divert run-on away from the active area and direct runoff toward temporary surface water ponds or the permanent stormwater retention pond. Surface water runoff that is not contact water may be managed via gravity drainage or pumping for use on site and/or to the stormwater retention pond. Details for the temporary stormwater control structures and other best management practices (BMPs) will be provided to the CDPHE for informational purposes with the construction packages for each cell prior to construction. Any temporary surface water controls will be designed to handle a 25-year, 24-hour storm event.

6.2.2 Final Stormwater Management System

Permanent drainage improvements for the facility were designed in conformance with the Weld County Code and the Urban Storm Drainage Criteria Manuals (USDCM), Volumes 1, 2, and 3.

6.2.2.1 Run-on Diversion

As discussed in Section 3.3, the NWLF site is located in an upland, topographically high area. As a result, the site received very little if any stormwater run-on from the surrounding areas. Surface water run-on from site areas up-gradient of Unit 2 will be diverted around the waste disposal footprint and returned to historic drainage patterns, to the greatest extent practical. This will be accomplished through the construction of a run-on stormwater control channel along the western and northern toe of the landfill perimeter berm that will concentrate the sheet flow around the waste disposal footprint and then return it to sheet flow through a permanent dissipation basin in the northeast corner of the NWLF site. Run-on flow from up-gradient areas will not be allowed to mix with on-site stormwater runoff from the landfill.

The run-on diversion channel will consist of a trapezoidal open channel with 3H:1V side slopes and a 5-foot (minimum) bottom width. The channel was designed to control the 100-year frequency, 24-hour duration storm event and include a minimum 1 foot of freeboard. The dissipation basin, which will be riprap-lined, will be placed directly downstream of the channel to spread and dissipate the flow prior to discharge as sheet flow onto natural topography. The dissipation basin has been designed to control the runoff from a 100-year, 24-hour storm event and reduce the discharge flow velocity to less than 4 feet per second.

6.2.2.2 Runoff Control

Perimeter channels adjacent to the waste footprint, bench channels, a downchute channel, and access road grading will be used to control runoff from intermediate- and final-covered areas of Unit 2. All channels were designed to control the 100-year frequency, 24-hour duration storm event and include a minimum 1-foot freeboard. All surface water runoff from the landfill is designed to be collected and report to the Unit 2 stormwater retention pond located southeast of the Unit 2 footprint.

Perimeter channels (Sections 1–3) will be grass-lined trapezoidal open channels with 3H:1V side slopes, 12-foot (minimum) bottom widths, and 3-foot (minimum) depths. The perimeter channels will be constructed in segments as the phased development of Unit 2 advances and the perimeter berm is constructed.

The bench channels will be grass-lined trapezoidal open channels formed by the construction of 29-foot-wide benches on landfill side slopes. Across its width an add-on berm will be constructed, creating a trapezoidal channel between the inboard add-on berm side slope (3H:1V) and the coincident final landfill side slope (4H:1V) and a channel depth of 3 feet. The bench channels will slope longitudinally at approximately 2% across the final cover surface and converge at the downchute channel on the east side of Unit 2. The access road will extend from the west side of Unit 2 to the top deck and will consist of an approximate 2% crowned roadway.

The downchute channel will be trapezoidal with 3H:1V sideslopes, a 20-foot bottom width and 3-foot depth, and will be lined with either riprap or articulated concrete block (ACB). At the base of the downchute channel, where the flow enters the perimeter channel, a hydraulic stilling (jump) basin will be constructed to dissipate hydraulic energy. The stilling basin will be lined with grouted riprap and include a six-foot-deep concrete cutoff wall at the toe to prevent erosion and/or wash-out.

This new access road will cross over two existing Unit 1 drainage facilities: a perimeter channel and a bench channel. The perimeter channel culvert crossing will use a 36-inch reinforced concrete pipe (RCP), while the bench channel crossing will be an 18-inch high-density polyethylene pipe (HDPE). Both culverts have been designed to convey the 100-year, 24-hour peak discharges reporting to these existing structures, which has been referenced from previous Unit 1 design information (provided in Appendix B).

6.2.2.3 Stormwater Retention

As discussed in Section 3.1 of this Drainage Report, the NWLF site is bounded by the man-made Pierce Lateral agricultural canal to the east and the Colorado State Highway 14 right-of-way to the south. During the development of Unit 1 at the NWLF site, these neighboring property owners informed WMDSC that they were not amenable to receiving discharge from stormwater detention on the NWLF site. Consequently, the CDPHE and the WCDPHE approved the conversion of the previously-designed Unit 1 detention basin to a retention basin.

WMDSC re-approached the Pierce Lateral Board of Directors on November 15, 2016, to update them on the Unit 2 development plans and re-gauge their willingness to accept detention discharge from the Unit 2 development. The Board of Directors communicated that they are not interested in receiving any discharge from the NWLF site. A letter from the Pierce Lateral's attorney summarizing their position is provided in this Drainage Report. Additionally, the concerns CDOT raised in their letter to NWLF dated August 9, 2000, about detention discharge to the State Highway 14 right-of-way are still applicable to and limit the discharge options from Unit 2

detention. Consequently, WMDSC is again requesting a variance from Article XII, Section 23-12-30, Part D of the Weld County Code to allow on-site retention rather than detention of site runoff.

The perimeter channel (Section 2) will convey stormwater to the 6.7-acre (77 acre-feet of storage) retention pond though a low-water crossing over the perimeter road. The low-water crossing will transition to channel flow (Section 3) prior to discharging to the retention pond over a riprap apron down the pond side slope. The retention pond was designed to contain 1.5 times the 100-year frequency, 24-hour duration storm event runoff from the ultimate Unit 2 buildout and includes a minimum of 1 foot of freeboard. In accordance with Weld County Code, the retention pond capacity will be re-established within 72 hours and an emergency spillway designed to convey the 100-year, 1-hour peak discharge reporting to the basin has been provided.

Stormwater will be managed in accordance with the Stormwater Management Plan (SWMP), North Weld Landfill (WMC 2016), issued and approved under the Colorado Discharge Permit System (CDPS) Permit No. COR-900412 by the CDPHE Water Quality Control Division.

6.2.1 Erosion Potential Evaluation

An evaluation of the effects of erosion due to rainfall on the proposed water balance final cover system was performed. The analysis consisted of using the Revised Universal Soil Loss Equation, Version 2 (RUSLE2) erosion modeling software (USDA 2010) to estimate the amount of soil loss caused by sheet and rill erosion of the final cover after one year and five years of vegetative growth on the final cover. Annual soil loss due to erosion at one and five years was predicted to be 2.9 tons/acre/year and 1.4 tons/acre/year, respectively, and less than the maximum soil loss tolerance of 5 tons/acre/year.

Table 2: Open Channel Summary

Channel Designation	Channel Lining	Design Peak Q_{100} (cfs)	Channel Slope (ft/ft)	Left Side Slope (H: 1V)	Right Side Slope (H: 1V)	Bottom Width (ft)	Minimum Channel Depth (ft)	Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)
Run-On (R1)	TRM	93.4	0.013	3.0	3.0	5	3.1	5.9	1.7
Run-On (R2)	TRM	119.4	0.012	3.0	3.0	5	3.1	6.1	2.0
Run-On (R3)	TRM	125.8	0.012	3.0	3.0	5	3.1	6.1	2.1
Run-On (R4)	TRM	165.8	0.022	3.0	3.0	5	3.1	8.3	2.0
Bench (D1)	TRM	126.6	0.020	4.0	3.0	8	3.0	7.0	1.5
Bench (D2)	TRM	84.8	0.020	4.0	3.0	8	3.0	6.2	1.2
Bench (D3)	TRM	153.3	0.020	3.0	4.0	8	3.0	7.4	1.7
Bench (D4)	TRM	208.7	0.020	3.0	4.0	8	3.0	8.0	2.0
Bench (D5)	TRM	108.7	0.020	3.0	4.0	8	3.0	6.7	1.4
Downchute (D6)	6 inches dumped riprap	1.5	0.250	3.0	3.0	20	3.0	2.6	0.03
Downchute (D7)	18 inches dumped riprap	236.5	0.262	3.0	3.0	20	3.0	19.1	0.6
Downchute (D8)	24 inches grouted riprap	525.6	0.262	3.0	3.0	20	3.0	25.4	0.9
Perimeter (D9)	Grass	60.8	0.012	3.0	3.0	12	3.0	4.5	1.0
Perimeter (D10)	Grass	99.6	0.012	3.0	3.0	12	3.0	5.3	1.3
Perimeter (D11)	TRM	645.7	0.012	3.0	3.0	18	4.0	8.9	3.0
Perimeter (D12)	Grass	40.2	0.017	3.0	3.0	12	3.1	4.4	0.7
Perimeter (D13)	TRM	645.7	0.012	3.0	3.0	20	4.0	8.7	2.9

Notes:
1. () denotes drainage basin location of the channel shown in Figures 2 and 3.

7.0 CONCLUSIONS

7.1 Compliance with Weld County Code

This Drainage Report has been prepared in compliance with Section 23, Article XII of the Weld County Code. This document is submitted as part of the Engineering Design and Operations Plan (EDOP) for the permitting of NWLF Unit 2 and in support of a Weld County Certificate of Designation (CD) and Use by Special Review (USR) permit application for the expanded NWLF facility. WMDSC is requesting a variance from Article XII, Section 23-12-30, Part D of the Weld County Code to allow on-site retention rather than detention of site runoff.

7.2 Drainage Concept

The general concept for management of stormwater for Unit 2 of NWLF is to manage the runoff completely separate from the existing Unit 1 structures and return flow to historic drainage patterns, to the extent practical. Additionally, the stormwater management system was designed to retain runoff from the developed footprint of the site on-site in order to comply with the requests of the neighboring properties, specifically the Pierce Lateral agricultural canal to the east and CDOT to the south of the NWLF site.

Unit 2 as designed is not predicted to have negative impacts on adjacent properties or property owners located upstream or downstream. Emergency spillway discharge from the Unit 2 retention pond will be contained within the NWLF site by the existing landscaping berm along the southeastern and southern property boundaries.

8.0 REFERENCES

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National Oceanic and Atmospheric Administration (NOAA). 2013. Precipitation-Frequency Atlas of the United States, NOAA Atlas 14, Volume 8, Version 2.0. S. Perica, D. Martin, S. Pavlovic, I. Roy, M. St. Laurent, C. Trypaluk, D. Unruh, M.Yekta, and G. Bonnin. NOAA, National Weather Service, Silver Spring, Maryland, 2013. Available online: http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?lat=40.5918&lon=-104.8250&dat (accessed August 25, 2016).

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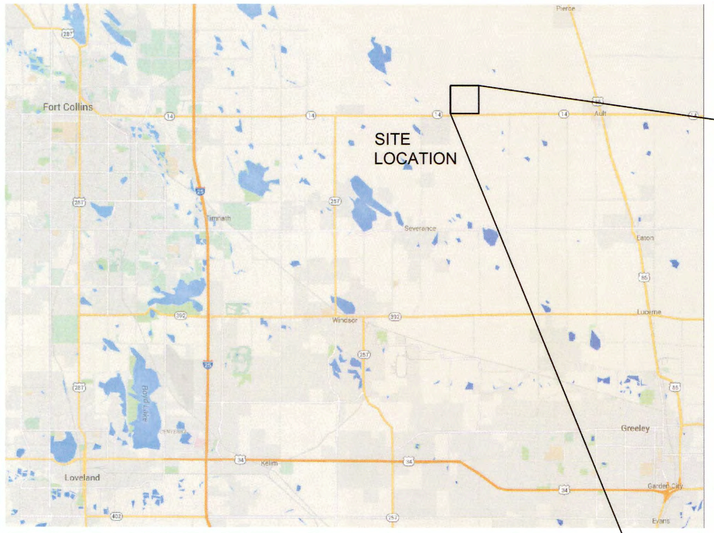
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Weld County (WC). 2016. Weld County Charter and County Code. April 2016.

FIGURES

NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO





Prepared for:

Waste Management Disposal Services of Colorado, Inc.
40,000 Weld County Road 25
Ault, Colorado 80610

Prepared by:

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

DRAWING LIST		
SHEET NO.	TITLE	REVISION
1	TITLE SHEET	A
2	HISTORIC DRAINAGE BASIN RUN-ON MAP	A
3	FULLY DEVELOPED DRAINAGE BASIN MAP	A
4	STORMWATER CONTROLS PLAN	A
5	DETAILS (1 OF 2)	A
6	DETAILS (2 OF 2)	A

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR WELD COUNTY USR	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

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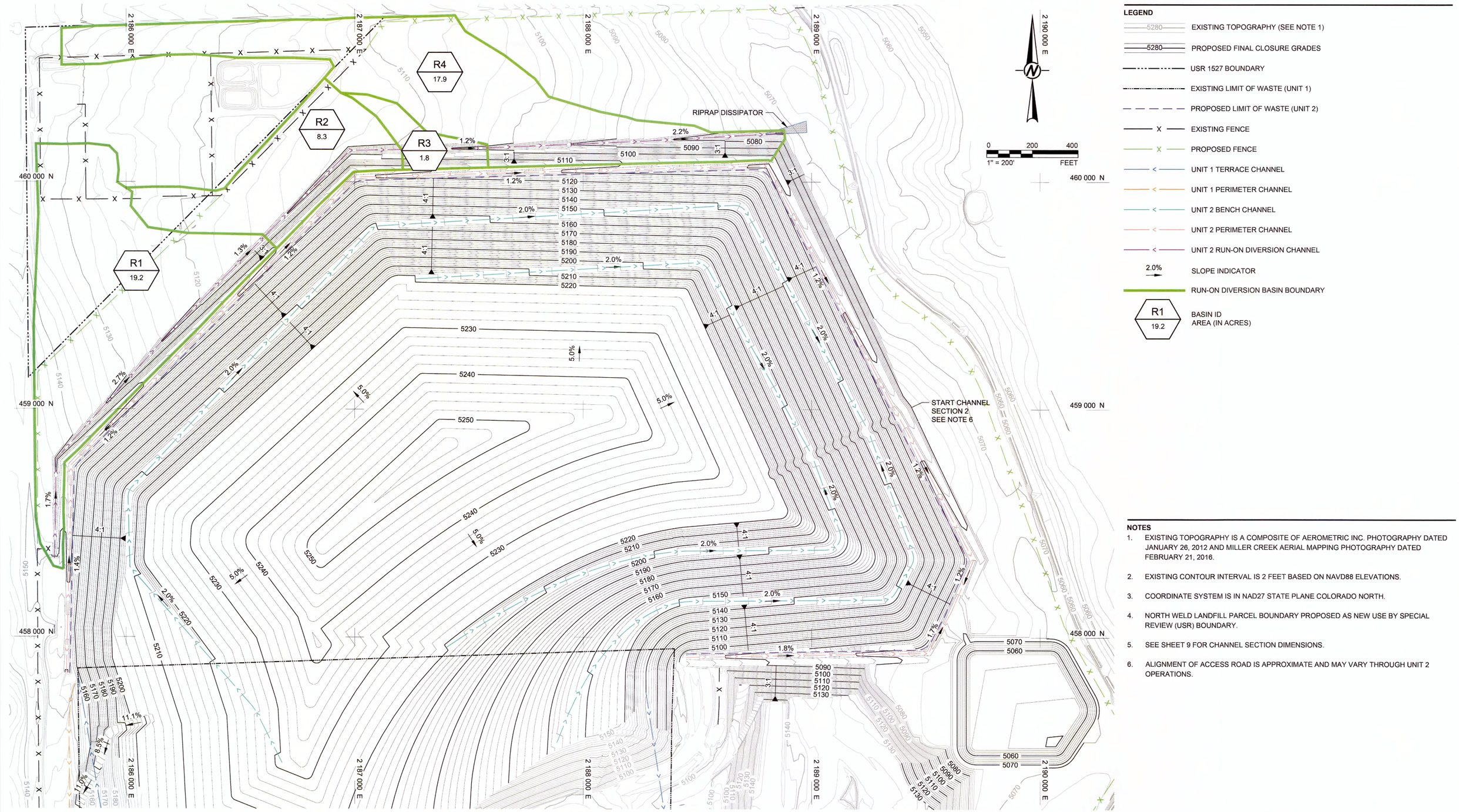
PROJECT
NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO

TITLE
TITLE SHEET

COLORADO LICENSED
JEFFREY A. RUTSCH
0044981
PROFESSIONAL ENGINEER

PROJECT NO.	CONTROL	REV.	of	FIGURE
1538880		A		1

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LEGEND

- 5280 — EXISTING TOPOGRAPHY (SEE NOTE 1)
- 5280 — PROPOSED FINAL CLOSURE GRADES
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- X — EXISTING FENCE
- X — PROPOSED FENCE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- UNIT 2 BENCH CHANNEL
- UNIT 2 PERIMETER CHANNEL
- UNIT 2 RUN-ON DIVERSION CHANNEL
- 2.0% — SLOPE INDICATOR
- RUN-ON DIVERSION BASIN BOUNDARY
- R1 / 19.2 — BASIN ID / AREA (IN ACRES)

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.
4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. SEE SHEET 9 FOR CHANNEL SECTION DIMENSIONS.
6. ALIGNMENT OF ACCESS ROAD IS APPROXIMATE AND MAY VARY THROUGH UNIT 2 OPERATIONS.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR WELD COUNTY USR	SPS	NIL	JAR	MEM

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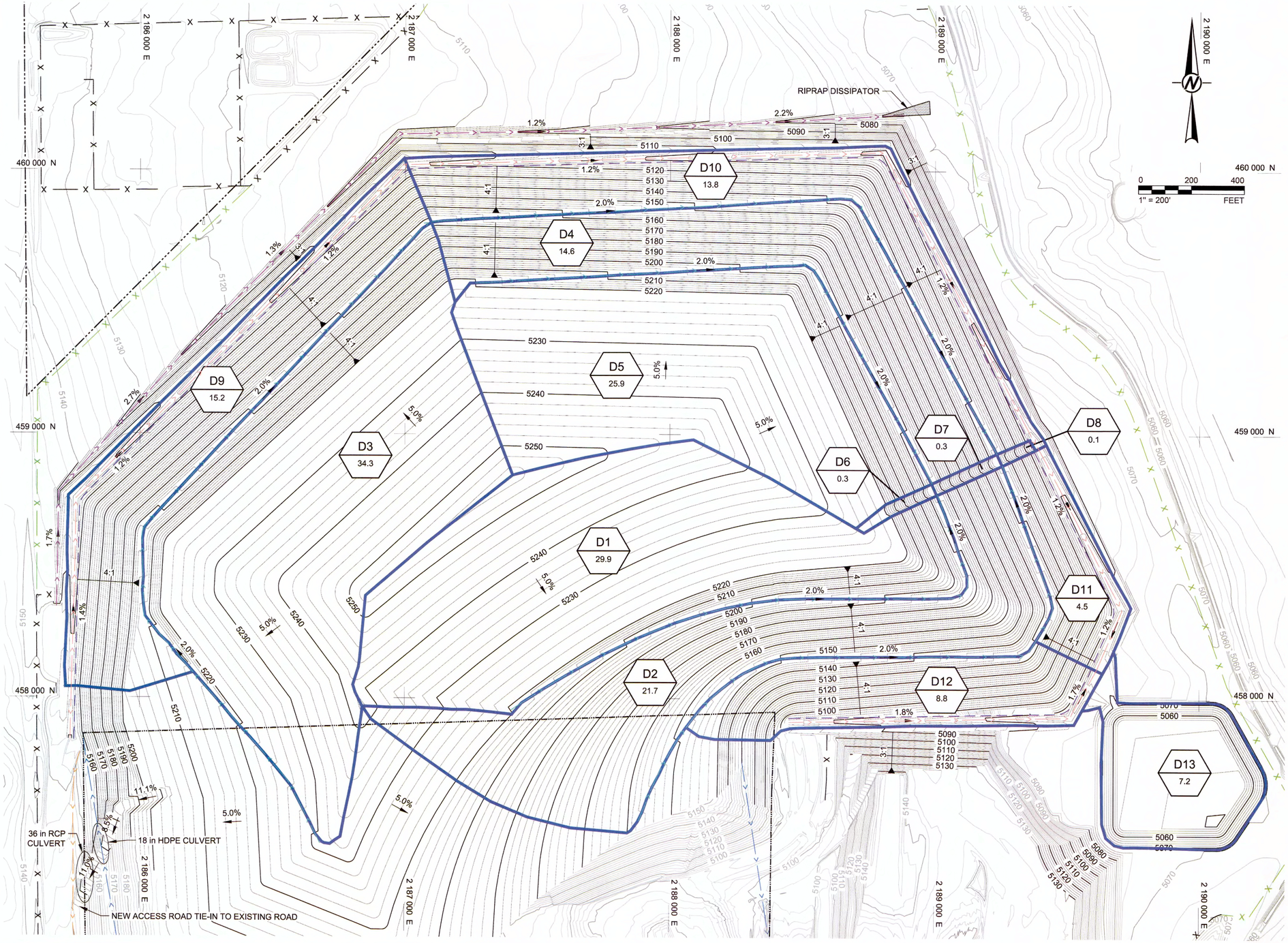
PROJECT
NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO

COLORADO LICENSED
JEFFREY A. RUSCH
004680
PROFESSIONAL ENGINEER
12/21/16

TITLE
HISTORIC DRAINAGE BASIN RUN-ON MAP

PROJECT NO. 1538880 | REV. A | of | FIGURE 2

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LEGEND

- EXISTING TOPOGRAPHY (SEE NOTE 1)
- PROPOSED FINAL CLOSURE GRADES
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- EXISTING FENCE
- PROPOSED FENCE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- UNIT 2 BENCH CHANNEL
- UNIT 2 PERIMETER CHANNEL
- UNIT 2 RUN-ON DIVERSION CHANNEL
- SLOPE INDICATOR
- RUNOFF CONTROL BASIN BOUNDARY
- BASIN ID / AREA (IN ACRES)

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY, 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.
4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. SEE SHEET 9 FOR CHANNEL SECTION DIMENSIONS.
6. ALIGNMENT OF ACCESS ROAD IS APPROXIMATE AND MAY VARY THROUGH UNIT 2 OPERATIONS.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR WELD COUNTY USR	SPS	NIL	JAR	MEM

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PROJECT
NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO

COLORADO LICENSED
JEFFREY A. RISSOM
0046809
PROFESSIONAL ENGINEER

TITLE
FULLY DEVELOPED DRAINAGE BASIN MAP

PROJECT NO. 1538880 | REV. A | of | FIGURE 3

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UNIT 2 STORMWATER RETENTION POND (77 AC-FT)

EXISTING UNIT 1 STORMWATER RETENTION POND (42.2 AC-FT)

SOIL STOCKPILE AREA

LOW WATER CROSSING SEE DETAIL 2/6

LOWER DOWNCHUTE CHANNEL SEE SECTION B/5

STILLING BASIN SEE DETAIL A/5

DISSIPATION BASIN SEE DETAIL 5/6

225 FT OFFSET

MIDDLE DOWNCHUTE CHANNEL SEE SECTION B/5

TERRACE CHANNEL TO DOWNCHUTE INTERSECTION SEE DETAIL 4/5

UPPER DOWNCHUTE CHANNEL SEE SECTION B/5

PERIMETER CHANNEL SEE DETAIL 2/5

BENCH CHANNEL SEE SECTION C/5

75 FT WIDE WESTERN AREA POWER AUTHORITY EASEMENT

RUN-ON CHANNEL SEE DETAIL 1/5

DUMPED RIP-RAP (D50 OF 18IN) APRON (20 FT AT CREST BY 60 FT AT TOE. 20 FT RUN OUT ON POND FLOOR)

RETENTION POND EMERGENCY SPILLWAY SEE DETAIL 6/6

315 FT

LIMIT OF UNIT 2 FINAL COVER

VARIES

ACCESS ROAD SEE NOTE 7 AND DETAIL 1/6

BENCH CHANNEL CULVERT CROSSING SEE DETAIL 4/6

PERIMETER CHANNEL CULVERT CROSSING SEE DETAIL 3/6

175 FT OFFSET

195 FT OFFSET

WELD COUNTY ROAD 84

WELD COUNTY ROAD 25

CO STATE HIGHWAY 14

USR 1527

SCALEHOUSE

MAINTENANCE SHOP

OFFICE

FACILITY ENTRANCE

GP-20 TW-01 GP-21 GP-22 GP-23 GP-24 GP-25 GP-26 GP-27 GP-28 GP-29 GP-30 GP-31 GP-32 GP-33 GP-34 GP-35 GP-36 GP-37 GP-38 GP-39 GP-1 GP-2 GP-3 GP-4 GP-5 GP-6 GP-7 GP-10 GP-11 GP-12 GP-13

TW-04 TW-05 TW-06 TW-08 TW-09 TW-10 TW-02

MW-3 MW-4 MW-5 MW-9 MW-10

LEGEND

- EXISTING TOPOGRAPHY (SEE NOTE 1)
- PROPOSED FINAL CLOSURE GRADES
- UNIT 2 PIGGYBACK OVER EXISTING UNIT 1
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- PROPOSED LIMIT OF WASTE (UNIT 2)
- EXISTING FENCE
- PROPOSED FENCE
- UNIT 1 TERRACE CHANNEL
- UNIT 1 PERIMETER CHANNEL
- UNIT 2 BENCH CHANNEL
- UNIT 2 PERIMETER CHANNEL
- UNIT 2 RUN-ON DIVERSION CHANNEL
- EXISTING ROADS
- PROPOSED ACCESS ROAD
- SLOPE INDICATOR
- EXISTING BUILDINGS
- EXISTING MONITORING WELL LOCATION
- TEMPORARY WELL LOCATION (SEE NOTE 5)
- EXISTING GAS PROBE LOCATION
- PROPOSED GAS PROBE LOCATION (APPROXIMATE) (INSTALLATION TO BE PHASED WITH LANDFILL DEVELOPMENT)

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.
4. NORTH WELD LANDFILL PARCEL BOUNDARY PROPOSED AS NEW USE BY SPECIAL REVIEW (USR) BOUNDARY.
5. TEMPORARY MONITORING WELLS INSTALLED BY SWIFT RIVER ENVIRONMENTAL SERVICES, LLC AS PART OF 2016 HYDROGEOLOGIC SITE INVESTIGATION.
6. RETENTION BASIN DESIGN INCLUDES ALLOWANCE FOR 1-FT MINIMUM FREEBOARD. CAPACITIES REPORTED ON THIS SHEET DO NOT INCLUDE VOLUME OF FREEBOARD.
7. ALIGNMENT OF ACCESS ROAD IS APPROXIMATE AND MAY VARY THROUGHOUT UNIT 2 OPERATIONS AND AT CLOSURE.

0 300 600
1" = 300' FEET

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR WELD COUNTY USR	ALB	DVS	JAR	MEM

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PROJECT
NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO

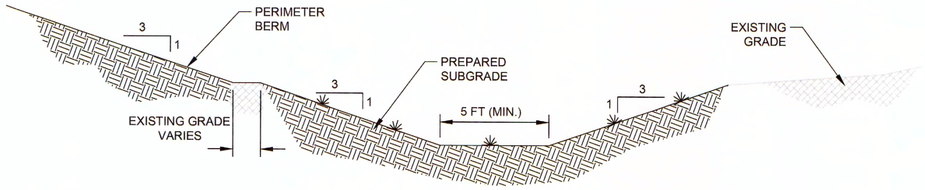
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STORMWATER CONTROLS PLAN

COLORADO LICENSED
JEFFREY A. RUCH
0046804
PROFESSIONAL ENGINEER

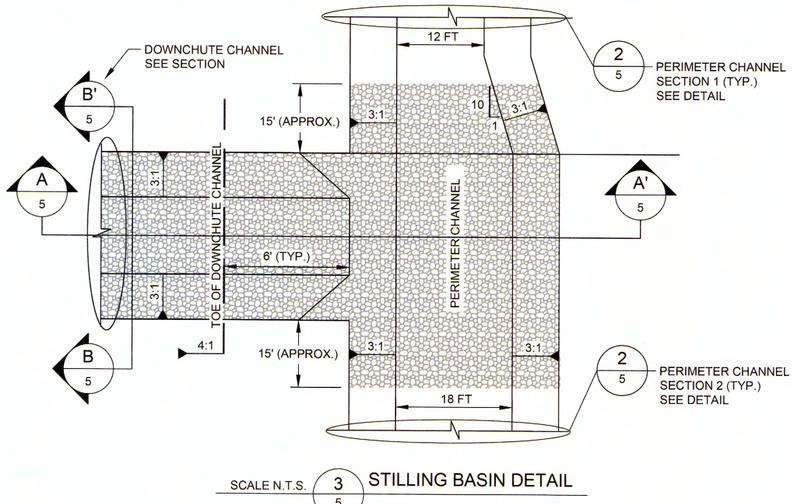
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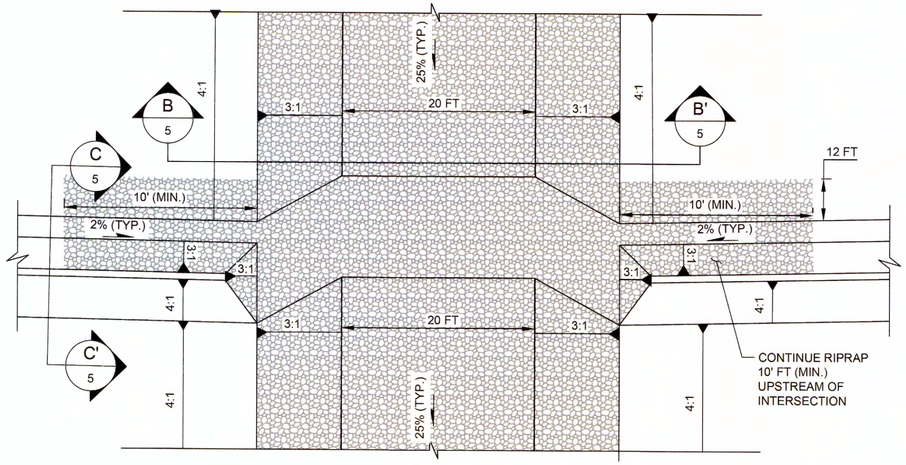
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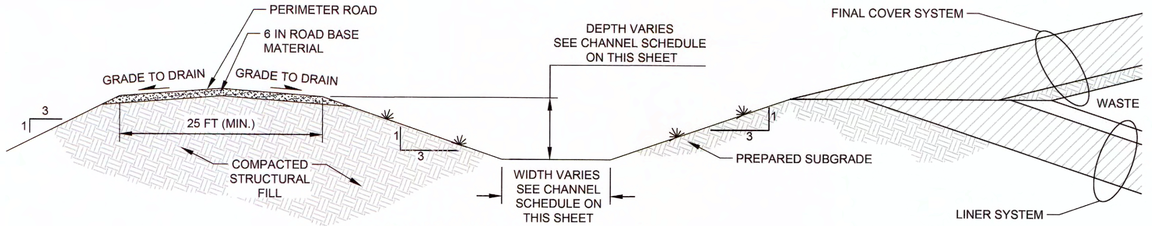
SCALE N.T.S. 1/5 RUN-ON CHANNEL SECTION DETAIL



SCALE N.T.S. 3/5 STILLING BASIN DETAIL



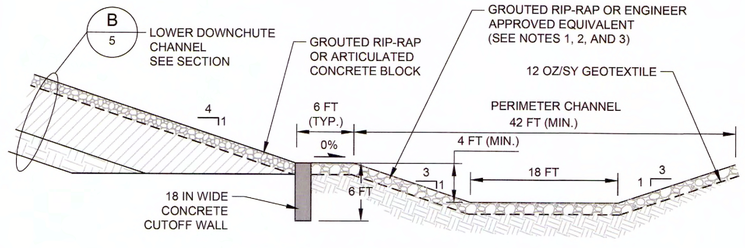
SCALE N.T.S. 4/5 TERRACE CHANNEL TO DOWNCHUTE INTERSECTION DETAIL



SCALE N.T.S. 2/5 PERIMETER CHANNEL DETAIL

PERIMETER CHANNEL SCHEDULE

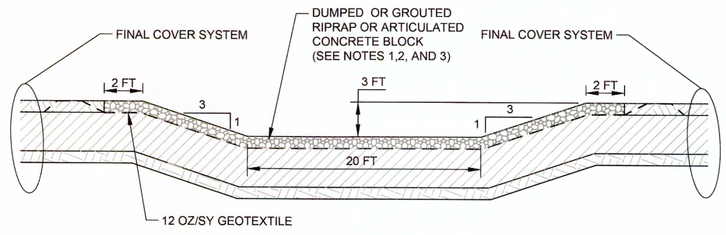
CHANNEL	SIDESLOPE (SS) (H:V)	MINIMUM CHANNEL SLOPE (%)	MINIMUM CHANNEL BOTTOM WIDTH (B) (FT)	MINIMUM CHANNEL DEPTH (D) (FT)	CHANNEL LINING
SECTION 1	3:1	1.2	12	3	GRASS
SECTION 2	3:1	1.2	18	4	TRM
SECTION 3	3:1	1.2	20	4	TRM



SCALE N.T.S. A/5 STILLING BASIN SECTION

NOTES

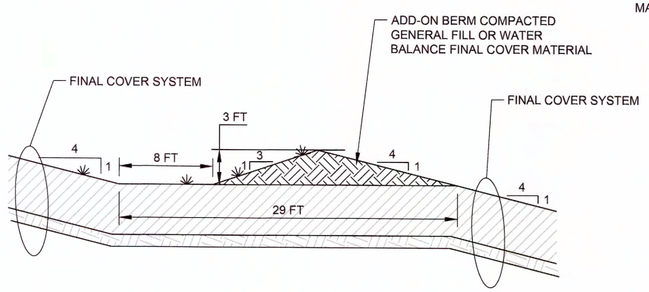
1. RIPRAP SHALL BE PLACED TO A THICKNESS OF 1.5 TIMES THE D_{50} DIMENSION.
2. LOWER DOWNCHUTE AND STILLING BASIN RIPRAP SHALL HAVE D_{50} OF 24 IN.
3. RIPRAP SHALL BE GROUTED TO ONE HALF OF LAYER THICKNESS (MINIMUM).



SCALE N.T.S. B/5 DOWNCHUTE CHANNEL SECTION

NOTES

1. RIPRAP SHALL BE PLACED TO A THICKNESS OF 1.5 TIMES THE D_{50} DIMENSION.
2. UPPER DOWNCHUTE CHANNEL DUMPED RIPRAP SHALL HAVE D_{50} OF 6 IN. MIDDLE DOWNCHUTE CHANNEL DUMPED RIPRAP SHALL HAVE D_{50} OF 18 IN. LOWER DOWNCHUTE CHANNEL GROUTED RIPRAP SHALL HAVE D_{50} OF 24 IN AND SHALL BE GROUTED TO ONE HALF OF LAYER THICKNESS (MINIMUM).
3. ARTICULATED CONCRETE BLOCK (ACB) MAY BE SUBSTITUTED FOR RIPRAP IN DOWNCHUTE CHANNEL. ACB SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.



SCALE N.T.S. C/5 BENCH CHANNEL SECTION

ALL BENCH CHANNELS SHALL BE GRASS-LINED

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A	2016-12-21	ISSUED FOR WELD COUNTY USR	ALB	DVS	JAR	MEM

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CONSULTANT
GOLDER ASSOCIATES INC.
44 UNION BLVD, SUITE 300
LAKEWOOD, CO
USA
+1 (303) 980 0540
www.golder.com

PROJECT
NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO

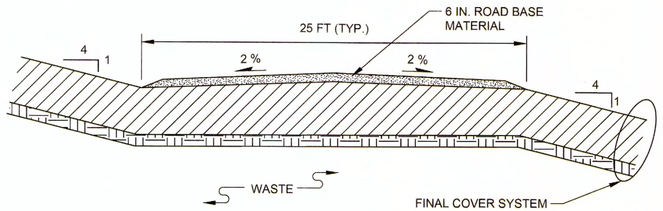
TITLE
DETAILS
(1 OF 2)

COLORADO LICENSED JEFFREY A. RUSCH 0046001 PROFESSIONAL ENGINEER

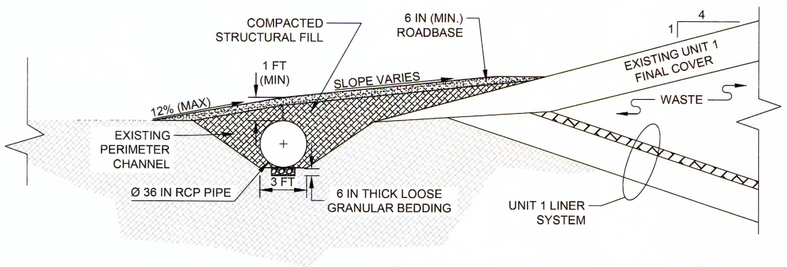
PROJECT NO. 1538880 REV. A of FIGURE 5

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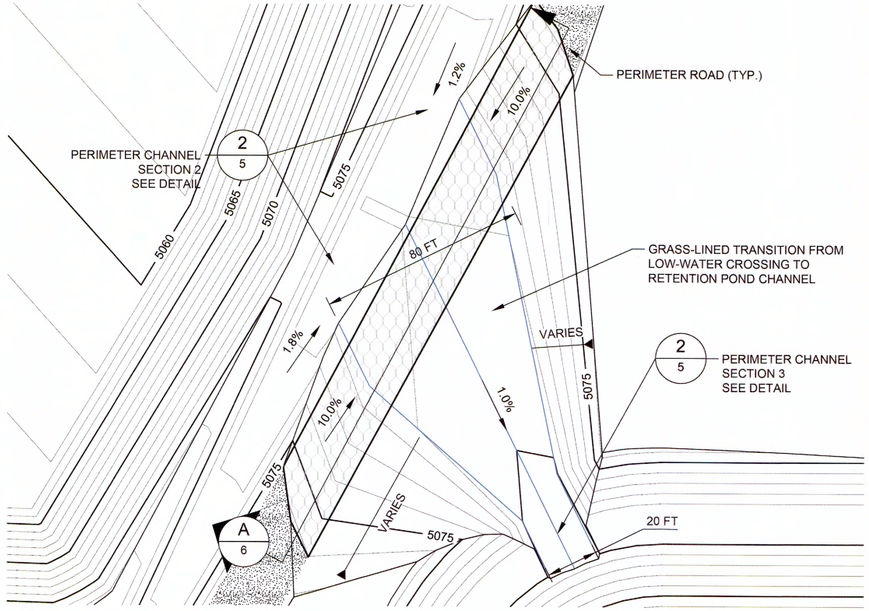
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0 1 in



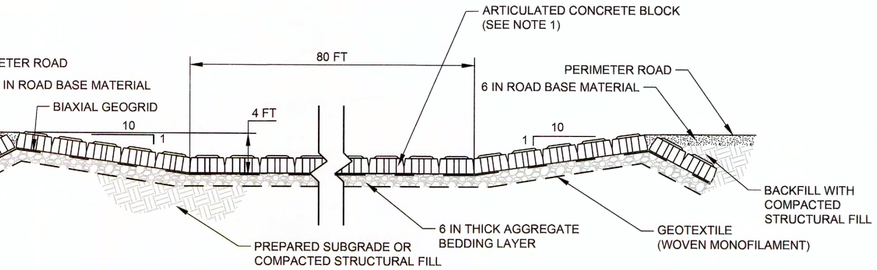
SCALE N.T.S. 1/6 ACCESS ROAD DETAIL



SCALE N.T.S. 3/6 EXISTING UNIT 1 PERIMETER CHANNEL CULVERT CROSSING DETAIL

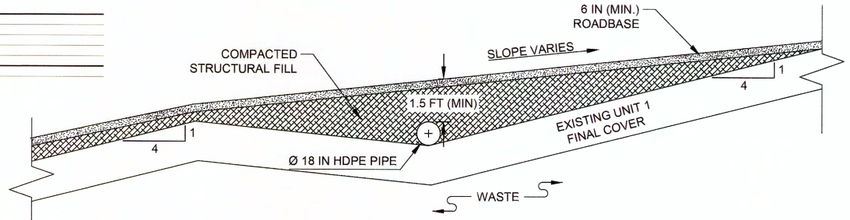


SCALE N.T.S. 2/6 LOW WATER CROSSING DETAIL

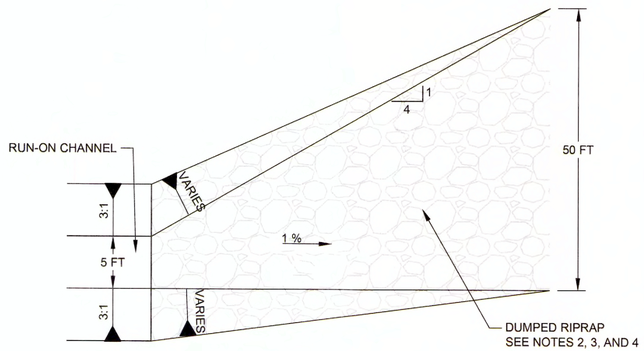


SCALE N.T.S. A/6 LOW WATER CROSSING SECTION

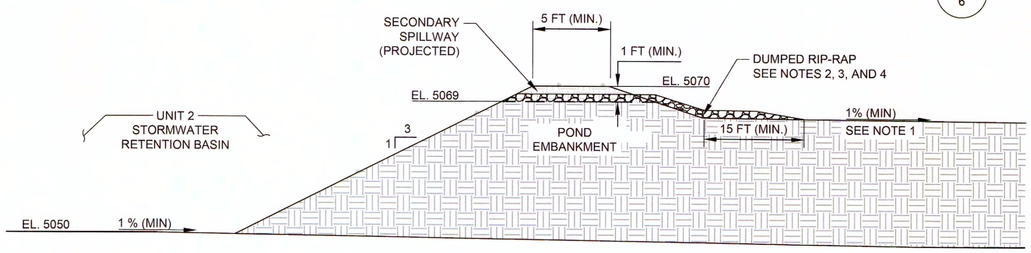
1. ARTICULATED CONCRETE BLOCK SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.



SCALE N.T.S. 4/6 EXISTING UNIT 1 BENCH CHANNEL CULVERT CROSSING DETAIL



SCALE N.T.S. 5/6 DISSIPATION BASIN PLAN VIEW DETAIL



SCALE N.T.S. 6/6 RETENTION BASIN SPILLWAY DETAIL

NOTES

1. EXISTING GRADE DOWNSTREAM OF EMERGENCY SPILLWAY VARIES. SPILLWAY DISCHARGE AREA WILL BE REGRADED TO DRAIN DURING UNIT 2 OPERATIONS.
2. RIPRAP SHALL BE PLACED TO A THICKNESS OF 1.5 TIMES THE D_{50} DIMENSION.
3. RIPRAP SHALL HAVE A D_{50} OF 6 IN.
4. RIPRAP SHALL BE PLACED ON 12 OZ/SY GEOTEXTILE.

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
A	2016-12-21	ISSUED FOR WELD COUNTY USR	ALB	DVS	JAR	MEM

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

GOLDER ASSOCIATES INC.
44 UNION BLVD, SUITE 300
LAKEWOOD, CO
USA
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PROJECT
NORTH WELD LANDFILL, UNIT 2
DRAINAGE REPORT
WELD COUNTY, COLORADO

TITLE
DETAILS
(2 OF 2)

COLORADO LICENSED JEFFREY A. RUSCH 0046901 PROFESSIONAL ENGINEER

PROJECT NO. 1538880 | REV. A | of | FIGURE 6

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APPENDIX A
UNIT 2 SURFACE WATER RUN-ON AND RUNOFF CONTROLS CALCULATIONS

Golder Associates

CALCULATIONS

Date:	December 21, 2016	**Made by:**	SPS SPS
Project No.:	1538880	**Checked by:**	DMW DMW
Site Name:	North Weld Landfill, Unit 2	**Reviewed by:**	JAR
Subject	**APPENDIX A: SURFACE WATER RUN-ON AND RUNOFF CONTROLS CALCULATIONS**		

1.0 OBJECTIVES

Determine the locations and sizes of surface water run-on and runoff controls to manage the stormwater affecting the development of Unit 2 of the North Weld Landfill facility (Facility).

2.0 METHODOLOGY

The Facility footprint area is approximately 155 acres and the contributing area of the upstream drainage basins impacting the Facility footprint is approximately 35 acres. Drainage basins (watershed areas) for the proposed surface water run-on and runoff control systems were delineated based on planned and existing two-foot contour interval topography. Times of concentration were calculated using the methodology described in TR-55 (NRCS 1986) for sheet flow, shallow concentrated flow, and channel flow. HEC-HMS modeling software (USACE 2013) was used to combine and route the surface runoff from the delineated drainage basins in order to estimate peak discharges and total stormwater volumes. The peak flows are used to size the proposed channels, culverts, and energy dissipater. Excel spreadsheet calculations based on Manning's equation were used to size the proposed channels, assuming normal depths. Required riprap median diameters (D_{50}) for proposed channel linings were developed using *Design of Rock Chutes* (Robinson et al. 1998). The Federal Highway Administration's HY-8 culvert analysis program (FHWA 2014) was used to evaluate proposed culvert designs. Bentley's FlowMaster software was used to determine the retention basin emergency spillway dimensions and the flow capacity of existing channels (Bentley 2009). Energy dissipaters were sized using Urban Drainage and Flood Control District (UDFCD) methodology (UDFCD 2016a and 2016b).

3.0 DESIGN CRITERIA

The storm drainage criteria presented in the Weld County Charter and Code (Weld County 2016) was used as the design basis for the project, except in certain instances where it is superseded by UDFCD design criteria (UDFCD 2016). A summary of this project's design criteria follows:

- Site precipitation from NOAA Atlas 14 (NOAA 2013) (see Appendix A-1):

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Project No.:	1538880	Made by:	SPS
Site Name:	North Weld Landfill, Unit 2	Checked by:	DMW
Date:	December 21, 2016	Reviewed by:	JAR

Design Event	Precipitation Depth (inches)
2-year, 24-hour	1.76
5-year, 1-hour	1.15
25-year, 24-hour	3.38
100-year, 1-hour	2.78
100-year, 24-hour	4.66

- Hydrologic soil group (HSG) B soils were determined to be the underlying soil conditions for all upgradient areas affecting the site based on the effective NRCS soil mapping (NRCS 2016), provided in Appendix A-1.
- Composite SCS curve numbers (CN) were developed for all basins based on the following:
  - CN = 84 for landfill surface (RUST 1997)
  - CN = 85 for agricultural lands, fallow, poor cover, HSG B soils (NRCS 1986)
  - CN = 98 for pond areas (NRCS 1986)
- Hydrologic modeling:
  - SCS Type II synthetic rainfall distribution used based on site location
  - TR-55 time of concentration method (NRCS 1986)
  - Lag time is equal to 60 percent of the time of concentration. The minimum lag time is 3.6 minutes, based on a minimum time of concentration of 0.1 hour (NRCS 1986)
  - Maximum length of sheet flow is 300 feet (NRCS 1986)
- Hydraulic structures (channels, culverts, energy dissipaters, etc.) designed for the 100-year, 24-hour peak discharge:
  - Bench, perimeter, and run-on channel design:
    - Channels to be lined with grass or turf reinforcement matting (TRM)
    - Manning's roughness coefficients of 0.035 (for design capacity) and 0.030 (for design velocity) were assumed for both grass and TRM linings
    - Maximum design velocity for grass-lined channels = 5.5 feet per second
    - Freeboard = one foot minimum
    - All channels will be trapezoidal with the following cross section properties:

Channel Type	Bottom Width (feet)	Side Slope (H:V)
Bench	8	4:1 (bench side), 3:1 (berm side)
Perimeter	12 or 18	3:1
Run-on	5	3:1

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Site Name:	North Weld Landfill, Unit 2	Checked by:	DMW
Date:	December 21, 2016	Reviewed by:	JAR

- Downchute channel design:
  - Channels to be lined with articulated concrete blocks (ACB) or riprap
  - Manning's roughness coefficient of 0.026 (for both design capacity and velocity) was assumed for ACB
  - Manning's roughness coefficients of 0.040 (for design capacity) and 0.035 (for design velocity) were assumed for riprap
  - Riprap will be specified for required D50 of 24 inches or less
  - Freeboard = one foot minimum
  - All channels will be trapezoidal with 3:1 side slopes and 20-foot minimum bottom width
- Culvert design:
  - Minimum diameter = 18 inches (UDFCD 2016a)
  - Culvert material to be either reinforced concrete pipe (RCP) or high-density polyethylene (HDPE) pipe, both with assumed Manning's n values of 0.012
  - Ratio of design headwater to diameter (HW/D) less than 1.5 (Weld County 2016)

- Retention design (Weld County 2016):
  - Required storage volume = 1.5 x (100-year, 24-hour runoff volume)
  - 4(H):1(V) side slopes or flatter
  - Basin freeboard = one foot minimum
  - Emergency spillway designed to convey 100-year, 1-hour peak discharge at maximum depth of 6 inches

4.0 CALCULATIONS

Four basins (Basin R1 – R4) have been delineated north of the expansion area to reflect the run-on from existing watersheds that will impact the Facility (see Figure 2 of the Drainage Report). The results from the hydrologic routing model developed for these basins will be used as the basis for sizing the run-on collection channels.

Thirteen basins (Basins D1–D13) have been delineated to determine the runoff from the proposed Facility expansion area (see Figure 3). The hydrologic modeling was developed to combine and route these basins per the proposed grading plan in order to properly size the required channels, downchutes, and retention basin. Runoff from all the delineated basins will report to the proposed retention basin in the southeast corner of the Facility.

The HEC-HMS model inputs and outputs are included as Appendix A-1. Channel design calculations are also provided in Appendix A-1. A stilling basin will be placed directly at the toe of the downchute; supporting calculation and documentation for that design are included in Appendix A-2.

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Site Name:	North Weld Landfill, Unit 2	Checked by:	DMW
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5.0 RESULTS

5.1 Run-on Analysis

One continuous run-on channel has been designed along the west and north perimeter of the Facility. Four channel sections were evaluated to account for the run-on from basins R1 through R4 each contributing to this channel. The channels are located within the drainage basins delineated in Figure 2 with alignments and the typical section shown in Figures 4 and 5, respectively. A summary of the 100-year, 24-hour design flows, flow depths and velocities for each section are provided in Table 1.

Table 1: Run-on Channel Design Summary

Basin Location	100-year, 24-hour Peak Discharge (cfs)	Side Slope (H:V)	Bottom Width (feet)	Total Depth (feet)	Peak Velocity (fps)	Channel Lining
R1	93.4	3:1	5	3.1	5.9	Grass
R2	119.4	3:1	5	3.1	6.1	Grass
R3	125.8	3:1	5	3.1	6.1	Grass
R4	165.8	3:1	5	3.1	8.3	Grass

5.2 Runoff Analysis

5.2.1 Channel Design

Five bench channel sections, four perimeter channel sections, and three downchute channel sections have been provided to collect and convey runoff generated within the Facility. The channels are located within the drainage basins delineated in Figure 3 with alignments and typical sections shown in Figures 4 and 5, respectively. A summary of the 100-year, 24-hour design flows, flow depths, and velocities for these channels are provided in Tables 2 through 4.

Table 2: Bench Channel Design Summary

Basin Location	100-year, 24-hour Peak Discharge (cfs)	Side Slope (H:V)	Bottom Width (feet)	Total Depth (feet)	Peak Velocity (fps)	Channel Lining
D1	126.6	4:1 (L), 3:1 (R)	8	3.0	7.0	Grass
D2	84.8	4:1 (L), 3:1 (R)	8	3.0	6.2	Grass
D3	153.3	3:1 (L), 4:1 (R)	8	3.0	7.4	Grass
D4	208.7	3:1 (L), 4:1 (R)	8	3.0	8.0	Grass
D5	108.7	3:1 (L), 4:1 (R)	8	3.0	6.7	Grass

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Site Name:	North Weld Landfill, Unit 2	Checked by:	DMW DMW
Date:	December 21, 2016	Reviewed by:	JAR

Table 3: Downchute Channel Design Summary

Basin Location	100-year, 24-hour Peak Discharge (cfs)	Side Slope (H:V)	Bottom Width (feet)	Total Depth (feet)	Peak Velocity (fps)	Channel Lining
D6	1.5	3:1	20	3.0	2.6	6 inches dumped riprap or ACB
D7	236.5	3:1	20	3.0	19.1	18 inches dumped riprap or ACB
D8	525.6	3:1	20	3.0	25.4	24 inches grouted riprap or ACB

Table 4: Perimeter Channel Design Summary

Basin Location	100-year, 24-hour Peak Discharge (cfs)	Side Slope (H:V)	Bottom Width (feet)	Total Depth (feet)	Peak Velocity (fps)	Channel Lining
D9	60.8	3:1	12	3.0	4.5	Grass
D10	99.6	3:1	12	3.0	5.3	Grass
D11	645.7	3:1	18	4.0	8.9	TRM
D12	40.2	3:1	12	3.0	4.4	Grass
D13	645.7	3:1	20	4.0	8.7	TRM

A stilling basin has been designed at the toe of the downstream-most downchute located in Basin D8. This stilling basin will be boulder-lined to facilitate energy dissipation and will be a minimum of 33-feet long, sufficient to contain the anticipated hydraulic jump that would form during the 100-year, 24-hour event.

5.2.2 Low-water Crossing

At the junction of perimeter channels for Basins D11 and D12, the combined runoff will be directed into the on-site retention basin by an at-grade low-water roadway crossing of the perimeter road and a short perimeter channel section. This depressed roadway area will be ACB-lined for improved stability. This crossing has been designed to limit the flow depth to 1 foot or less during the 100-year, 24-hour event. Flow depth calculations for this crossing are provided with the channel calculations in Appendix A-1.

The runoff entering the retention basin is expected to form a hydraulic jump upon reaching the basin floor. To minimize the potential for erosion, 18-inch median diameter dumped riprap will be extended through the basin inlet and along the basin floor for approximately 20 feet, the estimated length of the hydraulic jump.

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5.2.3 Culvert Design

Culverts have been designed where the proposed access road crosses two existing Unit 1 drainage facilities near the southwest corner of Unit 2: an existing bench channel and an existing perimeter channel. As there will be no modifications to these existing drainage structures, the design discharges have been referenced from previous designs.

For the perimeter channel culvert crossing, the referenced design discharge is 30 cubic feet per second (cfs), which takes into account the design update for the Unit 1 haul road improvements recently submitted to Weld County (Golder 2016). The bench channel design was included as part of the original site development plan (RUST 1996), but no design discharge was available for reference. The culvert design flow used for this crossing is 5 cfs, which is based on the flow capacity using the existing channel dimensions and bed slope and assuming one foot of freeboard is provided. The channel capacity calculation is provided in Appendix A-3. The culvert design is summarized in Table 5.

Table 5: Access Road Culvert Design Summary

Location	Pipe Diameter and Type	QDESIGN (cfs)	Design Headwater Depth (feet)	Available Headwater Depth (feet)	HW/D
Perimeter Channel	36-inch RCP	301	2.6	4.0	0.9
Bench Channel	18-inch HDPE	52	1.4	3.0	0.9

Notes:
1). Referenced from previous design (Golder 2016).
2). Developed from previous design (RUST 1996).

5.2.4 Retention Basin Design

The 100-year, 24-hour runoff volume reporting to the proposed retention basin in the southeast corner of the Facility is 44.1 acre-feet. The design retention volume per Weld County design standards is 1.5 times the 100-year, 24-hour volume or 66.2 acre-feet. The design volume is met at elevation 5,066.2 feet and the basin crest elevation is 5,070 feet, exceeding the minimum 1-foot basin freeboard criteria.

In accordance with Weld County design standards, an emergency spillway is provided to convey the 100-year, 1-hour peak discharge of 296 cfs that reports to this basin. A 315-foot-long spillway is required to convey the peak discharge at a maximum depth of 6 inches (0.5 feet). The spillway invert elevation is 5,069 feet and the flow depth at the peak discharge (296 cfs) is 0.5 feet.

Another retention basin requirement is that the 100-year, 24-hour runoff volume discharges the basin within 72 hours. This requirement will be met by infiltration through the in situ underlying soil. Based on the in situ hydraulic conductivity of 3.6×10^{-3} centimeters per second (cm/sec) (5.1 inches/hour), it is estimated

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Site Name:	North Weld Landfill, Unit 2	Checked by:	DMW DMW
Date:	December 21, 2016	Reviewed by:	JAR

that total runoff volume will discharge in approximately 25 hours. Drain time calculations are provided in Appendix A-4.

6.0 REFERENCES

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APPENDIX A-1

APPENDIX A-1-1

NOAA Atlas 14, Volume 8, Version 2
Location name: Ault, Colorado, US*
Latitude: 40.5918°, Longitude: -104.8250°
Elevation: 5107 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.241 (0.193–0.300)	0.291 (0.232–0.362)	0.386 (0.307–0.482)	0.480 (0.379–0.602)	0.631 (0.489–0.841)	0.763 (0.572–1.02)	0.910 (0.655–1.24)	1.07 (0.738–1.50)	1.31 (0.863–1.88)	1.51 (0.958–2.16)
10-min	0.353 (0.282–0.439)	0.425 (0.339–0.530)	0.566 (0.450–0.706)	0.703 (0.555–0.881)	0.923 (0.716–1.23)	1.12 (0.838–1.50)	1.33 (0.960–1.82)	1.57 (1.08–2.20)	1.93 (1.26–2.75)	2.22 (1.40–3.17)
15-min	0.431 (0.344–0.536)	0.519 (0.414–0.646)	0.690 (0.549–0.861)	0.858 (0.677–1.08)	1.13 (0.873–1.50)	1.36 (1.02–1.82)	1.63 (1.17–2.22)	1.92 (1.32–2.68)	2.35 (1.54–3.35)	2.70 (1.71–3.86)
30-min	0.585 (0.468–0.728)	0.703 (0.561–0.875)	0.932 (0.741–1.16)	1.16 (0.914–1.45)	1.52 (1.18–2.03)	1.84 (1.38–2.47)	2.20 (1.58–3.01)	2.60 (1.79–3.63)	3.18 (2.09–4.55)	3.67 (2.32–5.24)
60-min	0.719 (0.575–0.895)	0.865 (0.690–1.08)	1.15 (0.916–1.44)	1.44 (1.14–1.80)	1.90 (1.48–2.55)	2.32 (1.74–3.11)	2.78 (2.00–3.80)	3.30 (2.27–4.61)	4.06 (2.67–5.80)	4.69 (2.97–6.70)
2-hr	0.853 (0.685–1.05)	1.03 (0.824–1.27)	1.37 (1.10–1.70)	1.72 (1.37–2.14)	2.29 (1.79–3.04)	2.79 (2.11–3.72)	3.36 (2.44–4.56)	3.99 (2.77–5.54)	4.93 (3.27–6.99)	5.71 (3.65–8.08)
3-hr	0.924 (0.745–1.14)	1.11 (0.895–1.37)	1.49 (1.19–1.83)	1.87 (1.49–2.31)	2.49 (1.96–3.29)	3.04 (2.31–4.03)	3.66 (2.68–4.95)	4.36 (3.05–6.03)	5.40 (3.60–7.62)	6.26 (4.03–8.82)
6-hr	1.05 (0.855–1.28)	1.28 (1.04–1.56)	1.72 (1.39–2.10)	2.15 (1.72–2.64)	2.83 (2.23–3.69)	3.42 (2.62–4.48)	4.08 (3.00–5.45)	4.82 (3.39–6.58)	5.89 (3.97–8.22)	6.78 (4.41–9.46)
12-hr	1.25 (1.02–1.51)	1.50 (1.22–1.82)	1.97 (1.60–2.39)	2.41 (1.95–2.94)	3.11 (2.46–3.99)	3.70 (2.85–4.79)	4.36 (3.23–5.75)	5.08 (3.60–6.85)	6.13 (4.16–8.45)	6.99 (4.59–9.66)
24-hr	1.51 (1.24–1.81)	1.76 (1.44–2.11)	2.23 (1.82–2.68)	2.68 (2.18–3.23)	3.38 (2.70–4.30)	3.99 (3.09–5.11)	4.66 (3.48–6.09)	5.40 (3.86–7.22)	6.47 (4.44–8.84)	7.35 (4.88–10.1)
2-day	1.73 (1.43–2.05)	2.03 (1.68–2.41)	2.57 (2.11–3.06)	3.06 (2.50–3.66)	3.80 (3.03–4.75)	4.42 (3.44–5.57)	5.09 (3.82–6.55)	5.81 (4.18–7.65)	6.83 (4.72–9.21)	7.65 (5.13–10.4)
3-day	1.89 (1.57–2.23)	2.20 (1.82–2.60)	2.75 (2.27–3.26)	3.25 (2.66–3.87)	4.00 (3.20–4.97)	4.63 (3.61–5.80)	5.30 (4.00–6.78)	6.03 (4.36–7.89)	7.06 (4.91–9.46)	7.89 (5.33–10.6)
4-day	2.01 (1.67–2.37)	2.33 (1.94–2.75)	2.90 (2.40–3.43)	3.41 (2.81–4.05)	4.18 (3.36–5.16)	4.82 (3.77–6.01)	5.50 (4.16–7.00)	6.23 (4.52–8.12)	7.26 (5.07–9.69)	8.09 (5.49–10.9)
7-day	2.27 (1.90–2.66)	2.67 (2.23–3.13)	3.35 (2.79–3.94)	3.94 (3.26–4.64)	4.77 (3.83–5.81)	5.44 (4.27–6.70)	6.13 (4.66–7.72)	6.86 (5.00–8.83)	7.85 (5.52–10.4)	8.63 (5.90–11.5)
10-day	2.51 (2.10–2.93)	2.97 (2.49–3.46)	3.73 (3.11–4.36)	4.36 (3.62–5.12)	5.25 (4.22–6.34)	5.94 (4.67–7.26)	6.64 (5.06–8.29)	7.36 (5.39–9.40)	8.32 (5.87–10.9)	9.06 (6.23–12.0)
20-day	3.25 (2.74–3.75)	3.78 (3.18–4.37)	4.64 (3.89–5.37)	5.34 (4.46–6.22)	6.30 (5.09–7.51)	7.04 (5.57–8.49)	7.76 (5.95–9.57)	8.49 (6.27–10.7)	9.45 (6.72–12.2)	10.2 (7.07–13.3)
30-day	3.83 (3.24–4.41)	4.41 (3.73–5.08)	5.34 (4.50–6.16)	6.10 (5.12–7.06)	7.13 (5.78–8.44)	7.90 (6.28–9.47)	8.66 (6.67–10.6)	9.42 (6.99–11.8)	10.4 (7.45–13.4)	11.1 (7.79–14.5)
45-day	4.52 (3.84–5.17)	5.18 (4.39–5.93)	6.24 (5.28–7.16)	7.09 (5.97–8.16)	8.22 (6.69–9.66)	9.07 (7.23–10.8)	9.89 (7.65–12.0)	10.7 (7.97–13.3)	11.7 (8.43–14.9)	12.5 (8.78–16.2)
60-day	5.05 (4.30–5.76)	5.81 (4.94–6.63)	7.01 (5.95–8.01)	7.96 (6.72–9.14)	9.22 (7.51–10.8)	10.1 (8.11–12.0)	11.0 (8.55–13.3)	11.9 (8.88–14.7)	12.9 (9.34–16.4)	13.7 (9.69–17.7)

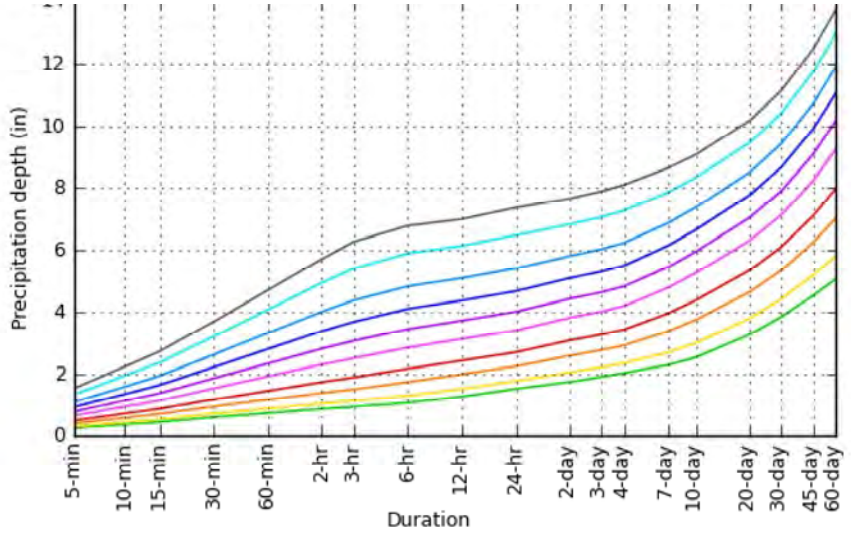
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

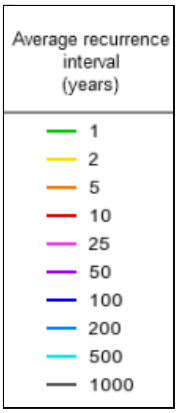
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

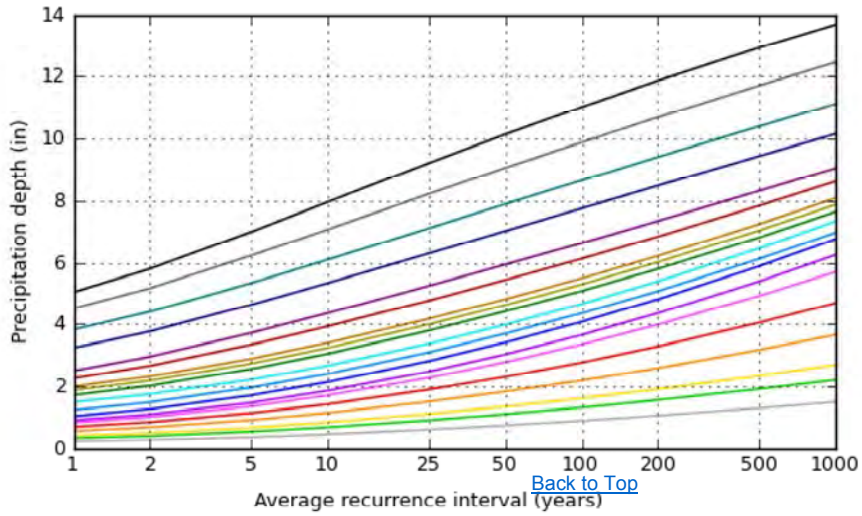
Please refer to NOAA Atlas 14 document for more information.

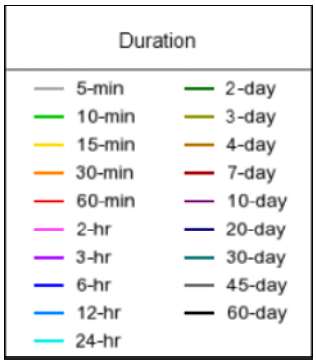
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PF graphical









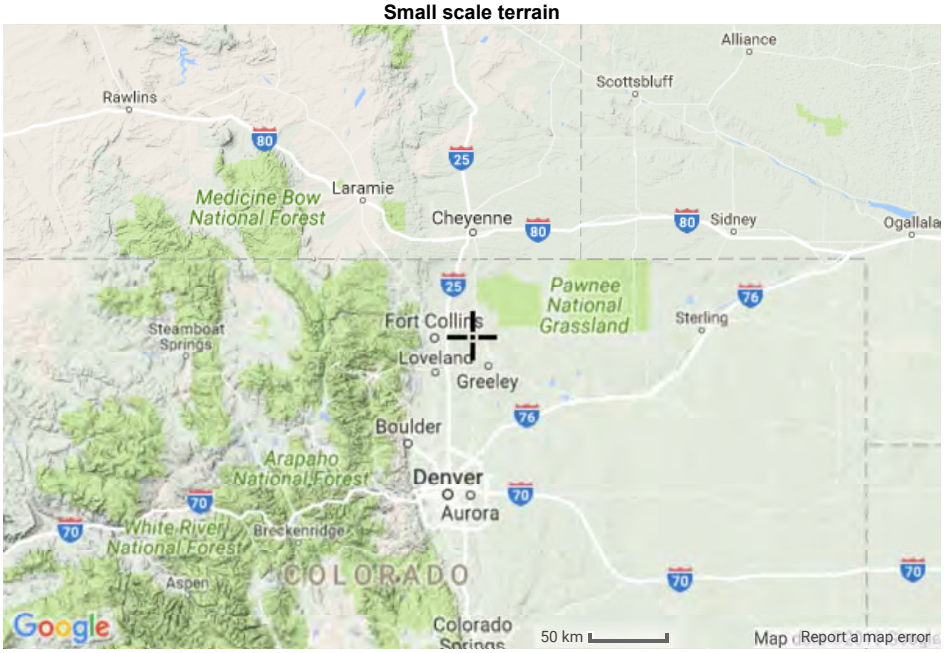
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Maps & aerials

NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Thu Aug 25 20:01:55 2016

Small scale terrain



Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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Silver Spring, MD 20910

Questions?: HDSC.Questions@noaa.gov

Disclaimer

APPENDIX A-1-2

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Weld County, Colorado, Southern Part

North Weld Landfill



August 17, 2016

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



Map Scale: 1:12,200 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 150 300 600 900

Feet
0 500 1000 2000 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Southern Part
Survey Area Data: Version 14, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 22, 2011—Oct 19, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Weld County, Colorado, Southern Part (CO618)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
4	Aquolls and Aquepts, flooded	2.8	0.4%
32	Kim loam, 1 to 3 percent slopes	51.1	7.7%
33	Kim loam, 3 to 5 percent slopes	5.2	0.8%
47	Olney fine sandy loam, 1 to 3 percent slopes	291.9	43.9%
48	Olney fine sandy loam, 3 to 5 percent slopes	312.7	47.0%
52	Otero sandy loam, 3 to 5 percent slopes	1.0	0.1%
Totals for Area of Interest		**664.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Weld County, Colorado, Southern Part

4—Aquolls and Aquepts, flooded

Map Unit Setting

National map unit symbol: 362l
Elevation: 3,600 to 4,700 feet
Mean annual precipitation: 12 to 16 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 100 to 165 days
Farmland classification: Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Aquolls and similar soils: 55 percent
Aquepts, flooded, and similar soils: 25 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aquolls

Setting

Landform: Depressions, drainageways, plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Recent alluvium

Typical profile

H1 - 0 to 8 inches: variable
H2 - 8 to 60 inches: stratified sandy loam to clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 6.00 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: Salt Meadow (R067BY035CO)
Hydric soil rating: Yes

Description of Aquepts, Flooded

Setting

Landform: Stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Recent alluvium

Typical profile

H1 - 0 to 8 inches: variable
H2 - 8 to 60 inches: stratified sandy loam to clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 6.00 in/hr)
Depth to water table: About 6 to 36 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: D
Ecological site: Wet Meadow (R067BY038CO)
Hydric soil rating: Yes

Minor Components

Thedalund

Percent of map unit: 10 percent
Hydric soil rating: No

Haverson

Percent of map unit: 10 percent
Hydric soil rating: No

32—Kim loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 362b
Elevation: 4,900 to 5,250 feet

Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 125 to 150 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Kim and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kim

Setting

Landform: Alluvial fans, plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed eolian deposits derived from sedimentary rock

Typical profile

H1 - 0 to 12 inches: loam
H2 - 12 to 40 inches: loam
H3 - 40 to 60 inches: fine sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Otero

Percent of map unit: 10 percent
Hydric soil rating: No

33—Kim loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 362c
Elevation: 4,900 to 5,250 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 125 to 150 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kim and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kim

Setting

Landform: Alluvial fans, plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed eolian deposits derived from sedimentary rock

Typical profile

H1 - 0 to 12 inches: loam
H2 - 12 to 40 inches: loam
H3 - 40 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Otero

Percent of map unit: 10 percent
Hydric soil rating: No

47—Olney fine sandy loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: 362v
Elevation: 4,600 to 5,200 feet
Mean annual precipitation: 11 to 15 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 125 to 175 days
Farmland classification: Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

Map Unit Composition

Olney and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Olney

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed deposit outwash

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 20 inches: sandy clay loam
H3 - 20 to 25 inches: sandy clay loam
H4 - 25 to 60 inches: fine sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Plains (R067BY024CO)
Hydric soil rating: No

Minor Components

Zigweid

Percent of map unit: 10 percent
Hydric soil rating: No

Vona

Percent of map unit: 5 percent
Hydric soil rating: No

48—Olney fine sandy loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 362w
Elevation: 4,600 to 5,200 feet
Mean annual precipitation: 11 to 15 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 125 to 175 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Olney and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Olney

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed deposit outwash

Typical profile

H1 - 0 to 10 inches: fine sandy loam
H2 - 10 to 20 inches: sandy clay loam
H3 - 20 to 25 inches: sandy clay loam
H4 - 25 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.0 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: Sandy Plains (R067BY024CO)
Hydric soil rating: No

Minor Components

Zigweid
Percent of map unit: 9 percent
Hydric soil rating: No

Vona
Percent of map unit: 6 percent
Hydric soil rating: No

52—Otero sandy loam, 3 to 5 percent slopes

Map Unit Setting
National map unit symbol: 3631
Elevation: 4,700 to 5,250 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 130 to 180 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Otero and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Otero

Setting
Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian deposits and/or mixed outwash

Typical profile
H1 - 0 to 12 inches: sandy loam

H2 - 12 to 60 inches: fine sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.7 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: Sandy Plains (R067BY024CO)
Hydric soil rating: No

Minor Components

Kim

Percent of map unit: 12 percent
Hydric soil rating: No

Vona

Percent of map unit: 3 percent
Hydric soil rating: No

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APPENDIX A-1-3

TABLE 1
SUBBASIN SUMMARY TABLE

North Weld Landfill (Unit 2)
Run-On and Runoff Hydrology
Project Number: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW

Design Storm — 100 -Year Reccurence Interval

Storm Duration (hours)	2-Year Depth (inches)	100 -Year Depth (inches)	Storm Distribution
24	1.76	4.66	II

Subbasin ID	Subbasin Area (ft^2)	Subbasin Area (acres)	Subbasin Area (sq mile)	CN = 85 Fallow Agricultural Lands, B Soils	CN = 84 Landfill Surface	CN = 98 Pond Area (acres)	Composite SCS Curve No.	$S = \frac{1000}{CN} - 10$	Unit Runoff Q (in)	Runoff Volume (ac-ft)	Runoff Volume (ft^3)
D1	1,303,704	29.9	0.0468		29.9		CN = 84	1.90	2.96	7.38	321,689
D2	944,543	21.7	0.0339		21.7		CN = 84	1.90	2.96	5.35	233,066
D3	1,496,125	34.3	0.0537		34.3		CN = 84	1.90	2.96	8.47	369,169
D4	635,291	14.6	0.0228		14.6		CN = 84	1.90	2.96	3.60	156,758
D5	1,128,332	25.9	0.0405		25.9		CN = 84	1.90	2.96	6.39	278,416
D6	14,466	0.3	0.0005		0.3		CN = 84	1.90	2.96	0.08	3,569
D7	13,323	0.3	0.0005		0.3		CN = 84	1.90	2.96	0.08	3,287
D8	6,476	0.1	0.0002		0.1		CN = 84	1.90	2.96	0.04	1,598
D9	663,358	15.2	0.0238		15.2		CN = 84	1.90	2.96	3.76	163,684
D10	599,984	13.8	0.0215		13.8		CN = 84	1.90	2.96	3.40	148,046
D11	196,832	4.5	0.0071		4.5		CN = 84	1.90	2.96	1.11	48,568
D12	381,441	8.8	0.0137		8.8		CN = 84	1.90	2.96	2.16	94,121
D13	315,058	7.2	0.0113		0.3	6.9	CN = 97	0.31	4.31	2.60	113,115
		0.0	0.0000								
R1	836,160	19.2	0.0300	16.3	2.9		CN = 85	1.76	3.06	4.89	212,890
R2	360,374	8.3	0.0129	6.6	1.6		CN = 85	1.76	3.06	2.11	91,753
R3	80,352	1.8	0.0029	0.9	0.9		CN = 84	1.90	2.96	0.46	19,827
R4	779,252	17.9	0.0280	14.5	3.4		CN = 85	1.76	3.06	4.55	198,401
		0.00	0.0000								
Total:	9,755,071	223.95	0.35							56.43	2,457,955

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TABLE 2
BASIN TIME OF CONCENTRATION CALCULATIONS

North Weld Landfill (Unit 2)
Run-On and Runoff Hydrology
Project Number: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW

					Flow Segment 1							Flow Segment 2						
Subbasin ID	Subbasin Area (sq mile)	Composite Curve Number	Total Lag (0.6*Tc) (min)	Total Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[(1)]		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[(1)]		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)
D1	0.0468	84	6.5	10.8	Sheet	289.9	0.048	A	Smooth		2.7	Shallow	434.2	0.044	U	Unpaved		2.1
D2	0.0339	84	8.4	14.0	Sheet	293.5	0.049	A	Smooth		2.7	Shallow	845.3	0.070	U	Unpaved		3.3
D3	0.0537	84	5.1	8.5	Sheet	75.8	0.050	A	Smooth		0.9	Channel	2957.2	0.020	G	Grass-lined	1.12	7.6
D4	0.0228	84	6.3	10.5	Sheet	298.2	0.184	A	Smooth		1.6	Channel	2648.3	0.020	G	Grass-lined	0.75	8.9
D5	0.0405	84	6.7	11.2	Sheet	281.3	0.048	A	Smooth		2.6	Shallow	470.5	0.047	U	Unpaved		2.2
D6	0.0005	84	1.8	3.0	Sheet	127.5	0.055	A	Smooth		1.3	Channel	200.9	0.224	R	Riprap	0.04	1.6
D7	0.0005	84	1.1	1.9	Sheet	26.0	0.058	A	Smooth		0.4	Channel	260.2	0.264	A	ACB	0.03	1.5
D8	0.0002	84	0.8	1.4	Sheet	26.2	0.057	A	Smooth		0.4	Channel	128.8	0.264	A	ACB	0.02	1.0
D9	0.0238	84	7.9	13.2	Sheet	247.6	0.048	A	Smooth		2.4	Shallow	218.1	0.231	U	Unpaved		0.5
D10	0.0215	84	8.9	14.9	Sheet	233.5	0.210	A	Smooth		1.3	Channel	3051.7	0.012	G	Grass-lined	0.72	13.6
D11	0.0071	84	4.2	7.0	Sheet	155.0	0.214	A	Smooth		0.9	Channel	920.8	0.012	G	Grass-lined	0.39	6.1
D12	0.0137	84	4.4	7.3	Sheet	129.0	0.068	A	Smooth		1.2	Shallow	292.6	0.195	U	Unpaved		0.7
D13	0.0113	97	4.4	7.4	Sheet	188.2	0.036	A	Smooth		2.2	Shallow	101.4	0.138	U	Unpaved		0.3
R1	0.0300	85	1.4	2.3	Sheet	69.3	0.075	A	Smooth		0.7	Channel	1758.8	0.314	G	Grass-lined	0.72	1.5
R2	0.0129	85	10.1	16.9	Sheet	218.6	0.023	B	Fallow		9.7	Shallow	650.1	0.019	U	Unpaved		4.9
R3	0.0029	84	9.1	15.2	Sheet	190.3	0.011	B	Fallow		11.9	Shallow	237.9	0.043	U	Unpaved		1.2
R4	0.0280	85	17.5	29.2	Sheet	138.0	0.027	B	Fallow		6.3	Shallow	2520.6	0.016	U	Unpaved		20.3

Notes:
(1) Refer to Attachment A for Roughness Condition descriptions and Tc Coeffiecients.

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TABLE 2
BASIN TIME OF CONCENTRATION CALCULATIONS

North Weld Landfill (Unit 2)
Run-On and Runoff Hydrology
Project Number: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW

			Flow Segment 3							Flow Segment 4						
Subbasin ID	Subbasin Area (sq mile)	Composite Curve Number	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[1]		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[1]		Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)
D1	0.0468	84	Channel	2182.6	0.020	G	Grass-lined	1.02	6.0							
D2	0.0339	84	Channel	2577.8	0.020	G	Grass-lined	0.85	8.0							
D3	0.0537	84														
D4	0.0228	84														
D5	0.0405	84	Channel	2197.2	0.020	G	Grass-lined	0.95	6.3							
D6	0.0005	84														
D7	0.0005	84														
D8	0.0002	84														
D9	0.0238	84	Channel	2480.2	0.013	G	Grass-lined	0.76	10.4							
D10	0.0215	84														
D11	0.0071	84														
D12	0.0137	84	Channel	1267.0	0.017	G	Grass-lined	0.59	5.4							
D13	0.0113	97	Shallow	518.5	0.012	U			5.0							
R1	0.0300	85														
R2	0.0129	85	Channel	500.0	0.012	G		0.68	2.3							
R3	0.0029	84	Channel	300.6	0.012	G		0.35	2.2							
R4	0.0280	85	Channel	788.0	0.022	G		0.75	2.5							

Notes:
(1) Refer to Attachment A for Roughness Condition descriptions and Tc Coeffiecients.

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TABLE 3
FLOW RESULTS FROM HEC-HMS

North Weld Landfill (Unit 2)
Run-On and Runoff Hydrology
Project Number: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW

HEC-HMS Basin Model:	Run-On and Runoff
HEC-HMS Met. Model:	100-yr, 24-hr
HEC-HMS Control Specs:	24 hour, 1 min

Hydrologic Element	Drainage Area (sq mile)	Peak Discharge (cfs)	Time of Peak	Total Volume (ac-ft)
D1	0.047	126.6	02Jan2050, 00:00	7.3761
D10	0.022	52.7	02Jan2050, 00:02	3.3858
D11	0.007	21	01Jan2050, 23:57	1.1199
D12	0.014	40.2	01Jan2050, 23:58	2.1607
D13	0.011	42.9	01Jan2050, 23:57	2.594
D2	0.034	84.8	02Jan2050, 00:02	5.3395
D3	0.054	153.3	01Jan2050, 23:58	8.4675
D4	0.023	62.1	02Jan2050, 00:00	3.5937
D5	0.041	108.7	02Jan2050, 00:00	6.3827
D6	0.001	1.5	01Jan2050, 23:57	0.0789
D7	0.001	1.5	01Jan2050, 23:57	0.0789
D8	0.000	0.6	01Jan2050, 23:57	0.0316
D9	0.024	60.8	02Jan2050, 00:01	3.7493
Junction-Downchute1	0.088	236.5	02Jan2050, 00:00	13.8377
Junction-Downchute2	0.199	525.6	02Jan2050, 00:01	31.2589
Junction-D10	0.045	99.6	02Jan2050, 00:07	7.0791
Junction-D11	0.265	645.7	02Jan2050, 00:03	41.5751
Junction-D4	0.077	208.7	02Jan2050, 00:02	12.0052
Junction-R1-R2	0.043	119.4	01Jan2050, 23:59	6.9688
Junction-R2-R3	0.046	125.8	02Jan2050, 00:00	7.4192
Junction-R4	0.074	165.8	02Jan2050, 00:03	11.9373
Junction-Stilling Basin	0.244	604.1	02Jan2050, 00:02	38.3672
Reach-D10 Perimeter Channel	0.024	60	02Jan2050, 00:09	3.6933
Reach-D11 Perimeter Channel	0.244	603.1	02Jan2050, 00:03	38.2945
Reach-D11-D12-to-Basin	0.265	645.7	02Jan2050, 00:03	41.5454
Reach-D4 Bench Channel	0.054	152	02Jan2050, 00:03	8.4115
Reach-D6-D7	0.088	236.2	02Jan2050, 00:00	13.8353
Reach-D7-D8	0.199	525	02Jan2050, 00:01	31.2566
Reach-R1-R2	0.030	92.9	01Jan2050, 23:58	4.8733
Reach-R2-R3	0.043	119.1	02Jan2050, 00:00	6.9625
Reach-R3-R4	0.046	125.5	02Jan2050, 00:02	7.4004
R1	0.030	93.4	01Jan2050, 23:57	4.8836
R2	0.013	31	02Jan2050, 00:03	2.0954
R3	0.003	7	02Jan2050, 00:02	0.4567
R4	0.028	50.8	02Jan2050, 00:10	4.5369
Sink-RetBasin	0.276	674.5	02Jan2050, 00:03	44.1394
Sink-Runon	0.074	165.8	02Jan2050, 00:03	11.9373

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TABLE 4
CHANNEL HYDRAULIC CALCULATIONS

North Weld Landfill (Unit 2)
Run-On and Runoff Hydrology
PROJECT NO.: **1538880**

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW

Reach Designation	Q100 from HEC-HMS (cfs)	HEC HMS Element ID for Q	Channel Design Geometry					Channel Roughness Parameters			
			Bed Slope (ft/ft)	Left Side Slope (H:1V)	Right Side Slope (H:1V)	Bottom Width (ft)	Minimum Channel Depth (ft)	Design Channel Lining		Mannings 'n' for Capacity (Depth Calculation)	Mannings 'n' for Stability (Velocity Calculation)
Bench Channel (D1)	126.6	D1	0.020	4.0	3.0	8	3.0	T	Turf Reinf.	0.035	0.030
Bench Channel (D2)	84.8	D2	0.020	4.0	3.0	8	3.0	T	Turf Reinf.	0.035	0.030
Bench Channel (D3)	153.3	D3	0.020	3.0	4.0	8	3.0	T	Turf Reinf.	0.035	0.030
Bench Channel (D4)	208.7	Junction-D4	0.020	3.0	4.0	8	3.0	T	Turf Reinf.	0.035	0.030
Bench Channel (D5)	108.7	D5	0.020	3.0	4.0	8	3.0	T	Turf Reinf.	0.035	0.030
Downchute (D6)	1.5	D6	0.250	3.0	3.0	20	3.0	A	ACB	0.026	0.026
Downchute (D7)	236.5	Junction-Downchute1	0.262	3.0	3.0	20	3.0	A	ACB	0.026	0.026
Downchute (D8)	525.6	Junction-Downchute2	0.262	3.0	3.0	20	3.0	A	ACB	0.026	0.026
Perimeter Channel (D9)	60.8	D9	0.012	3.0	3.0	12	3.0	G	Grass-lined	0.035	0.030
Perimeter Channel (D10)	99.6	Junction-D10	0.012	3.0	3.0	12	3.0	G	Grass-lined	0.035	0.030
Perimeter Channel (D11)	645.7	Junction-D11	0.012	3.0	3.0	18	4.0	T	Turf Reinf.	0.035	0.030
Perimeter Channel (D12)	40.2	D12	0.017	3.0	3.0	12	3.1	G	Grass-lined	0.035	0.030
Perimeter Channel (D13)	645.7	Reach-D11-D12-to-Basin	0.012	3.0	3.0	20	4.0	G	Grass-lined	0.035	0.030
Run-On Channel (R1)	93.4	R1	0.013	3.0	3.0	5	3.1	T	Turf Reinf.	0.035	0.030
Run-On Channel (R2)	119.4	Junction-R1-R2	0.012	3.0	3.0	5	3.1	T	Turf Reinf.	0.035	0.030
Run-On Channel (R3)	125.8	Junction-R2-R3	0.012	3.0	3.0	5	3.1	T	Turf Reinf.	0.035	0.030
Run-On Channel (R4)	165.8	Junction-R4	0.022	3.0	3.0	5	3.1	T	Turf Reinf.	0.035	0.030
Run-On Channel Dissipator	165.8	Junction-R4	0.010	3.0	3.0	50	3.1	R	Riprap	0.040	0.035
Low Water Crossing	645.7	Junction-D11	0.020	10.0	10.0	80	2.0	A	ACB	0.026	0.026

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TABLE 4
CHANNEL HYDRAULIC CALCULATIONS

North Weld Landfill (Unit 2)
Run-On and Runoff Hydrology
PROJECT NO.: **1538880**

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW

Reach Designation	Q100 from HEC-HMS (cfs)	Hydraulic Calculations							Channel Evaluations	
		Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)	Froude Number	Normal Depth Shear Stress (lb/ft^2)	Stream Power (W/m^2)	Top Width of Flow (ft)	Top Width of Channel (ft)	Available Freeboard (ft)	
Bench Channel (D1)	126.6	7.0	1.5	1.22	1.90	192.27	18.6	29.0	1.5	
Bench Channel (D2)	84.8	6.2	1.2	1.19	1.54	139.08	16.6	29.0	1.8	
Bench Channel (D3)	153.3	7.4	1.7	1.24	2.09	223.77	19.7	29.0	1.3	
Bench Channel (D4)	208.7	8.0	2.0	1.26	2.44	284.67	21.7	29.0	1.0	
Bench Channel (D5)	108.7	6.7	1.4	1.21	1.75	170.16	17.8	29.0	1.6	
Downchute (D6)	1.5	2.6	0.03	2.78	0.44	16.9	20.2	38.0	3.0	
Downchute (D7)	236.5	19.1	0.6	4.62	9.33	2583.2	23.4	38.0	2.4	< 1/2 Vel. Head
Downchute (D8)	525.6	25.4	0.9	4.96	14.90	5482.9	25.5	38.0	2.1	< 1/2 Vel. Head
Perimeter Channel (D9)	60.8	4.5	1.0	0.91	0.75	49.8	17.9	30.0	2.0	
Perimeter Channel (D10)	99.6	5.3	1.3	0.95	1.00	77.5	19.8	30.0	1.7	
Perimeter Channel (D11)	645.7	8.9	3.0	1.08	2.32	299.5	36.0	42.0	1.0	
Perimeter Channel (D12)	40.2	4.4	0.7	1.03	0.76	48.7	16.3	30.6	2.4	
Perimeter Channel (D13)	645.7	8.7	2.9	1.07	2.16	272.6	37.3	44.0	1.1	
Run-On Channel (R1)	93.4	5.9	1.7	1.00	1.44	123.3	15.4	23.6	1.4	
Run-On Channel (R2)	119.4	6.1	2.0	0.97	1.50	131.9	17.0	23.6	1.1	
Run-On Channel (R3)	125.8	6.1	2.1	0.97	1.54	137.1	17.3	23.6	1.0	
Run-On Channel (R4)	165.8	8.3	2.0	1.31	2.79	333.6	17.2	23.6	1.1	
Run-On Channel Dissipator	165.8	3.7	0.9	0.72	0.58	30.9	55.5	68.6	2.2	
Low Water Crossing	645.7	7.4	1.0	1.40	1.21	130.3	99.4	120.0	1.0	

(1) Note: Comments and Warnings:
< 1.0 ft indicates freeboard is less than 1 foot.
< 1/2 Vel. Head indicates that the remaining freeboard is less than 1/2 the velocity head ($V^2/2g$) suggesting water may splash out.
Warning: VxD>9 indicates that the velocity times the depth is greater than 9 ft^2/sec, which is undesirable and may be ur
Unstable V indicates that calculated velocity exceeds the recommended maximum for the lining material.
Unstable T indicates that calculated shear stress exceeds the recommended maximum for the lining material.

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Attachment A
Time of Concentration and Mannings Flow Coefficients

TR-55 (1986)

Sheet Flow Travel time (SCS Upland Method)

$$T_t = \frac{0.007\ (n'\ L)^{0.8}}{(P_2)^{0.5}\ S^{0.4}}$$

Where: T_t = travel time (hr); n' = roughness coefficient; L = flow length (ft);
P_2 = 2-yr storm depth (inches); s = slope (ft/ft)
flow velocity = $L/(60T_t)$

Flow Type	Surface Type	roughness n	Surface Description	Short Description
Sheet/Overland Flow	A	0.011	Smooth surfaces (concrete, asphalt, gravel, bare soil)	Smooth
	B	0.05	Fallow (no residue)	Fallow
	C	0.06	Cultivated soils: Residue cover <= 20%	Cover<20%
	D	0.17	Cultivated soils: Residue cover > 20%	Cover>20%
	E	0.15	Grass: Short grass prairie	Short Grass
	F	0.24	Grass: Dense grasses	Dense Grass
	G	0.41	Grass: Bermuda grass	Bermuda Grass
	H	0.13	Range (natural)	Range
	I	0.40	Woods: Light underbrush	Light woods
	J	0.80	Woods: Heavy underbrush	Heavy Woods

Shallow Concentrated Flow Velocity (SCS Upland Method)

$v = mS^{0.5}$

Where: v = velocity (fps); m = roughness coeffient; S = slope (ft/ft)

Flow Type	Surface Type	Roughness m	Surface Description	Short Description
Shallow Conc. Flow	P	20.3282	Paved Surfaces	Paved
	U	16.1345	Unpaved Surfaces	Unpaved

Channel Flow Velocity (Mannings Velocity)

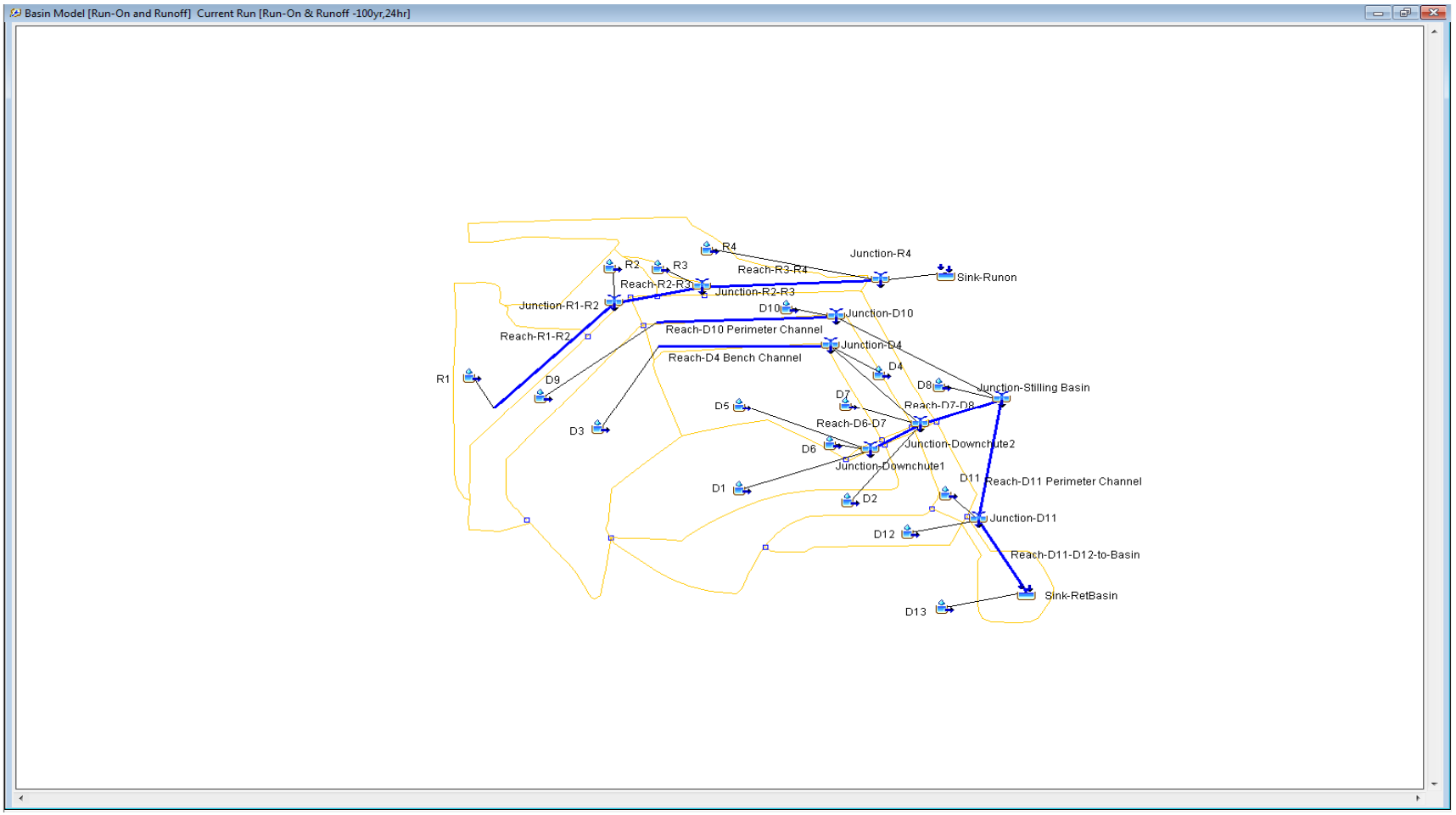
$v = 1.49/n\ Rh^{2/3}S^{1/2}$

Where: v = velocity (fps); n = roughness coeffient; Rh = Hydraulic Radius (ft), S = slope (ft/ft)

Lining Type	Mannings n for Depth	Mannings n for Velocity	Material	Maximum Velocity	Maximum Shear Stress
A	0.026	0.026	ACB	25	
C	0.024	0.022	CSP	50	
E	0.025	0.022	Earth-lined	3	
G	0.035	0.030	Grass-lined	5	
I	0.017	0.013	Ductile Iron	50	
P	0.012	0.009	Plastic	25	
R	0.040	0.035	Riprap	16	
T	0.035	0.030	Turf Reinf.	10	1.5
Z	0.060	0.005	Other	25	

Attachment B
HEC-HMS Screen Captures and Inputs

HEC-HMS Basin Model Schematic



Attachment B
HEC-HMS Screen Captures and Inputs

Sub Basin Area	
Subbasin	Area (mi^2)
D1	0.046800
D10	0.021500
D11	0.007100
D12	0.013700
D13	0.011300
D2	0.033900
D3	0.053700
D4	0.022800
D5	0.040500
D6	0.000500
D7	0.000500
D8	0.000200
D9	0.023800
R1	0.030000
R2	0.012900
R3	0.002900
R4	0.028000

Loss SCS Curve Number			
Subbasin	Initial Abstraction (in)	Curve Number	Impervious (%)
D1		84	0
D10		84	0
D11		84	0
D12		84	0
D13		97	0
D2		84	0
D3		84	0
D4		84	0
D5		84	0
D6		84	0
D7		84	0
D8		84	0
D9		84	0
R1		85	0
R2		85	0
R3		84	0
R4		85	0

Transform SCS Unit Hydrograph		
Subbasin	Graph Type	Lag Time (min)
D1	Standard	7
D10	Standard	9
D11	Standard	4
D12	Standard	4
D13	Standard	4
D2	Standard	8
D3	Standard	5
D4	Standard	6
D5	Standard	7
D6	Standard	4
D7	Standard	4
D8	Standard	4
D9	Standard	8
R1	Standard	4
R2	Standard	10
R3	Standard	9
R4	Standard	18

Routing Kinematic Wave Channel									
Reach	Length (ft)	Slope (ft/ft)	Manning's n	Subreaches	Invert	Shape	Diameter (ft)	Width (ft)	Side Slope (xH:1V)
Reach-D10 Perimeter Channel	3065	0.012	0.03	2		Trapezoid		12	3
Reach-D11 Perimeter Channel	940	0.012	0.03	2		Trapezoid		18	3
Reach-D11-D12-to-Basin	740	0.028	0.03	2		Triangle			3
Reach-D4 Bench Channel	2680	0.020	0.03	2		Trapezoid		8	3.5
Reach-D6-D7	270	0.250	0.026	2		Trapezoid		20	3
Reach-D7-D8	150	0.262	0.026	2		Trapezoid		20	3
Reach-R1-R2	755	0.013	0.03	2		Trapezoid		5	3
Reach-R2-R3	375	0.012	0.03	2		Trapezoid		5	3
Reach-R3-R4	1300	0.022	0.03	2		Trapezoid		5	3

Attachment B
HEC-HMS Screen Captures and Inputs

Global Summary Results for Run "Run-On & Runoff -100yr,24hr"

Project: NWLF Simulation Run: Run-On & Runoff -100yr,24hr

Start of Run: 01Jan2050, 12:00 Basin Model: Run-On and Runoff
End of Run: 02Jan2050, 12:01 Meteorologic Model: 100-yr, 24-hr
Compute Time: 15Dec2016, 10:41:08 Control Specifications: 24hr, 1min

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D1	0.0468	126.6	02Jan2050, 00:00	7.3761
D10	0.0215	52.7	02Jan2050, 00:02	3.3858
D11	0.0071	21.0	01Jan2050, 23:57	1.1199
D12	0.0137	40.2	01Jan2050, 23:58	2.1607
D13	0.0113	42.9	01Jan2050, 23:57	2.5940
D2	0.0339	84.8	02Jan2050, 00:02	5.3395
D3	0.0537	153.3	01Jan2050, 23:58	8.4675
D4	0.0228	62.1	02Jan2050, 00:00	3.5937
D5	0.0405	108.7	02Jan2050, 00:00	6.3827
D6	0.0005	1.5	01Jan2050, 23:57	0.0789
D7	0.0005	1.5	01Jan2050, 23:57	0.0789
D8	0.0002	0.6	01Jan2050, 23:57	0.0316
D9	0.0238	60.8	02Jan2050, 00:01	3.7493
Junction-Downchute1	0.0878	236.5	02Jan2050, 00:00	13.8377
Junction-Downchute2	0.1987	525.6	02Jan2050, 00:01	31.2589
Junction-D10	0.0453	99.6	02Jan2050, 00:07	7.0791
Junction-D11	0.2650	645.7	02Jan2050, 00:03	41.5751
Junction-D4	0.0765	208.7	02Jan2050, 00:02	12.0052
Junction-R1-R2	0.0429	119.4	01Jan2050, 23:59	6.9688
Junction-R2-R3	0.0458	125.8	02Jan2050, 00:00	7.4192
Junction-R4	0.0738	165.8	02Jan2050, 00:03	11.9373
Junction-Stilling Basin	0.2442	604.1	02Jan2050, 00:02	38.3672
Reach-D10 Perimeter Channel	0.0238	60.0	02Jan2050, 00:09	3.6933
Reach-D11 Perimeter Channel	0.2442	603.1	02Jan2050, 00:03	38.2945
Reach-D11-D12-to-Basin	0.2650	645.7	02Jan2050, 00:03	41.5454
Reach-D4 Bench Channel	0.0537	152.0	02Jan2050, 00:03	8.4115
Reach-D6-D7	0.0878	236.2	02Jan2050, 00:00	13.8353
Reach-D7-D8	0.1987	525.0	02Jan2050, 00:01	31.2566
Reach-R1-R2	0.0300	92.9	01Jan2050, 23:58	4.8733
Reach-R2-R3	0.0429	119.1	02Jan2050, 00:00	6.9625
Reach-R3-R4	0.0458	125.5	02Jan2050, 00:02	7.4004
R1	0.0300	93.4	01Jan2050, 23:57	4.8836
R2	0.0129	31.0	02Jan2050, 00:03	2.0954
R3	0.0029	7.0	02Jan2050, 00:02	0.4567
R4	0.0280	50.8	02Jan2050, 00:10	4.5369
Sink-RetBasin	0.2763	674.5	02Jan2050, 00:03	44.1394
Sink-Runon	0.0738	165.8	02Jan2050, 00:03	11.9373

Global Summary Results for Run "Run-On & Runoff -100yr,1hr"

Project: NWLF Simulation Run: Run-On & Runoff -100yr,1hr

Start of Run: 01Jan2050, 12:00 Basin Model: Run-On and Runoff
End of Run: 02Jan2050, 12:01 Meteorologic Model: 100-yr, 1-hr
Compute Time: 15Dec2016, 10:41:07 Control Specifications: 24hr, 1min

Show Elements: All Elements Volume Units: IN AC-FT Sorting: Alphabetic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D1	0.0468	57.9	02Jan2050, 00:00	3.3301
D10	0.0215	23.9	02Jan2050, 00:03	1.5284
D11	0.0071	9.7	01Jan2050, 23:58	0.5057
D12	0.0137	18.5	01Jan2050, 23:58	0.9757
D13	0.0113	25.0	01Jan2050, 23:57	1.4693
D2	0.0339	38.7	02Jan2050, 00:02	2.4104
D3	0.0537	70.4	01Jan2050, 23:59	3.8232
D4	0.0228	28.4	02Jan2050, 00:00	1.6225
D5	0.0405	49.6	02Jan2050, 00:00	2.8816
D6	0.0005	0.7	01Jan2050, 23:57	0.0356
D7	0.0005	0.7	01Jan2050, 23:57	0.0356
D8	0.0002	0.3	01Jan2050, 23:57	0.0142
D9	0.0238	27.7	02Jan2050, 00:02	1.6926
Junction-Downchute1	0.0878	108.1	02Jan2050, 00:00	6.2474
Junction-Downchute2	0.1987	236.5	02Jan2050, 00:02	14.0952
Junction-D10	0.0453	41.3	02Jan2050, 00:10	3.1836
Junction-D11	0.2650	282.1	02Jan2050, 00:04	18.7245
Junction-D4	0.0765	93.9	02Jan2050, 00:03	5.4037
Junction-R1-R2	0.0429	56.2	02Jan2050, 00:00	3.2027
Junction-R2-R3	0.0458	59.1	02Jan2050, 00:01	3.4050
Junction-R4	0.0738	78.1	02Jan2050, 00:04	5.4756
Junction-Stilling Basin	0.2442	264.9	02Jan2050, 00:02	17.2914
Reach-D10 Perimeter Channel	0.0238	27.6	02Jan2050, 00:12	1.6552
Reach-D11 Perimeter Channel	0.2442	264.6	02Jan2050, 00:04	17.2431
Reach-D11-D12-to-Basin	0.2650	281.4	02Jan2050, 00:04	18.7068
Reach-D4 Bench Channel	0.0537	69.9	02Jan2050, 00:05	3.7812
Reach-D6-D7	0.0878	107.7	02Jan2050, 00:01	6.2455
Reach-D7-D8	0.1987	236.2	02Jan2050, 00:02	14.0936
Reach-R1-R2	0.0300	43.8	01Jan2050, 23:59	2.2394
Reach-R2-R3	0.0429	56.0	02Jan2050, 00:01	3.1989
Reach-R3-R4	0.0458	58.7	02Jan2050, 00:04	3.3908
R1	0.0300	43.9	01Jan2050, 23:57	2.2459
R2	0.0129	14.4	02Jan2050, 00:04	0.9633
R3	0.0029	3.2	02Jan2050, 00:03	0.2061
R4	0.0280	23.3	02Jan2050, 00:10	2.0848
Sink-RetBasin	0.2763	295.9	02Jan2050, 00:04	20.1761
Sink-Runon	0.0738	78.1	02Jan2050, 00:04	5.4756

APPENDIX A-2

Table 1
Channel Geometry and Flow Input

Riprap Channel Evaluation
North Weld Landfill, Unit 2
PROJECT NO.: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW JR

			Channel Design Geometry									Channel Hydraulic Calculations			
Reach Designation	**Design Q**	**HEC HMS Element ID for Q**	**Approximate Channel Length (ft)**	**Bed Slope (ft/ft)**	**Left Side Slope (H:1V)**	**Right Side Slope (H:1V)**	**Bottom Width (ft)**	**Minimum Channel Depth (ft)**	**Channel Curve Radius (ft)**	**Mannings 'n'**	**Riprap Calculation Methodology**	**Normal Flow Depth (ft)**	**Flow Area (sq ft)**	**Flow Width at Median Depth (ft)**	**Average Channel Velocity (ft/sec)**
Downchute (D6)	1.5	D6	200	0.250	3.0	3.0	20	3.0	0.0	0.035	Robinson	0.03	0.7	20.10	2.21
Downchute (D7)	236.5	Junction-Downchute1	275	0.262	3.0	3.0	20	3.0	0.0	0.035	Robinson	0.68	15.0	22.04	15.79
Downchute (D8)	525.6	Junction-Downchute2	150	0.262	3.0	3.0	20	3.0	0.0	0.035	Robinson	1.08	25.2	23.25	20.88
Retention Basin Inlet	645.7	Reach-D11-D12-to-Basin	50	0.250	3.0	3.0	60	3.0	0.0	0.035	Robinson	0.66	40.9	61.98	15.77
Run-On Dissipator	165.8	Junction-R4	180	0.010	3.0	3.0	50	3.0	0.0	0.0350	USACE Mild	0.85	44.8	52.56	3.70

Table 2
Robinson Method Riprap Size Calculation

Riprap Channel Evaluation
North Weld Landfill, Unit 2
PROJECT NO.: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW JR

	Robinson Design of Rock Chutes Riprap Calculations for Steep Riprap (Bed Slopes >2% but <40%)						
Reach Designation	Unit Flow q (1) (cfs/ft)	Design Flow Q (cms)	Unit Width Flow q (cms/m)	Flow Concentration Factor	Calculated Particle Size D_{50} (2) (mm)	Factor of Safety	Riprap Size D_{50} (inches)
Downchute (D6)	0.07	0.042	0.007	1.25	26	1.20	1.2
Downchute (D7)	10.73	6.697	0.997	1.25	369	1.20	17.4
Downchute (D8)	22.61	14.883	2.100	1.25	547	1.20	25.8
Retention Basin Inlet	10.42	18.284	0.968	1.25	358	1.20	16.9

Design of Rock Chutes (ASAE Paper No. 982136 7/98)
Determine unit flow at incipient motion for rock particle size
(1) Unit flow rate is Q/ median width, adjusted by a flow concentration factor
1.25 Flow Concentration Factor (1.25 from USACE steep riprap method)
(2) Bed Slope < 10%, $q = 9.76e\text{-}7\ D_{50}^{1.89}\ S^{-1.50}$
10%<= Bed Slope <= 40%, $q = 8.07e\text{-}6\ D_{50}^{1.89}\ S^{-0.58}$
1.2 Factor of Safety over incipient motion

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Table 3
U.S. Army Corps of Engineers (Mild) Method Riprap Size Calculation

Riprap Channel Evaluation
North Weld Landfill, Unit 2
PROJECT NO.: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW 12

Reach Designation	USACE Method Riprap Calculations for Mild Riprap (Bed Slopes <2%)						
	Design Flow Q (cfs)	Normal Flow Depth d (ft)	Depth Averaged Velocity V (ft/s)	Velocity Distribution Coefficient C_V	Channel Side Slopes Correction K_1	Calculated Particle Size D_{30} (ft)	Riprap Size D_{50} (in)
Run-On Dissipator	165.8	0.85	3.70	1.00	0.97	0.06	0.9

USACE Paper EM 1110-2-1601, 6/30/94

$$D_{30} = S_f C_s C_V C_T d \left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w} \right) \frac{V}{\sqrt{K_1 g d}} \right]^{2.5}$$

Inputs below as determined in EM 1110-2-1601, 6/30/94

1.1	S_f: Minimum safety factor of 1.1 for moderate debris impact
0.3	C_s: Value of 0.30 for angular rock
165	γ_s: Density of solids (pcf)
2.2	Cg: Gradation Coefficient (D_{85}/D_{15})
2.0	T: Riprap Thickness (x D_{50})
0.910	C_T: Correction for thickness > 1.5 * D_{50}

Note: A C_V of 1.25 should be used downstream of concrete channels due to the difference in velocity profiles

Riprap D50 determined as recommended in EM 1110-2-1601, 6/30/94

$$D_{50} = D_{30} \left(\frac{D_{85}}{D_{15}} \right)^{1/3}$$

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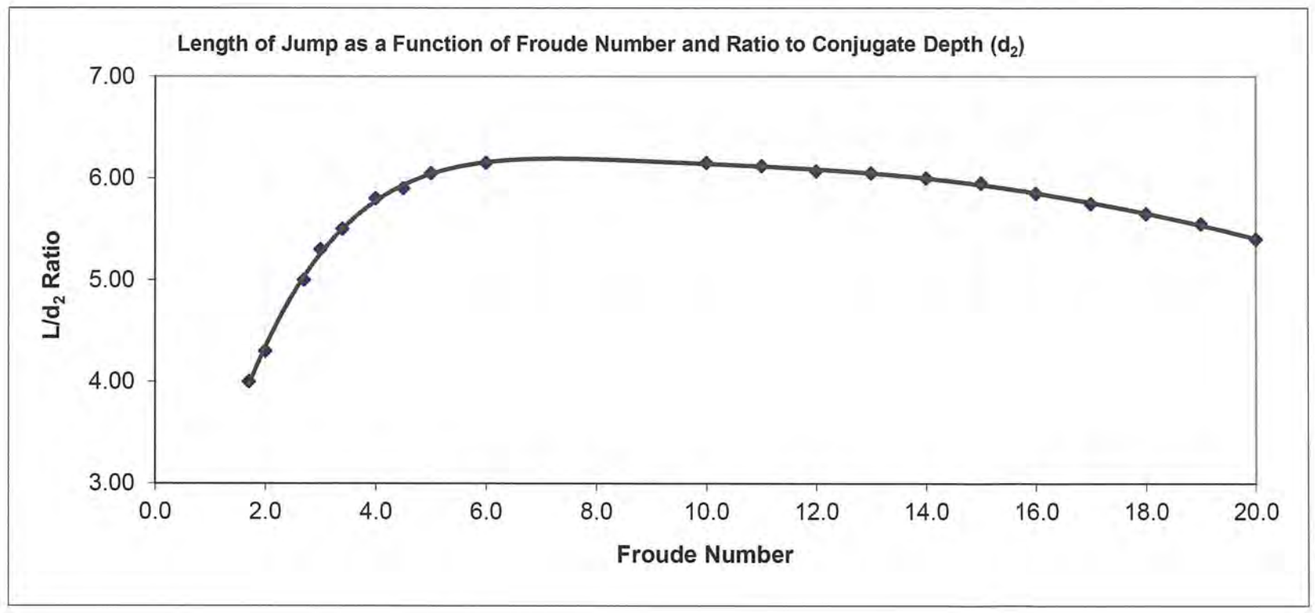
HYDRAULIC JUMP CALCULATIONS

North Welld Landfill (Unit 2)
Hydraulic Jump Calculation
PROJECT NO.: 1538880

Date:	12/19/16
By:	SPS
Chkd:	DMW
Apprvd:	JAR

SPS DMW JR

Reach Designation	Design Flow (cfs)	Channel Configuration							Hydraulic Calculations						
		Bed Slope	Left Side Slope (H:1V)	Right Side Slope (H:1V)	Bottom Width (ft)	Maximum Channel Depth (ft)	Mannings 'n' for Capacity (Depth Calculation)	Mannings 'n' for Stability (Velocity Calculation)	Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)	Normal Depth with Velocity 'n' (ft)	Froude Number	Conjugate Depth (ft)	L/d2 Ratio	Minimum Length of Jump (ft)
Downchute Toe (Basi	525.6	25.0%	3.0	3.0	20	3.0	0.026	0.026	25.0	0.92	0.92	4.85	5.54	6.01	33.31
Retention Basin Inlet	645.7	25.0%	3.0	3.0	50	4.0	0.035	0.035	16.8	0.74	0.74	3.53	3.25	5.57	18.07



$$d_2 = -\frac{d_1}{2} + \sqrt{\frac{2V_1^2 d_1}{g} + \frac{d_1^2}{4}}$$

Where:

d1 = Depth before the jump
V1 = Velocity before the jump
d2 = Depth after the jump,
g = Acceleration of gravity

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In non-cohesive soil channels and channels where future degradation is expected, especially where there is no drop structure immediately downstream, it is generally recommended that the stilling basin be eliminated and the sloping face extended five feet below the downstream future channel invert elevation (after accounting for future streambed degradation). A scour hole will form naturally downstream of a structure in non-cohesive soils and construction of a hard basin is an unnecessary cost. Additionally, a hard basin would be at risk for undermining. This configuration is shown in the profiles for GSB (Figure 9-12) and SC (Figure 9-17) drop structures. In some cases, the structure may have a net drop height of zero immediately after construction, but is designed with a long term net height of 3 to 5-feet to accommodate future lowering of the channel invert.

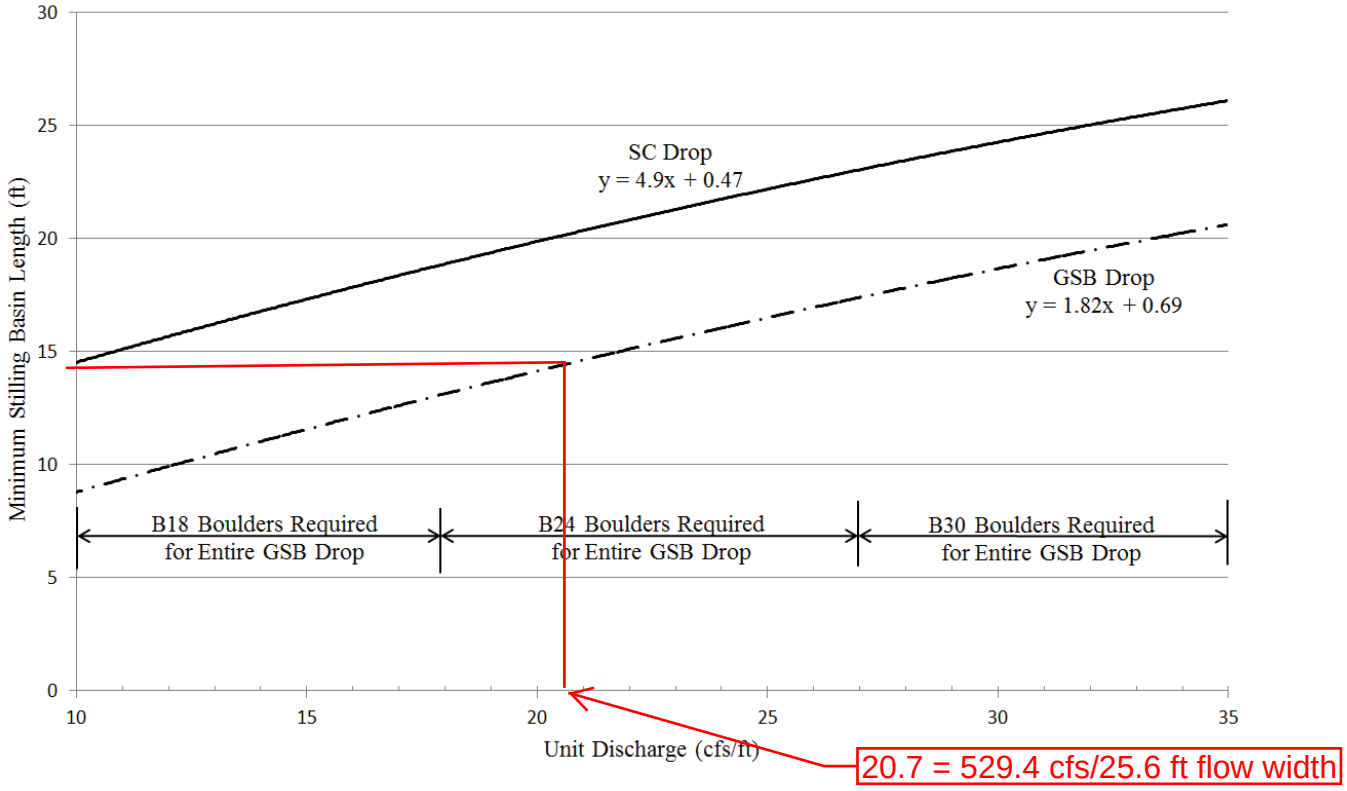


Figure 9-1. Stilling basin length based on unit discharge (for simplified design procedure)

2.2.6 Seepage Analysis and Cutoff Wall Design

The simplified drop structure design only applies to drops with cutoffs located in cohesive soils. Therefore, it is necessary to determine surface and subsurface soil conditions in the vicinity of a proposed drop structure prior to being able to use the simplified approach for cutoff design. For a drop structure constructed in cohesive soils meeting all requirements of a simplified design, the cutoff wall must be a minimum of six feet deep for concrete and ten feet deep for sheet pile.

If a proposed drop structure meets the requirements of the simplified approach, but is located in non-cohesive soils, guidance on determining the required cutoff wall depth is described in Section 2.4.

APPENDIX A-3

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 30 cfs

Maximum Flow: 55 cfs

Table 1 - Summary of Culvert Flows at Crossing: Access Rd - Perimeter Channel

Headwater Elevation (ft)	Total Discharge (cfs)	36" RCP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
100.00	0.00	0.00	0.00	1
100.98	5.50	5.50	0.00	1
101.42	11.00	11.00	0.00	1
101.81	16.50	16.50	0.00	1
102.14	22.00	22.00	0.00	1
102.43	27.50	27.50	0.00	1
102.56	30.00	30.00	0.00	1
102.99	38.50	38.50	0.00	1
103.28	44.00	44.00	0.00	1
103.61	49.50	49.50	0.00	1
103.96	55.00	55.00	0.00	1
104.00	55.53	55.53	0.00	Overtopping

Rating Curve Plot for Crossing: Access Rd - Perimeter Channel Crossing

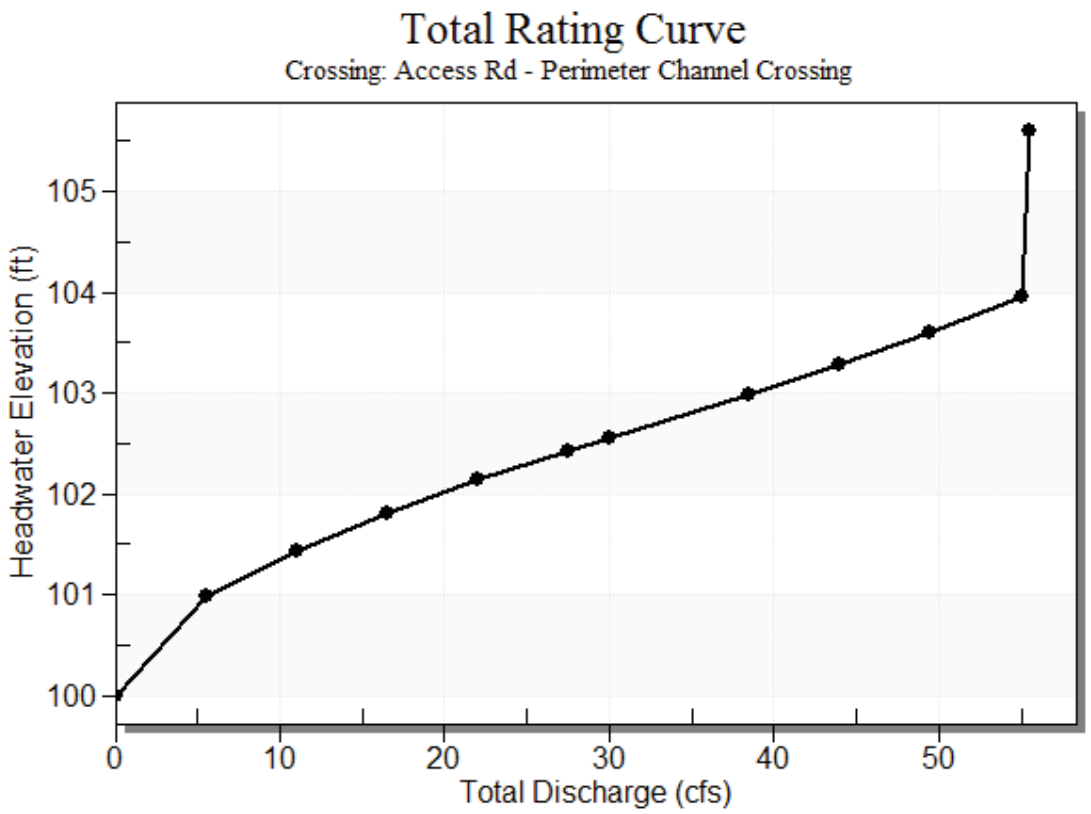


Table 2 - Culvert Summary Table: 36" RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	100.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
5.50	5.50	100.98	0.983	0.146	1-S2n	0.495	0.732	0.527	0.501	6.544	2.742
11.00	11.00	101.42	1.423	0.503	1-S2n	0.702	1.049	0.767	0.732	7.679	3.366
16.50	16.50	101.81	1.807	0.818	1-S2n	0.872	1.296	0.962	0.907	8.404	3.776
22.00	22.00	102.14	2.137	1.125	1-S2n	1.013	1.508	1.134	1.053	9.005	4.090
27.50	27.50	102.43	2.430	1.432	1-S2n	1.144	1.692	1.291	1.180	9.447	4.347
30.00	30.00	102.56	2.556	1.574	1-S2n	1.198	1.769	1.360	1.233	9.632	4.450
38.50	38.50	102.99	2.986	2.080	1-S2n	1.382	2.014	1.576	1.397	10.236	4.758
44.00	44.00	103.28	3.283	2.428	5-S2n	1.492	2.158	1.706	1.492	10.608	4.929
49.50	49.50	103.61	3.606	3.144	5-S2n	1.602	2.287	1.832	1.580	10.952	5.085
55.00	55.00	103.96	3.963	3.461	5-S2n	1.711	2.404	1.953	1.663	11.283	5.228

****

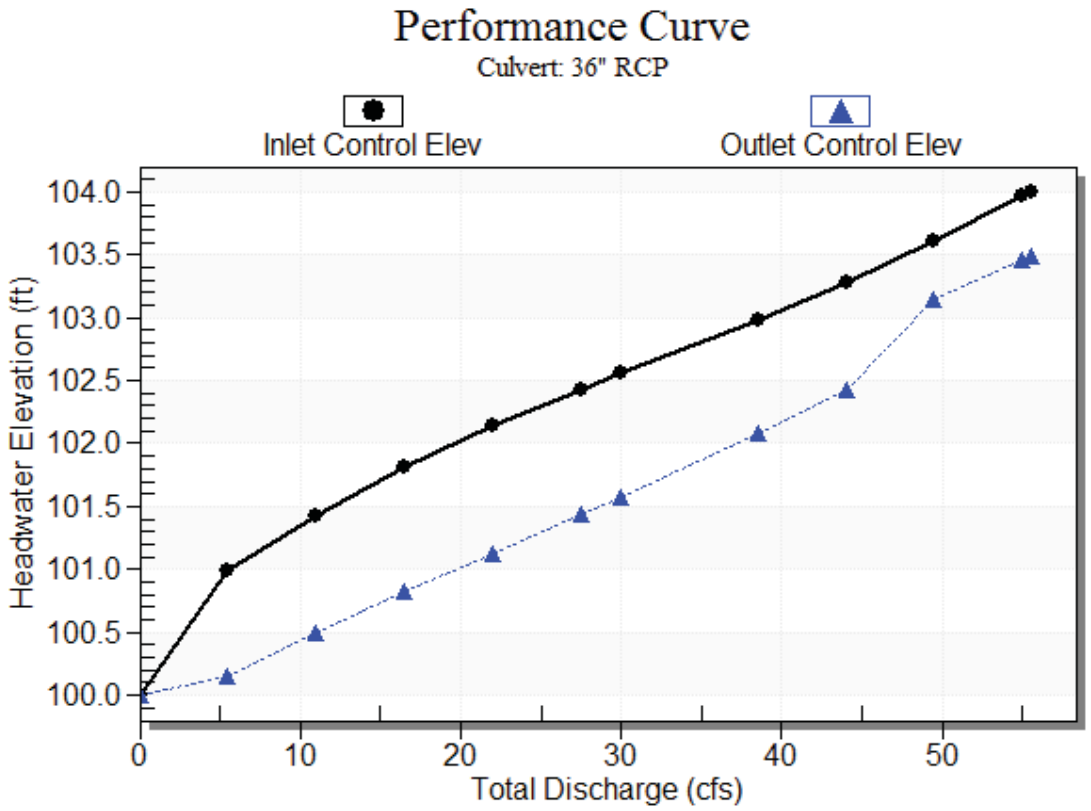
Straight Culvert

Inlet Elevation (invert): 100.00 ft, Outlet Elevation (invert): 99.40 ft

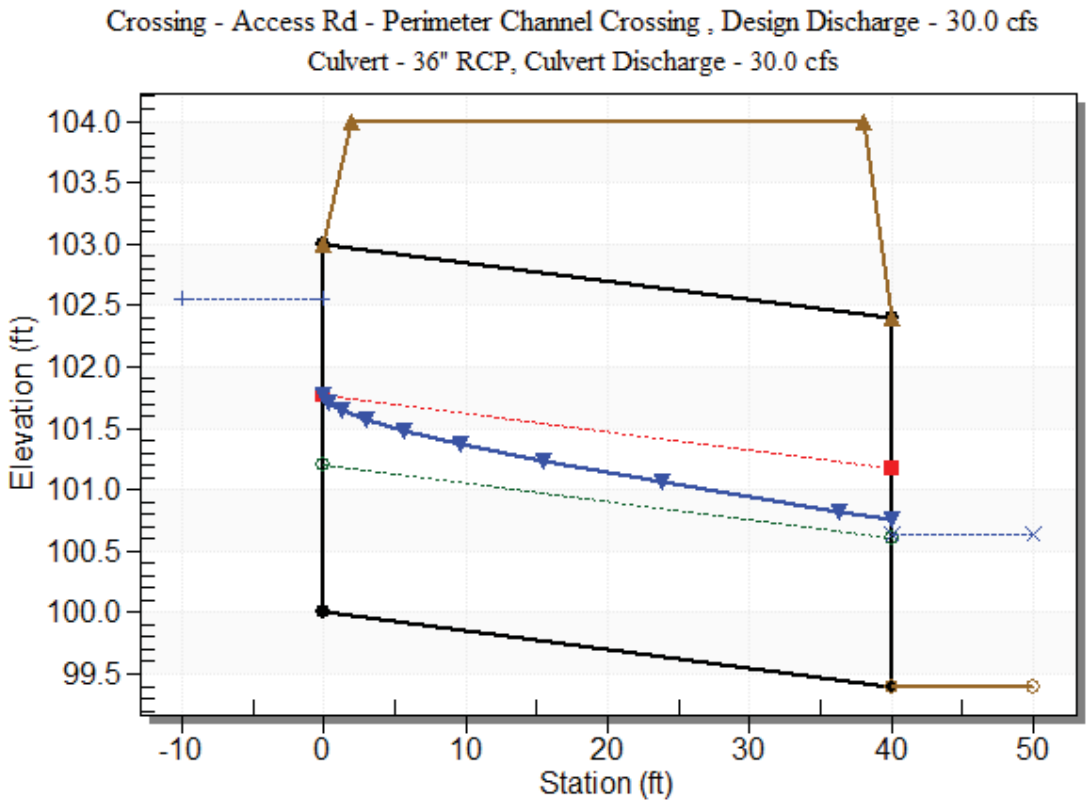
Culvert Length: 40.00 ft, Culvert Slope: 0.0150

****

Culvert Performance Curve Plot: 36" RCP



Water Surface Profile Plot for Culvert: 36" RCP



Culvert Data Summary - 36" RCP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Grooved End Projecting

Inlet Depression: NONE

Roadway Data for Crossing: Access Rd - Perimeter Channel Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 15.00 ft

Crest Elevation: 104.00 ft

Roadway Surface: Gravel

Roadway Top Width: 36.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 5 cfs

Maximum Flow: 11 cfs

Table 1 - Summary of Culvert Flows at Crossing: Access Rd - Bench Channel

Headwater Elevation (ft)	Total Discharge (cfs)	18" HDPE Discharge (cfs)	Roadway Discharge (cfs)	Iterations
100.00	0.00	0.00	0.00	1
100.56	1.10	1.10	0.00	1
100.82	2.20	2.20	0.00	1
101.05	3.30	3.30	0.00	1
101.26	4.40	4.40	0.00	1
101.38	5.00	5.00	0.00	1
101.71	6.60	6.60	0.00	1
101.98	7.70	7.70	0.00	1
102.28	8.80	8.80	0.00	1
102.62	9.90	9.90	0.00	1
103.00	11.00	10.97	0.00	36
103.00	10.97	10.97	0.00	Overtopping

Rating Curve Plot for Crossing: Access Rd - Bench Channel Crossing

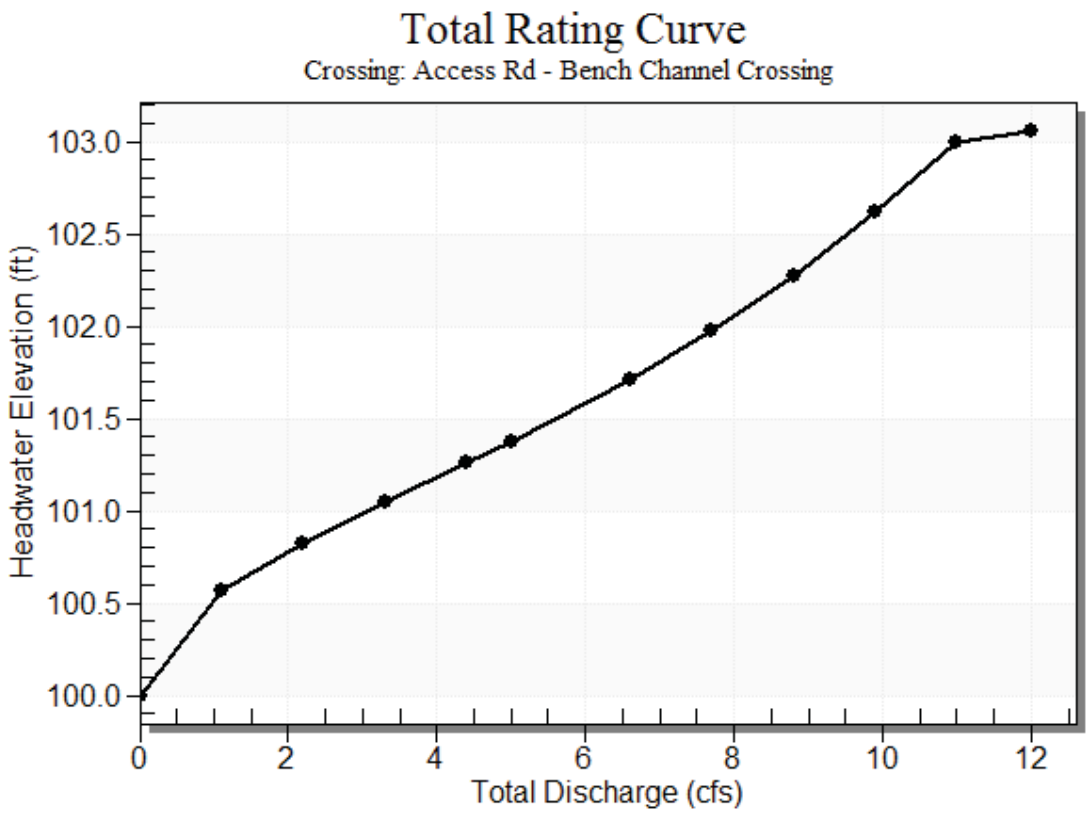


Table 2 - Culvert Summary Table: 18" HDPE

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	100.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
1.10	1.10	100.56	0.564	0.0*	1-S2n	0.232	0.388	0.232	0.282	6.188	1.978
2.20	2.20	100.82	0.821	0.0*	1-S2n	0.332	0.555	0.347	0.366	7.045	2.352
3.30	3.30	101.05	1.046	0.0*	1-S2n	0.414	0.692	0.431	0.426	7.887	2.603
4.40	4.40	101.26	1.260	0.0*	1-S2n	0.478	0.803	0.507	0.474	8.358	2.797
5.00	5.00	101.38	1.378	0.0*	1-S2n	0.512	0.856	0.544	0.497	8.643	2.888
6.60	6.60	101.71	1.713	0.337	5-S2n	0.595	0.991	0.641	0.552	9.145	3.096
7.70	7.70	101.98	1.976	0.614	5-S2n	0.649	1.071	0.703	0.585	9.475	3.218
8.80	8.80	102.28	2.276	1.091	5-S2n	0.701	1.144	0.763	0.615	9.745	3.327
9.90	9.90	102.62	2.618	1.383	5-S2n	0.750	1.212	0.821	0.642	10.000	3.426
11.00	10.97	103.00	2.996	1.690	5-S2n	0.798	1.268	0.876	0.668	10.245	3.518

* Full Flow Headwater elevation is below inlet invert.

****

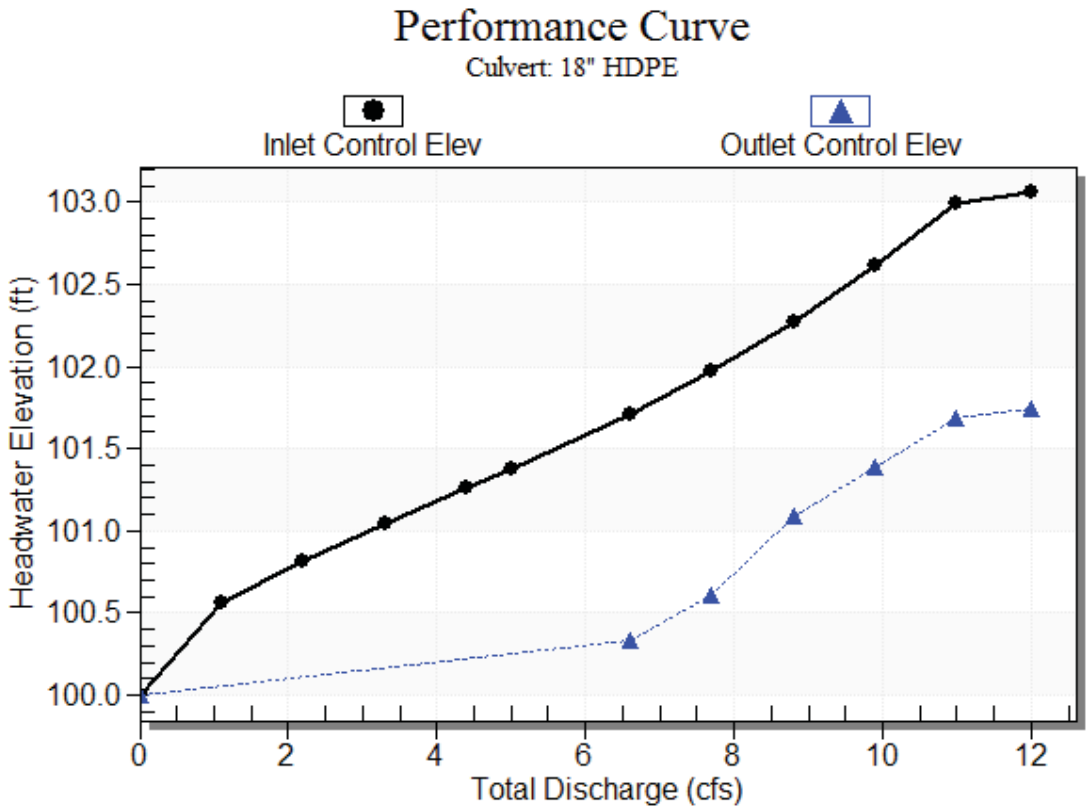
Straight Culvert

Inlet Elevation (invert): 100.00 ft, Outlet Elevation (invert): 98.80 ft

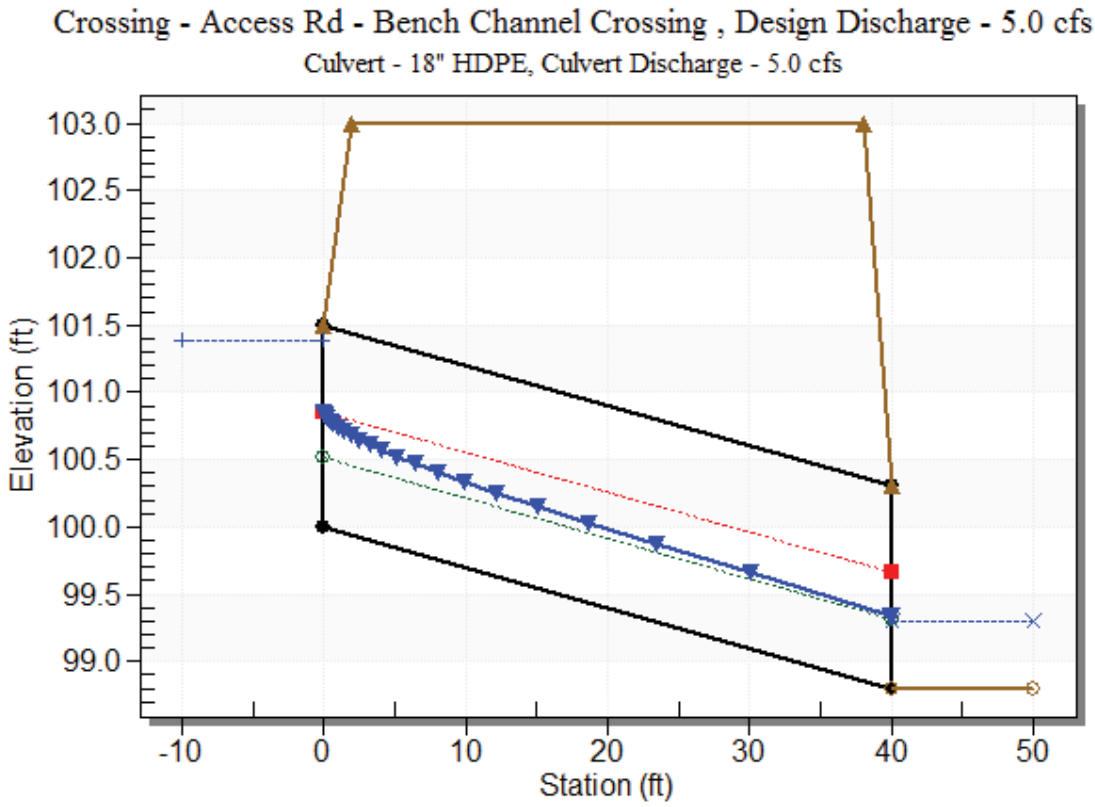
Culvert Length: 40.02 ft, Culvert Slope: 0.0300

****

Culvert Performance Curve Plot: 18" HDPE



Water Surface Profile Plot for Culvert: 18" HDPE



Culvert Data Summary - 18" HDPE

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: NONE

Roadway Data for Crossing: Access Rd - Bench Channel Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 21.00 ft

Crest Elevation: 103.00 ft

Roadway Surface: Gravel

Roadway Top Width: 36.00 ft

Worksheet for Unit 1 Diversion Berm

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.03000	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	10.00	ft/ft (H:V)

Results

Discharge	94.82	ft^3/s
Flow Area	15.75	ft^2
Wetted Perimeter	21.26	ft
Hydraulic Radius	0.74	ft
Top Width	21.00	ft
Critical Depth	1.63	ft
Critical Slope	0.01944	ft/ft
Velocity	6.02	ft/s
Velocity Head	0.56	ft
Specific Energy	2.06	ft
Froude Number	1.23	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.50	ft
Critical Depth	1.63	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.01944	ft/ft

Rating Table for Unit 1 Diversion Berm

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.03000	ft/ft
Normal Depth	1.50	ft
Left Side Slope	10.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)

Normal Depth (ft)	Discharge (ft³/s)	Velocity (ft/s)	Flow Area (ft²)	Wetted Perimeter (ft)	Top Width (ft)
0.50	5.07	2.89	1.75	7.09	7.00
1.00	32.16	4.59	7.00	14.17	14.00
1.50	94.82	6.02	15.75	21.26	21.00

Cross Section for Unit 1 Diversion Berm

Project Description

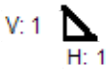
Friction Method	Manning Formula
Solve For	Discharge

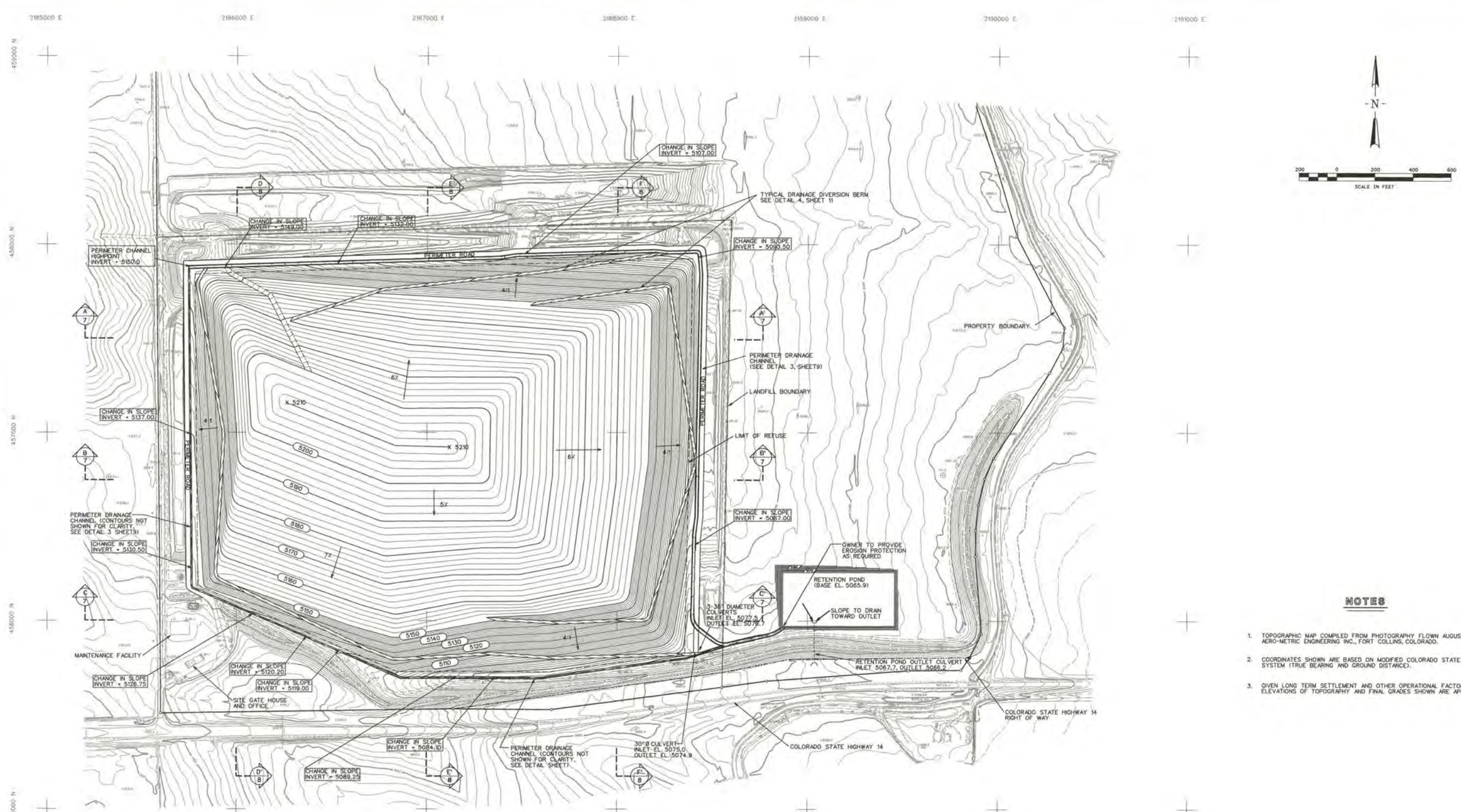
Input Data

Roughness Coefficient	0.035	
Channel Slope	0.03000	ft/ft
Normal Depth	1.50	ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	10.00	ft/ft (H:V)
Discharge	94.82	ft³/s

Cross Section Image







NOTES

1. TOPOGRAPHIC MAP COMPILED FROM PHOTOGRAPHY FLOWN AUGUST 5, 1993 BY AERO-METRIC ENGINEERING INC., FORT COLLINS, COLORADO.
2. COORDINATES SHOWN ARE BASED ON MODIFIED COLORADO STATE PLANE COORDINATE SYSTEM (TRUE BEARING AND GROUND DISTANCE).
3. GIVEN LONG TERM SETTLEMENT AND OTHER OPERATIONAL FACTORS, ELEVATIONS OF TOPOGRAPHY AND FINAL GRADES SHOWN ARE APPROXIMATE.

LEGEND

- INDEX 10' CONTOUR
- INTERMEDIATE 2' CONTOUR
- DEPRESSION CONTOUR
- PAVED ROAD
- IMPROVED DIRT ROAD
- PAVED ROAD WITH SHOULDER
- FENCE
- CULVERT
- INTERMITTENT DRAINAGE
- PROPERTY BOUNDARY
- FINAL GRADE CONTOUR
- RETENTION POND CONTOUR
- LIMIT OF REFUSE
- COLORADO STATE HIGHWAY 14 RIGHT OF WAY BOUNDARY
- SPOT ELEVATION
- CONTROL POINT
- LOCATED OBJECT
- SINGLE TREE
- VEGETATION OUTLINE
- GROUNDWATER MONITORING WELL
- PHOTO CENTER
- GAS PROBES
- POWER POLE
- PROPERTY CORNER
- PIEZOMETER
- CROSS SECTION LOCATION

Prepared by:
RUST ENVIRONMENT & INFRASTRUCTURE
CADD FILE: NWX6-DGN

REV	DATE	DESCRIPTION	DES BY	APP BY

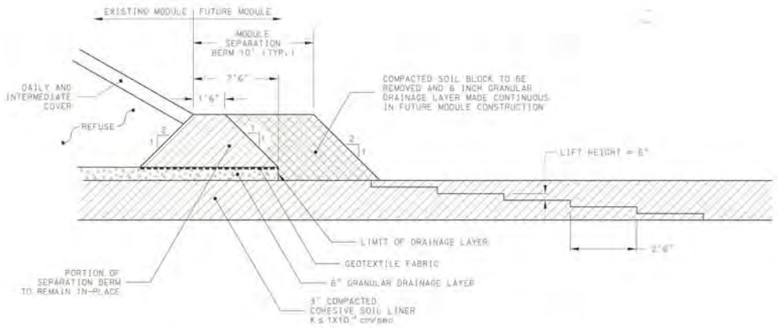
PROJECT NO	34821	SITE DEVELOPMENT PLANS NORTH WELD SANITARY LANDFILL WELD COUNTY, COLORADO	
DATE	JANUARY 1996		
DES BY	EGS	1/12/96	
DRN BY	EGS	1/12/96	
CHK BY	MLY	1/12/96	
APP BY	MRH	1/12/96	

COLORADO REGISTERED MICHAEL R. HUNTSTON 23830 PROFESSIONAL ENGINEER

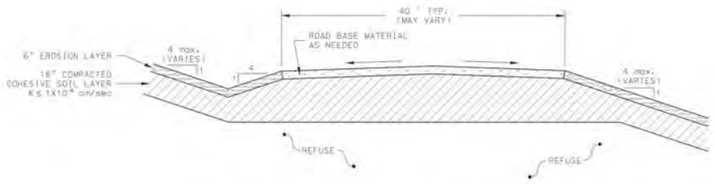
FINAL GRADE AND SURFACE WATER MANAGEMENT PLAN

Waste Management Disposal Services of Colorado, Inc.

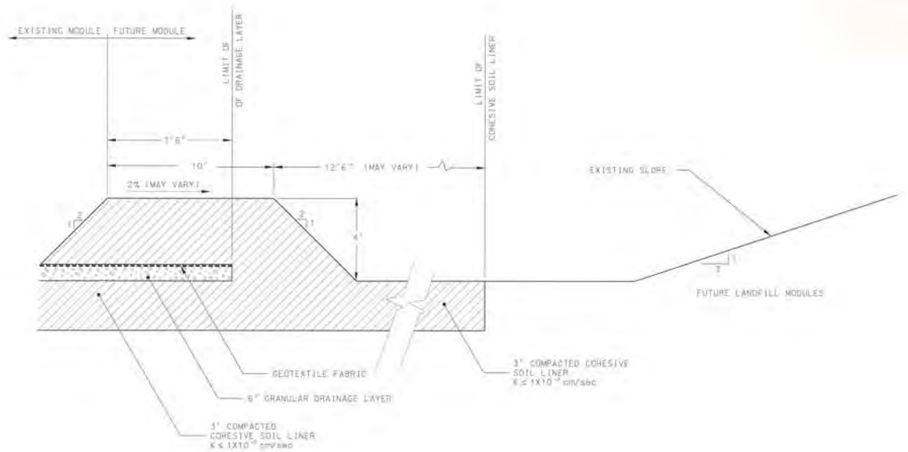
SHEET 6 OF 11
DRAWING NO 6



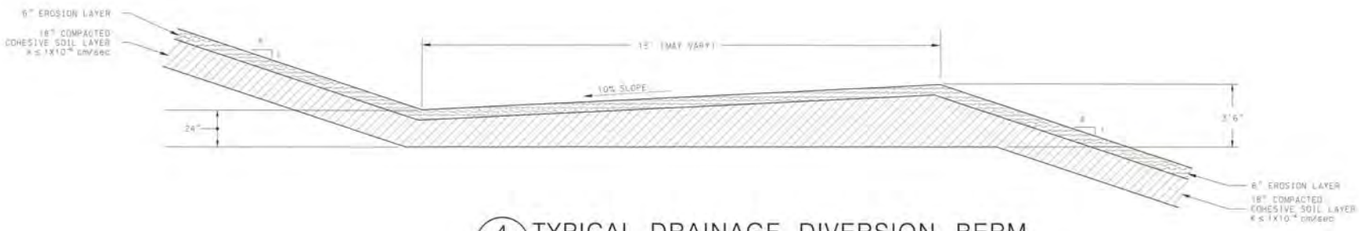
1/11 TYPICAL CLAY LINER TIE IN



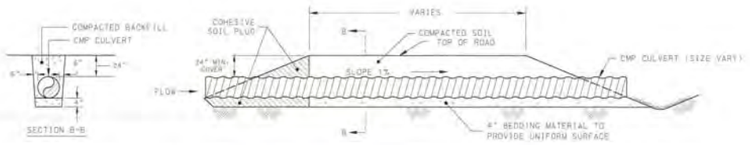
3/11 TYPICAL HAUL ROAD ON FILL



2/11 TYPICAL MODULE SEPARATION BERM



4/11 TYPICAL DRAINAGE DIVERSION BERM



5/11 TYPICAL CMP CULVERT

NOTE: 1. ALL DRAWINGS ARE NOT TO SCALE UNLESS OTHERWISE NOTED.
2. ALL DIMENSIONS ARE MINIMUMS UNLESS OTHERWISE NOTED.

REV	DATE	DESCRIPTION	DES BY	APP BY
A	11/13/97	FINAL COVER AND SOIL LINER DETAIL CHANGES	DLH	AS

F. I. F. SEAL FOR 11/13/97 REVISIONS

Revised by:
Waste Management Disposal Services of Colorado, Inc.

Prepared by:
RUST ENVIRONMENT & INFRASTRUCTURE

PROJECT NO: 34821
DATE: JANUARY 1996

DES BY	EGS	1/12/96
DRN BY	EGS	1/12/96
CHK BY	MLY	1/12/96
APP BY	MRH	1/12/96

SITE DEVELOPMENT PLANS
NORTH WELD SANITARY LANDFILL
WELD COUNTY, COLORADO

DETAILS

Waste Management Disposal Services of Colorado, Inc.

SHEET 11 OF 11
DRAWING NO.
11

APPENDIX A-4

Worksheet for Emergency Spillway

Project Description

Solve For	Headwater Elevation

Input Data

Discharge		296.00	ft³/s
Crest Elevation		5069.00	ft
Tailwater Elevation		5068.00	ft
Crest Surface Type	Gravel		
Crest Breadth		5.00	ft
Crest Length		315.00	ft

Results

Headwater Elevation	5069.50	ft
Headwater Height Above Crest	0.50	ft
Tailwater Height Above Crest	-1.00	ft
Weir Coefficient	2.69	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	2.69	US
Flow Area	156.17	ft²
Velocity	1.90	ft/s
Wetted Perimeter	315.99	ft
Top Width	315.00	ft

Golder Associates

CALCULATIONS

Date:	12/19/2006	**Made by:**	SPS
Project No.:	1538880	**Checked by:**	DMW
Subject:	Retention Basin - Drain Time Calculation	**Reviewed by:**	JAR
Project Short Title:	North Weld Landfill, Unit 2		

Goal: Estimate Drain Time for 100-Year, 24-Hour Runoff Volume Reporting to Retention Basin

Reference: New Jersey Department of Environmental Protection, Divison of Watershed Management, *New Jersey Stormwater Best Management Practices Manual*, Chapter 9.5 Infiltration Basins, February 2016

Given:

100-Year, 24-Hour Runoff Volume reporting to basin: 44.1 acre-feet

In-Situ Hydraulic Conductivity: 3.6×10^{-3} cm/sec or 5.1 inches/hour

Retention Basin Stage-Storage-Surface Area

Elevation	Surface Area (acres)	Cumulative Volume (acre-feet)	
5050	0.05	0.0	
5051	0.47	0.3	
5052	1.23	1.1	
5053	2.21	2.8	
5054	3.40	5.6	
5055	4.18	9.4	→ Basin Floor (Infiltration Area)
5056	4.33	13.7	
5057	4.48	18.1	
5058	4.64	22.6	
5059	4.80	27.4	
5060	4.96	32.2	
5061	5.12	37.3	
5062	5.28	42.5	
5063	5.45	47.8	
5064	5.62	53.4	
5065	5.79	59.1	
5066	5.96	64.9	
5067	6.14	71.0	
5068	6.31	77.2	
5069	6.49	83.6	
5070	6.68	87.0	

Drain Time Calculation

$$Drain\ Time = \frac{100 - Year, 24 - Hour\ Runoff\ Volume}{Infiltation\ Area\ x\ Design\ Permeability\ Rate}$$

$$Drain\ Time = \frac{44.1\ acre - ft\ x\ (12\ inches/ft)}{(4.18\ acres)\ x\ (5.1\ inches/hour)}$$

= 24.8 hours

APPENDIX B
UNIT 1 SURFACE WATER CALCULATIONS

APPENDIX B-1

UPDATED DESIGN AND OPERATIONS PLAN
NORTH WELD SANITARY LANDFILL
AULT, COLORADO

Prepared By:

Rust Environment & Infrastructure, Inc.

5575 DTC Parkway, Suite 200

Englewood, Colorado 80111

January 1996

Revised By:

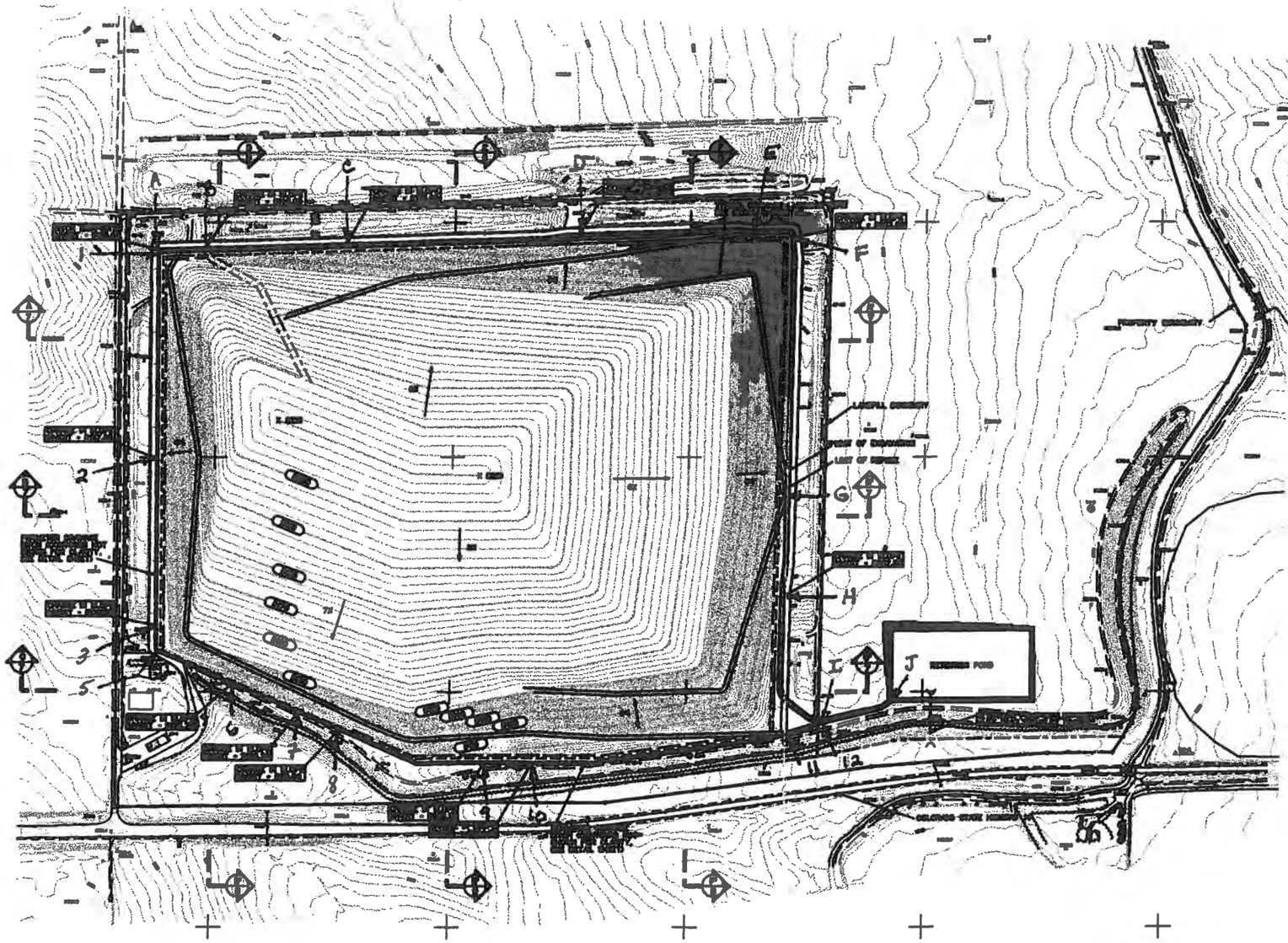
Waste Management Disposal Services Of Colorado, Inc.

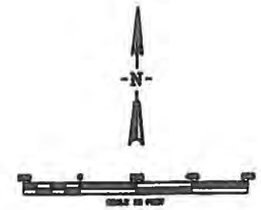
November 1997

Printed on recycled paper

NORTH WELD SANITARY LANDFILL
UPDATED DESIGN AND OPERATIONS PLAN

FIGURES





NOTES

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

LEGEND

- DEED 10' CONTOUR
- INTERMEDIATE 2' CONTOUR
- DEPRESSION CONTOUR
- PAVED ROAD
- GRAVED DIRT ROAD
- PAVED ROAD WITH SHOULDER
- FENCE
- CULVERT
- INTERMITTENT DRAINAGE
- PROPERTY BOUNDARY
- FINAL GRADE CONTOUR
- RETENTION POND CONTOUR
- FENCE BOUNDARY
- LIMIT OF CONSTRUCTION
- LIMIT OF REFUSE
- LIMIT OF FINAL COVER
- SPOT ELEVATION
- CONTROL POINT
- LOCATED CORNER
- SINGLE TREE
- VEGETATION OUT OF SCALE
- GROUNDWATER MONITORING WELL
- PHOTO CENTER
- GAS PROBES
- POWER POLE
- PROPERTY CORNER
- PERIMETER

FIGURE 1
CHANNEL LOCATIONS

DRAWN BY	[illegible]	FINAL GRADE AND SURFACE WATER MANAGEMENT PLAN	
DATE	June 1990		
DES BY	DSS		
DWN BY	DSS		
CHK BY	MLT		
APP BY	DSS		
Waste Management Disposal Services of Colorado, Inc.			6

NORTH WELD SANITARY LANDFILL
UPDATED DESIGN AND OPERATIONS PLAN

APPENDIX B
LANDFILL PERIMETER CHANNELS DESIGN

CALCULATION SHEET

PAGE 01 OF 05

PROJECT NO. 82488.100

CLIENT Waste Services Corp. SUBJECT Perimeter

PROJECT North Weld SDP Channel Sizing

Prepared By ECS Date 12-93

Reviewed By MRH Date 10-95

Approved By _____ Date _____

Purpose: Estimate developed condition peak discharge, for a 100-year, 24-hour storm event, from the landfill to the stormwater detention pond.

Assumptions & Method:

- Use SCS Haastead computer software to generate developed conditions peak runoff estimate and hydrograph.
- The information included and methods used to determine final hydrograph at watershed outlet included:
  1. Estimating velocities in channel segments to obtain first estimate of time of concentration and flow.
  2. Calculating new velocity flow time, and flow amount based on first flow velocity estimate.
  3. If necessary, calculate new velocity, flow time, and flow amount based on second flow estimate.

- Type II rainfall distribution
- Soils classified as silty-clay
- Cover type: pasture, grassland, range
- Cover Condition: fair 50% cover
- CN = 84
- Mannings # for sheet flow = 0.17
  # for channel flow = 0.035 natural
  # for rip-rap = 0.040 rip-rap

- Precipitation: 100-year, 2 hour = 1.7"
  100-year, 24 hour = 4.0"

CALCULATION SHEET

PAGE 92 OF 95

PROJECT NO. 82488.100

CLIENT Waste Services Corp. SUBJECT Perimeter

PROJECT North Weld SDP Channel Sizing

Prepared By EGS Date 12-93

Reviewed By MRH Date 16-95

Approved By _____ Date _____

Based on modeling results and using attached Figure, the following channel segments were identified with must be sized from the computer modeling results.

Channel	Length	Width	Slope	Required Flow
A → B	190'	12.0'	0.005	35 cfs
B → C	600'	12.0'	0.028	35 cfs
C → D	1,000'	12.0'	0.025	35 cfs
D → E	730'	12.0'	0.014	69 cfs
E → F	250'	12.0'	0.014	100 cfs
F → G	1,100'	12.0'	0.004	133 cfs
G → H	430'	12.0'	0.004	175 cfs
H → I	650'	12.0'	0.020	175 cfs
I → J	320'	12.0'	0.035	233 cfs
1 → 2	890'	2.0'	0.015	24 cfs
2 → 3	710'	2.0'	0.009	24 cfs
3 → 5	100'	2.0'	0.006	24 cfs
5 → 6	480'	2.0'	0.006	28 cfs
6 → 7	310'	2.0'	0.021	28 cfs
7 → 8	185'	2.0'	0.006	28 cfs
8 → 9	660'	2.0'	0.045	32 cfs
9 → 10	200'	2.0'	0.026	36 cfs
10 → 11	1,090'	2.0'	0.008	36 cfs
11 → 12	120'	2.0'	0.008	44 cfs
Landfill Terrace		0.0'	0.040	66 cfs

Channel sizing was based on the attached EXCEL worksheets. See these sheets for channel sizes and lining requirements for the North Weld Surface Water Channels.

Rust Environment & Infrastructure
Denver Division - Solid Waste Design
Surface Water Run-Off - Open Channel Sizing

FILE NAME: Openchan.wk3 DISK NAME: North Weld

USES CHANNEL DIMENSIONS AND SLOPE TO CALCULATE V AND Q
FROM MANNING'S EQUATION FOR OPEN-CHANNEL FLOW:

$$V = \frac{1.486}{n} r^{2/3} s^{1/2}$$

Project: North Weld Sanitary Landfill **Proj. No.:** 82488.100 **Date:** 02-Oct-95
By: EGS Checked By: MRH

CHANNEL NAME	SIDESLOPE1 (z)	SIDESLOPE 2 (z)	WIDTH (b) (ft)	DEPTH (d) (ft)	SLOPE (s) (ft/ft)
Channel A -> B	1.0	1.0	12.0	1.000	0.005
Channel B -> C	1.0	1.0	12.0	0.600	0.028
Channel C -> D	1.0	1.0	12.0	0.700	0.025
Channel D -> E	1.0	1.0	12.0	1.100	0.014
Channel E -> F	1.0	1.0	12.0	1.500	0.014
Channel F ->G	1.0	1.0	12.0	2.400	0.004
Channel G -> H	1.0	1.0	12.0	2.750	0.004
Channel H -> I	1.0	1.0	12.0	1.900	0.020
Channel I -> J	1.0	1.0	12.0	2.500	0.013
Channel 1 -> 2	1.0	1.0	2.0	1.600	0.015
Channel 2 -> 3	1.0	1.0	2.0	1.800	0.009
Channel 3 -> 5	1.0	1.0	2.0	1.900	0.006
Channel 5 -> 6	1.0	1.0	2.0	2.100	0.006
Channel 6 -> 7	1.0	1.0	2.0	1.600	0.021
Channel 7 -> 8	1.0	1.0	2.0	2.100	0.006
Channel 8 -> 9	1.0	1.0	2.0	1.400	0.045
Channel 9 -> 10	1.0	1.0	2.0	1.800	0.026
Channel 10 -> 11	1.0	1.0	2.0	2.200	0.008
Channel 11 -> 12	1.0	1.0	2.0	2.400	0.008

Rust Environment & Infrastructure
Denver Division - Solid Waste Design
Surface Water Run-Off - Open Channel Sizing

FILE NAME: Openchan.wk3 DISK NAME: North Weld

USES CHANNEL DIMENSIONS AND SLOPE TO CALCULATE V AND Q
FROM MANNING'S EQUATION FOR OPEN-CHANNEL FLOW:

$$V = \frac{1.486}{n} r^{2/3} s^{1/2}$$

Project: North Weld Sanitary Landfill **Proj. No.:** 82488.100 **Date:** 02-Oct-95
By: EGS Checked By: MRH

CHANNEL NAME	MANNINGS NO. (n)	AREA (A) (sq ft)	HYDRLC RAD. (r),(ft)	VELOCITY (V),(fps)	MAX. FLOW Q,(cfs)	REQ. FLOW (cfs)
Channel A -> B	0.035	13.000	0.877	2.75	35.8	35.0
Channel B -> C	0.035	7.560	0.552	4.78	36.1	35.0
Channel C -> D	0.035	8.890	0.588	4.71	41.9	35.0
Channel D -> E	0.035	14.410	0.954	4.87	70.1	69.0
Channel E -> F	0.040	20.250	1.247	5.09	103.1	100.0
Channel F ->G	0.035	34.560	1.839	4.03	139.3	133.0
Channel G -> H	0.035	40.563	2.051	4.33	175.8	175.0
Channel H -> I	0.040	26.410	1.520	6.95	183.4	175.0
Channel I -> J	0.040	36.250	1.901	6.50	235.6	233.0
Channel 1 -> 2	0.035	5.760	0.883	4.78	27.6	24.0
Channel 2 -> 3	0.035	6.840	0.965	3.93	26.9	24.0
Channel 3 -> 5	0.035	7.410	1.005	3.30	24.4	24.0
Channel 5 -> 6	0.035	8.610	1.084	3.47	29.9	28.0
Channel 6 -> 7	0.040	5.760	0.883	4.95	28.5	28.0
Channel 7 -> 8	0.035	8.610	1.084	3.47	29.9	28.0
Channel 8 -> 9	0.040	4.760	0.799	6.78	32.3	32.0
Channel 9 -> 10	0.040	6.840	0.965	5.85	40.0	36.0
Channel 10 -> 11	0.035	9.240	1.124	4.10	37.9	36.0
Channel 11 -> 12	0.035	10.560	1.202	4.29	45.3	44.0

North Weld Sanitary Landfill
Perimeter Channel Schedule

Channel Designation	Slope (ft/ft)	Flow Rate (cfs)	Velocity (ft/s)	Bottom Width b, (ft)	Water Depth d, (ft)	Channel Depth D, (ft)	Channel Lining
Landfill Terraces	0.040	66.0	6.16	0	1.3	1.5	Grass (Rip Rap Ends)
Channel A -> B	0.005	35.0	2.75	12	1.0	3.0	Grass
Channel B -> C	0.028	35.0	4.78	12	0.6	3.0	Grass
Channel C -> D	0.025	35.0	4.71	12	0.7	3.0	Grass
Channel D -> E	0.014	69.0	4.87	12	1.1	3.0	Grass
Channel E -> F	0.014	100.0	5.09	12	1.4	3.0	Grass
Channel F -> G	0.004	133.0	4.03	12	2.4	3.0	Grass
Channel G -> H	0.004	175.0	4.33	12	2.8	3.0	Grass
Channel H -> I	0.020	175.0	6.95	12	1.8	3.0	Rip Rap
Channel I -> J	0.013	233.0	6.50	12	2.3	3.0	Rip Rap
Channel 1 -> 2	0.015	24.0	4.78	2	1.6	3.0	Grass
Channel 2 -> 3	0.009	24.0	3.93	2	1.8	3.0	Grass
Channel 3 -> 5	0.006	24.0	3.30	2	1.9	3.0	Grass
Channel 5 -> 6	0.006	28.0	3.47	2	2.1	3.0	Grass
Channel 6 -> 7	0.021	28.0	4.95	2	1.6	3.0	Rip Rap
Channel 7 -> 8	0.006	28.0	3.47	2	2.1	3.0	Grass
Channel 8 -> 9	0.045	32.0	6.78	2	1.4	3.0	Rip Rap
Channel 9 -> 10	0.026	36.0	5.85	2	1.6	3.0	Rip Rap
Channel 10 -> 11	0.008	36.0	4.10	2	2.2	3.0	Grass
Channel 11 -> 12	0.008	44.0	4.29	2	2.4	3.0	Grass

NORTH WELD SANITARY LANDFILL
UPDATED DESIGN AND OPERATIONS PLAN

APPENDIX C
SEDIMENTATION POND OUTLET DESIGN

CALCULATION SHEET PAGE 01 OF 02

PROJECT NO 82488.100

CLIENT WASTE SERVICES CORP. SUBJECT DETERMINATION Prepared By EGS Date 10-95

SUBJECT NORTH WELD SDP OF 5-YEAR, 24-HOUR Reviewed By MRH Date 10-95

STORM EVENT RUN-OFF Approved By Date

PURPOSE: DETERMINE IF THE SEDIMENTATION POND AT THE NORTH WELD SANITARY LANDFILL HAS BEEN DESIGNED TO MEET THE WELD COUNTY, PUBLIC WORKS DEPARTMENT STORM DRAINAGE DESIGN CRITERIA.

In the Weld County, Public Works Department Storm Drainage Design Criteria:

Item 10.13.4.3: "All Storm water dentention facilities shall be designed to detain the storm water runoff from the fully developed subdivision from a 100-year storm and release the detained water at a quantity and rate not to exceed the quantity and rate of a 5-year storm falling on the undeveloped site.

Utilizing Haestead Surface water runoff software, the peak discharge from the 119 acre undeveloped site was computed.

From: Proceedures for Determining Peak Flows in Colorado, Soil Conservation Service;

- CN = 80 for cultivated land (Soil Group D)
- 5-Year, 24-Hour Storm = 2.20 inches

Based on the modeling: the 5-year, 24-hour runoff from the undeveloped site is approximately 59 cfs (see attached modeling sheets.

CALCULATION SHEET PAGE 02 OF 02

PROJECT NO 82488.100

CLIENT WASTE SERVICES CORP. SUBJECT DETERMINATION OF Prepared By EGS Date 10-95

PROJECT NORTH WELD SDP 5-YEAR, 24-HOUR Reviewed By MRH Date 10-95

STORM EVENT RUNOFF Approved By ____ Date ____

The sedimentation pond was previously designed and its outflow is limited by a 36 ϕ CMP outlet. The peak discharge rate of 41 cfs was determined based on the peak flow minus any contributing area flows of the culvert that lies beneath Colorado State Highway 14. This culverts peak flow determined what amount of flow could be discharged from the sedimentation pond.

∴ Peak discharge out of Pond during 100-year, 24-hour storm:

$Q_{100} = 41$ cfs

Peak discharge from undeveloped site during 5-year, 24-hour storm:

$Q_5 = 59$ cfs

Pond Stats:

Peak inflow = 233.0 cfs
Peak outflow = 41.0 cfs
Peak Elevation = 5070.14 ft
Top of Pond = 5071.58 ft

The pond, as designed, meets the drainage design criteria of the Public Works Department of Weld County

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-02-1995 12:36:06
Watershed file: --> NORTH5YR.WSD
Hydrograph file: --> NORTH .HYD

North Weld Sanitary Landfill
5-Year, 24-Hour Storm Event Run-off
By: Mike Heinstein October 2, 1995

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input	Ia/p used
subarea g	6.80	80.0	0.20	0.20	2.20	0.69	.23	.30
subarea f	5.50	80.0	0.10	0.20	2.20	0.69	.23	.30
subarea e	11.00	80.0	0.20	0.10	2.20	0.69	.23	.30
subarea d	8.60	80.0	0.10	0.00	2.20	0.69	.23	.30
subarea c	17.50	80.0	0.10	0.00	2.20	0.69	.23	.30
subarea b	18.30	80.0	0.20	0.00	2.20	0.69	.23	.30
subarea a	54.00	80.0	0.40	0.00	2.20	0.69	.23	.30

* Travel time from subarea outfall to composite watershed outfall point.
Total area = 121.70 acres or 0.1902 sq.mi
Peak discharge = 59 cfs

WARNING: Drainage areas of two or more subareas differ by a factor of 5 or greater.

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
subarea g	0.20	0.20	**	**	No	--
subarea f	0.10	0.20	**	**	No	--
subarea e	0.20	0.10	**	**	No	--
subarea d	0.10	0.00	**	**	No	--
subarea c	0.10	0.00	**	**	No	--
subarea b	0.20	0.00	**	**	No	--
subarea a	0.40	0.00	**	**	No	--

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-02-1995 12:36:06
Watershed file: --> NORTH5YR.WSD
Hydrograph file: --> NORTH .HYD

North Weld Sanitary Landfill
5-Year, 24-Hour Storm Event Run-off
By: Mike Heinstein October 2, 1995

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
subarea g	4	12.3
subarea f	4	12.3
subarea e	7	12.3
subarea d	9	12.1
subarea c	18	12.1
subarea b	14	12.2
subarea a	29	12.4
Composite Watershed	59	12.3

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-02-1995 12:36:06
Watershed file: --> NORTH5YR.WSD
Hydrograph file: --> NORTH .HYD

North Weld Sanitary Landfill
5-Year, 24-Hour Storm Event Run-off
By: Mike Heinstein October 2, 1995

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
subarea g	0	0	0	0	0	1	2	4	4
subarea f	0	0	0	0	0	0	2	4	4
subarea e	0	0	0	0	0	2	5	7	6
subarea d	0	0	0	1	5	9	5	2	2
subarea c	0	0	0	3	11	18	10	4	3
subarea b	0	0	0	1	4	11	14	10	5
barea a	0	0	0	0	2	7	17	28	29
Total (cfs)	0	0	0	5	22	48	55	59	53

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
subarea g	3	2	2	1	1	1	1	1	0
subarea f	3	2	1	1	1	1	0	0	0
subarea e	4	3	2	2	1	1	1	1	1
subarea d	1	1	1	1	1	1	1	1	1
subarea c	3	2	2	2	2	1	1	1	1
subarea b	4	3	3	2	2	2	1	1	1
subarea a	24	18	14	11	7	6	5	4	4
Total (cfs)	42	31	25	20	15	13	10	9	8

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-02-1995 12:36:06
Watershed file: --> NORTH5YR.WSD
Hydrograph file: --> NORTH .HYD

North Weld Sanitary Landfill
5-Year, 24-Hour Storm Event Run-off
By: Mike Heinstein October 2, 1995

Composite Hydrograph Summary (cfs)

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
subarea g	0	0	0	0	0	0	0	0	0
subarea f	0	0	0	0	0	0	0	0	0
subarea e	1	1	1	1	0	0	0	0	0
subarea d	0	0	0	0	0	0	0	0	0
subarea c	1	1	1	1	1	1	1	1	1
subarea b	1	1	1	1	1	1	1	1	1
subarea a	4	3	3	3	2	2	2	2	2
Total (cfs)	7	6	6	6	4	4	4	4	4

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
subarea g	0	0	0	0	0
subarea f	0	0	0	0	0
subarea e	0	0	0	0	0
subarea d	0	0	0	0	0
subarea c	1	0	0	0	0
subarea b	1	0	0	0	0
subarea a	2	1	1	1	0
Total (cfs)	4	1	1	1	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-02-1995 12:36:06
Watershed file: --> NORTH5YR.WSD
Hydrograph file: --> NORTH .HYD

North Weld Sanitary Landfill
5-Year, 24-Hour Storm Event Run-off
By: Mike Heinstein October 2, 1995

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	0	14.8	6
11.1	0	14.9	6
11.2	0	15.0	6
11.3	0	15.1	6
11.4	0	15.2	5
11.5	0	15.3	5
11.6	0	15.4	4
11.7	2	15.5	4
11.8	3	15.6	4
11.9	5	15.7	4
12.0	22	15.8	4
12.1	48	15.9	4
12.2	55	16.0	4
12.3	59	16.1	4
12.4	53	16.2	4
12.5	42	16.3	4
12.6	31	16.4	4
12.7	25	16.5	4
12.8	20	16.6	4
12.9	18	16.7	4
13.0	15	16.8	4
13.1	14	16.9	4
13.2	13	17.0	4
13.3	12	17.1	4
13.4	10	17.2	4
13.5	10	17.3	4
13.6	9	17.4	4
13.7	8	17.5	4
13.8	8	17.6	4
13.9	8	17.7	4
14.0	7	17.8	4
14.1	7	17.9	4
14.2	6	18.0	4
14.3	6	18.1	4
14.4	6	18.2	3
14.5	6	18.3	3
14.6	6	18.4	3

14.7	6	18.5	2

TR-55 TABULAR HYDROGRAPH METHOD
Type II Distribution
(24 hr. Duration Storm)

Executed: 10-02-1995 12:36:06
Watershed file: --> NORTH5YR.WSD
Hydrograph file: --> NORTH .HYD

North Weld Sanitary Landfill
5-Year, 24-Hour Storm Event Run-off
By: Mike Heinstein October 2, 1995

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	2	22.4	1
18.7	2	22.5	1
18.8	2	22.6	1
18.9	1	22.7	1
19.0	1	22.8	1
19.1	1	22.9	1
19.2	1	23.0	1
19.3	1	23.1	1
19.4	1	23.2	1
19.5	1	23.3	1
19.6	1	23.4	1
19.7	1	23.5	1
19.8	1	23.6	1
19.9	1	23.7	1
20.0	1	23.8	1
20.1	1	23.9	1
20.2	1	24.0	0
20.3	1	24.1	0
20.4	1	24.2	0
20.5	1	24.3	0
20.6	1	24.4	0
20.7	1	24.5	0
20.8	1	24.6	0
20.9	1	24.7	0
21.0	1	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0
21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

APPENDIX B-2

Golder Associates Inc.

44 Union Boulevard, Suite 300
Lakewood, CO USA 80228
Telephone (303) 980-0540
Fax (303) 985-2080

Golder Associates

October 14, 2002

Our Ref.: 023-2387

Mr. Doug Ikenberry
Colorado Department of Public Health and Environment
HMWMD-SWIM-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Ms. Cindi Etcheverry
Weld County, Department of Public Health and Environment
1555 N. 17th Avenue
Greeley, Colorado 80631

RE: NORTH WELD SANITARY LANDFILL (NWSL), RETENTION POND CONSTRUCTION QUALITY ASSURANCE

Dear Mr. Ikenberry and Ms. Etcheverry:

On behalf of Waste Management Disposal Services, Inc. (WMDS), Golder Associates Inc. (Golder) is providing this letter to outline a Construction Quality Assurance (CQA) Plan for modification of the existing detention pond at NWSL and request approval of the CQA Plan and the design modification.

As previously discussed with WMDS, the current pond design includes a stormwater outlet structure. Because of the concern by the Colorado Department of Transportation (CDOT) regarding discharge of stormwater onto the State Right of Way, CDPHE had requested NWSL consider converting the stormwater detention pond to a retention pond.

Accordingly, WMDS is proposing the detention pond at NWSL be modified to a retention pond in accordance with the enclosed modified design calculations provided by Earth Tech, Inc. on February 19, 2002. These calculations provide the required dimensions for a retention pond that will store the 100-year, 24-hour storm event from the 119 acre completed landfill. The results of this analysis are being incorporated into construction drawings by WMDS. These construction drawings will provide survey points that establish the slope and bottom elevations of the retention pond. Golder will review survey data provided by a licensed surveyor during construction and certify that it is within design tolerances established by the specifications. Upon certification of the survey data, Golder will provide a certification letter sealed by a Professional Engineer in Colorado along with as-built drawings and survey tables that demonstrate that retention pond has been built in accordance with the design. Since NWSL would like to incorporate this work in with the Phase 2 Module 1 construction project an expeditious review of this design modification and CQA Plan is appreciated.

If you have any questions feel free to contact the undersigned at 303-980-0540.

Sincerely,

GOLDER ASSOCIATES INC.

Mark McClain, P.E.
Senior Project Manager

Attachment: Design Calculations

cc: Kim Ogle, WCDPS w/attachment
Alan Scheere, WMDS w/attachment
Bill Hedberg, WMDS w/attachment

MEM/ljd

ATTACHMENT

5575 DTC Parkway, Suite 200, Englewood, Colorado 80111-3016

February 19, 2002

Mr. Alan Scheere
Waste Management of Colorado at CSI
2090 E. 104th Avenue, Suite 300
Denver, Colorado 80233

Re: Re-Evaluation of North Weld Sanitary Landfill Retention Pond and Ground Water Discharge Permit Requirement

Dear Mr. Scheere:

Earth Tech, Inc. has completed a re-evaluation of the North Weld Sanitary Landfill's (NWSL) proposed retention pond to store the runoff resulting from a 100-year, 24-hour storm event from the fully developed landfill. The re-evaluation of the pond to contain the 100-year, 24-hour storm runoff is required due the Colorado Department of Transportation's concern regarding NWSL's discharge of collected storm water to the Colorado State Highway 14 right-of-way south of the site. The calculations completed to evaluate the pond are attached. The 100-year, 24-hour storm event volume is approximately 22.6 acre-feet. Using a 1.5 factor of safety (approximately 34 acre-feet) for available storage, the pond's dimensions, as previously designed, can remain at a length of approximately 600 feet and a width of 400 feet with 4H:1V sideslopes. The depth should be increased by 1.5 feet to 8 feet (elevation 5066.0 feet) in order to limit the top of water elevation to approximately 5073.5 feet. This depth assumes that sediment storage of 2 feet (elevation 5066.0 to 5068.0) is incorporated into the pond's design.

Telephone
303.694.6660
Facsimile
303.694.4410

Earth Tech contacted the Colorado Department of Public Health and Environment Water Quality Control Department to determine if the surface water storage pond would require a ground water discharge permit. Mr. Liuzzi of the Water Quality Control Department indicated that under the Colorado Discharge Permit System Regulations [5CCR 1002-61.14(1)(b)(iii), attached], any storm water retention or detention impoundment is exempt from the ground water discharge permit requirement.

If you have any questions concerning this re-sizing of the NWSL retention pond, please contact me at (505) 350-1306 or Randy Thompson at (303) 694-6660.

Very truly yours,
Earth Tech, Inc.



Michael R. Heinstein, P.E.
Civil Engineer

cc: Randy Thompson, P.E.

work\44645\nwsl\pond-analysis.doc

ATTACHMENT 1
CALCULATIONS – NWSL RETENTION POND RE-EVALUATION

CALCULATION SHEET

PROJECT: Waste Management – North Weld Sanitary Landfill – Weld County, Colorado

CALCULATION TITLE: North Weld Sanitary Landfill Retention Revaluation

PROJECT NUMBER:	PREPARED BY:	REVIEWED/CHECKED BY:	DATE:	PAGE 01 OF 02
39973.0702	MRH	RT	December 16, 2001	

PROBLEM STATEMENT

The purpose of this evaluation is to determine the size of the North Weld Sanitary Landfill (NWSL) retention pond to store the runoff from a 100-year, 24-hour storm event from the fully developed 119-acre site.

DESIGN CRITERIA

The flow into the NWSL retention pond was determined during the completion of the January 1996 Site Development Plans. The storm hydrograph will be used to estimate the total volume of water that must be stored by the pond.

SITE LOCATION AND LAYOUT

North Weld Sanitary Landfill

NWSL is located approximately six miles west of Colorado State Highway 85 on Colorado State Highway 14. The facility's address is 40000 Weld County Road 25, Ault, Colorado 80610.

Final grades for the NWSL were designed to promote positive drainage of precipitation runoff (Site Development Plans [January 1996]). Runoff from the landfill slopes will collect in channels and will be conveyed to the proposed retention pond that will be located in the southeast corner of the site.

The proposed retention pond was initially designed with 2H:1V sideslopes but, to facilitate easier access to collected sediments, the sideslopes will be flattened to 4H:1V. The retention pond was sized to control the runoff volume as a result of a 100-year, 24-hour storm event from the 119 acre completed landfill.

ANALYSIS RESULTS AND DISCUSSION

NWSL Retention Pond Capacity Analysis

1. Design factors developed during the completion of the January 1996 Site Development Plans which were used in this analysis include:

   a. 100-year, 24-hour storm event flow into the pond from the landfill = 214 cfs;
   b. Inlet channel invert elevation to pond = approximately 5070.0 feet;
   c. Inlet channel top of water surface elevation due to 100-year storm = 5072.3 feet; and
   d. Inlet channel top of sideslope elevation = 5074.0.
   e. Factor of safety = 1.5 (100-year, 24-hour runoff volume) [to account for existing water that may be in the pond at the time of the storm event, etc.]

	CALCULATION SHEET			
PROJECT: Waste Management – North Weld Sanitary Landfill – Weld County, Colorado **CALCULATION TITLE:** North Weld Sanitary Landfill Retention Revaluation				
PROJECT NUMBER: 39973.0702	**PREPARED BY:** MRH	**REVIEWED/CHECKED BY:** RT	**DATE:** December 16, 2001	PAGE 42 OF 42

NWSL Retention Pond Volume Capacity Estimate

	Elevation (ft)	Area (acres)	Cumulative Volume of Storage (acre-ft)	Depth of Water (ft)
Sediment Storage	5066.0	5.34	0	0
	5067.0	5.41	5.41	0
	5068.0	5.53	10.82	0
Working Stormwater Volume	5068.0	5.53	0	0.0
	5069.0	5.70	5.70	1.0
	5070.0	5.87	11.74	2.0
	5071.0	6.01	18.03	3.0
	5072.0	6.14	24.56	4.0
	5073.0	6.28	31.40	5.0
Top of Pond	5074.0	6.42	38.52	6.0

Notes:

1. Storage volumes and primary structure outflow rates based on a 595 ft x 400 ft retention pond with 4H:1V sideslopes and located as shown on the January 1996 Site Development Plans.

2. Using the pond volume capacity estimates, the 100-year, 24-hour storm hydrograph, developed during the January 1996 completion of the Site Development Plans, can be easily stored in the pond. Pond dimensions: 600 feet in length, 400 feet in width and a total of 8 feet in depth.

****
*
* North Weld Sanitary Landfill *
* Revised Retention Pond Characteristics - Widened Pond to 600x400 *
* Mike Heinstein July 10,2000 *
*
*
****

Inflow Hydrograph: NWELDHYD.HYD
Rating Table file: NWPOND .PND

100-Year, 24-Hour Storm Event @ Landfill

----INITIAL CONDITIONS----
Elevation = 5069.80 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + O (cfs)
5069.80	0.0	0.000	0.0	0.0
5070.00	0.5	1.170	283.1	283.6
5071.00	3.5	7.110	1720.6	1724.1
5072.00	6.7	13.190	3192.0	3198.7
5073.00	10.2	19.400	4694.8	4705.0
5074.00	13.0	25.750	6231.5	6244.5

≈ 22.6

Time increment (t) = 0.100 hrs.

Summary: Keep dimensions of pond at 600' x 400'
Total Depth = 2 ft with sediment storage area.

Pond File: NWPOND .PND
Inflow Hydrograph: NWELDHYD.HYD
Outflow Hydrograph: NWFLOW .HYD

0.1 hrs = 6 min = 360 sec

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS					
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	
11.000	7.00	-----	0.0	0.0	0.00	5069.80	
11.100	8.00	15.0	14.9	15.0	0.03	5069.81	2,700 cf
11.200	9.00	17.0	31.8	31.9	0.06	5069.82	3,060 cf
11.300	10.00	19.0	50.7	50.8	0.09	5069.84	3,420 cf
11.400	12.00	22.0	72.4	72.7	0.13	5069.85	3,760 cf
11.500	14.00	26.0	98.1	98.4	0.17	5069.87	4,680 cf
11.600	16.00	30.0	127.6	128.1	0.23	5069.89	5,400 cf
11.700	30.00	46.0	173.0	173.6	0.31	5069.92	8,280 cf
11.800	44.00	74.0	246.1	247.0	0.44	5069.97	13,320 cf
11.900	58.00	102.0	346.8	348.1	0.63	5070.04	18,360 cf
12.000	112.00	170.0	514.9	516.8	0.99	5070.16	30,600 cf
12.100	192.00	304.0	815.6	818.9	1.61	5070.37	54,720 cf
12.200	214.00	406.0	1216.7	1221.6	2.45	5070.65	73,080 cf
12.300	197.00	411.0	1621.1	1627.7	3.30	5070.93	73,980 cf
12.400	172.00	369.0	1982.0	1990.1	4.08	5071.18	66,420 cf
12.500	128.00	300.0	2272.6	2282.0	4.71	5071.38	54,000 cf
12.600	89.00	217.0	2479.2	2489.6	5.16	5071.52	39,960 cf
12.700	66.00	155.0	2623.3	2634.2	5.48	5071.62	27,900 cf
12.800	50.00	116.0	2727.9	2739.3	5.70	5071.69	20,880 cf
12.900	42.00	92.0	2808.1	2819.9	5.88	5071.74	16,560 cf
13.000	35.00	77.0	2873.1	2885.1	6.02	5071.79	13,860 cf
13.100	31.00	66.0	2926.8	2939.1	6.14	5071.82	11,880 cf
13.200	27.00	58.0	2972.3	2984.8	6.24	5071.85	10,440 cf
13.300	24.00	51.0	3010.7	3023.3	6.32	5071.88	9,180 cf
13.400	22.00	46.0	3043.9	3056.7	6.39	5071.90	8,280 cf
13.500	21.00	43.0	3074.0	3086.9	6.46	5071.92	7,740 cf
13.600	20.00	41.0	3102.0	3115.0	6.52	5071.94	7,380 cf
13.700	19.00	39.0	3127.8	3141.0	6.57	5071.96	7,020 cf
13.800	18.00	37.0	3151.6	3164.8	6.63	5071.98	6,660 cf
13.900	18.00	36.0	3174.2	3187.6	6.68	5071.99	6,480 cf
14.000	17.00	35.0	3195.8	3209.2	6.72	5072.01	6,300 cf
14.100	16.00	33.0	3215.2	3228.8	6.77	5072.02	5,940 cf
14.200	16.00	32.0	3233.6	3247.2	6.81	5072.03	5,760 cf
14.300	15.00	31.0	3250.9	3264.6	6.85	5072.04	5,580 cf
14.400	15.00	30.0	3267.1	3280.9	6.89	5072.05	5,400 cf
14.500	14.00	29.0	3282.3	3296.1	6.93	5072.06	5,220 cf
14.600	14.00	28.0	3296.3	3310.3	6.96	5072.07	5,040 cf
14.700	14.00	28.0	3310.4	3324.3	6.99	5072.08	5,040 cf
14.800	14.00	28.0	3324.3	3338.4	7.02	5072.09	5,040 cf
14.900	13.00	27.0	3337.2	3351.3	7.05	5072.10	4,860 cf
15.000	13.00	26.0	3349.0	3363.2	7.08	5072.11	4,680 cf
15.100	13.00	26.0	3360.8	3375.0	7.11	5072.12	4,680 cf
15.200	12.00	25.0	3371.5	3385.8	7.13	5072.12	4,500 cf
15.300	12.00	24.0	3381.2	3395.5	7.16	5072.13	4,320 cf
15.400	11.00	23.0	3389.9	3404.2	7.18	5072.14	4,140 cf

For 0 - 7 cfs use 14.3 - 25.5

Σ =

Pond File: NWPOND .PND
Inflow Hydrograph: NWELDHYD.HYD
Outflow Hydrograph: NWFLOW .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS					
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	
15.500	11.00	22.0	3397.5	3411.9	7.20	5072.14	3,960 cf
15.600	11.00	22.0	3405.1	3419.5	7.21	5072.15	3,960 cf
15.700	10.00	21.0	3411.6	3426.1	7.23	5072.15	3,780 cf
15.800	10.00	20.0	3417.1	3431.6	7.24	5072.15	3,600 cf
15.900	9.00	19.0	3421.6	3436.1	7.25	5072.16	3,420 cf
16.000	9.00	18.0	3425.1	3439.6	7.26	5072.16	3,240 cf
16.100	9.00	18.0	3428.6	3443.1	7.27	5072.16	3,240 cf
16.200	9.00	18.0	3432.0	3446.6	7.28	5072.16	3,240 cf
16.300	8.00	17.0	3434.4	3449.0	7.28	5072.17	3,060 cf
16.400	8.00	16.0	3435.9	3450.4	7.28	5072.17	3,060 cf
16.500	8.00	16.0	3437.3	3451.9	7.29	5072.17	3,060 cf
16.600	8.00	16.0	3438.7	3453.3	7.29	5072.17	3,060 cf
16.700	8.00	16.0	3440.1	3454.7	7.29	5072.17	3,060 cf
16.800	8.00	16.0	3441.5	3456.1	7.30	5072.17	3,060 cf
16.900	8.00	16.0	3442.9	3457.5	7.30	5072.17	3,060 cf
17.000	8.00	16.0	3444.3	3458.9	7.30	5072.17	3,060 cf
17.100	8.00	16.0	3445.7	3460.3	7.31	5072.17	3,060 cf
17.200	8.00	16.0	3447.1	3461.7	7.31	5072.17	3,060 cf
17.300	7.00	15.0	3447.5	3462.1	7.31	5072.17	2,700 cf
17.400	7.00	14.0	3446.8	3461.5	7.31	5072.17	2,700 cf
17.500	7.00	14.0	3446.2	3460.8	7.31	5072.17	2,700 cf
17.600	7.00	14.0	3445.6	3460.2	7.31	5072.17	2,700 cf
17.700	7.00	14.0	3445.0	3459.6	7.31	5072.17	2,700 cf
17.800	6.00	13.0	3443.4	3458.0	7.30	5072.17	2,340 cf
17.900	6.00	12.0	3440.8	3455.4	7.30	5072.17	2,340 cf
18.000	6.00	12.0	3438.2	3452.8	7.29	5072.17	2,340 cf
18.100	6.00	12.0	3435.6	3450.2	7.28	5072.17	2,340 cf
18.200	6.00	12.0	3433.1	3447.6	7.28	5072.17	2,340 cf
18.300	6.00	12.0	3430.5	3445.1	7.27	5072.16	2,340 cf
18.400	6.00	12.0	3428.0	3442.5	7.27	5072.16	2,340 cf
18.500	6.00	12.0	3425.5	3440.0	7.26	5072.16	2,340 cf
18.600	6.00	12.0	3423.0	3437.5	7.25	5072.16	2,340 cf
18.700	6.00	12.0	3420.5	3435.0	7.25	5072.16	2,340 cf
18.800	6.00	12.0	3418.0	3432.5	7.24	5072.16	2,340 cf
18.900	6.00	12.0	3415.5	3430.0	7.24	5072.15	2,340 cf
19.000	6.00	12.0	3413.1	3427.5	7.23	5072.15	2,340 cf
19.100	6.00	12.0	3410.6	3425.1	7.23	5072.15	2,340 cf
19.200	6.00	12.0	3408.2	3422.6	7.22	5072.15	2,340 cf
19.300	5.00	11.0	3404.7	3419.2	7.21	5072.15	1,980 cf
19.400	5.00	10.0	3400.3	3414.7	7.20	5072.14	1,800 cf
19.500	5.00	10.0	3395.9	3410.3	7.19	5072.14	1,800 cf
19.600	5.00	10.0	3391.6	3405.9	7.18	5072.14	1,800 cf
19.700	5.00	10.0	3387.2	3401.6	7.17	5072.13	1,800 cf
19.800	4.00	9.0	3381.9	3396.2	7.16	5072.13	1,620 cf
19.900	4.00	8.0	3375.6	3389.9	7.14	5072.13	1,440 cf
20.000	4.00	8.0	3369.4	3383.6	7.13	5072.12	1,440 cf

Pond File: NWPOND .PND
Inflow Hydrograph: NWELDHYD.HYD
Outflow Hydrograph: NWFLOW .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS					
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	
20.100	4.00	8.0	3363.1	3377.4	7.12	5072.12	1,440 cf
20.200	4.00	8.0	3356.9	3371.1	7.10	5072.11	
20.300	4.00	8.0	3350.8	3364.9	7.09	5072.11	
20.400	4.00	8.0	3344.6	3358.8	7.07	5072.11	
20.500	4.00	8.0	3338.5	3352.6	7.06	5072.10	
20.600	4.00	8.0	3332.4	3346.5	7.04	5072.10	
20.700	4.00	8.0	3326.4	3340.4	7.03	5072.09	
20.800	4.00	8.0	3320.3	3334.4	7.02	5072.09	
20.900	4.00	8.0	3314.3	3328.3	7.00	5072.09	
21.000	4.00	8.0	3308.4	3322.3	6.99	5072.08	
21.100	4.00	8.0	3302.4	3316.4	6.97	5072.08	
21.200	4.00	8.0	3296.5	3310.4	6.96	5072.07	25 x 1,440 cf
21.300	4.00	8.0	3290.6	3304.5	6.95	5072.07	
21.400	4.00	8.0	3284.7	3298.6	6.93	5072.07	
21.500	4.00	8.0	3278.9	3292.7	6.92	5072.06	
21.600	4.00	8.0	3273.1	3286.9	6.90	5072.06	
21.700	4.00	8.0	3267.3	3281.1	6.89	5072.05	
21.800	4.00	8.0	3261.6	3275.3	6.88	5072.05	
21.900	4.00	8.0	3255.8	3269.6	6.86	5072.05	
22.000	4.00	8.0	3250.1	3263.8	6.85	5072.04	
22.100	4.00	8.0	3244.4	3258.1	6.84	5072.04	
22.200	4.00	8.0	3238.8	3252.4	6.82	5072.04	
22.300	4.00	8.0	3233.2	3246.8	6.81	5072.03	
22.400	4.00	8.0	3227.6	3241.2	6.80	5072.03	
22.500	4.00	8.0	3222.0	3235.6	6.79	5072.02	1,440 cf
22.600	3.00	7.0	3215.5	3229.0	6.77	5072.02	1,260 cf
22.700	3.00	6.0	3208.0	3221.5	6.75	5072.02	1,080 cf
22.800	3.00	6.0	3200.5	3214.0	6.74	5072.01	1,080 cf
22.900	3.00	6.0	3193.0	3206.5	6.72	5072.01	1,080 cf
23.000	3.00	6.0	3185.6	3199.0	6.70	5072.00	1,080 cf
23.100	3.00	6.0	3178.3	3191.6	6.68	5072.00	1,080 cf
23.200	3.00	6.0	3170.9	3184.3	6.67	5071.99	1,080 cf
23.300	3.00	6.0	3163.6	3176.9	6.65	5071.99	1,080 cf
23.400	3.00	6.0	3156.4	3169.6	6.64	5071.98	1,080 cf
23.500	2.00	5.0	3148.1	3161.4	6.62	5071.97	900 cf
23.600	2.00	4.0	3138.9	3152.1	6.60	5071.97	720 cf
23.700	2.00	4.0	3129.8	3142.9	6.58	5071.96	720 cf
23.800	2.00	4.0	3120.6	3133.8	6.56	5071.96	720 cf
23.900	2.00	4.0	3111.6	3124.6	6.54	5071.95	720 cf
24.000	2.00	4.0	3102.5	3115.6	6.52	5071.94	720 cf
24.100	2.00	4.0	3093.5	3106.5	6.50	5071.94	720 cf
24.200	2.00	4.0	3084.6	3097.5	6.48	5071.93	720 cf
24.300	2.00	4.0	3075.6	3088.6	6.46	5071.93	720 cf
24.400	2.00	4.0	3066.8	3079.6	6.44	5071.92	720 cf
24.500	2.00	4.0	3057.9	3070.8	6.42	5071.91	720 cf
24.600	1.00	3.0	3048.1	3060.9	6.40	5071.91	540 cf

POND-2 Version: 5.17 S/N: 1295130221
EXECUTED: 07-10-2000 11:10:12

Pond File: NWPOND .PND
Inflow Hydrograph: NWELDHYD.HYD
Outflow Hydrograph: NWFLOW .HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS					
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	
24.700	1.00	2.0	3037.4	3050.1	6.38	5071.90	360 cf
24.800	1.00	2.0	3026.7	3039.4	6.35	5071.89	360 cf
24.900	1.00	2.0	3016.0	3028.7	6.33	5071.88	360 cf
25.000	1.00	2.0	3005.4	3018.0	6.31	5071.88	360 cf
25.100	1.00	2.0	2994.8	3007.4	6.28	5071.87	360 cf
25.200	1.00	2.0	2984.3	2996.8	6.26	5071.86	360 cf
25.300	1.00	2.0	2973.8	2986.3	6.24	5071.86	360 cf
25.400	1.00	2.0	2963.4	2975.8	6.22	5071.85	360 cf
25.500	0.00	1.0	2952.0	2964.4	6.19	5071.84	180 cf
25.600	0.00	0.0	2939.7	2952.0	6.16	5071.83	0 cf
25.700	0.00	0.0	2927.4	2939.7	6.14	5071.82	0 cf
25.800	0.00	0.0	2915.2	2927.4	6.11	5071.82	0 cf
25.900	0.00	0.0	2903.0	2915.2	6.08	5071.81	0 cf

Σ = 865,180 cf

+ up front = 117,180 cf

Total Storage = 982,360 cf

= 22.6 acre-ft

Factor of Safety = 1.5

∴ Total Storage = 34 acre-ft

ATTACHMENT 2
COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
WATER QUALITY CONTROL DEPARTMENT
COLORADO DISCHARGE PERMIT SYSTEM REGULATIONS
5CCR 1002-61.14(1)(B)(III)

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
WATER QUALITY CONTROL COMMISSION

REGULATION NO. 61

COLORADO DISCHARGE PERMIT SYSTEM REGULATIONS

ADOPTED: November 17, 1981
EFFECTIVE: December 20, 1981
AMENDED: March 29, 1982
EFFECTIVE: April 29, 1983
AMENDED: September 13, 1983
EFFECTIVE: October 31, 1983
AMENDED: May 15, 1984
EFFECTIVE: June 30, 1984
AMENDED: April 14, 1986
EFFECTIVE: May 30, 1986
AMENDED: June 2, 1987
EFFECTIVE: July 31, 1988
AMENDED: May 2, 1988
EFFECTIVE: July 1, 1989
AMENDED: November 2, 1988
EFFECTIVE: December 30, 1988
AMENDED: July 10, 1989
EFFECTIVE: August 31, 1989
AMENDED: December 4, 1990
EFFECTIVE: July 1, 1991
AMENDED: January 8, 1991
EFFECTIVE: March 2, 1991
AMENDED: June 4, 1991
EFFECTIVE: July 1, 1992
AMENDED: November 4, 1991
EFFECTIVE: December 30, 1991
EMERGENCY AMENDED: January 6, 1992
EFFECTIVE: January 6, 1992
AMENDED: April 7, 1992
EFFECTIVE: July 1, 1993
AMENDED: June 2, 1992
EFFECTIVE: June 30, 1992
AMENDED: February 2, 1993
EFFECTIVE: March 30, 1993
AMENDED: August 2, 1993
EFFECTIVE: September 30, 1993
AMENDED: July 11, 1994
EFFECTIVE: August 30, 1994
EMERGENCY AMENDED: November 14, 1994
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(b) The Division shall take immediate enforcement action against any housed commercial swine feeding operation that has exceeded the agronomic rate limit of subsection 61.13(4)(e).

61.14 GROUND WATER

(1) APPLICABILITY

(a) Pursuant to this section a permit shall be required for all land application discharges and for all discharges from impoundments unless:

(i) The discharge is exempted under section 61.14(1)(b);

(ii) The discharge is subject to regulation by one of the implementing agencies described in 61.14(2);

(iii) The impoundment has received a waiver from the Division pursuant to section 61.14(9)(a); or

(iv) The owner of a land application system can demonstrate that:

(A) The design and operation of the system will result in complete evapotranspiration of the effluent;

(B) There is adequate storage provided for the effluent during periods of inclement weather or where the ground has been frozen unless the provisions of (A) above, can be met during the entire year; and;

(C) Any augmentation plan or substitute supply plan for the land application site does not provide a credit for return of the effluent to ground water.

(b) The following facilities are specifically exempted from coverage under the ground water discharge provisions of this regulation:

(i) Any impoundment subject to regulation under the Uranium Mill Tailings Radiation Control Act, 42 U.S.C., Section 7901, et seq. as amended.

(ii) Any impoundment used in the treatment, storage or recharge of raw or potable water.

(iii) Any stormwater retention or detention impoundment.

(iv) Any impoundment or land application system for which a currently valid certificate of designation has been obtained pursuant to the Solid Waste Disposal Sites and Facilities Act, C.R.S. 1973, 30-20-101, et seq. as amended, and other impoundments or land application systems subject to regulation under that Act which are not part of a wastewater treatment system for which a Colorado Discharge Permit System (CDPS) permit for a discharge to surface waters is required.

(v) Any tank which does not result in a discharge to ground water.

APPENDIX B-3

Golder Associates

CALCULATIONS

Date:	08-November 2010	**Made by:**	MBR
Project No.:	103-81825	**Checked by:**	VJV
Subject:	Supplemental Runon H&H Calculations	**Reviewed by:**	
Project Short Title:	NWLF Drainage Improvements		

1.0 OBJECTIVES

Size a culvert to collect and divert stormwater runoff contributing to the maintenance shop area from the western portions of the landfill property to the landfill perimeter channels. Peak 100-year, 24-hour stormwater flowrates for the landfill were calculated in a previous calculation (RUST, 1995). This report will determine the 100-year, 24-hour peak flow contributing to a point upgradient of the maintenance shop area. This peakflow will then be added directly (no routing) to the flowrates provided in the RUST calculation to determine if the as-designed perimeter channels will be adequate to accommodate the additional runoff.

2.0 METHODS

The contributing basin was delineated based on site topography, see Figure 1. SCS Curve Number (CN) methodology is used to model the basin to the north of the existing berm and shop area; TR-55 methodology was used to model the basin in HEC-HMS (USACE, 2009). Parameters including subbasin area, CN, lag time, and slope are entered into HEC-HMS to develop a peak flow. Attachment A presents the manning's n and overland flow coefficients. A routing diagram displaying the routing logic is included in the attached HEC-HMS output (Attachment B). Channel dimensions provided by Waste Management were analyzed using a spreadsheet that solves for normal depth using manning's equation to verify that the additional stormwater flows determined in this calculation would not cause overtopping. Culvert sizing was performed using HY8 culvert sizing software (FHWA, 2009).

3.0 DATA AND ASSUMPTIONS

- NOAA Technical Atlas 2 precipitation depths (NOAA, 1973):

Return Period (years)	Precipitation Depth (inches)
2	1.7
100	4.0

- The rainfall hyetograph assumed an SCS Type II storm distribution.
- Minimum lag time is 3 minutes.
- SCS Curve Number was assumed to be 84 for consistency with the RUST calculations
- Manning's roughness coefficients:

Channel Lining/Material	Manning's n for Stability	Manning's n for Capacity
Grass	0.030	0.033
Riprap	0.035	0.040
HDPE (culvert)	0.012	0.012

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- Runoff contributing to the site was assumed to be bounded by the fence line to the west, as there is a ditch on the westernside of the fence to intercept stormwater from the county road.
- Culvert sizing assumed smooth-wall corrugated HDPE culvert with a conventional entrance.

4.0 CALCULATIONS

Figure 1 presents the subbasin delineation and approximate locations of the affected perimeter channel reaches. Table 1 presents the area-weighted curve number calculations. Table 2 shows the time of concentration calculations but due to uncertainties in determining a defined flow path a conservative, minimum lag time of 3-minutes was used. Table 3 includes a summary of the HEC-HMS model output. Table 4 provides channel geometry provided by Waste Management and flow information for the perimeter channels. The peak flow from the western runon area as determined from the HEC-HMS model was conservatively added directly to the peak flows in the perimeter channels as reported in the RUST report. HY8 output for the culvert sizing calculations are presented as C.

5.0 CONCLUSIONS/RESULTS

The HEC-HMS results indicate that the estimated 100-year, 24-hour peak flow from the western run-on area is 7 cubic feet per second. The HY8 results indicate that an 18-inch diameter smooth wall HDPE culvert is adequate to pass the 7 cubic feet per second design flow. Based on the channel dimensions provided by Waste Management the additional peak flow will not adversely impact the as-designed perimeter channels. However, in order to provide adequate cover for the proposed culvert under the access road perimeter channel Reach 5-6 was steepened and Reach 6-7 was flattened to allow for a lower pipe invert elevation at the outlet, this change is reflected in Table 4.

6.0 LIST OF ATTACHMENTS

Attachment A - Travel Time, Manning's n, and Overland Flow Coefficients

Attachment B - HEC-HMS Model Parameters

Attachment C - HY8 Model Output

7.0 REFERENCES

HEC-HMS Hydrologic Modeling System [computer software] August, 2009. US Army Corps of Engineers Version 3.4

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Drawing File: C:\Users\MRichey\Documents\TEMP\ NWLF Culv Basin.dwg | Layout: 11x17 Landscape | Modified: Nov 08, 2010 08:57 MRichey | Plotted: 11/08/10 8:58am MRichey

DRAFT

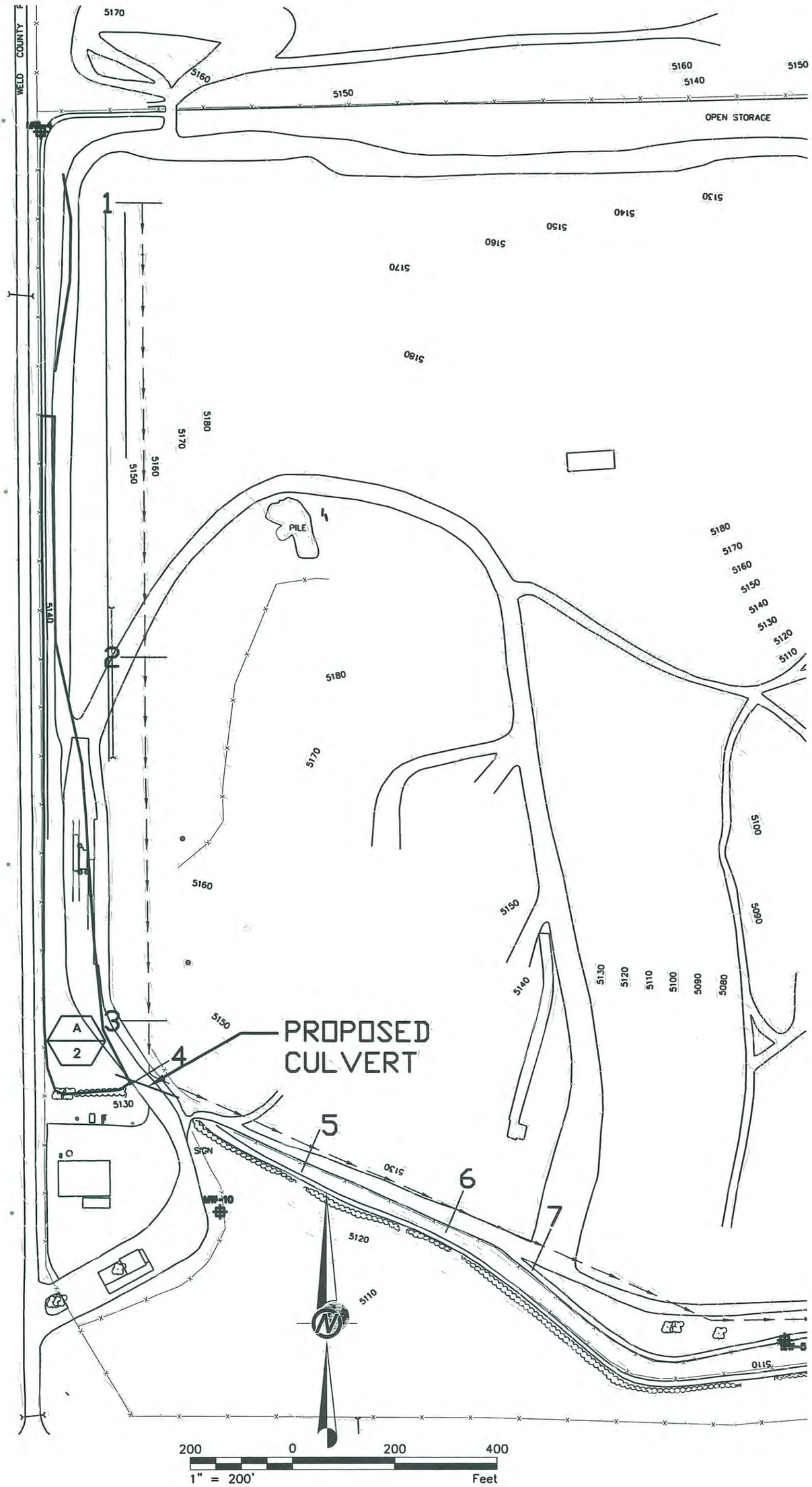


FIGURE 1

PROJECT No.	103-81825
FILE No.	NWLF Culv Basin
REV.	A
SCALE	AS SHOWN
DESIGN	MBR 10/05/10
CADD	MBR 10/05/10
CHECK	
REVIEW	

TITLE

RUNON BASIN DELINEATION AND SELECT PERIMETER CHANNEL LOCATIONS

PROJECT

NORTH WELD LANDFILL

Golder Associates

TABLE 1
SUBBASIN SUMMARY TABLE

Waste Management
North Weld Landfill
Project Number: 103-81825

Date:	11/8/10
By:	MBR
Chkd:	VJV
Apprvd:	JCV

Design Storm **100 -Year Reccurence Interval**

Storm Duration (hours)	2-Year Depth (inches)	100 -Year Depth (inches)	Storm Distribution
24	2.2	4.0	II

Subbasin ID	Subbasin Area (ft^2)	Subbasin Area (acres)	Subbasin Area (sq mile)	CN = 84 Landfill Slopes (acres)	Composite SCS Curve No.	$S = \frac{1000}{CN} - 10$	Unit Runoff Q (in)	Runoff Volume (ac-ft)	Runoff Volume (ft^3)
A	87,265	2.00	0.0031	2.00	CN = 84	1.90	2.37	0.40	17,243
Total:	87,265	2.00	0.00					0.40	17,243

TABLE 2
BASIN TIME OF CONCENTRATION CALCULATIONS

Waste Management
North Weld Landfill
Project Number: 103-81825

Date:	11/8/10
By:	MBR
Chkd:	VJV
Apprvd:	

					Flow Segment 1						Flow Segment 2						Flow Segment 3					
Subbasin ID	Subbasin Area (sq mile)	Composite Curve Number	Total Lag (0.6*Tc) (min)	Total Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[1]	Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[1]	Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)	Type of Flow	Length (ft)	Slope (ft/ft)	Roughness Condition[1]	Typical Hydraulic Radius (Channel Only) (ft)	Travel Time (min)
A	0.0031	84	15.4	25.7	Sheet	100.0	0.010	E Short Grass		15.6	Shallow	590.0	0.010	U Unpaved		6.1	Channel	630	0.008	E Earth-lined	0.34	4.1

Notes:
(1) Refer to Attachment A for Roughness Condition descriptions and Tc Coeffiecients.

TABLE 3
FLOW RESULTS FROM HEC-HMS

Waste Management
North Weld Landfill
Project Number: 103-81825

Date:	11/8/10
By:	MBR
Chkd:	VJV
Apprvd:	

HEC-HMS Basin Model:	Western Runon
HEC-HMS Met. Model:	100-year 24-hour
HEC-HMS Control Specs:	48-hr 5-min

Hydrologic Element	Drainage Area (sq mile)	Peak Discharge (cfs)	Time of Peak	Total Volume (ac-ft)
A	0.0031	7.0	05Jun2020, 00:55	0.4

Channel Hydraulic Calculations

Waste Management
North Weld Landfill
PROJECT 103-81825

Date:	11/8/10
By:	MBR
Chkd:	VJN
Apprvd:	MJF

	Reach Designation	Estimated 100-year Flow Rate (cfs)	Channel Design Geometry: Bed Slope (ft/ft)	Left Side Slope (H:1V)	Right Side Slope (H:1V)	Bottom Width (ft)	Minimum Channel Depth (ft)	Channel Roughness Parameters: Design Channel Lining		Mannings 'n' for Capacity (Depth Calculation)	Mannings 'n' for Stability (Velocity Calculation)	Hydraulic Calculations: Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)	Froude Number	Normal Depth Shear Stress (lb/ft^2)	Stream Power (W/m^2)	Top Width of Flow (ft)	Top Width of Channel (ft)	Channel Evaluations: Available Freeboard (ft)	
Revised	Reach 1 - 2.	24.0	0.015	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.7	1.10	0.97	1.03	70.1	7.4	15.0	1.9	
	Reach 2 - 3	24.0	0.009	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	3.9	1.25	0.77	0.70	39.8	8.0	15.0	1.7	
	Reach 3 - 5	24.0	0.006	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	3.4	1.38	0.63	0.52	25.3	8.5	15.0	1.6	
	Reach 5 - 6	35.0	0.014	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	5.1	1.35	0.96	1.18	87.0	8.4	15.0	1.6	
	Reach 6 - 7	35.0	0.015	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	5.2	1.33	1.00	1.25	94.0	8.3	15.0	1.7	
	Reach 7-8	35.0	0.006	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	3.7	1.67	0.65	0.62	33.6	9.7	15.0	1.3	
	Reach 8 - 9	39.0	0.045	2.0	2.0	3	3.0	R	Riprap	0.040	0.035	7.1	1.14	1.45	3.20	331.6	7.6	15.0	1.9	
	Reach 9 - 10	43.0	0.026	2.0	2.0	3	3.0	R	Riprap	0.040	0.035	6.0	1.37	1.13	2.23	194.2	8.5	15.0	1.6	
	Reach 10 - 11	43.0	0.008	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.4	1.72	0.75	0.86	54.2	9.9	15.0	1.3	
	Reach 11 - 12	51.0	0.008	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.6	1.86	0.76	0.93	61.5	10.5	15.0	1.1	

(1) Note: Comments and Warnings:
< 1.0 ft indicates freeboard is less than 1 foot.
< 1/2 Vel. Head indicates that the remaining freeboard is less than 1/2 the velocity head ($V^2/2g$) suggesting water may splash out.
Warning: VxD>9 indicates that the velocity times the depth is greater than 9 ft^2/sec, which is undesirable and may be ur
Unstable V indicates that calculated velocity exceeds the recommended maximum for the lining material.
Unstable T indicates that calculated shear stress exceeds the recommended maximum for the lining material.

Attachment A
Travel Time, Manning's n, and Overland Flow Coefficients

Attachment A
Time of Concentration and Mannings Flow Coefficients

TR-55 (1986)

Sheet Flow Travel time (SCS Upland Method)

$$T_t = \frac{0.007\ (n'\ L)^{0.8}}{(P_2)^{0.5}\ S^{0.4}}$$

Where: T_t = travel time (hr); n' = roughness coefficient; L = flow length (ft);
P_2 = 2-yr storm depth (inches); s = slope (ft/ft)
flow velocity = $L/(60T_t)$

Flow Type	Surface Type	roughness n	Surface Description	Short Description
Sheet/Overland Flow	A	0.011	Smooth surfaces (concrete, asphalt, gravel, bare soil)	Smooth
	B	0.05	Fallow (no residue)	Fallow
	C	0.06	Cultivated soils: Residue cover <= 20%	Cover<20%
	D	0.17	Cultivated soils: Residue cover > 20%	Cover>20%
	E	0.15	Grass: Short grass prairie	Short Grass
	F	0.24	Grass: Dense grasses	Dense Grass
	G	0.41	Grass: Bermuda grass	Bermuda Grass
	H	0.13	Range (natural)	Range
	I	0.40	Woods: Light underbrush	Light woods
	J	0.80	Woods: Heavy underbrush	Heavy Woods

Shallow Concentrated Flow Velocity (SCS Upland Method)

$v = mS^{0.5}$ Where: v = velocity (fps); m = roughness coeffient; S = slope (ft/ft)

Flow Type	Surface Type	Roughness m	Surface Description	Short Description
Shallow Conc. Flow	P	20.3282	Paved Surfaces	Paved
	U	16.1345	Unpaved Surfaces	Unpaved

Channel Flow Velocity (Mannings Velocity)

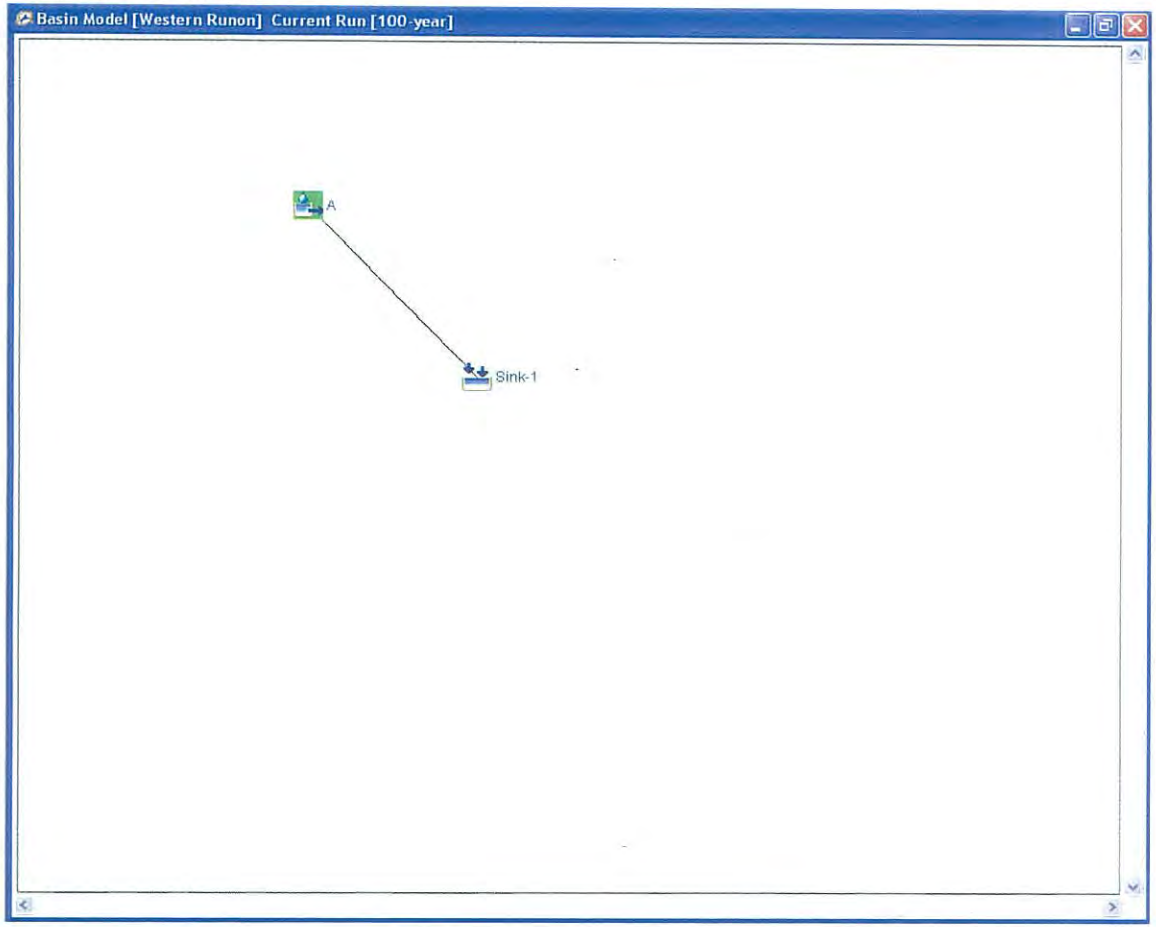
$v = 1.49/n\ Rh^{2/3}S^{1/2}$ Where: v = velocity (fps); n = roughness coeffient; Rh = Hydraulic Radius (ft), S = slope (ft/ft)

Lining Type	Mannings n for Depth	Mannings n for Velocity	Material	Maximum Velocity	Maximum Shear Stress
A	0.026	0.026	ACB	25	
C	0.024	0.022	CSP	50	
E	0.025	0.022	Earth-lined	3	
G	0.035	0.030	Grass-lined	5	
I	0.017	0.013	Ductile Iron	50	
P	0.012	0.009	Plastic	25	
R	0.040	0.035	Riprap	16	
T	0.035	0.030	Turf Reinf.	10	1.5
Z	0.060	0.005	Other	25	

Attachment B
HEC-HMS Model Parameters

Attachment B
HEC-HMS Screen Captures and Inputs

HEC-HMS Basin Model Schematic



Sub Basin Area	
Subbasin	Area (mi^2)
A	0.003100

Loss SCS Curve Number			
Subbasin	Initial Abstraction (in)	Curve Number	Impervious (%)
A		84	0

Transform SCS Unit Hydrograph	
Subbasin	Lag Time (min)
A	3

Attachment C
HY8 Model Output

HY-8 Culvert Analysis Report

Water Surface Profile Plot for Culvert: Culvert 1

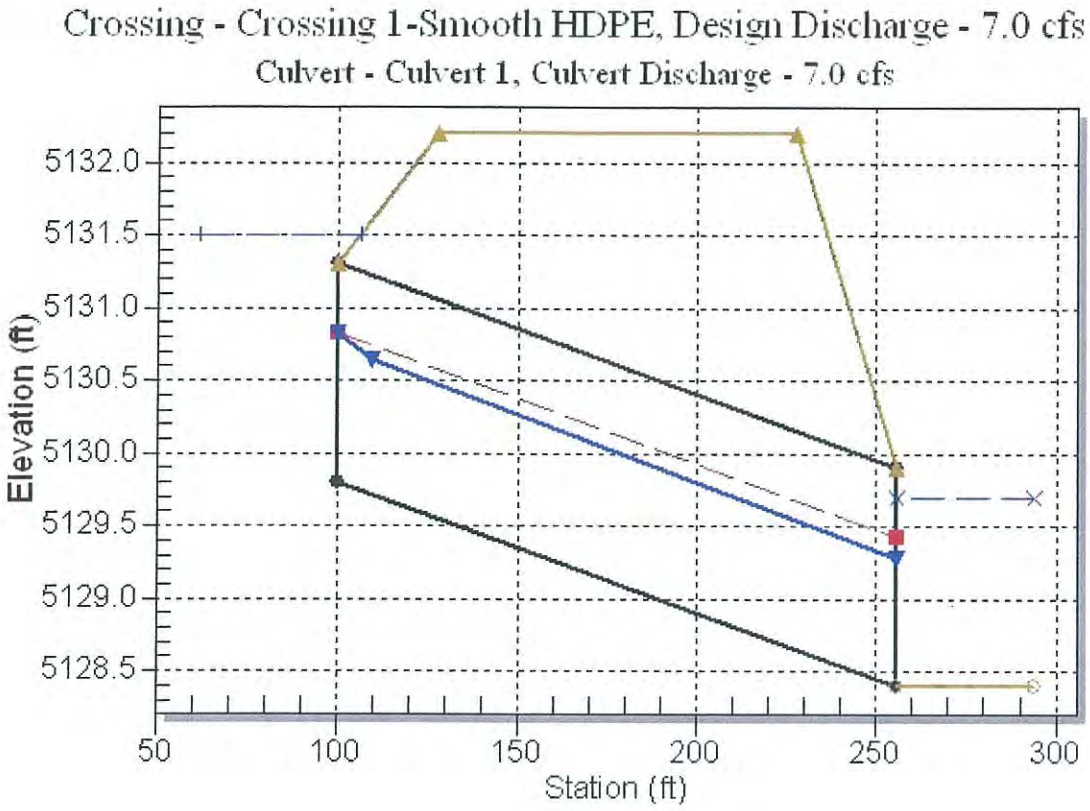


Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5129.80	0.000	0.0*	0-NF	0.000	0.000	0.000	1.300	0.000	0.000
0.70	0.70	5130.24	0.440	0.0*	1-S2n	0.248	0.309	0.249	1.300	3.551	0.000
1.40	1.40	5130.43	0.631	0.0*	1-S2n	0.358	0.442	0.361	1.300	4.231	0.000
2.10	2.10	5130.59	0.786	0.0*	1-S2n	0.447	0.542	0.448	1.300	4.741	0.000
2.80	2.80	5130.73	0.926	0.0*	1-S2n	0.516	0.632	0.522	1.300	5.097	0.000
3.50	3.50	5130.85	1.050	0.0*	1-S2n	0.585	0.711	0.586	1.300	5.468	0.000
4.20	4.20	5130.97	1.168	0.0*	1-S2n	0.647	0.783	0.647	1.300	5.777	0.000
4.90	4.90	5131.09	1.288	0.0*	1-S2n	0.706	0.848	0.707	1.300	5.975	0.000
5.60	5.60	5131.21	1.414	0.0*	1-S2n	0.765	0.912	0.765	1.300	6.185	0.000
6.30	6.30	5131.35	1.551	0.0*	5-S2n	0.821	0.967	0.826	1.300	6.320	0.000
7.00	7.00	5131.50	1.702	0.0*	5-S2n	0.877	1.022	0.878	1.300	6.513	0.000

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5129.80 ft, Outlet Elevation (invert): 5128.40 ft

Culvert Length: 155.01 ft, Culvert Slope: 0.0090

****

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 2 - Downstream Channel Rating Curve (Crossing: Crossing 1-Smooth HDPE)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	5129.70	1.30
0.70	5129.70	1.30
1.40	5129.70	1.30
2.10	5129.70	1.30
2.80	5129.70	1.30
3.50	5129.70	1.30
4.20	5129.70	1.30
4.90	5129.70	1.30
5.60	5129.70	1.30
6.30	5129.70	1.30
7.00	5129.70	1.30

Tailwater Channel Data - Crossing 1-Smooth HDPE

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5129.70 ft

Roadway Data for Crossing: Crossing 1-Smooth HDPE

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 72.00 ft

Crest Elevation: 5132.20 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

APPENDIX B-4

CALCULATIONS

Date:	14-January-2013	**Made by:**	MBR
Project No.:	123-82269	**Checked by:**	CPA
Subject:	Supplemental H&H Calculations Revision 1	**Reviewed by:**	DCB
Project Short Title:	NWLF Drainage Improvements		

1.0 OBJECTIVES

This calculation serves as a supplement to the Engineering Design and Operations Plan (EDOP) prepared by RUST (RUST, 1995) to document changes to the hydrology and hydraulics calculations. In this revision the calculations originally prepared by Golder in 2010 are updated to reflect changes to the landfill perimeter channel as a result of the proposed liner grading associated with the construction of Phase 3a Module 3. Additionally, a culvert has been sized for an access road crossing over the perimeter channel, and the perimeter channel riprap revetment has been re-analyzed. Peak 100-year, 24-hour stormwater flowrates for the landfill were calculated in a previous calculation (RUST, 1995). This memorandum estimates a 100-year, 24-hour peak flow contributing to a point upgradient of the maintenance shop area which is subsequently added directly (no routing) to the flowrates provided in the RUST calculation to determine if the as-designed perimeter channels will be adequate to accommodate the additional runoff.

2.0 METHODS

The contributing basin for the maintenance shop area was delineated based on site topography, see Figure 1. SCS Curve Number (CN) methodology was used to estimate runoff from this area. Parameters including subbasin area, CN, lag time, and slope were entered into HEC-HMS to develop a peak flow. Attachment A presents the manning's n and overland flow coefficients. A routing diagram displaying the routing logic is included in the attached HEC-HMS output (Attachment B). Revised channel dimensions provided by Waste Management (Figure 2) were analyzed using a spreadsheet that solves for normal depth using manning's equation to verify that the additional stormwater flows determined in this calculation would not cause overtopping. Culvert sizing was performed using HY8 culvert sizing software (FHWA, 2009).

3.0 DATA AND ASSUMPTIONS

- NOAA Technical Atlas 2 precipitation depths (NOAA, 1973):

Return Period (years)	Precipitation Depth (inches)
2	1.7
100	4.0

- The rainfall hyetograph assumed an SCS Type II storm distribution.
- Basin A lag time assumed to be 3 minutes (for consistency with previous calculations).
- SCS Curve Number was assumed to be 84 for consistency with the RUST calculations

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- Manning's roughness coefficients:

Channel Lining/Material	Manning's n for Stability	Manning's n for Capacity
Grass	0.030	0.033
TRM	0.030	0.035
HDPE (culvert)	0.012	0.012

- Runoff contributing to the site was assumed to be bounded by the fence line to the west, as there is a ditch on the western side of the fence to intercept stormwater from the county road.
- Culvert sizing assumed smooth-wall corrugated HDPE culvert with an entrance mitered to match the fill slope.
- Maximum allowable peak flow velocity in the perimeter channel with grass lining is assumed to be 5.5 ft/s. Channel reaches with peak velocities in excess of 5.5 ft/s will be lined with TRM.

4.0 CALCULATIONS

Figure 1 presents the subbasin delineation and approximate locations of the affected perimeter channel reaches. Table 1 presents the area-weighted curve number calculations. Table 3 includes a summary of the HEC-HMS model output. Table 4 provides channel geometry provided by Waste Management and flow information for the perimeter channels. The peak flow from the western runon area as determined from the HEC-HMS model was conservatively added directly to the peak flows in the perimeter channels as reported in the RUST report.

5.0 CONCLUSIONS/RESULTS

The HEC-HMS results indicate that the estimated 100-year, 24-hour peak flow from the western run-on area is 7 cubic feet per second (cfs). The HY8 results indicate that an 18-inch diameter smooth wall HDPE culvert is adequate to pass the 7 cfs design flow for the main haul road culvert with a headwater of 1.7 ft above the culvert invert and a 36-inch diameter smooth wall HDPE culvert is adequate to pass the 24 cfs design flow for the access road crossing of the perimeter channel with a headwater of 2.4 ft above the culvert invert. Based on the channel dimensions provided by Waste Management, the additional peak flow will not adversely impact the as-designed perimeter channels. A summary of the estimated design flows and subsequent flow velocities is presented in the following table:

Reach I.D	Sidslope	Bottom Width (ft)	Depth (ft)	Lining	100-year Peak Flow (cfs)	100-year Peak Velocity (fps)
1 – 7	2H:1V	3	3	Grass	24	4.8
7 – 8	2H:1V	3	3	TRM	35	6.0
8 – 10	2H:1V	3	3	Grass	35	4.9
10 – 12	2H:1V	3	3	TRM	35	8.4
12-15	2H:1V	3	3	Grass	43	5.4
15 - 16	2H:1V	3	3	TRM	51	5.6

6.0 LIST OF ATTACHMENTS

Attachment A - Travel Time, Manning's n, and Overland Flow Coefficients

Attachment B - HEC-HMS Model Parameters

Attachment C - HY8 Model Output

7.0 REFERENCES

HEC-HMS Hydrologic Modeling System [computer software] August, 2009. US Army Corps of Engineers Version 3.4

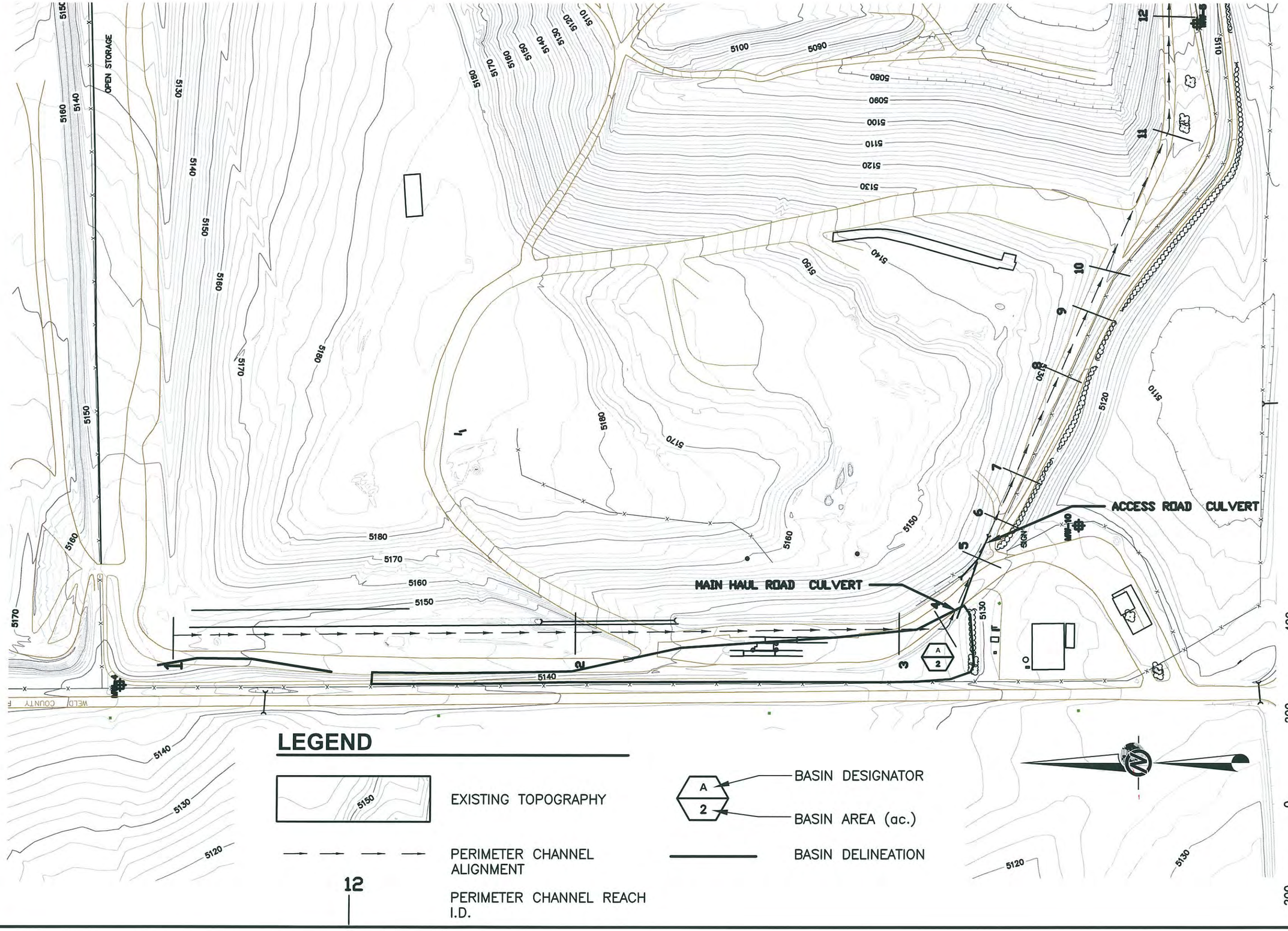
U.S. National Oceanic and Atmospheric Administration (NOAA). 1973. *Precipitation Frequency Atlas of the Western US, Atlas No. 2, volume III - Colorado.* Silver Spring MD : US Department of Commerce.

U.S. Army Corps of Engineers (USACE). 1994. *Hydraulic Design of Flood Control Channels.* Engineer Manual 1110-2-1601. Department of the Army. Washington D.C. : United States Government Printing Office.

U.S. Federal Highway Administration (FHWA). 2009. HY8 Version 7.2 FHWA Culvert Analysis. Washington, DC. : FHA Office of Technology Applications.

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LEGEND

- EXISTING TOPOGRAPHY (5150)
- PERIMETER CHANNEL ALIGNMENT
- PERIMETER CHANNEL REACH I.D. (12)
- BASIN DESIGNATOR (A) / BASIN AREA (ac.) (2)
- BASIN DELINEATION

Golder Associates

PROJECT

NORTH WELD LANDFILL

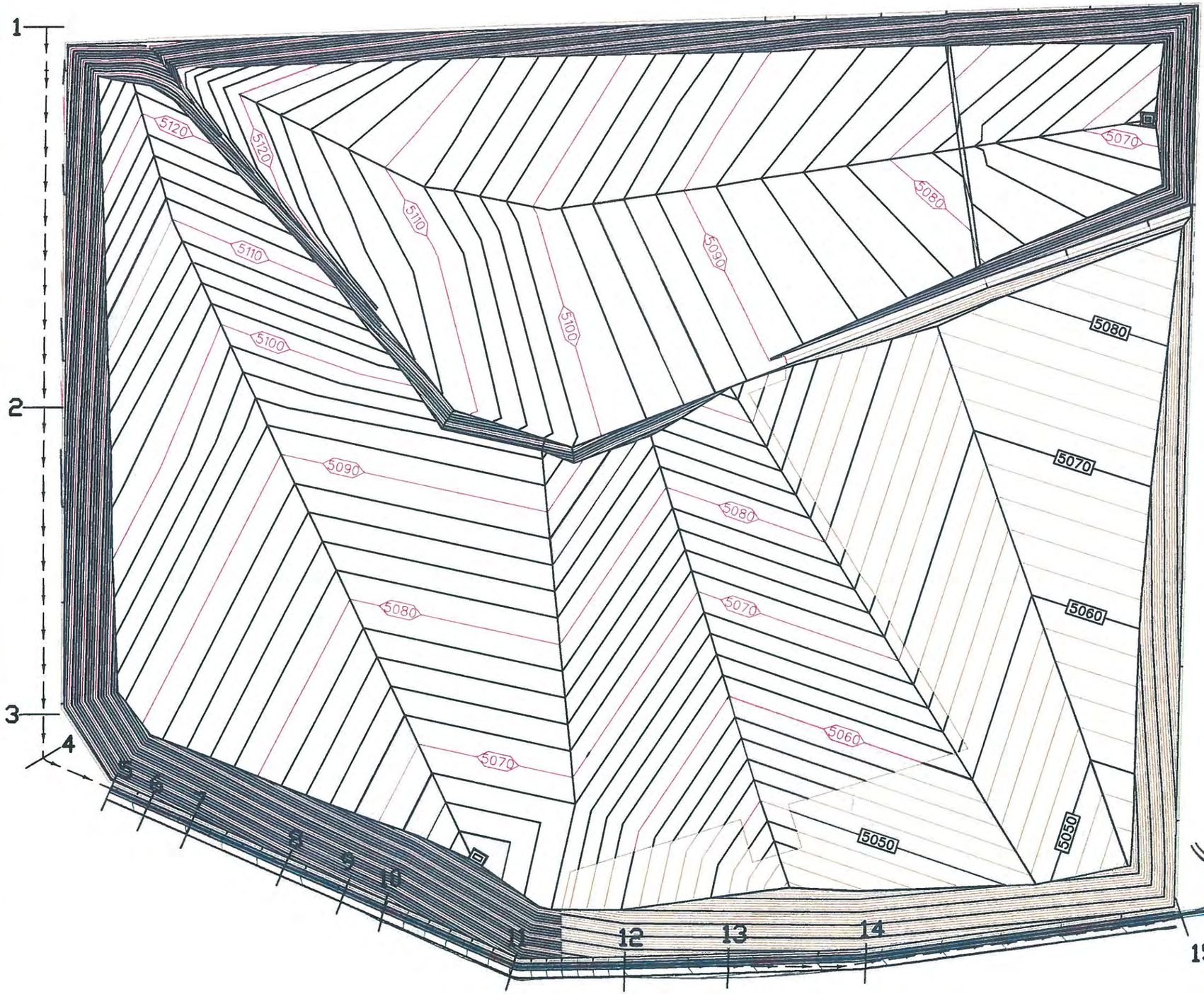
TITLE

RUNON BASIN DELINEATION AND SELECT PERIMETER CHANNEL LOCATIONS

PROJECT No. 103-81825		
FILE No. NWLF Culv Basin		
REV. A	SCALE AS SHOWN	
DESIGN	MBR	10/05/10
CADD	MBR	10/05/10
CHECK		
REVIEW		

FIGURE 1

Drawing File: N:\10\103-81825\DESIGN\ NWLF Culv Basin.dwg | Layout: 11x17 Landscape | Modified: Apr 18, 2013 09:30 jparisi | Plotted: 06/19/13 11:06am jparisi



LEGEND

175
150

PROPOSED LINER GRADE TOPOGRAPHY

PERIMETER CHANNEL ALIGNMENT

12

PERIMETER CHANNEL REACH I.D.

250 0 250 500

1" = 250' Feet

PROJECT

WASTE MANAGEMENT
NORTH WELD LANDFILL

TITLE

REVISED CHANNEL ALIGNMENT AND LANDFILL LINER GRADES

Golder Associates

PROJECT No.		123-82269	FILE No.	Liner Grades and Channel Reaches 2012	
DESIGN	MBR	12/14/12	SCALE	N/A	REV. A
CADD	MBR	12/14/12	FIG 2		
CHECK		12/14/12			
REVIEW		12/14/12			

Drawing File: N:\12\123-82269\DESIGN\ Liner Grades and Channel Reaches 2012.dwg | Layout: 11x17 Landscape | Modified: Dec 20, 2012 10:38 CPBaxter | Plotted: 12/20/12 11:24am CPBaxter

TABLE 1
SUBBASIN SUMMARY TABLE

Waste Management
North Weld Landfill
Project Number: 103-81825

Date:	11/8/10
By:	MBR
Chkd:	VJV
Apprvd:	JCV

Design Storm **100 -Year Reccurence Interval**

Storm Duration (hours)	2-Year Depth (inches)	100 -Year Depth (inches)	Storm Distribution
24	2.2	4.0	II

Subbasin ID	Subbasin Area (ft^2)	Subbasin Area (acres)	Subbasin Area (sq mile)	CN = 84 Landfill Slopes (acres)	Composite SCS Curve No.	$S = \frac{1000}{CN} - 10$	Unit Runoff Q (in)	Runoff Volume (ac-ft)	Runoff Volume (ft^3)
A	87,265	2.00	0.0031	2.00	CN = 84	1.90	2.37	0.40	17,243
Total:	87,265	2.00	0.00					0.40	17,243

TABLE 3
FLOW RESULTS FROM HEC-HMS

Waste Management
North Weld Landfill
Project Number: 103-81825

Date:	11/8/10
By:	MBR
Chkd:	VJV
Apprvd:	

HEC-HMS Basin Model:	Western Runon
HEC-HMS Met. Model:	100-year 24-hour
HEC-HMS Control Specs:	48-hr 5-min

Hydrologic Element	Drainage Area (sq mile)	Peak Discharge (cfs)	Time of Peak	Total Volume (ac-ft)
A	0.0031	7.0	05Jun2020, 00:55	0.4

Table 4
Channel Hydraulic Calculations

Waste Management
North Weld Landfill
PROJECT 123-82269

Date:	1/14/13
By:	MBR
Chkd:	CPB 1/14/13
Apprvd:	BDS 1/14/13

	Reach Designation	Estimated 100-year Flow Rate (cfs)	Channel Design Geometry: Bed Slope (ft/ft)	Left Side Slope (H:1V)	Right Side Slope (H:1V)	Bottom Width (ft)	Minimum Channel Depth (ft)	Channel Roughness Parameters: Design Channel Lining		Mannings 'n' for Capacity (Depth Calculation)	Mannings 'n' for Stability (Velocity Calculation)	Hydraulic Calculations: Maximum Velocity (ft/sec)	Maximum Normal Flow Depth (ft)	Froude Number	Normal Depth Shear Stress (lb/ft^2)	Stream Power (W/m^2)	Top Width of Flow (ft)	Top Width of Channel (ft)	Channel Evaluations: Available Freeboard (ft)	
Revised (2012 Alignment)	Reach 1 - 2.	24.0	0.015	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.7	1.10	0.97	1.03	70.1	7.4	15.0	1.9	
	Reach 2 - 3	24.0	0.009	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	3.9	1.25	0.77	0.70	39.8	8.0	15.0	1.7	
	Reach 3 - 5	24.0	0.006	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	3.4	1.38	0.63	0.52	25.3	8.5	15.0	1.6	
	Reach 5 - 6	24.0	0.012	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.4	1.15	0.89	0.89	56.8	7.6	15.0	1.8	
	Reach 6 - 7	24.0	0.016	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.8	1.09	1.00	1.07	74.2	7.3	15.0	1.9	
	Reach 7 - 8	35.0	0.022	2.0	2.0	3	3.0	T	Turf Reinf.	0.035	0.030	6.0	1.21	1.19	1.66	144.0	7.8	15.0	1.8	
	Reach 8 - 9	35.0	0.013	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	4.9	1.39	0.92	1.09	77.3	8.6	15.0	1.6	
	Reach 9 - 10	35.0	0.007	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	3.9	1.60	0.70	0.70	40.0	9.4	15.0	1.4	
	Reach 10 - 11	35.0	0.037	2.0	2.0	3	3.0	T	Turf Reinf.	0.035	0.030	7.2	1.06	1.52	2.45	256.9	7.2	15.0	1.9	
	Reach 11 - 12	35.0	0.056	2.0	2.0	3	3.0	T	Turf Reinf.	0.035	0.030	8.4	0.95	1.85	3.32	404.4	6.8	15.0	2.0	
	Reach 12 - 13	39.0	0.013	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	5.1	1.45	0.94	1.18	87.0	8.8	15.0	1.5	
	Reach 13 - 14	43.0	0.013	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	5.2	1.53	0.94	1.24	93.6	9.1	15.0	1.5	
	Reach 14 - 15	43.0	0.014	2.0	2.0	3	3.0	G	Grass-lined	0.035	0.030	5.4	1.50	0.98	1.31	101.8	9.0	15.0	1.5	
	Reach 15 - 16	51.0	0.014	2.0	2.0	3	3.0	T	Turf Reinf.	0.035	0.030	5.6	1.63	0.99	1.42	115.7	9.5	15.0	1.4	

(1) Note: Comments and Warnings:
< 1.0 ft indicates freeboard is less than 1 foot.
< 1/2 Vel. Head indicates that the remaining freeboard is less than 1/2 the velocity head ($V^2/2g$) suggesting water may splash out.
Warning: VxD>9 indicates that the velocity times the depth is greater than 9 ft^2/sec, which is undesirable and may be u
Unstable V indicates that calculated velocity exceeds the recommended maximum for the lining material.
Unstable T indicates that calculated shear stress exceeds the recommended maximum for the lining material.

Attachment A
Travel Time, Manning's n, and Overland Flow Coefficients

Attachment A
Time of Concentration and Mannings Flow Coefficients

TR-55 (1986)

Sheet Flow Travel time (SCS Upland Method)

$$T_t = \frac{0.007\,(n' L)^{0.8}}{(P_2)^{0.5}\, s^{0.4}}$$

Where: T_t = travel time (hr); n' = roughness coefficient; L = flow length (ft);

P_2 = 2-yr storm depth (inches); s = slope (ft/ft)

flow velocity = $L/(60T_t)$

Flow Type	Surface Type	roughness n	Surface Description	Short Description
Sheet/Overland Flow	A	0.011	Smooth surfaces (concrete, asphalt, gravel, bare soil)	Smooth
	B	0.05	Fallow (no residue)	Fallow
	C	0.06	Cultivated soils: Residue cover <= 20%	Cover<20%
	D	0.17	Cultivated soils: Residue cover > 20%	Cover>20%
	E	0.15	Grass: Short grass prairie	Short Grass
	F	0.24	Grass: Dense grasses	Dense Grass
	G	0.41	Grass: Bermuda grass	Bermuda Grass
	H	0.13	Range (natural)	Range
	I	0.40	Woods: Light underbrush	Light woods
	J	0.80	Woods: Heavy underbrush	Heavy Woods

Shallow Concentrated Flow Velocity (SCS Upland Method)

$v = mS^{0.5}$

Where: v = velocity (fps); m = roughness coeffient; S = slope (ft/ft)

Flow Type	Surface Type	Roughness m	Surface Description	Short Description
Shallow Conc. Flow	P	20.3282	Paved Surfaces	Paved
	U	16.1345	Unpaved Surfaces	Unpaved

Channel Flow Velocity (Mannings Velocity)

$v = 1.49/n\ Rh^{2/3}S^{1/2}$

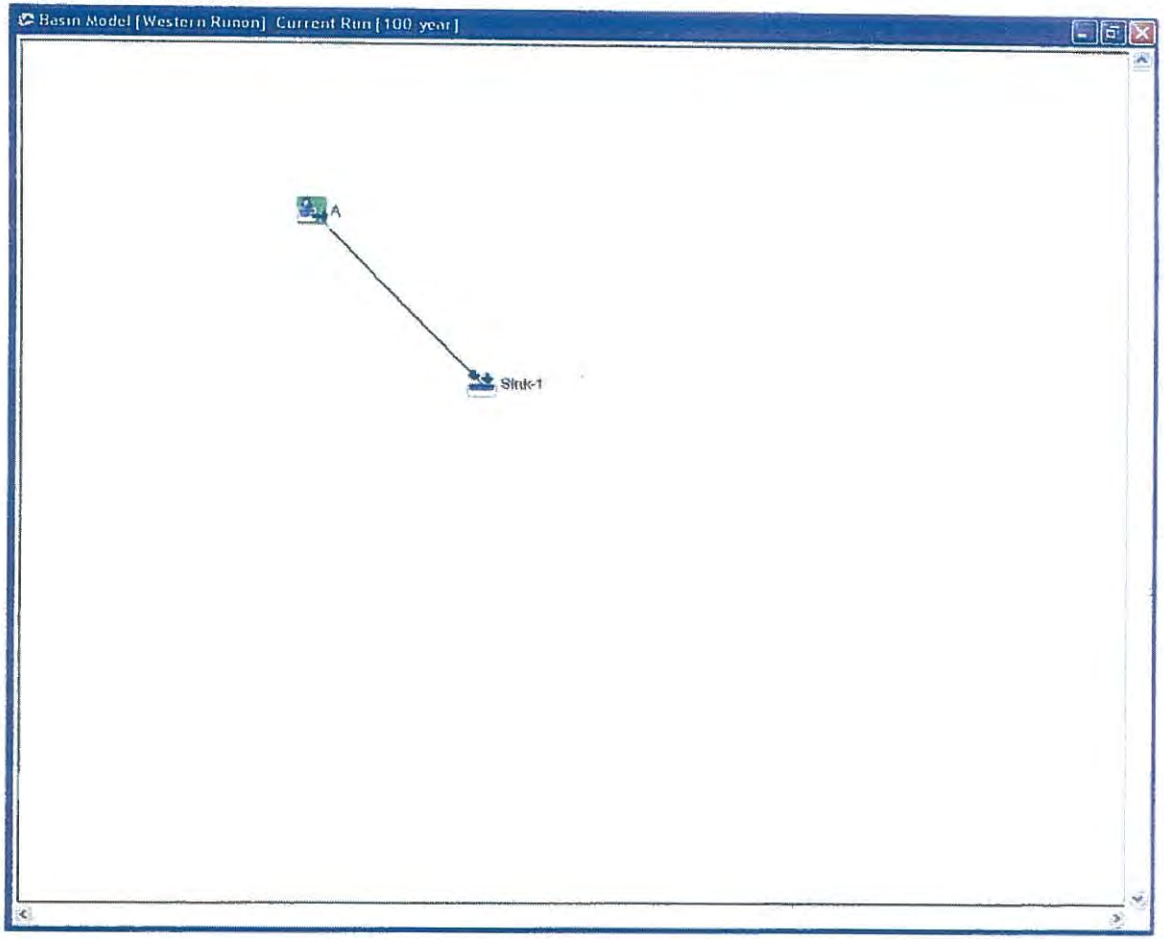
Where: v = velocity (fps); n = roughness coeffient; Rh = Hydraulic Radius (ft), S = slope (ft/ft)

Lining Type	Mannings n for Depth	Mannings n for Velocity	Material	Maximum Velocity	Maximum Shear Stress
A	0.026	0.026	ACB	25	
C	0.024	0.022	CSP	50	
E	0.025	0.022	Earth-lined	3	
G	0.035	0.030	Grass-lined	5	
I	0.017	0.013	Ductile Iron	50	
P	0.012	0.009	Plastic	25	
R	0.040	0.035	Riprap	16	
T	0.035	0.030	Turf Reinf.	10	1.5
Z	0.060	0.005	Other	25	

Attachment B
HEC-HMS Model Parameters

Attachment B
HEC-HMS Screen Captures and Inputs

HEC-HMS Basin Model Schematic



Sub Basin Area	
Subbasin	Area (mi^2)
A	0.003100

Loss SCS Curve Number			
Subbasin	Initial Abstraction (in)	Curve Number	Impervious (%)
A		84	0

Transform SCS Unit Hydrograph	
Subbasin	Lag Time (min)
A	3

Attachment C
HY8 Model Output

HY-8 Culvert Analysis Report

Water Surface Profile Plot for Culvert: Culvert 1

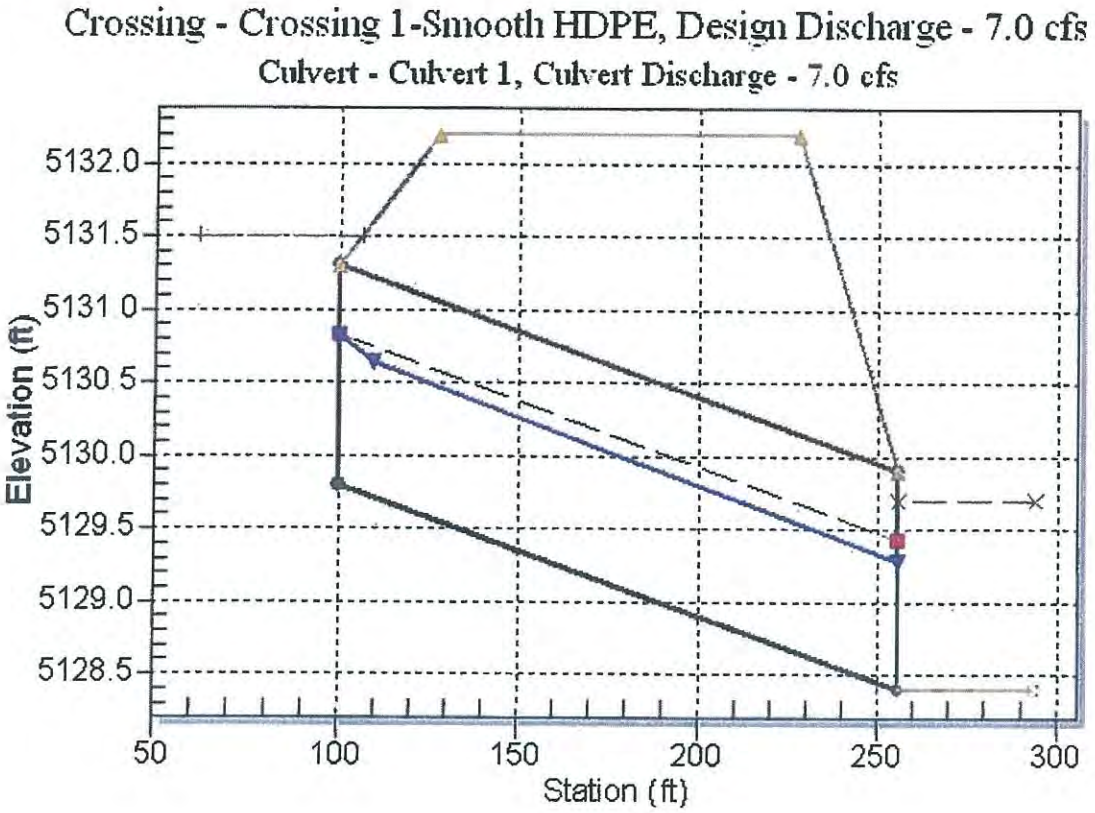


Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5129.80	0.000	0.0*	0-NF	0.000	0.000	0.000	1.300	0.000	0.000
0.70	0.70	5130.24	0.440	0.0*	1-S2n	0.248	0.309	0.249	1.300	3.551	0.000
1.40	1.40	5130.43	0.631	0.0*	1-S2n	0.358	0.442	0.361	1.300	4.231	0.000
2.10	2.10	5130.59	0.786	0.0*	1-S2n	0.447	0.542	0.448	1.300	4.741	0.000
2.80	2.80	5130.73	0.926	0.0*	1-S2n	0.516	0.632	0.522	1.300	5.097	0.000
3.50	3.50	5130.85	1.050	0.0*	1-S2n	0.585	0.711	0.586	1.300	5.468	0.000
4.20	4.20	5130.97	1.168	0.0*	1-S2n	0.647	0.783	0.647	1.300	5.777	0.000
4.90	4.90	5131.09	1.288	0.0*	1-S2n	0.706	0.848	0.707	1.300	5.975	0.000
5.60	5.60	5131.21	1.414	0.0*	1-S2n	0.765	0.912	0.765	1.300	6.185	0.000
6.30	6.30	5131.35	1.551	0.0*	5-S2n	0.821	0.967	0.826	1.300	6.320	0.000
7.00	7.00	5131.50	1.702	0.0*	5-S2n	0.877	1.022	0.878	1.300	6.513	0.000

* theoretical depth is impractical. Depth reported is corrected.

****

Inlet Elevation (invert): 5129.80 ft, Outlet Elevation (invert): 5128.40 ft

Culvert Length: 155.01 ft, Culvert Slope: 0.0090

****

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: None

Table 2 - Downstream Channel Rating Curve (Crossing: Crossing 1-Smooth HDPE)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
0.00	5129.70	1.30
0.70	5129.70	1.30
1.40	5129.70	1.30
2.10	5129.70	1.30
2.80	5129.70	1.30
3.50	5129.70	1.30
4.20	5129.70	1.30
4.90	5129.70	1.30
5.60	5129.70	1.30
6.30	5129.70	1.30
7.00	5129.70	1.30

Tailwater Channel Data - Crossing 1-Smooth HDPE

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 5129.70 ft

Roadway Data for Crossing: Crossing 1-Smooth HDPE

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 72.00 ft

Crest Elevation: 5132.20 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

HY-8 Culvert Analysis Report

Water Surface Profile Plot for Culvert: Culvert 1

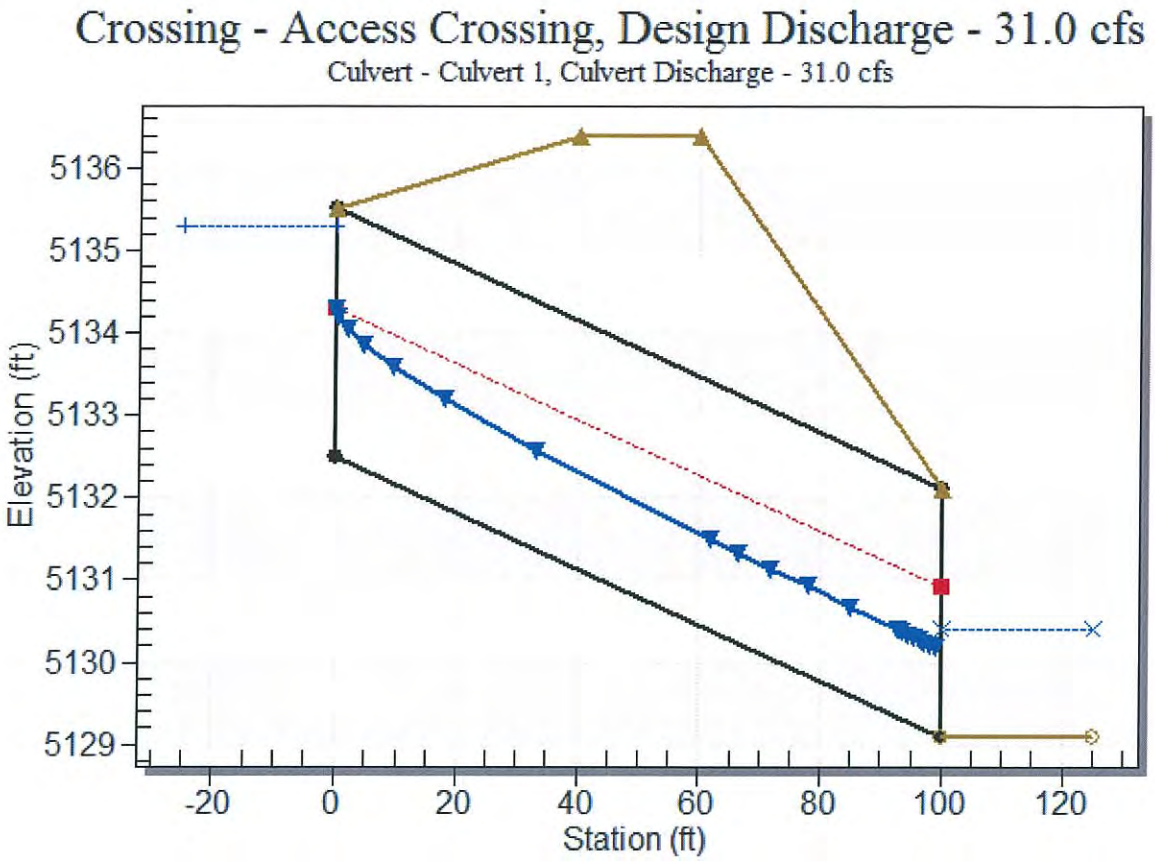


Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5132.50	0.000	0.0*	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
3.10	3.10	5133.27	0.768	0.0*	1-S2n	0.311	0.535	0.325	0.381	8.485	2.159
6.20	6.20	5133.61	1.106	0.0*	1-S2n	0.415	0.769	0.429	0.562	9.665	2.675
9.30	9.30	5133.87	1.374	0.0*	1-S2n	0.519	0.957	0.527	0.701	10.928	3.014
12.40	12.40	5134.11	1.611	0.0*	1-S2n	0.615	1.111	0.620	0.817	11.827	3.273
15.50	15.50	5134.33	1.829	0.0*	1-S2n	0.679	1.252	0.682	0.919	12.730	3.485
18.60	18.60	5134.53	2.027	0.0*	1-S2n	0.743	1.374	0.764	1.010	12.986	3.667
21.70	21.70	5134.71	2.214	0.0*	1-S2n	0.808	1.497	0.819	1.094	13.796	3.825
24.80	24.80	5134.90	2.399	0.0*	1-S2n	0.872	1.600	0.924	1.171	13.432	3.966
27.90	27.90	5135.09	2.587	0.0*	1-S2n	0.928	1.703	0.935	1.242	14.884	4.095
31.00	31.00	5135.28	2.783	0.0*	1-S2n	0.977	1.804	1.047	1.310	14.062	4.212

****

Inlet Elevation (invert): 5132.50 ft, Outlet Elevation (invert): 5129.10 ft

Culvert Length: 100.06 ft, Culvert Slope: 0.0340

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 5132.50 ft

Outlet Station: 100.00 ft

Outlet Elevation: 5129.10 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Smooth HDPE

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Mitered to Conform to Slope

Inlet Depression: NONE

Table 2 - Summary of Culvert Flows at Crossing: Access Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5132.50	0.00	0.00	0.00	1
5133.27	3.10	3.10	0.00	1
5133.61	6.20	6.20	0.00	1
5133.87	9.30	9.30	0.00	1
5134.11	12.40	12.40	0.00	1
5134.33	15.50	15.50	0.00	1
5134.53	18.60	18.60	0.00	1
5134.71	21.70	21.70	0.00	1
5134.90	24.80	24.80	0.00	1
5135.09	27.90	27.90	0.00	1
5135.28	31.00	31.00	0.00	1
5136.40	45.35	45.35	0.00	Overtopping

Table 3 - Downstream Channel Rating Curve (Crossing: Access Crossing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	5129.10	0.00	0.00	0.00	0.00
3.10	5129.48	0.38	2.16	0.30	0.68
6.20	5129.66	0.56	2.68	0.44	0.71
9.30	5129.80	0.70	3.01	0.55	0.73
12.40	5129.92	0.82	3.27	0.64	0.74
15.50	5130.02	0.92	3.49	0.72	0.75
18.60	5130.11	1.01	3.67	0.79	0.76
21.70	5130.19	1.09	3.82	0.86	0.77
24.80	5130.27	1.17	3.97	0.92	0.77
27.90	5130.34	1.24	4.09	0.98	0.78
31.00	5130.41	1.31	4.21	1.03	0.79

Tailwater Channel Data - Access Crossing

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.00 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0126

Channel Manning's n: 0.0350

Channel Invert Elevation: 5129.10 ft

Roadway Data for Crossing: Access Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 80.00 ft

Crest Elevation: 5136.40 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

APPENDIX B-5

September 22, 2016 Project No. 1538880

Ms. Hayley Brown
Weld County Engineering
1555 N. 17th Avenue
Greeley, CO 80631

RE: SUPPORTING HYDROLOGIC AND HYDRAULIC CALCULATIONS; NORTH WELD LANDFILL PAVING IMPROVEMENTS

Dear Ms. Brown:

On behalf of Waste Management Disposal Services of Colorado, Inc. (WMDSC), Golder Associates Inc. (Golder) is pleased to provide Weld County Engineering (the County) with this letter summarizing the hydrologic and hydraulic calculations performed in support of the proposed paving improvements at the North Weld Landfill.

As previously discussed between the County and WMDSC, WMDSC plans to pave approximately 1,000 feet of the main haul road along the west side of the landfill. Golder understands that the County requested additional information on potential drainage impacts on site drainage structures related to the increase in impervious area. On September 6, 2016, Senior Engineer Tom Schweitzer with WMDSC provided the County with a letter providing historical information on the design (storage capacity) and construction of the existing stormwater retention pond that ultimately receives stormwater runoff from the haul road to be paved. In response, the County requested additional hydrologic calculations supporting the proposed paving improvements. This purpose of this letter is summarize the scope and results of the hydrologic and hydraulic calculations performed to support the paving improvements.

1.0 STORMWATER MANAGEMENT SYSTEM DESIGN

The stormwater management system for the North Weld Landfill was designed as part of the development of the Updated Design and Operations (D&O) Plan for the North Weld Sanitary Landfill originally prepared by Rust Environment & Infrastructure, Inc. in January 1996, and revised by WMDSC in November 1997. Runoff from closed landfill slopes and surrounding run-on areas is collected by permanent perimeter channels and conveyed to a retention pond located in the southeastern corner of the property. The highpoint of the property is in the northwest corner. Runoff from the primary haul road is initially collected in the western perimeter channel, as shown in the attached Figure 1.

In 2010, Golder modified the facility hydrologic and hydraulic calculations to capture stormwater runoff from west of the primary haul road and convey it to the landfill perimeter channel via an 18-inch culvert crossing beneath the primary haul road (Golder 2010). Golder subsequently modified the calculations again in 2013 to replace approximately 100 feet of perimeter channel with a 36-inch-diameter culvert to allow for the development of a landfill access road across the channel alignment and to incorporate several changes to the perimeter channel alignment as a result of as-built liner grading plans (Golder 2013). The locations of these culverts are shown in the attached Figure 1.

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2.0 HYDROLOGIC AND HYDRAULIC CALCULATIONS

2.1 Scope

As the new paved section of the haul road will report to the culverts and perimeter channels, the affected channel sections and culvert crossings were re-evaluated to demonstrate that the structures will have sufficient conveyance capacity. As the perimeter channel discharges into the existing retention basin in the southeast corner of the property, the increased runoff volume was also estimated in order to verify that the basin will have sufficient storage capacity.

2.2 Methodology

Drainage basins along the main haul road, which include the proposed pavement area, were delineated using site topography provided by WMDSC. The paved roadway was assumed to be crowned perpendicular to the centerline, with runoff from one basin (A1) draining west off the pavement, then south through a drainage ditch and ultimately reporting to the existing 18-inch high-density polyethylene (HDPE) culvert under the haul road and the other basin (A2) draining east off the pavement into the landfill perimeter channel and continuing south to the existing 36-inch HDPE culvert under the landfill access road.

Consistent with the original hydrologic calculations, the Soils Conservation Service (SCS) methodology was used as the basis of the hydrologic modeling. SCS curve numbers and rainfall data were referenced from the previous Golder calculations (Golder 2010 and 2013). HEC-HMS (USACE 2013) software was used to calculate peak discharges. For hydraulic analysis of the perimeter channel, Manning's equation flow calculation spreadsheets previously used for the channel design were updated for the purposes of this modification. The Federal Highway Administration's HY-8 culvert analysis program (FHWA 2014) was used to evaluate capacity of the previously-deigned culvert crossings.

2.3 Results

The results of the HEC-HMS hydrologic analysis are presented in Table 1 below.

Table 1: Peak Discharge Summary

Basin	Drainage Area (acres)	Basin Imperviousness (%)	100-Yr, 24-Hr Peak Discharge (cfs)
A1 (West)	2.2	14	7
A2 (East)	2.2	21	6

Due to a lack of detail provided in the original design calculations and supporting figures presented in the D&O Plan, it is unclear whether runoff from the main haul road and surrounding area west of the road was included in the original channel design. Therefore, it was conservatively assumed that these basin areas along the haul road and corresponding peak flows were not previously included in the areas and runoff volumes presented in the 1997 D&O Plan. As such, the calculated peak flows presented in Table 1 were added directly (no routing) to the perimeter channel flowrates provided in the 1997 calculations to determine if the as-designed perimeter channels and culvert crossings are adequate to accommodate the additional runoff from the pavement improvements.

All channel reaches and culvert inlets as currently sized and constructed have adequate capacity to accommodate the additional discharge from the paved haul road and surrounding runoff areas shown in Figure 1 while maintaining a minimum of one foot of available freeboard.

The additional discharge will result in an increase in total runoff volume of approximately 1.0 acre-feet requiring storage in the retention basin. As outlined in the retention basin documentation previously provided to the County by WMDSC, the design runoff volume reporting to the basin is 22.6 acre-feet prior

to the pavement improvements work. Conservatively assuming that the runoff from the main haul road and surrounding area west of the road was not previously included in the basin design, the total estimated runoff volume requiring storage will be 23.6 acre-feet. As constructed, the available volume for stormwater retention in the basin is 42.2 acre-feet (10.8 acre-feet set aside for sediment storage in the design calculations and 31.4 acre-feet of stormwater storage). This available storage volume does not include the storage volume set aside for maintaining one foot of freeboard (7.1 acre-feet) per Weld County Code requirements.

Complete versions of the supporting hydrologic and hydraulic calculations are not attached to this letter. Complete copies of the calculations can be submitted to the County if required upon request.

Please let me know if you have any questions regarding these calculations.

Best Regards,

GOLDER ASSOCIATES INC.



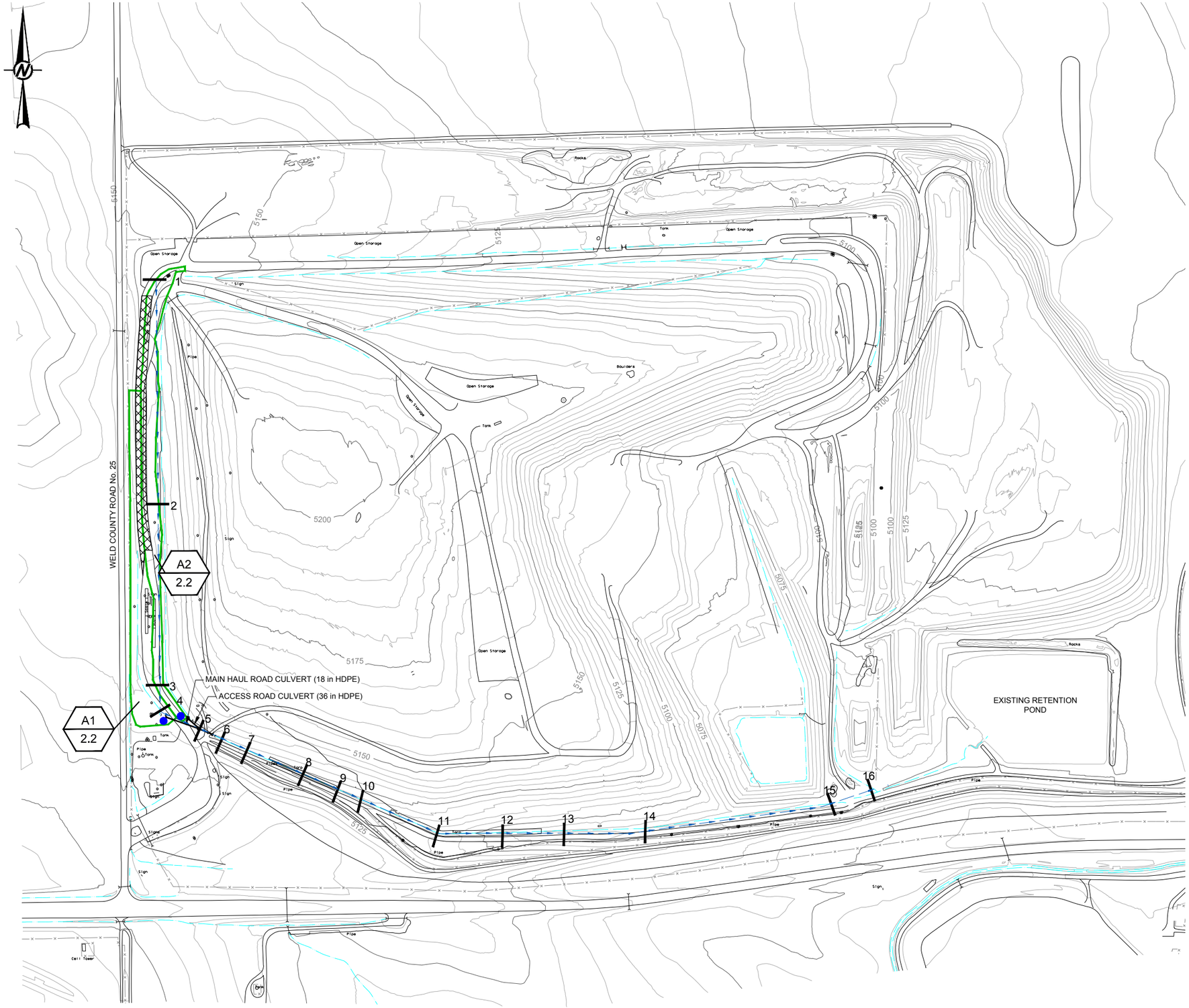
Jeff Rusch, PE
Senior Engineer

cc: Tom Schweitzer, Waste Management Disposal Services of Colorado, Inc.
Bill Hedberg, North Weld Landfill
Kim Ogle, Weld County Planning

Enclosures: Figure 1

JAR/ap

FIGURE 1



LEGEND

- 3600 — EXISTING GROUND CONTOUR (ft -MSL)
- EXISTING ROADS
- PERIMETER CHANNEL ALIGNMENT
- 2 — PERIMETER CHANNEL REACH LOCATION AND ID
- BASIN DELINEATION
- PROPOSED HAUL ROAD PAVED AREA
- CONCENTRATION POINT
- A1 / 2.2 — BASIN ID / WATERSHED AREA (ACRES)

0 200 400
1" = 400' FEET

CLIENT
WASTE MANAGEMENT

PROJECT
NORTH WELD LANDFILL
WELD COUNTY, COLORADO
MAIN HAUL ROAD IMPROVEMENTS

TITLE
RUNON BASIN DELINEATION AND SELECT PERIMETER CHANNEL LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2016-09-21
DESIGNED	SPS
PREPARED	JHR
REVIEWED	DMW
APPROVED	JAR

PROJECT NO.	CONTROL	REV.	FIGURE
1538880	0002	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: \\tucson\cad\FM\Stafford\99_PROJECTS\16656687_2016Stafford\MAP\Update\0001_MAP\02_PRODUCTION\DWGs\ | File Name: 1538880_0002_FIG_001.dwg

APPENDIX E
CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

North Weld Landfill
Weld County, Colorado

Prepared By: Golder Associates Inc.
44 Union Boulevard, Suite 300
Lakewood, CO 80228

Prepared For: Waste Management Disposal Services of Colorado, Inc.
North Weld Landfill
40000 Weld County Road 25
Ault, CO 80610

December 21, 2016

1538880

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1.0 INTRODUCTION

1.1 Project Background

The North Weld Landfill (NWLF) is located in Weld County, Colorado and is owned and operated by Waste Management Disposal Services of Colorado, Inc. (WMDSC). The NWLF site occupies approximately 358 acres. A Certificate of Designation (CD) from the Weld County Board of Commissioners was first issued on June 27, 1990, for Unit 1, which encompassed approximately 122 acres of disposal area. The site first received waste on February 3, 1992. An application for a CD for Unit 2, which will add approximately 155 acres of disposal area, will be submitted to Weld County in 2016.

This Construction Quality Assurance Plan (CQA Plan) outlines the monitoring, testing, and documentation requirements for liner and final cover construction at NWLF. CQA personnel shall use this CQA Plan as the guidance document to implement the CQA program for all future liner and final cover construction work and is intended to eliminate the need for preparation of separate CQA Plans for each construction project.

This CQA Plan addresses quality assurance, not quality control. This CQA Plan provides the plan for independent third-party CQA verification and testing. Construction quality control (CQC) is independently provided by manufacturers and contractors and refers only to those actions taken by them to ensure that materials and workmanship meet the requirements of the design.

1.2 Scope

Construction activities associated with liner construction at NWLF may include:

- Excavation and stockpiling of soil from within the project area;
- Excavation and grading for appropriate drainage control and stormwater control features;
- Installation of a two-foot-thick compacted cohesive soil liner;
- Installation of a leachate collection system consisting of gravel drain lines;
- Installation of a drainage layer over the compacted cohesive soil liner and leachate collection system and a six-inch-thick protective layer over the liner side slopes;
- Construction of temporary and/or permanent leachate collection sumps, including the installation of geomembrane liner below the permanent sumps; and
- Installation of inter-phase and/or inter-module separation berms over the liner system.

Construction activities associated with final cover construction at NWLF may include:

- Installation of a 30-inch-thick water balance alternative final cover (AFC); and
- Seeding of the AFC cover.

1.3 Construction Schedules

Construction schedules shall be prepared prior to each construction project and updated as necessary during construction.

1.4 Document Format

This CQA Plan is organized as follows:

- Section 1 provides this introduction and defines the scope of the document.
- Section 2 defines personnel and organizations that will be involved with CQA and their roles.
- Section 3 provides information regarding various CQA-related meetings.
- Section 4 defines general CQA documentation procedures, including items such as project reporting, data collection, record keeping, and site surveying requirements.
- Section 5 defines CQA procedures for earthwork construction.
- Section 6 defines CQA procedures for leachate collection system construction.
- Section 7 defines CQA procedures for geomembrane manufacturing and installation.
- Section 8 defines requirements for the Construction Documentation Report.

2.0 PROJECT PERSONNEL AND CONTACTS

2.1 WMDSC Personnel

Key WMDSC personnel for construction projects at NWLF will include the district manager and project manager.

2.2 Design Engineer

The design engineer is the individual or firm that is responsible for the design as it exists at the time construction begins and the preparation of the construction drawings for the project. Construction drawings are defined as the part of the contract documents that graphically show the scope, extent, character, and details of the work to be performed.

The design engineer may be a WMDSC representative or a consulting engineering firm contracted by WMDSC to prepare the construction drawings. Contact information for the design engineer shall be provided to appropriate parties prior to the construction.

2.3 Certifying Engineer (CQA Engineer)

The certifying engineer (CQA engineer) is the individual or firm that, on behalf of WMDSC, is responsible for monitoring construction activities on site and certifying that the work is constructed in accordance with the contract documents, including this CQA Plan. A certifying engineer shall be chosen by WMDSC prior to each construction project.

2.4 CQA Laboratory

A CQA soils laboratory shall be selected by the certifying engineer or by WMDSC prior to each construction project to perform quality assurance (QA) testing on soil samples to verify that the work is constructed in accordance with the contract documents, including this CQA Plan.

2.5 Site Surveyor

A site surveyor shall be chosen by WMDSC or subcontracted by the contractor for each construction project to certify that as-built conditions conform to the design specified in the contract documents.

2.6 Construction Contractor

A general construction contractor shall be chosen by WMDSC for each construction project and shall be contracted directly by WMDSC. Work conducted by the contractor shall be overseen and certified by the certifying engineer.

2.7 Geomembrane Liner Contractor

A liner contractor shall be selected to install geomembrane in the sump areas. The liner contractor may be the general contractor, a subcontractor to the contractor, or independently contracted by WMDSC. Work conducted by the liner contractor shall be overseen by the certifying engineer.

2.8 Colorado Department of Health and Environment (CDPHE)

Construction documentation reports certifying that the construction work was constructed in accordance with the contract documents, including this CQA Plan, shall be submitted to the Colorado Department of Health and Environment (CDPHE) Hazardous Materials and Waste Management Division, Solid Waste Unit at the following address:

Colorado Department of Public Health & Environment
Solid Waste Unit
Hazardous Materials & Waste Management Division
4300 Cherry Creek Drive South
Denver, Colorado 80246

2.9 Weld County Department of Public Health and Environment (WCDPHE)

Construction documentation reports shall also be submitted to the Weld County Department of Public Health and Environment at the following address:

Weld County, Department of Public Health and Environment
1555 N. 17th Avenue
Greeley, Colorado 80631

3.0 CONSTRUCTION MEETINGS

3.1 Preconstruction Meeting

Prior to the start of construction, a preconstruction meeting shall be held involving the general contractor, liner contractor (if applicable), district manager, project manager, site surveyor, and certifying CQA engineer. The preconstruction meeting agenda shall identify party responsibilities, construction documents, lines of communication, design and CQA Plan requirements, construction schedule requirements and/or limitations, and Health and Safety Environment Plan (HaSEP) requirements. The purpose of the meeting shall be to:

- Present a proposed construction progress schedule and submittal log as required by the contract documents
- Discuss procedures for handling submittals
- Discuss the rules for project correspondence and roles and responsibilities
- Establish reporting and documentation procedures for each party
- Schedule weekly progress meetings
- Present a summary of the laboratory testing and field testing required to meet CQC and CQA requirements
- Discuss procedures for field orders, work change directives, and change orders
- Discuss the WMDSC's site rules
- Review the contract documents
- 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 the work area, stockpile areas, lay-down areas, material storage areas, access roads, haul roads, and related items

The minutes from the meeting shall be included as an appendix to the Construction Documentation Report.

3.2 Project Progress Meetings

Generally, project progress meetings shall be conducted on a weekly basis with the contractor, liner contractor (if applicable), certifying CQA engineer, district manager, project manager, and site surveyor (as necessary). These meetings shall include the following:

- Discussion of health and safety issues relevant to scheduled work
- Work in progress and key activities scheduled for the upcoming week

- Updates to the overall construction schedule
- Review of relevant CQA test data
- Discussion of any necessary decisions or project requirements regarding the construction activities.
- Resolution of outstanding issues or disputes

If necessary, a brief daily meeting with the above parties shall be conducted to address any critical construction matters and determine an acceptable course of action. The certifying engineer shall maintain a file containing notes from such meetings and a copy of the notes shall be provided to the project manager.

4.0 DOCUMENTATION

The success of the CQA program requires thorough performance of the specified monitoring and testing activities, documentation of completed monitoring and testing activities, and frequent senior review of CQA documentation. Therefore, the certifying engineer must help assure that all CQA procedures have been implemented, results of the program are reviewed frequently, and corrections are implemented as needed.

4.1 Standard Reporting Procedures

The CQA engineer shall issue a daily report of construction activities. These reports shall contain, at a minimum and as applicable, the following information:

1. Date, project name, location, weather, and other information as appropriate
2. Description and locations of ongoing construction
3. Equipment used
4. Description of areas tested and sampled
5. Description of areas requiring reconditioning, retesting, and procedures followed
6. Summary of compacted cohesive soil liner lift thickness and cohesive soil moisture–density at time of placement, as applicable
7. Summary of leachate collection system and sump construction, as applicable
8. Surveys performed for lift thickness control and any record surveys performed
9. Description of any variations from the contract documents and justification for the variance

4.2 Applicable Forms

The forms to be used in documenting the daily activities shall generally consist of the following:

1. Daily Field Report
2. Request for Information
3. Field Density Test Forms
4. Soil Sample Test Request Forms
5. Soil Testing Tracking Log
6. Geomembrane Testing, Deployment, Seaming, Defect, and Repair Logs

Prior to the preconstruction meeting, the certifying engineer shall provide the project manager with samples of these forms for review and approval.

All completed daily recordkeeping forms shall be checked, reviewed, signed, and dated by the certifying engineering on a weekly basis. Completed daily field report forms shall be bound separate from the Construction Documentation Report and copies shall be kept at NWLF. Applicable field data sheets and

recordkeeping forms shall also be included as appendices to the Construction Documentation Report as further described in Section 8.0 of this CQA Plan.

4.3 Agency Notification

All contact with the CDPHE and the WCDPHE shall be the responsibility of and conducted by the project manager or a project manager-designated representative.

4.4 Issue Identification and Corrective Action

The certifying engineer shall inform the contractor and/or liner contractor in a timely manner of any difference between the contractor's and/or liner contractor's interpretation of the contract documents and the certifying engineer's interpretation. In addition, any actual or suspected work deficiencies shall be promptly brought to the attention of the project manager.

If a difference in interpretation cannot readily be resolved between the contractor and certifying engineer, a meeting shall be held involving the district manager, project manager, contractor, and certifying engineer. The objective of the meeting shall be to define and discuss the issue, review alternative solutions, and implement an action plan to resolve the issue to the satisfaction of all parties. If the issue involves a possible design modification, the design engineer shall be contacted for approval.

If a field modification is required that affects the Engineering Design and Operations Plan (EDOP) or regulatory requirement, the CDPHE and, if necessary, the WCDPHE, shall be contacted for approval and to identify the documentation that is required. Applicable documentation shall be included as an appendix to the Construction Documentation Report.

4.5 Photographic Documentation

Photographs (indicating date) shall be taken to document observations and as-built conditions of elements of construction. These photos shall be labeled to identify, at a minimum, date, location where photo was taken, direction of photo, and a brief description of the photo. The photographs shall be compiled in chronological order and captioned by the certifying engineer in a photograph log. Copies of the photograph log shall be kept at NWLF.

4.6 Site Survey Requirements

4.6.1 Record Surveys

Site survey requirements shall include performing record surveys. At a minimum, record surveys shall be performed on the subgrade, compacted cohesive soil liner, leachate collection drain line and drainage layer, and bottom and top elevations of sumps. Record surveys shall confirm that the work was constructed in

accordance with the contract documents. Record surveys to be performed by the site surveyor shall include the following, as applicable to the construction project:

1. Subgrade record survey:
   a. Subgrade on a 50-foot x 50-foot grid, inclusive of sumps.
   b. All subgrade breaklines on 50-foot centers, inclusive of the leachate collection drain line alignment.
   c. Edge of the subgrade/compacted cohesive soil liner interface for existing liner on 50-foot centers.
2. Top of compacted cohesive soil liner:
   a. 50-foot x 50-foot grid, inclusive of sumps. The certification grid shall be the same grid used for the certification of the subgrade on the floor.
   b. All breaklines, as appropriate, and edges on 50-foot centers.
   c. Top of edge where liners are tied together on 50-foot centers.
   d. Location where geomembrane liner is anchored in compacted cohesive soil liner on 50-foot centers.
3. Leachate collection drain line and permanent/temporary sumps:
   a. Subgrade at 50-foot intervals along the leachate collection drain line.
   b. Top of compacted cohesive soil liner along the leachate collection drain line at 50-foot intervals.
   c. Survey stationing shall be at the same horizontal locations as the 50-foot grid used for certification of subgrade and top of compacted cohesive soil liner. Each survey point along the 50-foot stationing shall have three associated elevations: subgrade, top of compacted cohesive soil liner, and top of gravel drain line.
   d. Top of leachate collection drain line at tie-in points and end of line.
   e. Grade breaks and corners for subgrade and top of compacted cohesive soil liner in sumps.
4. Finished grades:
   a. Top of drainage layer on 100-foot x 100-foot grid. The grid shall be the same grid used for certification of subgrade and top of compacted cohesive soil liner on the floor. Thickness may be verified using a calibrated probe or by survey.
   b. All breaklines and mid-slope points of protective layer on 50-foot centers.
   c. Thicknesses shall be summarized in a plan view figure identifying grid points and in a table presenting thickness measurements to be included in the Construction Documentation Report.

All survey data shall be reduced at the end of each working day, or other frequency appropriate for the survey work performed, and given to the certifying engineer in the form of a report. Record surveys and record grade tables shall be included in an appendix to the Construction Documentation Report to document that the work was performed in accordance with the construction documents.

4.6.2 Survey Tolerances

Construction tolerances for excavation and fill shall consist of the following:

1.	Top of Subgrade	Line: Grade:	±0.5 foot -0.2 to 0.0 feet
2.	Compacted cohesive soil liner:	Line: Grade: Thickness:	±0.5 feet -0.0 to +0.1 feet of top of liner design grade 2.0 feet (minimum)
3.	Protective layer:	Line: Grade: Thickness:	±0.5 feet -0.0 to +0.2 feet of top of protective layer design grade 2.5 to 2.8 feet combined thickness of compacted cohesive soil liner and protective layer measured perpendicular to slope
4.	Drainage layer:	Thickness:	0.5 feet (minimum)
5.	Gravel drain lines	Line: Grade: Thickness:	±0.5 foot -0.0 to +0.1 foot 1.0 foot (minimum)
6.	Sumps	Line: Grade:	±0.5 foot -0.2 to +0.1 feet
7.	Final Cover	The final cover line and grade may vary due to landfill settlement. Construction documentation will demonstrate conformance with the minimum cover thickness and mini um/maximum final design slopes.	

4.7 Calibrating Testing Equipment

Before on-site testing equipment is placed into service, the accuracy of each piece of equipment shall be verified by calibration. Types of on-site equipment requiring calibration include nuclear gauges (calibration and daily standardization), tensiometers, scales, and field ovens. The calibration procedures and frequencies shall be completed per the equipment manufacturer's instructions and American Society for Testing and Materials (ASTM) standards as applicable. Copies of current calibration certificates for equipment shall be maintained by the CQA engineer and dates of last calibration for all field and laboratory testing equipment shall be provided in the Construction Documentation Report. Whenever a piece of equipment is suspected of producing questionable results, it shall be removed from service and re-calibrated.

4.8 Complying with Test Standards

The CQA laboratory and CQA engineer must perform various field and laboratory tests in accordance with applicable standards as specified in this CQA Plan. In most instances, the applicable test procedure is an ASTM standard. Only the most recent version of each test standard identified in this CQA Plan shall be used.

5.0 LANDFILL CQA – EARTHWORK

5.1 Subgrade Preparation

5.1.1 Construction Requirements

The liner subgrade shall be established by excavating overburden soils to the design grades as shown in the construction drawings. In some areas, engineered fill may be required to develop the design grades.

Upon attainment of subgrade grades by excavation and compaction, the CQA engineer shall observe the subgrade conditions and document any unexpected conditions, such as wet or unstable areas, permeable lenses, or other condition not be suitable for liner foundation as determined by CQA engineer. Any unstable area, permeable lens, or other unsuitable condition shall be excavated at least one foot in depth and replaced with engineered fill material. Engineered fill shall be placed in compacted lifts not exceeding 12 inches. Engineered fill shall be compacted to a minimum density of 95% of the standard Proctor maximum dry density (ASTM D698).

5.1.2 CQA Testing

Subgrade material and construction shall conform to the following specifications:

- Grade control: as described in Sections 4.6.1 and 4.6.2 of this CQA Plan
- Compaction (ASTM D6938) greater than or equal to 95% of standard Proctor
- (Engineered Fill only) maximum dry density (ASTM D698)

In situ density testing (ASTM D6938) of engineered fill shall be performed on an approximate grid pattern randomly defined by the CQA engineer for each 12-inch lift placed.

5.1.3 CQA Sampling

Representative samples of the native subgrade and engineered fill materials shall be obtained prior to and during subgrade preparation for the following laboratory testing:

- Grain size (no hydrometer) (ASTM D6913)
- Moisture content (ASTM D2216 or ASTM D4643)
- Standard Proctor (5 points per curve) (ASTM D698)

In the event that the engineered fill material changes, additional samples shall be collected and tested for each material type to define standard Proctor maximum dry density and optimum moisture content. Sampling and testing frequencies for subgrade preparation and engineered fill placement are provided in Table 1 of this CQA Plan. All field and laboratory testing results shall be provided as an appendix to the Construction Documentation Report. The certifying engineer shall reference all test and sample points and reconstructed areas by measuring from reference points established for the on-site coordinate system.

5.1.4 Leachate Collection Drain Line CQA

While constructing the subgrade, the chevron pattern shall be graded to form the leachate collection drain line alignment. As discussed in Section 4.6.1 of this CQA Plan, the site surveyor shall perform record survey documentation of the subgrade, top of compacted cohesive soil liner, and top of gravel drain line along the leachate collection drain line alignment.

Field density testing of the subgrade along the leachate collection drain line shall be in accordance with the requirements of Section 5.1.2 of this CQA Plan.

5.2 Compacted Cohesive Soil Liner

5.2.1 Construction Requirements

The compacted cohesive soil liner shall be constructed in accordance with design criteria presented in the NWLF Unit 2 EDOP (briefly summarized below) and as described in the contract documents.

- Base grades will be consistent with approved design grades.
- The minimum thickness of the compacted cohesive soil liner at all locations shall be two feet measured perpendicular to the liner surface.
- The compacted cohesive soil liner shall be constructed in lift heights no greater than six inches after compaction (eight inches loose) and no greater than the depth of the teeth of the compaction equipment used.
- Typical side slopes shall not exceed three horizontal to one vertical (3H:1V), unless otherwise shown in the construction drawings.

The compacted cohesive soil liner material shall have a maximum allowable clod size of three inches. A pull-type disc (or similarly effective equipment as approved by CQA engineer) shall be used to break up clods, expose stones in the cohesive soil to allow for removal, and assist in establishing moisture content above optimum as determined by standard Proctor moisture–density testing (ASTM D698). The specification for acceptable moisture content range is described below in Section 5.2.2 of this CQA Plan.

Compaction shall be performed using a tamping foot compactor with fully penetrating feet extending the full depth of the loose lift of soil (Caterpillar 815, 825, or CQA engineer-approved alternate equipment). Compaction may be supplemented by running wheeled tracks of construction equipment across fill areas; however, the use of supplementary vehicular tracking shall not be used in place of mechanical compaction with the tamping foot compactor. The number of tamping foot compactor passes required to achieve the required compaction shall be determined during the first lift of compacted cohesive soil liner placement, and monitored throughout subsequent lifts. Compaction shall be performed to form a stable non-yielding base. Frozen materials, organics, roots, and large rocks (greater than three inches in any dimension based on visual observation) shall be removed prior to compaction.

Prior to placing compacted cohesive soil liner on side slopes, the subgrade shall be scarified (if lifts are placed horizontally) or proof-rolled with a tamping foot compactor (if lifts are placed parallel to the slope).

The surface of previous lifts shall be watered as necessary until subsequent lifts or cover materials are placed to prevent desiccation. The contractor shall not be allowed to place cohesive soil at temperatures below freezing unless it can be demonstrated that freezing of the compacted cohesive soil liner will not occur. Previously placed soils shall be protected from freezing by the contractor by methods such as placing additional soil over the completed compacted cohesive soil liner until protective cover is placed. Any placed liner material that is found to be frozen shall be removed or thawed and reworked as necessary.

Tie-in to compacted cohesive soil liner of previously constructed cells (where applicable) shall be performed by constructing “steps” in the formerly placed liner. The “steps” shall be approximately six inches in depth and at least six inches wide, shall be cut with an excavator or other appropriate equipment, and shall extend the full depth of the previously placed compacted cohesive soil liner. After the “steps” are cut, placement of the new compacted cohesive soil liner shall begin by placing in lifts that correspond to the thickness of the “steps.” Each lift shall be compacted through the step area so that there are no vertical seams in the former “step” area. Once this is complete, the next lift shall be placed and the procedure repeated until the entire thickness of compacted cohesive soil liner has been placed through the tie-in area.

5.2.2 CQA Testing

Compacted cohesive soil liner material and construction shall conform to the following specifications:

- Grade control: As described in Sections 4.6.1 and 4.6.2 of this CQA Plan
- Classification (ASTM D2487): CL or CH under the Unified Soil Classification System
- Hydraulic conductivity (ASTM D5084): Less than or equal to 1 x 10^{-7} cm/sec
- Density (ASTM D3668): Greater than or equal to 95% of standard Proctor maximum dry density (ASTM D698)
- Moisture content (ASTM D6938, ASTM D2216, or D4643): 80% of tests exceeding required degree of saturation and a minimum degree of saturation of 75% for all tests
- Liquid limit (ASTM D4318): Greater than 25%
- Plasticity index (ASTM D4318): Greater than 10%
- Grain size (ASTM D6913): P200 content of 50% or greater by weight

In-place moisture content and density testing (ASTM D6938) of the compacted cohesive soil liner shall be performed randomly but on a density equivalent to a 100-foot grid pattern for each 6-inch compacted lift placed to ensure that the testing locations and samples collected for hydraulic conductivity are evenly distributed with a comparable number of tests for each lift. The testing grid pattern shall be offset on subsequent lifts. For side slopes, minimum testing requirements shall be determined based on the surface area of the slopes.

Additional moisture and density tests shall be obtained in confined areas where equipment movement is hindered or hand compaction is necessary. The number of density tests in these areas shall be specified by the CQA engineer based on the size of the confined area. If areas are encountered which do not meet the specified compaction, moisture content, or percent saturation the area shall be reworked, moisture conditioned, and/or recompacted as necessary. Retests shall be performed following rework activities.

At least 80% of all field moisture and density tests (and within two-acre subareas) shall have a degree of saturation on or wet of the degree of saturation line corresponding to the applicable standard Proctor test optimum moisture content and maximum dry density, which is defined as the line or curve corresponding to the degree of saturation that goes through the optimum moisture content/maximum dry density point. The degree of saturation defining the line is calculated using the following equation:

$$S = \frac{(\frac{(w)(G_s)}{100})}{(\frac{(G_s)(\gamma_w)}{\gamma_d} - 1)} x100\%$$

where:
S = Degree of saturation (%)
W = In situ moisture content from field test (%)
G_s = Specific gravity
γ_w = Unit weight of water (62.4 pcf)
γ_d = Dry unit weight of soil (pcf)

The minimum degree of saturation shall be 75%. Degree of saturation shall be calculated from standard Proctor optimum moisture content and maximum dry density unless evidence demonstrates that the compactive energy being used is higher than that corresponding to the standard Proctor (i.e., moisture content/density tests that are plotting at significantly higher dry densities). In this case, the degree of saturation corresponding to the optimum moisture content/maximum dry density of the modified Proctor or an average of standard Proctor and modified Proctor can be used at the CQA engineer's discretion. Plan view figures identifying the locations of field density measurements and the two-acre subareas for each lift shall be prepared and included in the Construction Documentation Report.

If areas with compaction of less than 95% of the standard Proctor maximum dry density or required degree of saturation are encountered, the area shall be reworked to provide additional moisture conditioning or additional compactive effort. Retests shall be performed following the reworking activities.

Each penetration made into the compacted cohesive soil liner for density testing purposes shall be repaired after testing. The test hole shall be repaired by backfilling with bentonite and hydrated or other material(s) approved by the CQA engineer.

All density tests shall be reported on the field density forms. Test locations shall be presented on a plan view figure. Completed field density forms shall be included as an appendix to the Construction Documentation Report. Prior to the preconstruction meeting, the CQA engineer shall provide the project manager with a sample of the field density form for review and approval.

5.2.3 CQA Sampling

Representative samples of compacted cohesive soil liner material shall be obtained prior to and during liner construction for the following laboratory testing:

1. Soil classification (ASTM D2487)
2. Grain size (no hydrometer) (ASTM D6913)
1. Atterberg limits (ASTM D4318)
2. Moisture content (ASTM D2216 or ASTM D4643)
3. Standard Proctor (five points per curve) (ASTM D698)
4. Modified Proctor (ASTM D1557)
5. Hydraulic conductivity (ASTM D5084)
6. Specific gravity (ASTM D854)
7. One-point Proctors (conducted in the field) (AASHTO T272)

Sampling and testing frequencies for the compacted cohesive soil liner are provided in Table 1 of this CQA Plan. One-point Proctors shall be performed at the specified frequency to assist the certifying engineer in the selection of the appropriate standard Proctor for the purposes of evaluating passing moisture content and density conditions. A soil sample inventory log shall be maintained as samples are acquired. The certifying engineer shall reference all test and sample points and reconstructed areas by measuring from reference points established for the on-site coordinate system. All completed inventory logs and field and laboratory testing results shall be provided as an appendix to the Construction Documentation Report.

5.3 Inter-phase and Inter-module Separation Berms

Compacted engineered fill material shall be used to construct inter-phase and inter-module berms. Moisture conditioning shall be performed as necessary and/or as directed by the CQA engineer.

5.4 Protective Layer

A six-inch soil protective layer shall be placed over the compacted cohesive soil liner side slopes. The protective layer material shall consist of compacted cohesive soil liner material or random material as defined in the contract documents. The protective layer shall be placed in successive lifts of not more than eight inches in loose depth. Compaction operations shall consist of at least three passes with suitable equipment or otherwise approved by the CQA engineer. The CQA engineer shall observe and report on appropriate CQA test results and placement operations to verify uniform lift thickness and adequate compaction.

5.5 Alternative Final Cover

5.5.1 Construction Requirements

The water balance alternative final cover (AFC) soil shall be placed without active compaction so as to obtain a density of between 80% and 90% of the standard Proctor (ASTM D698) maximum dry density and dry of the optimum moisture content.

After placement, the AFC shall be fertilized if necessary and planted with erosion-controlling grasses native to the region, such as the seed mix provided in Table 3 of this CQA Plan. Soil amendment recommendations are also provided in Table 3.

5.5.2 CQA Testing

AFC material and construction shall conform to the following specifications:

- Grade control: verification of foundation grades and slopes prior to AFC construction. Thickness of AFC layers on 100-foot x 100-foot grid, by grade stakes or survey.
- Grain Size (ASTM D6913): gravel content 15% or less by weight.
- Maximum particle size less than two inches.
- Moisture content (ASTM D6938 and ASTM D2216 or D4643): dry of the optimum moisture content.
- Moisture–density (ASTM D698): between 80% and 90% of standard Proctor maximum dry density.
- pH (SW-846 SW 9045C): 6.0 – 8.4.
- Calcium carbonate ($CaCO_3$) (USDA Handbook Number 60): less than 15% by weight.

In-place moisture content and density testing (ASTM D6938) of the AFC portion of the final cover shall be performed at a frequency of 1 test per 6,500 cubic yards of final cover placed. If areas are encountered which do not meet the specified compaction or moisture content requirements, the area shall be reworked or ripped as necessary. Retests shall be performed following rework activities.

5.5.3 CQA Sampling

Representative samples of AFC material shall be obtained during final cover construction for the following laboratory testing:

1. Grain size (ASTM D422)
2. Hydrometer (ASTM D7928)
3. Moisture content (ASTM D2216 or D4346)
4. Standard Proctor (five points per curve) (ASTM D698)
5. pH (SW-846 SW 9045C)
6. $CaCO_3$ (USDA Handbook Number 60)

Sampling and testing frequencies for final cover are provided in Table 1 of this CQA Plan consistent with the CDPHE Final Guidance Document for Water Balance Covers in Colorado (CDPHE 2013). The certifying engineer shall reference all test and sample points and reconstructed areas by measuring from reference points established for the on-site coordinate system. All field and laboratory testing results shall be provided as an appendix to the Construction Documentation Report.

6.0 CQA – LEACHATE COLLECTION SYSTEM

Leachate collection system construction shall follow completion of the compacted cohesive soil liner in the areas of the sumps and leachate collection gravel drain lines. Construction shall consist of the placement of geomembrane (in permanent sumps), geotextile fabric, leachate drain and sump gravel, and granular drainage layer (granular earthen material or glass cullet) material as discussed in this section.

6.1 Geotextile Fabric

Geotextile fabric used to wrap the leachate collection trenches shall be non-woven, 10-ounce per square yard (oz/sq. yd.) geotextile. Placement shall conform to the following requirements:

1. Fabric shall be placed as smooth and wrinkle-free as possible without “stretching.”
2. The gravel drain lines shall be wrapped in geotextile fabric as shown in the construction drawings.
3. Geotextile fabric shall overlap at all seams by a minimum of 24 inches.

CQA requirements for the geotextile fabric consist of the following:

1. Geotextile fabric shall be free of tears, holes, other visible damage, and significant folds or wrinkles.
2. Geotextile fabric quality control (CQ) certificates shall be included as an appendix to the Construction Documentation Report.

6.2 Leachate Drain and Sump Gravel

The leachate drain and sump gravel shall consist of rounded, semi-angular or angular clean gravel or other permeable material that meets the following requirements:

- Grade control:
  - As described in Sections 4.6.1 and 4.6.2 of this CQA Plan.
- Classification (ASTM D2487):
  - Earthen material (i.e., not glass cullet) classified as GP.
- Grain size (ASTM C136):
  - A minimum of 99% passing the three-inch sieve by weight;
  - Between 0 and 5% passing the 3/8-inch sieve by weight; and
  - d_{50} of less than 1.5 inch. (The material gradation may vary provided that testing confirms the material meets the permeability requirement)
- Hydraulic conductivity (ASTM D5084): Greater than or equal to 1 cm/sec
- Thickness: A minimum of 12 inches of aggregate material shall be placed within each geotextile-wrapped gravel drain measured perpendicular to the slope. The aggregate height shall be documented with a field survey or hand measurements.

Representative samples of drainage gravel material shall be obtained prior to and during leachate collection system construction for the following laboratory testing:

1. Grain size (no hydrometer) (ASTM C136)
2. Hydraulic conductivity (ASTM D5084)

Sampling and testing frequencies for drainage gravel are provided in Table 1 of this CQA Plan. Laboratory testing results shall be provided as an appendix to the Construction Documentation Report.

6.3 Granular Drainage Layer

The granular drainage layer shall consist of a minimum of 6 inches of sand or 8.5 inches of glass cullet placed over the compacted cohesive soil liner. The granular drainage layer requirements are as follows:

- Grade control: as described in Sections 4.6.1 and 4.6.2 of this CQA Plan.
- Hydraulic conductivity (ASTM D5084): greater than or equal to 1 x 10^{-2} cm/sec.

Representative samples of granular drainage layer material shall be obtained prior to and during cell construction for the following laboratory testing:

- Hydraulic conductivity (ASTM D5084)

Sampling and testing frequencies for granular drainage layer material are provided in Table 1 of this CQA Plan. Laboratory testing results shall be provided as an appendix to the Construction Documentation Report.

6.4 Leachate Collection Sumps (Permanent and Temporary)

Permanent leachate collection sumps shall be constructed at the low point in each disposal phase (Phases 4 and 5). Temporary leachate collection sumps shall be installed at the low point of each module within disposal phases.

Two feet of compacted cohesive soil liner shall be maintained beneath all portions of the leachate collection system, including leachate collection sumps. Compacted cohesive soil liner material shall be placed and compacted as described in Section 5.2 of this CQA Plan in the leachate collection sump areas prior to additional sump construction. At least five in-place density tests shall be taken per six-inch lift within the base and on each sidewall of the sump. Additionally, a minimum of one in-place density test shall be performed on the compacted cohesive soil located in the geoembrane anchor trench surrounding the permanent sump after geomembrane installation (see Section 7.0 of this CQA Plan for geomembrane CQA requirements).

Gravel material, as described in Section 6.2 of this CQA Plan, shall be used to backfill leachate collection sumps. The same sampling and testing frequencies for drainage gravel as discussed in Section 6.2 and

provided in Table 1 of this CQA Plan shall apply to the leachate collection sumps. Laboratory testing results shall be provided as an appendix to the Construction Documentation Report. In addition, survey control of the sumps shall be documented as discussed in Sections 4.6.1 and 4.6.2 of this CQA Plan.

The CQA requirements for geomembrane liner in permanent sump areas is described in Section 7.0 of this CQA Plan.

7.0 CQA – GEOMEMBRANE LINER

7.1 CQA Functions

Prior to geomembrane installation, the CQA engineer shall observe the on-site liner storage area and handling of the liner packaging to detect possible damage. During placement, the CQA engineer shall observe the seam overlap, seam preparation, welding, seam testing, and correction of deficiencies. The CQA engineer shall document the sampling conducted, sampling results, locations of destructive samples, locations of patches, locations of seams and any problems encountered during geomembrane placement and include as an appendix to the Construction Documentation Report.

7.2 Pre-construction Submittal Review

Prior to scheduled delivery of the product, the liner contractor shall submit the following items to the CQA engineer for review:

- The geosynthetic manufacturer's description (cut sheet) for the proposed resin and geomembrane documenting that it will meet or exceed the requirements summarized in Table 2 of this CQA Plan
- Shop drawings showing the proposed layout of the panels, field seams, and any other details that are needed to describe the proposed installation

Prior to installation of the geomembrane, the CQA engineer shall review and approve submittals and shop drawings for conformance with the contract documents.

7.3 Material Specifications, Handling, and Storage

Geomembrane used for the project shall conform to the minimum specifications detailed in Table 2 of this CQA Plan. Geomembrane shall be manufactured of first-quality resin and shall be compounded and manufactured specifically for containment applications.

The geomembrane material shall be free of holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Any such defect shall be repaired in accordance with the manufacturer's recommendations.

The geomembrane shall also be protected from puncture, dirt, grease, mechanical abrasions, and excessive heat; stored on a level, prepared surface (not wooden pallets); and stacked in accordance with the manufacturer's recommendation.

At all times, geomembrane material shall be handled in a manner that:

- Prevents damage by such activities as handling, traffic, smoking, and use of equipment and tools;
- Prevents scratching or crimping of panels during unrolling;

- Prevents damage of the underlying liner components;
- Prevents uplifting of in-place panels by wind; and
- Minimizes the wrinkles (e.g., distribute across cell, avoid wrinkles at seams) and compensates for those that cannot be prevented.

7.4 Geomembrane Support

Sump and riser pipe corridor surfaces to be lined with geomembrane shall be smooth and free of debris and angular or sharp rocks. The underlying compacted cohesive soil liner shall be smooth-rolled and shall not contain protrusions of stones, clods, rocks, or debris greater than 3/8-inch. The surface of the underlying compacted cohesive soil liner shall have no sudden sharp or abrupt changes in grade. These conditions shall be certified on a daily basis by the liner contractor and/or the CQA engineer.

The contractor shall protect the surface underlying the geomembrane from desiccation, flooding, and freezing until such time that placement of geomembrane begins. Protection, if required, may consist of a thin, plastic protective cover (or other material as approved by the CQA engineer) installed over the completed underlying surface. The thin, plastic protective cover may only be used as a short-term (e.g., overnight, over a weekend, or multiple days of inclement weather) measure to protect the compacted cohesive soil liner surface until the geomembrane is deployed. It shall not be used for long-term frost protection during the winter. Geomembrane deployment shall be performed as soon as practical after completion of the compacted cohesive soil liner. Long-term exposure situations shall require placement of additional protective soil over the compacted cohesive soil liner.

Underlying compacted cohesive soil liner surfaces found to have significant desiccation cracking or that exhibit swelling, heaving, or other similar conditions, shall be replaced or reworked by the Contractor to repair the defects.

The geomembrane shall be installed in direct and uniform contact with the underlying compacted cohesive soil liner.

7.5 Deployment

7.5.1 Weather Conditions

Generally, geomembrane deployment shall not occur during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of standing water, or during high winds (in excess of 30 miles per hour). The liner contractor shall have the final responsibility to determine if conditions are suitable for liner placement. Placement and welding of the geomembrane shall not be undertaken during periods when the air temperature six inches above the surface of the geomembrane is colder than 32ºF or warmer than 105ºF, unless pre-construction site weld tests for the seaming reveal adequate results at temperatures outside this range.

7.5.2 Documentation of Panel Placement

Prior to placement of the geomembrane, the liner contractor and the CQA engineer shall review the panel layout drawing. Any subsequent changes of the panel layout initiated by the liner contractor shall require approval by the CQA engineer. Information relating to panel placement including date, time, panel number, and panel dimensions shall be maintained on a panel placement form by the liner contractor. If a portion of a roll is set aside to be used at another time, the roll number shall be written on the remainder of the roll in several places.

7.5.3 Method of Deployment

The method deployment of the geomembrane shall meet the following requirements:

- The method and equipment used to deploy the panels shall not damage the geomembrane or the supporting surface.
- No personnel working on the geomembrane shall wear shoes that may damage the geomembrane liner or engage in actions that could result in damage to the liner.
- Adequate temporary anchoring (e.g., sandbags, tires, or other approved anchorage) that will not damage the geomembrane shall be placed to prevent uplift of the geomembrane by wind.
- The geomembrane shall be deployed in a manner to minimize wrinkles.
- Any area of a panel observed and noted as damaged (torn, twisted, punctured, or crimped) shall be marked and repaired or replaced. Any repaired panels shall be approved by the CQA engineer.
- Bridging or stressed conditions in the geomembrane shall be minimized. Proper slack allowance for shrinkage shall be provided during installation and before the placement of overlying components.
- Panels shall have a minimum four-inch finished overlap. Seams shall be oriented parallel to the line of maximum slope (i.e., horizontal seams shall not be allowed). In corners and odd-shaped geometric locations, the number of field seams shall be minimized. No base T-seam shall be closer than five feet to the toe of the slope.
- Objects such as pipes, gas vents, manholes, sumps, and other objects that may penetrate the liner shall be connected to the liner material in such a way that prevents leakage and unnecessary stresses.

7.5.4 General Seaming/Welding Procedures

- Seaming shall extend to the outside edge of panels to be placed in the anchor trench.
- While welding a seam, the proper overlap shall be monitored and maintained.
- Seams shall be inspected to ensure that the area is clean and free of moisture, dust, dirt, and debris of any kind.
- Welding technicians shall periodically check machine operating temperature and speed and shall mark this information on the geomembrane.
- Wrinkles shall be aligned at the seam overlap to allow welding through the wrinkle.
- “Fishmouths” or wrinkles at seam overlaps that cannot be welded through shall be cut along the ridge in order to achieve a flat overlap. The cut “fishmouth” or wrinkle shall be

heat-tacked flat and extruded or patched with an oval or round patch of the same geomembrane extending a minimum of three inches beyond the cut in all directions.

- Prior to welding cross/butt seams, the top and bottom overlaps of intersecting fusion welded seams shall be trimmed six inches. Intersecting extrusion fillet-welded seams shall be ground to flatten the extrusion bead prior to welding butt seams.
- All “T” joints produced as a result of cross/butt seams shall be extrusion fillet welded. The overlap on each “leg” of the “T” joint shall be trimmed back 6 inches. A minimum of 3 inches on each of the three legs of the “T” shall be ground, and all of the area prepared by grinding shall be extrusion welded.
- The seam area shall be cleaned prior to seaming to provide an area that is clean and free of moisture, dust, dirt, and debris of any kind. No grinding is required for fusion welding.

7.5.5 Extrusion Fillet Welding

- Whenever possible, extrusion-welded seams shall be pre-beveled prior to heat-tacking into place.
- Geomembrane shall be overlapped a minimum of four inches.
- Using a hot-air source, temporarily bond the panels of geomembrane to be welded, taking care not to damage the geomembrane.
- Clean the seam area prior to seaming to provide an area that is clean and free of moisture, dust, dirt, and debris of any kind.
- Prior to welding but within an hour of the welding operation, grind seam overlap in a manner that does not damage the geomembrane. Grind marks should be covered with extrudate whenever possible. In all cases, grinding should not extend more than ¼ inch past the edge of the area covered by the extrudate during welding.

7.5.6 Seaming Documentation

Seaming information including panel number, seam number, welder ID, machine number, temperature setting, and weather conditions shall be documented. Welding technicians shall mark the following information on the liner with permanent markers at the start of all seaming operations: date, time, welding technician ID, machine number, and machine operating temperature and speed. All personnel performing seaming operations shall be trained and certified in the operation of the specific seaming equipment being used. The liner contractor shall provide direct supervision of the seaming operations.

As-built drawings shall show locations of seams, samples cut for destructive testing, and repairs. Results of field seam test strips shall be recorded.

7.5.7 Trial Welds

Trial welds for fusion and extrusion welds shall be conducted by certified welding technicians prior to each seaming period, every five hours, as weather conditions dictate, if welding problems are suspected, or at the discretion of the certifying engineer. All trial welds shall be performed under the same conditions encountered during actual seaming. Once qualified by a passing trial weld, welding technicians shall not change parameters (e.g., temperature and speed) without performing another trial weld.

1. A trial weld shall be made by joining two pieces of geomembrane that are at least six inches in width. Trial welds for fusion welds shall be a minimum of five feet long, and extrusion weld trial seams shall be a minimum of four feet long.
2. Samples shall consist of three 1-inch-wide specimens, one from the middle of the seam and two that are each one foot from each end of the test seam. Specimens shall be obtained using a one-inch die cutter. The specimens shall then be tested in peel using a field tensiometer capable of 500 pounds of tensile force.
3. For a trial weld to be considered acceptable, all three specimens must meet the following criteria:
   A. They must exhibit film-tearing bond (FTB).
   B. They must meet or exceed the minimum strength values shown in Table 2. If any specimen should fail, the entire procedure shall be repeated.
   C. In the case of double-track fusion-welded seams, both welds must pass to be considered acceptable.
   D. If repeat tests utilizing reasonable sets of welding parameters also fail, the seaming apparatus shall not be accepted and shall not be used for seaming until the deficiencies are corrected and a passing test seam is achieved.
   E. Trial weld documentation: The certifying engineer or designated representative shall be present during peel testing. The liner contractor shall record the date, time, operator, machine number, ambient and operating temperatures, speed setting, peel values, shear values, and pass/fail designation. A log of recorded test values shall be maintained and shall become part of the record documents for the installation.
   F. In the event that non-complying seam test strips are encountered, the welding machine shall be taken out of service until a passing trial weld is obtained, and additional peel specimens shall be taken to localize the flaw.
   G. All acceptable seams must be bounded by two locations from which passing tests have been taken.

7.5.8 Testing

The following laboratory tests shall be conducted on collected samples:

- Shear test by method ASTM D4437 (Mod. NSF 54) or equivalent thereof; and
- Peel test by method ASTM D4437 (Mod. NSF 54) or equivalent thereof.

Testing requirements are detailed in Table 2. Non-destructive tests shall be performed over the full (100%) length of all field seams. Testing shall be by vacuum (for extrusion welds) or pressure (for double-fusion welds). Samples of field welds shall be collected at least every 500 feet for laboratory destructive testing. All holes in the geomembrane resulting from destructive seam sampling shall be repaired and tested in accordance with the following section. Archival of field weld samples shall not be required.

7.6 Repairs

- Any portion of the geomembrane or geomembrane seam showing a flaw or having a destructive or nondestructive test in noncompliance shall be repaired and non-destructively tested.
- Repair holes larger than 1/4 inch with a patch; repair smaller holes by extrusion cap welding.
- Grind and clean the surface to be patched no more than 15 minutes prior to patching. Remove no more than 10% of the thickness.
- Patches shall have rounded corners or be oval in shape, made of the same geomembrane, and extend a minimum of six inches beyond the edge of the defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top edges beveled with an angle grinder prior to placement on the geomembrane. Patches shall be applied using approved methods only.
- Each repair shall be nondestructively tested, except when the CQA engineer requires a destructive seam sample obtained from a repaired seam. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair must be repeated and retested until passing test results are achieved.
- All acceptable seams shall be bounded by two locations from which passing tests have been taken.

8.0 FINAL CONSTRUCTION DOCUMENTATION REPORT

After completion of each liner or final cover construction project, a Construction Documentation Report shall be prepared and submitted to the CDPHE. The report shall consist of a detailed narrative describing construction of the area in chronological fashion. It shall describe all major aspects of construction including (as applicable): excavation, subgrade preparation, compacted cohesive soil liner placement, leachate collection system construction, granular drainage layer placement, geomembrane liner placement, and/or final cover construction. In addition, the report shall include a discussion of all changes or variances from the contract documents that were made during construction. All forms and reports relating to the installation of the geomembrane liner shall be included as appendices to the Construction Documentation Report, as referenced throughout this CQA Plan.

An analysis and discussion of all field and laboratory testing work performed shall be included, including identification of any non-conforming items. For any non-conforming item, the certifying engineer shall specifically discuss whether the item is acceptable as-is, or whether further testing or additional evaluation is required for approval.

A cover letter shall be included under the seal of a registered professional engineer (PE) licensed in the state of Colorado, rendering an opinion as to whether the facility has been constructed in substantial conformance to the contract documents. A registered land surveyor in the state of Colorado shall certify all survey data and documentation which shall be included in the report. A complete set of record drawings shall also be submitted along with the report.

TABLES

NORTH WELD LANDFILL
SOIL CONSTRUCTION QUALITY ASSURANCE TESTING AND FREQUENCY

ENGINEERED FILL TESTING AND FREQUENCY

Test	ASTM Designation	Minimum Construction Frequency	Minimum Preconstruction Frequency
Field Density	D6938	1 per 370 cy	--
Field Moisture	D6938	1 per 370 cy	--
Field Test and Sample Locations	D6938	Selected randomly by CQA Engineer within an approximate predetermined grid	--
Grain Size (no hydrometer)	D6913	At CQA Engineer's discretion	1 per source and material type
Moisture Content	D2216 or D4643	At CQA Engineer's discretion	1 per source and material type
Standard Proctor	D698	At CQA Engineer's discretion	1 per source and material type

COMPACTED COHESIVE SOIL LINER TESTING AND FREQUENCY

Test	ASTM Designation	Minimum Construction Frequency	Minimum Preconstruction Frequency
Field Density	D6938	1 per 370 cy	--
Field Moisture	D6938	1 per 370 cy	--
Field Test and Sample Locations	--	Selected randomly by the CQA Engineer within an approximate predetermined 100 ft x 100 ft grid pattern offset for subsequent lifts	--
Soil Classification	D2487	1 per 5,000 cy and change in material type	1 per 20,000 cy
Grain Size (no hydrometer)	D6913	1 per 5,000 cy and change in material type	1 per 20,000 cy
Atterberg Limits	D4318	1 per 5,000 cy and change in material type	1 per 20,000 cy
Moisture Content	D2216 or D4643	1 per 5,000 cy	1 per 20,000 cy
Standard Proctor	D698	1 per 10,000 cy and change in material type	1 per 20,000 cy
Modified Proctor	D1557	At CQA Engineer's discretion	1 per source
Hydraulic Conductivity	D5084	1 per 10,000 cy and change in material type	1 per 20,000 cy
Specific Gravity	D854	1 per 5,000 cy and change in material type	1 per 20,000 cy
One Point Proctor	AASHTO T272	1 per change in material type, with a minimum of 1 per 5,000 cy	--

Golder Associates

NORTH WELD LANDFILL
SOIL CONSTRUCTION QUALITY ASSURANCE TESTING AND FREQUENCY

LEACHATE DRAIN AND SUMP GRAVEL TESTING AND FREQUENCY

Test	ASTM Designation	Minimum Construction Frequency	Minimum Preconstruction Frequency
Grain Size	C136	1 per 1,000 LF or minimum of 2 samples	1 per source
Hydraulic Conductivity	D5084	1 per 10,000 cy	1 per source

GRANULAR DRAINAGE LAYER TESTING AND FREQUENCY

Test	ASTM Designation	Minimum Construction Frequency	Minimum Preconstruction Frequency
Hydraulic Conductivity*	D5084	1 per 10,000 cy	1 per source

* Preconstruction hydraulic conductivity tests for glass cullet to be conducted under loaded and unloaded effective stress conditions, construction tests to be conducted under unloaded effective stress conditions.

FINAL COVER TESTING AND FREQUENCY

Test	ASTM Designation	Minimum Construction Frequency	Minimum Preconstruction Frequency
Field Density	D6938	1 per 6,500 cy	--
Field Moisture	D6938	1 per 6,500 cy	--
Field Test Locations	--	Selected randomly by the certifying CQA Engineer	--
Grain Size	D6913	1 per 6,500 cy	1 per source and material type
Hydrometer	D7928	1 per 6,500 cy	1 per source and material type
Moisture Content	D2216 or D4643	1 per 6,500 cy	1 per source and material type
Standard Proctor	D698	1 per 6,500 cy	1 per source and material type
pH	SW-846 SW 9045C	1 per 6,500 cy	1 per source and material type
$CaCO_3$	USDA Handbook Number 60	1 per 6,500 cy	1 per source and material type

TABLE 2
GEOMEMBRANE CONSTRUCTION QUALITY ASSURANCE TESTING AND FREQUENCIES

Item	Parameter	Specification	Test Method	Construction Frequency	Preconstruction Frequency	Survey/Comments
HDPE Resin	Specific Gravity	greater than or equal to 0.932	ASTM D792 Method A	N/A	Manufacturer: 1 per resin batch	Resin without carbon black
	Melt Index	max 1.0g per 10 minutes	ASTM D1238 Condition E			
Extrudate Rod or Bead	Specific Gravity	greater than or equal to 0.94	ASTM D792 Method A			
	Carbon Black Content	2-3%	ASTM D1603			
	Melt Index	max 1.0g per 10 minutes	ASTM D1238 Condition E			
Geomembrane (60-mil HDPE Liner)	Thickness	54-mils minimum, average of 10 tests 60 mils	ASTM D5994	5 per side/5 per end	N/A	Panel Record Drawing to be prepared by Registered Kansas Land Surveyor
	Compound Density	greater than or equal to 0.94	ASTM D792/1505	N/A	Manufacturer: 1 per lot	
	Carbon Black Content	2-3%	ASTM D1603			
	Carbon Black Dispersion	Minimum 9 views category 1 or 2, No more than 1 view from category 3.	ASTM D5596			
	Strength at Yield	Minimum 126 lbs/in	ASTM D638			
	Elongation at Yield	Minimum 12%	ASTM D638			
	Strength at Break	Textured: Minimum 90 lbs/in	ASTM D638			
		Smooth: Minimum 228 lbs/in				
	Elongation at Break	Textured: Minimum 100%	ASTM D638			
		Smooth: Minimum 700%				
	Tear Strength	Minimum 42 lbs.	ASTM D1004			
	Puncture Resistance	Textured: Minimum 90 lbs/in	ASTM D4833			
		Smooth: Minimum 108 lbs/in				
Destructive Tests (60-mil HDPE Liner)	Fusion Weld or Extrusion Fillet Testing	Peel: Greater than 78 lbs.; Shear greater than 120 lbs.	ASTM D6392	1 per 500 feet of seam length, Observation of each destructive sample	N/A	Based on Specifications Set forth by Geosynthetics Research Institute, March 2002
	Trial Seam Testing: Fusion		ASTM D6392	1 per shift or 1 per 5 hours, Observation of each destructive sample		
	Trial Seam Testing: Extrusion		ASTM D6392			
Non-destructive Tests (60-mil HDPE Liner)	Fusion Weld Continuity by air-pressure testing	27 to 35 psi for 5 minutes; permissible drop of 3 psi	ASTM D5820	Each Seam	N/A	
	Extrusion Weld Continuity by vacuum-box testing	induce pressure of 5 psi; hold for 10 seconds	ASTM D5641	Each Seam		

TABLE 3
SEED MIX AND SOIL AMENDMENTS
GRASS SPECIES

Common Name	Variety	Lbs PLS/Acre
Buffalo Grass	Texoka	2.8
Blue Grama	Hachita	0.8
Switchgrass	Dakotah	1.2
Side-oats Grama	Vaughn	1.6
Sand Dropseed	Native	0.02
Western Wheatgrass	Arriba	4.4
Slender Wheatgrass	Primar or Revenue	3.8
Thickspike Wheatgrass	Critana	1
Little bluestem	Cimmaron	2.2
Total		**17.82**

Notes:

A. The CQA Engineer shall inspect seed labels/certifications upon delivery of seed to worksite to ensure that they contain correct seed mix. Native seed varieties shall be from appropriate climatic region. All legume species shall be inoculated by the seed supplier with the appropriate rhizobium species. Sources for native seed variety shall be subject to inspection and concurrence by the CQA Engineer before subcontractor is authorized to proceed with seeding.

B. Perform seeding operations only during periods when successful results can be obtained (i.e., not during drought or excessive precipitation periods). Do not conduct seeding operations when soil is frozen or when snow is present. Do not conduct seedbed preparation, seeding, or mulch application when wind conditions cause the seed/mulch to blow from the intended target area.

C. Seedbed preparation shall be conducted to maintain existing drainage patterns or as indicated on the project-specific drawings. Re-till areas compacted by construction. Protect finished graded areas from damage by vehicular or pedestrian traffic and erosion. Prior to seeding, rework any previously prepared seedbed areas compacted or damaged by rain, traffic, or other cause to restore the seedbed to previous condition.

D. Seeding times shall be: fall seeding: September 1 until freezing conditions; spring seeding: March 1 through May 15. Perform seeding within 10 days of completion of seedbed preparation.

E. Plant by drill seeding or by evenly broadcasting and incorporating the seed into the soil surface by harrowing. Drill seeding will be accomplished with a rangeland type drill equipped with double coulter furrow openers and depth bands followed by packer wheels. Use a drill capable of evenly seeding the native seed mixes over the entire site. Do not exceed 6 inches between drill rows. Plant seed to an average depth of 0.25 inch but not deeper than 0.50 inch.

F. If broadcast seeding is used, seeding rate shall be increased by 50%. Broadcast seed shall be distributed uniformly. Rake seed into the soil to an average depth of 0.25 inch but not deeper than 0.50 inch by a harrow device.

G. Fertilization and seeding mix shall be finalized after agricultural analysis of topsoil.

H. Spread and anchor grass straw mulch on areas that have been seeded with fall-seeded mixes within 24 hours after seeding. Apply straw mulch in a continuous cover of uniform thickness at a rate of 2 tons per acre. Anchor straw mulch to the soil by crimping straw into the soil. Start mulching on the windward side of relatively flat areas or on the upper part of steep slopes and continue uniformly until the area is covered. Immediately after seeding, protect seeded areas against traffic or other use by erecting barricades and providing signage. Re-till, seed, and mulch any areas impacted by traffic as directed by the contractor.

I. Repair: Reseed and mulch eroded, damaged, or barren areas that occur prior to completion of the seeding operation as determined by the Contractor. Repair or replace mulch as required.

APPENDIX F
WASTE IDENTIFICATION PLAN



WASTE IDENTIFICATION PLAN

North Weld Landfill
40,000 Weld County Road 25
Ault, Colorado 80610

December 2016

Prepared by:

Waste Management Disposal Services of Colorado, Inc.
5500 S. Quebec St., Suite 250
Greenwood Village, CO 80111

ERRATA - FOR INTERIM UPDATES

NORTH WELD LANDFILL
WASTE IDENTIFICATION PLAN

DATE	DESCRIPTION OF CHANGE
April 2002	Addition of Errata Sheet and replacement of Generator Waste Profile Sheet
October 2002	Plan revised pursuant to CDPHE letter dated July 10, 2002
December 2005	Plan updated pursuant to SB 05-141 and replaced Unacceptable Load Notification with Load Rejection Report
June 2013	Plan updated pursuant to SB 12-133 banning all electronic waste as defined in Section 16 of the Regulations Pertaining to Solid Waste Sites and Facilities
December 2016	Plan updated to include acceptance and handling procedures for sludge and marijuana. Other minor revisions made to text and appendices.

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ATTACHMENTS

Attachment A — Waste Inspection Report Sheet

Attachment B — Generator's Waste Profile

Attachment C — Load Rejection Report

1.0 PURPOSE

Waste Management Disposal Services of Colorado, Inc. (WMDSC) has adopted a Waste Identification Plan (Plan) for the North Weld Landfill (NWLF) to screen regulated hazardous waste, radioactive waste, polychlorinated biphenyl (PCB) waste, infectious waste, certain wastes related to motorized equipment, electronic waste, and waste tires to prevent these waste streams from entering the facility. The Plan also serves to identify commercial and industrial wastes that may require special handling from an employee or public safety perspective.

Compliance with the Plan will also ensure compliance with the waste screening requirements of Section 2.1.2 (B) of the Colorado Department of Public Health and Environment (the Department), "Regulations Pertaining to Solid Waste Disposal Sites and Facilities", 6 CCR 1007-2, amended November 17, 2015, hereinafter referred to as "the Regulations."

2.0 DEFINITIONS

Commercial Waste - In accordance with 6 CCR 1107-2 Section 1.2, "all solid wastes generated by stores, hotels, markets, offices, restaurants, warehouses, construction and demolition debris and other non-manufacturing activities, excluding community and industrial wastes."

Electronic Device - A device that is marketed by a manufacturer for use by a consumer and that is a computer, peripheral, printer, facsimile machine, digital video disc players, video cassette recorder, or other electronic device specified by rule promulgated by the commission; or a video display device or computer monitor including a laptop, notebook, ultrabook, or netbook computer, television, tablet, or slate computer, electronic book, or other electronic device specified by rule promulgated by the commission that contains a cathode ray tube or flat panel screen with a screen size that is greater than four inches, measured diagonally. "Electronic device" does not include a device that is part of a motor vehicle or any component part of a motor vehicle, including replacement parts for use in a motor vehicle; a device, including a touch-screen display, that is functionally or physically part of or connected to a system or equipment designed and intended for use in any of the following settings, including diagnostic, monitoring, or control equipment: industrial; commercial, including retail; library checkout; traffic control; security, sensing, monitor, or counterterrorism; border control; medical; or governmental or research and development; a clothes washer or dryer; a refrigerator, freezer, or refrigerator and freezer; a microwave oven or conventional oven or range; a dishwasher, a room air conditioner, dehumidifier, or air purifier; or exercise equipment; a device capable or using commercial mobile radio service, as defined in 47 CFR 20.3, that does not contain a video display area greater than four inches, measured diagonally; or a telephone.

Hazardous Waste - Those substances and materials defined or classified as such by the Colorado Solid and Hazardous Waste Commission pursuant to 25-15-302, C.R.S., as amended.

Hazardous Waste Facility - A facility that has received all required U.S., Mexican or Canadian Federal or State/Provincial approvals, licenses, or permits necessary to receive and manage Hazardous Waste.

Industrial Waste - All solid wastes, including mill tailings and mining wastes, resulting from the manufacture of products or goods by mechanical or chemical processes that are not a hazardous waste regulated under 6 CCR 1007-3, the Colorado Hazardous Waste Regulations. Such waste may include, but is not limited to, waste resulting from the following manufacturing processes: electric power generation; fertilizer/agricultural chemicals; food and related products/byproducts; inorganic chemicals; iron and steel manufacturing; leather and leather products; nonferrous metals manufacturing/foundries; organic chemicals; plastics and resins manufacturing; pulp and paper industry; rubber and concrete products; textile manufacturing; transportation equipment; and water treatment. This term does not include oil and gas wastes regulated by the Colorado Oil and Gas Conservation Commission.

Infectious Waste - Waste containing pathogens or biologically active material which because of its type, concentration and quantity could present a potential hazard to human health when improperly handled, stored, processed, transported or disposed of. Wastes presumed to be infectious medical waste include blood and body fluids, potentially infectious waste, pathological waste, sharps, trauma scene waste, and any additional waste determined to pose a sufficient risk of infectiousness as determined by the Department on a case-by case basis. This also includes any residue or contaminated soil, water, or other debris resulting from the cleanup of a spill of any infectious medical waste. For purposes of the Regulations, it does not include saliva, nasal secretions, sweat, tears, used feminine hygiene products, vomitus, urine or feces unrelated to isolation wastes, uncontaminated disposable bedding or garments, or lightly to moderately contaminated bandages, garments, etc. unless these wastes are soiled to the extent that the generator of the waste determines that they should be managed as infectious waste. Such wastes remain regulated under the provisions of Parts 1 through 3 of the Regulations.

Lead-Acid Battery - A battery that:

a. consists of lead and sulfuric acid;
b. is used as a power source; and
c. is not intended as a power source for consumer products.

Liquid Waste - Any waste that is determined to contain "free liquids" as determined by Method 9095 (Paint Filter Liquids Test), described in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods: USEPA Publication SW-846". According to 40 CFR 258.28, this definition does not include waste in containers similar in size to that normally found in household waste (e.g., beverage containers).

Marijuana Waste – Refers to confiscated, medical, or recreational marijuana; by-products; plants; and/orresidues; including those from grow operations, to be disposed in accordance with 6 CCR 1007-2 and either 1 CCR 212-2M 307 or R 307.

Municipal Solid Waste - Solid waste from household, community, commercial and industrial sources that does not contain hazardous wastes as defined in Section 25-15-101(6)(a) of the Colorado Hazardous Waste Act unless otherwise regulated by CDPHE.

NWLF – North Weld Landfill

Radioactive wastes - Wastes handled at facilities licensed pursuant to the provisions on radiation control in Article 11 of Title 25, C.R.S.

Residentially generated used lead-acid batteries, used oil or tires - Any used lead-acid batteries, used oil or waste tires generated by a person.

Residual Sludge – Any solids, semi-solids, or liquids remaining in a waste impoundment after final evaporative or other treatment or storage of the waste is completed, or which may be dredged out during the active life.

Sludge – Any solid or semi-solid waste generated by a municipal, commercial, or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility.

Solid Waste - Any garbage, refuse sludge from a waste treatment plant, water supply treatment plant, air pollution control facility, or other discarded material; including solid, liquid, semisolid, or contained gaseous material resulting from industrial operations, commercial operations or community activities. "Solid waste" does not include any solid or dissolved materials in domestic sewage, or agricultural wastes, or solid or dissolved materials in irrigation return flows, or industrial discharges which are point sources subject to permits under the provisions of the "Colorado Water Quality Control Act", Title 25, Article 8, CRS or materials handled at facilities licensed pursuant to the provisions in "Radiation Control Act" in Title 25, Article 11, CRS.

Solid Waste Management - Transportation, transfer, storage, treatment, reclamation, incineration or disposal of solid waste.

Special Waste Handling - Any waste that causes WMC to alter standard collection, transportation, processing, manifesting or landfilling practices for safety, health, regulatory or environmental reasons (e.g., immediate burial, worker protection, solidification, bioremediation, analysis, engineering controls, or any other special preparation to receive the waste).

SW-846 Methods - The latest edition of "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" USEPA Publication SW-846.

Used Oil - Any residentially generated motor oil, refined from crude oil or a synthetic oil that has been used and as a result of that use is contaminated by physical or chemical impurities.

Waste Tire - A tire that is modified from its original specifications but not processed into a tire-derived product, is no longer being used for its initial intended purpose, and is not a used tire.

3.0 WASTE EVALUATION PROGRAM

Although it is the generator's responsibility to accurately characterize its waste, the procedures identified in this Plan will be implemented to screen waste produced by commercial and industrial customers for regulated hazardous, PCB and radioactive wastes, wastes generated by residential customers related to motorized equipment, electronic waste, and waste tires. Evaluations may be made by physically reviewing commercial and industrial processes, laboratory analysis, written survey, phone questionnaires or other methods, which will identify prohibited wastes or wastes requiring special handling. Prohibited wastes that are identified during the waste evaluation program will be referred to a permitted hazardous waste transfer, storage or disposal facility or other appropriate facility. Additional questions and/or observations of incoming wastes are completed at the gatehouse and a minimum of two (2) random load inspection per week are completed at the disposal area. The waste inspection report form included in Attachment A will be used. If prohibited wastes are discovered at the facility, the procedures described in Section 6.0 of this Plan will be followed.

3.1 PROHIBITED WASTES

Regulated hazardous, radioactive, PCB, or infectious wastes, which are subject to U.S. or Colorado regulations will not be accepted at NWLF. Other wastes that are banned include residentially generated lead-acid batteries and used oil, waste tires, and electronic devices. Generators with these wastes will be referred to an appropriately permitted facility.

3.2 WASTE SCREENING PROCESS

An acceptance decision to approve a waste stream will be documented for certain industrial and commercial waste stream destined for disposal at NWLF. The following requirements will be followed prior to acceptance of certain industrial and commercial wastes:

- The customer or its agent must provide information about the waste and sign a waste profile (a facsimile signature is acceptable). A sample waste profile is included in Attachment B.

- The profile and associated information will be reviewed. Material characterized as prohibited waste will not be accepted. The information provided by the generator will be used to assign any appropriate conditions/limitations on managing the waste.

- The waste profile must be updated if the process generating the waste changes.

3.3 WASTE TYPE DOCUMENTATION

The waste profile will be completed and signed by the generator or his designee for specific waste streams managed at NWLF. The generator must complete the form

to the best of his/her knowledge in accordance with the instructions attached to the profile. Prior to the expiration date of the waste profile approval, the underlying facts concerning the waste stream will be re-examined and a decision rendered in accordance with Section 3.2 whether to continue managing the waste. Any changes made to the written information provided by the generator will be initialed and dated by the person authorizing the changes. Facsimile changes are acceptable. If these changes affect the precautions, conditions, or limitations for managing the waste, the generator will be informed in writing of the changes.

4.0 LABORATORY USAGE

4.1 ANALYTICAL REQUIREMENTS

WMDSC personnel will review the waste profile and any analytical results or equivalent information (i.e., 40 CFR 262.11 allows generator's knowledge of the waste and process generating the waste) to screen waste from certain commercial and industrial customers so that prohibited wastes are not accepted.

4.2 ACCEPTABLE LABORATORIES

A commercial or private laboratory, using SW-846 or equivalent approved test methods acceptable to WMDSC will be used for conducting any required waste analyses.

5.0 TRAINING

All employees responsible for waste acceptance or inspection will be trained, at a minimum, to recognize and properly respond to prohibited and banned wastes.

6.0 OPERATIONAL REQUIREMENTS

If prohibited wastes are identified at the facility, the material will be rejected and returned to the generator if possible or segregated until adequate information can be obtained to accurately identify the waste and determine an appropriate management method. CDPHE and Weld County authorities will be notified as required. Additionally, efforts will be taken to identify the generator of the material. A "Load Rejection Report" form (Attachment C) will be completed and filed in the site operating record.

Marijuana waste will only be accepted in accordance with M 307 or R 307 of the Colorado Department of Revenue regulations. The requirements include receipt of marijuana waste that has been rendered unusable and unrecognizable through grinding and incorporating the marijuana waste with non-consumable, solid wastes including paper waste, plastic waste, cardboard waste, food waste, grease or other compostable oil waste, Bokashi, or soil such that the resulting mixture is at least 50 percent non-marijuana waste.

Sludge will be accepted at the working face in a manner to prevent customers and the public from coming into contact with the sludge. This can be accomplished by pushing the sludge into the working face prior to allowing other customers in the immediate area where the sludge was dumped or preparing a trench, so the sludge can be pushed into the trench and covered with other solid waste.

7.0 PROGRAM RECORDS

Records will be maintained in accordance with applicable regulations. All documents will be maintained at the facility or an alternative location approved by the Department.

ATTACHMENT A

WASTE INSPECTION REPORT

WASTE INSPECTION REPORT

Date: _____ **Hauler:** _____

Time: _____ **Truck #:** _____

Inspector: _____ **Ticket #:** _____
(Print Name)

Are the following wastes present in the load?

	Yes	No
Waste Requiring Special handling?		
Regulated Hazardous Waste?		
Radioactive Waste?		
PCB Wastes?		
Infectious Waste?		
Liquid Waste?		
Residentially generated used lead-acid batteries or used oil?		
Electronic Waste?		
Waste Tires?		

Comments: _____

ATTACHMENT B

GENERATOR'S WASTE PROFILE SHEET

WASTE MANAGEMENT

780 East 96th Avenue, Henderson, CO 80640 • (303) 336-3900 • Fax: (303) 280-9848

GENERATOR'S WASTE PROFILE SHEET

WM Use Only	
Expiration Date:	
Technical Approval By:	
Approval Date:	
Profile #	
Safety/Health Review By:	
Limitations:	

INSTRUCTIONS: Please answer each question as completely as possible by circling "YES**" or "**NO", checking the appropriate boxes, filling in the blanks, and attaching additional sheets as necessary. **An ink pen or typewriter must be used. The Generator or an Authorized Representative must sign the form. All related analyses and associated chains of custody must be included with the form. If the waste changes or future analyses differ from what was submitted, WM must be notified immediately. Originals must follow fax or email copies.**

Please check the box below indicating the landfill where you would like your waste managed:

☐ **DADS** ☐ **CSI** ☐ **NWLF** ☐ **MIDWAY** ☐ **CSLF** ☐ **BRL** ☐ **MONTROSE** ☐ **OTHER (Specify below)**

FOR 'OTHER': Provide Name and Address of Management Facility:

A. GENERATOR INFORMATION

Generator Name:	Generator Contact:
Generator Address: Phone: Fax:	Generator Title: **BROKER INFORMATION** (if applicable) P.O. # _____ Account #: _____
Billing Address: Phone: Fax:	Broker Name: Broker Contact: Phone: Fax:

B. PROCESS GENERATING WASTE (Based on 40 CFR 261 and 6 CCR 1007.3 Part 261)

Waste Name:	Mode of Shipment: ☐ Bulk Liquid ☐ Bulk Solid ☐ Drums (55 gallon), ☐ Other (specify below) For OTHER:
Process Generating Waste:	Estimated Volume: ☐ Gallons, ☐ Cubic yards, ☐ Drums (55 gallon), _____ ☐ Other (specify below) OTHER (Specify type and quantity):
Describe the business of generator:	Frequency Per: ☐ Day ☐ Month ☐ Year ☐ One Time ☐ Project

C. WASTE PROPERTIES

Profile #:

Appearance:

Color: _____

Odor:
- ☐ None
- ☐ Mild
- ☐ Strong

Phases:
- ☐ Single
- ☐ Bi-layered
- ☐ Multi-layered

pH:
- ☐ < or equal to 2
- ☐ 2.1 – 7
- ☐ 7-12.4
- ☐ > or equal to 12.5
- ☐ N/A-Solid

Viscosity: (Similar to)
- ☐ Solid
- ☐ Tar
- ☐ Honey
- ☐ Motor Oil
- ☐ Water

Specific Gravity:
- ☐ < 0.8
- ☐ 1.0-1.7
- ☐ >1.7
- ☐ _____ actual
- ☐ N/A

Total SuspendedSolids (% wt):
- ☐ <0.5
- ☐ 0.5-2.0
- ☐ 2-5
- ☐ 6-20
- ☐ >20
- ☐ _____ actual
- ☐ N/A

Physical State:
- ☐ oil
- ☐ Liquid (water)
- ☐ Sludge
- ☐ Damp solid
- ☐ Dry solid
- ☐ Powder
- ☐ Filter cake
- ☐ Soil
- ☐ Concrete
- ☐ Debris
- ☐ Lab pack
- ☐ Ash

Paint Filter Test:
- ☐ Pass
- ☐ Fail

Liquid Flashpoint (closed cup):
- ☐ <140^0 F (60^0 C)
- ☐ 140^0- 200^0 F
- ☐ > 200 ^{0} F
- ☐ _____ actual
- ☐ Non-Ignitable solid

Attachments:
- ☐ Material Safety Data Sheet(s)
- ☐ Analytical Data
- ☐ Other (Agency correspondence, process knowledge statement, etc.)

D. REGULATORY QUESTIONS (Based on 40 CFR 261 and 6 CCR 1007.3 Part 261)

1. Is the waste a hazardous waste as defined by 6CCR 1007-3 Part 261 Sections 261.21-24 (D Code), 261.31 (F Code), 261.32 (K Code), 261.33 (P or U Codes)?	☐YES ☐NO
2. Is the waste from an UST corrective action as defined under 40 CFR Part 280? *(If 'YES', also check 'YES' on the following question)*	☐YES ☐NO
3. Is the waste specifically excluded from hazardous waste regulations in 6 CCR 1007-3 Section 261.4? If 'YES', attach an explanation including the portion of the regulation where the exclusion is mentioned.	☐YES ☐NO
4. Is the waste being legally treated for a single hazardous characteristic? If so, attach a copy of the Agency notification and a certification that no Underlying Hazardous Constituents (UHC's) are present. *(WM can provide a blank notification/certification form, if needed.)*	☐YES ☐NO
5. Is the waste from any of the following? • CERCLA project; • In response to a Compliance Order; • Hazardous waste in another State; • Subject to Land Disposal Restrictions	☐YES ☐NO
6. Does the waste contain regulated quantities of radioactives or PCB's? (Attach analyses)	☐YES ☐NO

E. AUTHORIZED SIGNATORY:

I hereby certify that:

- ***I am the Generator (or authorized by the Generator identified herein to provide the information submitted in this form and any attached documents and to enter into this Agreement on the Generator's behalf).***
- ***I have made a complete and thorough investigation of all matters relevant to completion of this form and based on this investigation certify that no hazardous waste codes are associated with this waste stream.***
- ***If laboratory analysis was used to evaluate this waste stream, the analysis was performed on a representative sample of the waste stream in accordance with 6CCR 1007-3 Section 261.20(c).***
- ***All applicable information concerning the waste stream has been provided in this and the attached documents. Such information is complete and accurate and all known or suspected hazardous constituents/characteristics or safety hazards associated with the waste stream have been disclosed herein.***
- ***I will inform Waste Management if the waste characteristics or process changes.***

Signature:	**Print:**
Title:	**Date:**
Company:	

ATTACHMENT C

LOAD REJECTION REPORT

Load Rejection Report

Date: _____ Time: _____ ☐ A.M. ☐ P.M.

CUSTOMER/GENERATOR

Name: _____

Address: _____

City, State, Zip: _____

TRANSPORTER/HAULER

☐ Same as Customer/Generator

Name: _____

Address: _____

City, State, Zip: _____

ORIGIN OF LOAD INFORMATION

Location: _____

Street Address: _____

City, State, Zip: _____

REASON FOR REJECTION

☐ Liquid Waste ☐ Suspected Infectious Waste ☐ Electronic Waste

☐ Suspected Hazardous or PCB Waste ☐ Suspected Friable Asbestos ☐ Other (See Comments)

Explanation: _____

_____

_____

ACKNOWLEDGEMENT

☐ Rejected Prior to Dumping ☐ Rejected After Load Was Dumped

Comments: _____

_____

Driver's Signature _____ Site Signature _____

Customer/Generator Notified ☐ Yes ☐ No If yes, name of person contacted: _____	Transporter/Hauler Notified ☐ Yes ☐ No If yes, name of person contacted: _____

APPENDIX G
GROUNDWATER MONITORING PLAN

WILL BE REPLACED WITH CURRENT GWMP
ONCE REVISED TO INCLUDE UNIT 2 FOLLOWING PERMIT APPROVAL

APPENDIX H
OPERATIONAL PERSONNEL INFORMATION

APPENDIX H

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Updated December 2016

APPENDIX I
UNIT 2 ALTERNATIVE LINER DEMONSTRATION

ALTERNATIVE LINER DEMONSTRATION

ALTERNATIVE LINER DEMONSTRATION

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Weld County, Colorado

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December 21, 2016

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1.0 INTRODUCTION

1.1 Background

The North Weld Landfill (NWLF) is a municipal solid waste landfill (MSWLF) owned and operated by Waste Management Disposal Services of Colorado, Inc. (WMDSC) in Weld County, Colorado. The NWLF received a Certificate of Designation (CD) from the Weld County Board of County Commissioners on June 27, 1990, authorizing the development of four landfill phases for solid waste disposal (identified as Phases 1, 2, 3A, and 3B), which provided approximately 122 acres of waste disposal area. This disposal area is hereinafter referred to as the Unit 1 waste disposal area.

The Updated Design and Operations Plan for the North Weld Sanitary Landfill (Rust 1997) for the Unit 1 waste disposal area, approved by the Colorado Department of Public Health and Environment (CDPHE) and the Weld County Department of Public Health and the Environment (WCDPHE), and Condition 7(b) of the WCDPHE CD Development Standards required that the entire landfill be underlain by a two-foot-thick compacted clay liner.

1.2 Purpose and Objective

WMDSC plans to further the productive life of the NWLF through the development of Unit 2, which will be located immediately north of, and contiguous to, the existing Unit 1 waste disposal area and will add an additional 155 acres of waste disposal capacity to the site. The same alternative liner system previously approved for Unit 1 is proposed for Unit 2. In accordance with Section 3.2.5(C)(4) of the CDPHE "Regulations Pertaining to Solid Waste Sites and Facilities," 6 CCR 1007-2, Part 1 as amended November 17, 2015 (Regulations) (CDPHE 2015), it is the responsibility of the owner or operator of a landfill to demonstrate that an alternative liner system design will ensure that the maximum contaminant levels (MCLs) listed in Table 1 of 40 CFR 258.40 will not be exceeded in the uppermost aquifer at the relevant point of compliance (POC).

The purpose of this Alternative Liner Demonstration (ALF) is to demonstrate that the alternative liner system proposed for the development of Unit 2 at the NWLF reasonably ensures groundwater protection considering expected waste characteristics, site construction, and site setting. Groundwater protection is demonstrated in this report through technical evaluation and modeling that MCLs listed in Table 1 of 40 CFR 258.40 will not be exceeded at the Unit 2 POC.

1.3 Methodology

The following methodology was used to demonstrate the performance of the alternative liner system:

1. Define geotechnical characteristics of proposed alternative liner system;
2. Develop conceptual site hydrogeologic model;

3. Evaluate leachate generation and impingement rates through alternative liner system using Hydrologic Evaluation of Landfill Performance (HELP) model, version 3.07 (USACE 1997);
4. Demonstrate that selected leachate chemical constituents will not exceed their MCL listed in Table 1 of 40 CFR 258.40 at the Unit 2 POC by calculating and applying dilution factors (DFs) using the Multimedia Exposure Assessment (MULTIMED) model for Windows, Version 1.51 (AGC 2005); no attenuation factors were applied for conservatism;
5. Compute constituent concentrations at the POC based on site-specific leachate analytical data and/or published leachate data and the calculated DFs; and
6. Compare computed concentrations with allowable MCLs to evaluate alternative liner system performance.

1.4 Proposed Alternate Liner System

1.4.1 Alternative Liner System Components

The alternative liner system for Unit 2 will be identical to the alternative liner system previously approved for Unit 1, consisting of the following components listed from top of liner down to existing foundation material:

- A 6-inch-thick granular leachate collection drainage layer installed over the liner floor area and composed of soils exhibiting a hydraulic conductivity equal to or greater than 1×10^{-2} cm/sec;
- A six-inch-thick protective soil layer installed over the liner side slope area;
- A 24-inch-thick compacted cohesive soil liner composed of on-site or imported soils exhibiting a hydraulic conductivity no greater than 1×10^{-7} cm/sec; and
- Prepared subgrade material composed of conditioned and compacted existing subsurface material.

A detail of the alternative liner system is shown in Figure 1.

Within permanent leachate collection sumps, the thickness of the compacted cohesive soil liner will be extended to 30-inches, and a second liner (60-mil HDPE geomembrane) will be installed to create a composite liner system where leachate head may accumulate. For conservatism, these additional design features were not considered in estimating leachate impingement rates through the alternative liner system.

1.4.2 Construction Qualify Assurance

The alternative liner system will be constructed under a comprehensive Construction Quality Assurance (CQA) Plan (Golder 2016) to verify that the liner components are prepared and installed as intended in the design. During liner construction, CQA monitoring, sampling, and testing will be required for the following properties, providing a level of confidence that the alternative liner system will be constructed as modeled in this ALF and as required to ensure performance:

- Grade control
- Soil classification (ASTM D2487)

- Grain size (ASTM D422)
- Atterberg limits (ASTM D4318)
- Moisture content (ASTM D2216 or ASTM D4643)
- Compaction characteristics (ASTM D698)
- In-place moisture content and density (ASTM D6938)
- Hydraulic conductivity (ASTM D5084)

Following each liner construction project, a certification report will be prepared to document that the liner and leachate collection systems were constructed in accordance with the contract documents, EDOP requirements, and approved CQA Plan. The certification report will be signed and sealed by a professional engineer (PE) registered by the State of Colorado and submitted to the CDPHE and the WCDPHE for approval prior to placement of waste.

1.4.3 Material Availability

In support of the siting and engineering design of Unit 2, WMDSC commissioned a comprehensive geotechnical and hydrogeologic site characterization field program of the proposed Unit 2 area of the NWLF site. The results of the site characterization are presented in the Report of Geotechnical Investigation, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016a) and Report of Hydrogeological Characterization, North Weld Landfill Unit 2, Permitting and Development (Swift River 2016b).

As reported in the Report of Geotechnical Investigation (Swift River 2016a), the field program encountered clayey silt with fine-grained sand to a typical depth of approximately 15 feet below existing ground surface across the Unit 2 waste disposal footprint. Disturbed bulk samples of this material were collected from within the proposed landfill excavation depth for the development of the Unit 2 subgrade and subjected to laboratory testing to evaluate suitability for use in landfill construction. Five disturbed samples were remolded to 97% maximum dry density and moisture content at 2.5% above optimum to evaluate possible use as cohesive soil liner material. Remolded hydraulic conductivities ranged from 2.8×10^{-7} to 2.5×10^{-8} cm/sec, with a geometric average of 1.2×10^{-7} cm/sec, suggesting that suitable material is available on site for use in alternative liner system construction.

2.0 CONCEPTUAL HYDROGEOLOGIC SITE MODEL

2.1 Geologic Setting

The NWLF site is located in an upland area which is covered by as much as 30 feet of Pleistocene-age eolian (wind-deposited) deposits overlying as much as 20 feet of undifferentiated Pleistocene- to Holocene-age glacial outwash alluvium. Within the Unit 2 area of the NWLF site, their combined thickness ranges from between 17 and 45 feet.

Consistent with the lithology characterized prior to the development of Unit 1 to the south (ATEC 1993), the eolian deposits generally consist of clayey silt and very fine to fine-grained silty sand and range from 7 to 20 feet in thickness within the Unit 2 waste disposal footprint. The underlying glacial outwash alluvium consists of interbedded coarser-grained sand and fine gravel with varying amounts of silt and clay and range from less than 10 to approximately 25 feet in thickness.

Directly beneath the glacial outwash deposits is the weathered Laramie Formation, characterized as a mixture of claystone, siltstone, fine-grained sandstone, and shale interstratified with laterally discontinuous lignite. The Laramie Formation is present beneath the entire NWLF site. Within the proposed Unit 2 waste disposal footprint, the Laramie Formation was encountered at depths ranging from 17 to 45 feet below ground surface and measured up to 30 feet in thickness. Conformably underlying the Laramie Formation is approximately 200 feet of the Fox Hills Sandstone, generally consisting of interbedded layers of fine-grained sandstone, siltstone, and shale (Swift River 2016b).

A simplified representative geologic profile of the Unit 2 waste disposal footprint was developed for the purposes of modelling as discussed in Section 4.2.4 of this ALF.

2.2 Hydrogeologic Setting

As reported in the Report of Hydrogeological Characterization (Swift River 2016b) and consistent with groundwater conditions monitored around Unit 1, groundwater in the vicinity of the Unit 2 waste disposal occurs within the following formations, listed from shallowest to deepest:

- Alluvium/Laramie Formation: Discontinuous saturated alluvial deposits of gravelly sands and sandstones were encountered in three monitoring wells at the contact between the alluvium and the Laramie Formation between 38 feet and 48 feet below top of well casing. These zones are present along only the eastern boundary of the Unit 1 and Unit 2 waste disposal areas. These zones are assumed to be unconfined.
- Laramie Formation: Localized, discontinuous water-bearing sands and lignite seams within the Laramie formation were encountered in two monitoring wells along the eastern Unit 2 boundary between 46 feet and 56 feet below top of well casing. These isolated zones appear to be confined and not hydraulically connected to the deeper saturated aquifer.
- Fox Hills Sandstone: The regional zone of saturation within the Fox Hills Sandstone was encountered across both Unit 1 and Unit 2 areas of the NWLF site, with water levels that

can be correlated and mapped together across the site. This zone appears to be confined beneath all or most of the NWLF site and represents the uppermost continuous saturated zone. Groundwater flow within this zone is south-southwestward, consistent with conditions routinely monitored at Unit 1. Stabilized water levels within the Unit 2 area of the NWLF site ranged from 50 feet to 128 feet below top of well casing.

The discontinuous water-bearing zones encountered at the contact between the alluvium and the Laramie Formation and within the Laramie Formation itself along the western boundary of Unit 2 are isolated, perched zones and are not continuous across the NWLF site. The POC for this demonstration (i.e., the vertical surface that is not more than 150 meters from the waste management unit boundary) occurs within the saturated and laterally continuous Fox Hills Sandstone (uppermost aquifer). Since the direction of groundwater flow within the Fox Hills Sandstone is south-southwestward, the POC was defined along the southern and western boundaries of the Unit 2 disposal footprint, as shown in Figure 2. This POC is consistent with the POC previously defined for Unit 1 in the North Weld Sanitary Landfill Alternative Design Evaluation (Rust 1993). The POC is discussed in greater detail in Section 4.2.5 of this ALF.

3.0 LEACHATE SOURCE ANALYSIS

The HELP Model was used for the leachate source analysis to estimate the maximum leachate impingement rate through the alternative liner system within Unit 2.

3.1 Operational Scenarios

A HELP model analysis was performed to estimate leachate generation rates within Unit 2, assuming various waste depths and cover configurations. The analysis was initially performed for the following operational conditions, assumed to represent the most critical typical operational scenarios anticipated to occur throughout the life of the landfill from a leachate-generation standpoint:

- Scenario 1: 6 feet of waste with daily cover (1 year weather generation);
- Scenario 2: 70 feet of waste with daily cover (1 year of weather generation);
- Scenario 3: 70 feet of waste with intermediate cover (10 years of weather generation); and
- Scenario 4: 154 feet of waste with final cover (30 years of weather generation representative of post-closure period).

The results of the initial analysis indicated that the operational conditions modeled under both Scenarios 1 and 2 result in very similar leachate impingement rates through the alternative liner system. For the purposes of this ALF, the maximum impingement rate from Scenario 2 was used as the input parameter to the MULTIMED model discussed in Section 4.0. Since the HELP model is limited to a quasi-two-dimensional input model of a single geometrically defined waste mass, the operational input parameters for Scenario 2 (i.e., the waste height, slope length) were further varied to evaluate the sensitivity of the results to changes in these parameters. The results of the HELP model are discussed in Section 3.3 of this ALF.

3.2 HELP Input Parameters

3.2.1 Meteorological Data

Meteorological data for the Landfill site was synthetically generated using the WGEN synthetic weather generator developed by the USDA Agricultural Research Service (ARS) and built into the HELP model. Statistical characteristics for synthetic weather data generation were adopted from Cheyenne, Wyoming, the nearest city to the site with published values in the program's default database. Daily solar radiation and evapotranspiration data were synthetically generated based on the latitude for Ault, Colorado (40.59° N).

3.2.2 General Design Inputs

The following is a list of the general input parameters used for the HELP analysis:

- The length and slope of the landfill floor was modeled at 845 feet and 2.64%, based on the maximum leachate flow path length within the leachate collection drainage layer and considering the maximum estimated consolidation of foundation soils;
- The compacted cohesive soil liner consists of 24 inches of on-site low-permeability soil;

- The granular leachate collection drainage layer consists of six -inches of coarse-grained sand;
- Daily and intermediate cover soils consist of on-site eolian deposit material (sandy clay loam) encountered within the proposed excavation depth for the development of the Unit 2 subgrade;
- 100% of the waste area was allowed to have runoff, with an SCS runoff curve number (CN) of 85;
- The waste surface was assumed to be bare ground (i.e., Leaf Area Index of 0); and
- The evaporative zone depth was limited to the thickness of the cover material modeled.

3.2.3 HELP Material Layers

Material properties were referenced site-specific geotechnical data from the Report of Geotechnical Investigation (Swift River 2016a) and correlated to default HELP model soil textures, with user-defined properties input to reflect specific material requirements, where appropriate. Material properties used in the HELP analysis are listed below from bottom of the alternative liner system to top of the daily, intermediate, or final cover:

- The 24-inch-thick compacted cohesive soil liner (all scenarios) was modeled as a barrier soil liner, with user-defined soil properties referenced from recent NWLF CQA data from Unit 1 cell construction projects and a hydraulic conductivity of 1 x 10^{-7} cm/sec.
- The granular leachate collection drainage layer (all scenarios) was modeled as a lateral drainage layer, HELP default Soil Type 1 (SP in USCS, CoS in USDA), with a hydraulic conductivity of 1 x 10^{-2} cm/sec.
- The waste mass (all scenarios, varying thickness) was modeled as a vertical percolation layer, HELP default Soil Type 18 (municipal solid waste), with a hydraulic conductivity of 1 x 10^{-3} cm/sec.
- Daily and intermediate cover (all scenarios) were modeled as a vertical percolation layer with user-defined soil properties from site-specific laboratory test data (Swift River 2016a) and a default hydraulic conductivity of 1.9 x 10^{-4} cm/sec for HELP default Soil Type 10 (SC in USCS, SCL in USDA).
- The 30-inch-thick water balance final cover (Scenario 4) was modeled as a vertical percolation layer with user-defined soil properties from site-specific laboratory test data (Swift River 2016a) and a default hydraulic conductivity of 1.9 x 10^{-4} cm/sec for HELP default Soil Type 10 (SC in USCS, SCL in USDA).

3.3 Results

As previously discussed in Section 3.1 of this Alterative Liner Demonstration and summarized in Table 1 below, the operational conditions modeled under both Scenarios 1 and 2 result in very similar critical leachate generation and impingement rates through the alternative liner system. This observation indicates that leachate generation at the NWLF site is primarily driven by the moisture content of the waste and limited to the first lift of waste placed. Subsequent waste lifts do not contribute to additional generation of leachate, primarily due to storage capacity and evaporation of precipitation within the cover soils. For example, the NWLF site has an average annual precipitation of approximately 14 inches (NOAA 2016b). The climate's demand for water, referred to as potential evapotranspiration, is calculated as approximately 54 inches

(NOAA 2016a and NMSU 1996), or 390% more than the actual supply of water (i.e., precipitation). This behavior is also consistent with site-specific observations from throughout the operational life of Unit 1 at NWLF, where generation of leachate has been observed to significantly decrease once the first lift of waste is placed in the active phase.

Table 1: Initial Leachate Generation Analysis HELP Model Results

Scenario	Waste and Cover Configuration	Model Duration (yrs)	Peak Daily Head on Liner (inches)	Average Annual Liner Impingement (in/yr)
1	6 feet of waste with daily cover	1	4.28	0.9720
2	70 feet of waste with daily cover	1	4.28	0.9739
3	70 feet of waste with intermediate cover	10	8.10	0.4306
4	154 feet of waste with final cover	30	8.06	0.0826

In order to conservatively identify the maximum leachate impingement rate under the operational conditions represented by Scenario 2, a sensitivity analysis was performed to evaluate the sensitivity of the HELP model results to the operational input parameters (i.e., the waste height, slope length). The results of the sensitivity analysis indicated that the base operational conditions modeled as Operational Scenario 2 (i.e., slope length of 845 feet and floor slope of 2.64%) result in the most critical (i.e., maximum) leachate impingement rate of 0.9739 inches per year. This rate was used as the source infiltration rate input parameter to the MULTIMED model discussed in Section 4.2.2 of this ALF. The HELP model output report from Operational Scenario 2 is provided in Appendix A.

4.0 EVALUATION OF IMPACT ON GROUNDWATER QUALITY

The MULTIMED model was used to demonstrate that predicted concentrations of selected leachate chemical constituents will not exceed the MCLs listed in Table 1 of 40 CFR 258.4 at the Unit 2 POC.

4.1 Dilution Factors (DFs)

DFs were used to demonstrate the level of groundwater protection the alternative liner system will provide at the POC. DFs are also commonly referred to as Dilution Attenuation Factors (DAFs); however, as discussed in Section 4.2.3, attenuation factors (i.e., hydrolysis, decay, and adsorption) were neglected in this demonstration to add a significant conservative element to the modeling. Therefore, DAFs are hereinafter referred to as DFs throughout this ALF.

Based on the MCLs and site-specific leachate concentrations, minimum DFs that must be achieved to meet the regulatory requirements were calculated. The DF is defined as the initial concentration of a contaminant within the leachate, C_o, divided by the concentration at the point of compliance, C_p. Therefore, if the initial concentration C_o is set to a unit concentration of 1, the MULTIMED model will calculate a value of C_p for which the inverse is the DF. This DF can then be directly compared with the highest required DF to demonstrate that listed MCLs as shown in Table 2 below are not exceeded. Background concentrations from Unit 1 groundwater monitoring wells completed within the Fox Hills Sandstone are provided for reference but were not considered in DF calculations (i.e., natural background for the modeled parameters were assumed to be non-detect within the Fox Hills Sandstone). This methodology has been adopted for this analysis.

Site-specific leachate concentration data from Unit 1 was reviewed from between 1995 and 2016. Maximum constituent concentrations from leachate samples collected during that period for which MCLs have been established are listed in Table 2. Also shown in Table 2 are the calculated required minimum DFs to ensure MCLs are not exceeded at the POC, which range from 1 to 14 for those constituents where site-specific data was available. For those constituents that have not been tested but for which an MCL is defined, a DF of 100 was assumed. A DF of 1 or less indicates that no dilution or attenuation is needed (i.e., the concentration of that constituent within the leachate is below the MCL).

Table 2: MCLs, Leachate Input Concentrations, and DF Requirements

Constituent	MCL listed in 40 CFR 258.4 (mg/L)	Maximum Site-specific Leachate Concentration (mg/L)	Background Concentration (1)(2)(3) (mg/L)	Minimum Required DF
Arsenic	0.05	0.0549	< 0.0100 - 0.0132	2
Barium	1.0	3.37	< 0.200 – 0.225	4
Benzene	0.005	0.03	< 0.005	6
Cadmium	0.01	0.009	< 0.0050 - 0.0064	< 1
Carbon tetrachloride	0.005	< 0.005	< 0.010	< 1
Chromium (hexavalent)	0.05	0.16 (total Cr)	< 0.010 - 0.0780 (total Cr)	4
2,4-Dichlorophenoxy acetic acid	0.1	--	n/a	100
1,4-Dichlorobenzene	0.075	< 1	< 0.005	14
1,2-Dichloroethane	0.005	0.062	< 0.005	13
1,1-Dichloroethylene	0.007	0.049	< 0.005	7
Endrin	0.0002	--	n/a	100
Fluoride	4	--	n/a	100
Lindane	0.004	--	n/a	100
Lead	0.05	0.113	< 0.0050 - 0.0369	3
Mercury	0.002	0.00056	n/a	3
Methoxychlor	0.1	--	n/a	100
Nitrate	10	< 1	< 0.5	< 1
Selenium	0.01	0.014	< 0.0050 - 0.0082	2
Silver	0.05	< 0.125	< 0.0250	3
Toxaphene	0.005	--	n/a	100
1,1,1-Trichloroethane	0.2	0.039	n/a	< 1
Trichloroethylene	0.005	0.016	< 0.005	4
2,4,5-Trichlorophenoxy acetic acid	0.01	--	n/a	100
Vinyl chloride	0.002	0.012	< 0.010	6

Notes:

1). Where site-specific data exists from Unit 1 detection monitoring program, background concentration range reported as laboratory reporting limit to highest detection to date.

2). No volatile organic compounds (VOCs) have been detected to date in Unit 1 detection monitoring program. For VOCs, background concentration range reported as less than practical quantitation limits (PQL) provided in 6 CCR 1007-2, Part I, Appendix II for Assessment Monitoring.

3). n/a – Not analyzed in NWLF detection monitoring program.

4.2 MULTIMED Input Parameters

The following subsections describe the input parameters that were used to demonstrate that a suitable DF will be obtained using the proposed alternative liner system design.

4.2.1 General Parameters

The following is a list of the general model parameters used for the MULTIMED analysis:

- The MULTIMED model was run using a Subtitle D Landfill-type evaluation. Under the Subtitle D type, certain parameter values are preset to appropriate default values; such preset parameters are noted herein. The use of the Subtitle D type simulation implies that the following model assumptions were also made:
  - The contaminant pulse is continuous and constant over time;
  - The receptor well (POC) is located downgradient in the center of the contaminant plume at the top of the aquifer;
  - No attenuation of contaminants occurs in the leachate during flow through the liner system; and
  - The primary mode of attenuation for contaminants entering the subsurface is physical dispersion and dilution in the receiving aquifer.
- To compensate for uncertainty in input parameters, conservative assumptions were applied in the MULTIMED analysis. These assumptions are noted herein.
- The concentration of contaminant was treated as a Gaussian source, enriched along the centerline and tapering to each side of the plume.
- Additional transient simulations were conducted to more accurately simulate operational site life conditions and evaluate modeled leachate constituent concentrations at the POC through the post-closure care period.

4.2.2 Source Parameters

4.2.2.1 Source Geometry

For the steady-state MULTIMED model, the maximum area of alternative liner system that is expected to be subjected to leachate head was conservatively estimated to be 2,025 square feet. This area represents the total footprint of a temporary leachate collection sump within Unit 2 and exceeds the total area of the two permanent leachate collection sumps. For the transient MULTIMED models, the source area was modeled as the total surface area of the two permeant leachate collection sumps, 1,368 square feet.

4.2.2.2 Source Infiltration Rate

The HELP model was used to evaluate leachate impingement rates through the alternative liner system throughout the operational life of Unit 2.

As discussed in Section 3.3 of this ALF, the operational scenario that resulted in the maximum impingement rate was 70 feet of waste with daily cover. The impingement rate associated with this operational condition was 0.9739 inches per year (2.474×10^{-2} m/yr).

4.2.2.3 Outside Recharge Rate

The outside recharge rate is defined as the rate of infiltration into the aquifer resulting from natural precipitation downgradient and outside of the waste disposal limit. For conservatism, the outside recharge rate was neglected (i.e., 0 m/yr); in this way, no dilution of the contaminant plume occurs in the saturated zone from outside infiltration.

4.2.2.4 Initial Leachate Concentration

The initial leachate concentration was set to a unit concentration of one milligram per liter (mg/L) in order to directly derive the DAF. The DAF is defined as the initial leachate concentration divided by the predicted concentration at the POC.

4.2.2.5 Source Duration and Decay Constant

The source duration and decay constant parameters are not applicable to the Subtitle D-type evaluation. As discussed in Section 4.2.1 of this ALF, the Subtitle D evaluation assumes that the contaminant pulse is continuous and constant over time. For transient simulations, the source duration was set to 35 years to conservatively simulate a constant leachate source (strength and volume) for the approximate operational life of the facility.

4.2.2.6 Initial Spread of Source

The initial spread of source parameter is defined as the standard deviation of the aquifer source plane geometry parameter and was auto-derived from the Gaussian distribution input parameter.

4.2.3 Chemical Parameters

Chemical input parameters are related to chemical reaction (hydrolysis), biodegradation (decay), and chemical adsorption processes. For conservatism in this MULTIMED analysis, chemical processes were neglected in the transport mechanism. Therefore, all chemical parameters were set to 0.

4.2.4 Hydrogeologic Properties

Subsurface data collected from the geotechnical and hydrogeologic site characterization of the Unit 2 area of the NWLF site (Swift River 2016) served as the basis of the MULTIMED analysis. Temporary well TW-10, drilled to a depth of 98.5 feet below ground surface and completed within the Fox Hills Sandstone, was determined to be the most conservative representation of the general subsurface profile across the Unit 2 waste disposal footprint due to the well's proximity to the permanent leachate collection sumps and considering the Fox Hills Sandstone is a regionally extensive water-bearing zone that is laterally continuous across the NWLF site. The base grades of the permanent leachate collection sumps represent the minimum vertical separation between the base of the liner system and the uppermost continuous saturated zone, the Fox Hills Sandstone. For the purposes of the steady-state MULTIMED model, the soil profile at TW-10 was

conservatively assumed to exist at the western limit of waste in Phase 4, which represents the minimum distance from the limit of waste to the nearest theoretical Unit 2 POC groundwater monitoring well.

4.2.4.1 Unsaturated Zone Flow and Transport Properties

Flow and transport input properties for the MULTIMED analysis are presented in Table 3. Where possible, input properties were referenced from site-specific data. Where site-specific data was not available, input properties were referenced from published literature.

Table 3: MULTIMED Input Parameters – Unsaturated Zone Flow and Transport Properties

Vadose Zone Flow and Transport	Unit	Value	Reference
Layer 1 – Silty Sand			
Flow Layer Thickness	m	5	TW-10 (Swift River 2016b)
Flow Layer Number	--	1	--
Saturated Hydraulic Conductivity (k_{sat})	cm/sec	2.9E-03	Site-specific lab data (NWE-7, NWE-12) and slug test data (Swift River 2016a and 2016b)
Saturated Hydraulic Conductivity (k_{sat})	cm/hr	10.44	Site-specific lab data (NWE-7, NWE-12) (Swift River 2016a)
Effective Porosity (n)	--	0.437	HELP Model (Loamy Sand - NWE-01, NWE-03)
Air Entry Pressure Head	m	0	--
Layer 1 – Silty Sand (Cont.)			
Residual Water Content	--	0.057	Carsel and Parrish, 1988
van Genuchten Alpha (α)	1/cm	0.124	Carsel and Parrish, 1988
van Genuchten Beta (β)	-	2.28	Carsel and Parrish, 1988
Bulk Density	pcf	90.7	Site-specific lab data (NWE-7, NWE-12) (Swift River 2016a)
Bulk Density	g/cm3	1.45	Site-specific lab data (NWE-7, NWE-12) (Swift River 2016a)
Layer 2 – Stiff Clay			
Flow Layer Thickness	m	6.5	TW-10 (Swift River 2016b)
Flow Layer Number	--	2	--
Saturated Hydraulic Conductivity (k_{sat})	cm/sec	6.4E-05	HELP Model (Material 11 - CL)
Saturated Hydraulic Conductivity (k_{sat})	cm/hr	0.2304	HELP Model (Material 11 - CL)
Effective Porosity (n)	--	0.464	HELP Model (Material 11 - CL)
Air Entry Pressure Head	m	0	--
Residual Water Content	--	0.068	Carsel and Parrish, 1988
van Genuchten Alpha (α)	1/cm	0.008	Carsel and Parrish, 1988
van Genuchten Beta (β)	-	1.09	Carsel and Parrish, 1988

Vadose Zone Flow and Transport	Unit	Value	Reference
Bulk Density	pcf	110	NAVFAC 7.01, 1986
Bulk Density	g/cm3	1.60	NAVFAC 7.01, 1986
Layer 3 – Claystone			
Flow Layer Thickness	m	3.5	TW-10 (Swift River 2016b)
Flow Layer Number	--	3	--
Saturated Hydraulic Conductivity (ksat)	cm/sec	8.60E-07	Lu, Kaya, and Godt, 2014
Saturated Hydraulic Conductivity (ksat)	cm/hr	0.0031	Lu, Kaya, and Godt, 2014
Effective Porosity (n)	--	0.55	Lu, Kaya, and Godt, 2014
Air Entry Pressure Head	m	0	--
Residual Water Content	--	0.01	Lu, Kaya, and Godt, 2014
van Genuchten Alpha (α)	1/cm	0.02	Lu, Kaya, and Godt, 2014
van Genuchten Beta (β)	-	1.40	Lu, Kaya, and Godt, 2014
Bulk Density	g/cm3	2.19	Manger, 1963 (Cretaceous-Adaville)
Layer 4 – Dense Sand with Silt			
Flow Layer Thickness	m	2	TW-8 (Swift River 2016b)
Flow Layer Number	--	4	--
Saturated Hydraulic Conductivity (ksat)	cm/sec	1.2E-03	Carsel and Parrish, 1988
Layer 4 – Dense Sand with Silt (Cont.)			
Saturated Hydraulic Conductivity (ksat)	cm/hr	4.420	Carsel and Parrish, 1988
Effective Porosity (n)	--	0.189	Carsel and Parrish, 1988
Air Entry Pressure Head	m	0	--
Residual Water Content	--	0.065	Carsel and Parrish, 1988
van Genuchten Alpha (α)	1/cm	0.075	Carsel and Parrish, 1988
van Genuchten Beta (β)	-	1.89	Carsel and Parrish, 1988
Bulk Density	pcf	120	NAVFAC 7.01, 1986
Bulk Density	g/cm3	1.92	NAVFAC 7.01, 1986

Additional input parameter assumptions included:

- In the absence of published air entry pressure head data, air entry pressure head of all strata was conservatively set to 0 to be representative of coarse soil materials;
- The longitudinal dispersivity parameter was auto-derived from the depth of the unsaturated zone;
- The percent organic matter and biological decay coefficients were conservatively set to 0 since chemical reaction, biodegradation, or chemical adsorption processes were neglected in the analysis.

4.2.4.2 Saturated Zone Properties

Aquifer-specific input properties for the MULTIMED analysis are presented in Table 4.

Table 4: MULTIMED Input Parameters – Saturated Zone Properties

Saturated Zone	Unit	Value	Reference
Aquifer			
Estimated Aquifer Thickness	m	12	TW-10 (Swift River 2016b)
Effective Porosity (n)	--	0.32	Robson, 1987
Bulk Density	g/cm3	2.25	Robson, 1987 (Cretaceous)
Saturated Hydraulic Conductivity (ksat)	cm/sec	1.2E-02	Site-specific slug test data (Swift River, 2016b)
Saturated Hydraulic Conductivity (ksat)	m/yr	3796	Site-specific slug test data (Swift River, 2016b)
Hydraulic Gradient	--	0.003	Site-specific aquifer data (Swift River, 2016b)
Aquifer Temperature	° C	13.3	Site-specific aquifer data (Swift River, 2016b)
Aquifer pH	--	7.66	Site-specific aquifer data (Swift River, 2016b)

Additional input parameter assumptions included:

- Aquifer temperature, pH, and fraction organic carbon were input based on Swift River sampling. However, these properties are not considered in the MULTIMED analysis as retardation and decay were conservatively neglected.
- Aquifer fraction organic carbon was neglected.
- Longitudinal, transverse, and vertical dispersivity were auto-derived from the distance to the receptor well.

4.2.5 Point of Compliance (POC) Location

As discussed in Section 2.2 of this ALF, the Unit 2 POC was defined as the vertical surface that is not more than 150 meters from the waste management unit boundary along the southern and western boundaries of the Unit 2 waste disposal footprint. This defined POC includes the following existing monitoring wells screened within the Fox Hills Sandstone:

- Down-gradient of Unit 1: MW-4, MW-5, MW-9, and MW-10
- Down-gradient of Unit 2: MW-3 and TW-2

For the purposes of the steady-state MULTIMED model, the radial distance of the receptor well (i.e., the POC) from the leachate source was conservatively set to only 34 meters (m), the minimum distance from the nearest theoretical Unit 2 POC groundwater monitoring well to the limit of waste. For

transient MULTIMED models, the radial distance of the receptor well was more accurately defined as 708 m which represents the distance between the permanent leachate collection sump in Phase 5 and the western limit of waste. The location of this receptor well appropriately considers site-specific flow direction of the Fox Hills Sandstone, the nearest Unit 2 POC groundwater monitoring well located hydraulically downgradient of Unit 2, and the permanent sump leachate source used in the MULTIMED model.

4.2.6 Time Parameters

For transient simulations, the source duration was set to 35 years to simulate the approximate operational life of the facility and the MULTIMED model was run for 65 years to approximate the full post-closure period of the facility. DAFs were calculated at five-year increments for the full model duration.

4.3 MULTIMED Model Results

4.3.1 Steady-state Results

The steady-state Subtitle D model assumes a continuous source pulse (i.e., impingement rate) through time, thus the leachate source strength and volume never decreases. In addition, it assumes equilibrium between the fluid moving into the system being modeled and the fluid moving out of the system. The steady-state model was also run with all attenuating parameters set to 0, thus maximizing transport capability. These assumptions create a very conservative simulation of actual operations at NWLF.

Once the system has reached equilibrium, the predicted leachate concentrations at the Unit 2 POC will be approximately 4.5×10^{-3} of the initial constituent concentration (equivalent to a DF value of 220 and conservatively ignoring attenuation factors). Based on the site-specific leachate data, leachate constituent concentrations at the Unit 2 POC are summarized in Table 5 below. For all leachate constituents with historical site-specific data, the steady-state concentrations at the POC are more than one order of magnitude less than the corresponding MCLs. Background concentrations from Unit 1 detection monitoring of the Fox Hills Sandstone are provided for reference.

The output file for the steady-state MULTIMED model is provided in Appendix B-1.

Table 5: MULTIMED Steady-state Analysis Results
Leachate Constituent Concentrations at Point of Compliance

Constituent	MCL (mg/L) listed in 40 CFR 258.40	Background Concentration (1)(2)(3) (mg/L)	Concentration at Point of Compliance (mg/L)	Minimum Required DF	Calculated DF
Arsenic	0.05	< 0.0100–0.0132	2.50×10^{-4}	2	274
Barium	1.0	< 0.200–0.225	1.53×10^{-2}	4	274

Benzene	0.005	< 0.005	1.36×10^{-4}	6	274
Cadmium	0.01	< 0.0050–0.0064	4.09×10^{-5}	< 1	274
Carbon tetrachloride	0.005	< 0.010	$< 2.27 \times 10^{-5}$	< 1	274
Chromium (hexavalent)	0.05	< 0.010–0.0780 (total Cr)	7.27×10^{-4} (total Cr)	4	274
2,4-Dichlorophenoxy acetic acid	0.1	n/a	--	100	274
1,4-Dichlorobenzene	0.075	< 0.005	$< 4.55 \times 10^{-3}$	14	274
1,2-Dichloroethane	0.005	< 0.005	2.82×10^{-4}	13	274
1,1-Dichloroethylene	0.007	< 0.005	2.23×10^{-4}	7	274
Endrin	0.0002	n/a	--	100	274
Fluoride	4	n/a	--	100	274
Lindane	0.004	n/a	--	100	274
Lead	0.05	< 0.0050–0.0369	5.14×10^{-4}	3	274
Mercury	0.002	n/a	2.55×10^{-6}	3	274
Methoxychlor	0.1	n/a	--	100	274
Nitrate	10	< 0.5	$< 4.55 \times 10^{-3}$	< 1	274
Selenium	0.01	< 0.0050–0.0082	6.36×10^{-5}	2	274
Silver	0.05	< 0.0250	$< 5.68 \times 10^{-4}$	3	274
Toxaphene	0.005	n/a	--	100	274
1,1,1-Trichloroethane	0.2	n/a	1.77×10^{-4}	< 1	274
Trichloroethylene	0.005	< 0.005	7.27×10^{-5}	4	274
2,4,5-Trichlorophenoxy acetic acid	0.01	n/a	--	100	274
Vinyl chloride	0.002	< 0.010	5.45×10^{-5}	6	274

Notes:
1). Where site-specific data exists from Unit 1 detection monitoring program, background concentration range reported as laboratory reporting limit to highest detection to date.
2). No volatile organic compounds (VOCs) have been detected to date in Unit 1 detection monitoring program. For VOCs, background concentration range reported as less than Practical Quantitation Limits (PQL) provided in 6 CCR 1007-2, Part I, Appendix II for Assessment Monitoring.
3). n/a – Not analyzed in NWLF detection monitoring program.

4.3.2 Transient Results

Transient model runs were conducted to more accurately simulate operational site life conditions and evaluate leachate constituent concentrations at the POC through the post-closure period (i.e., 30 years after closure). The input parameters from the steady-state model were used as the initial input for the transient model except the source (i.e., impingement rate) duration, source area, and radial distance to the POC, which were updated to more accurately model operational and groundwater monitoring conditions as discussed in Section 4.2 above.

The results of the transient analyses are summarized in Table 6, which presents the reciprocal of the DFs (conservatively ignoring attenuation factors) at five-year increments through the operational life of the landfill and post-closure period. These DFs can be compared to the DF reciprocal limit for the critical leachate constituent with the highest DF (1,4-dichlorobenzene, DF reciprocal of 7.1×10^{-2}) to evaluate whether any MCL at the POC would be exceeded (i.e., if the modeled concentration of 1,4-dichloribenzene at the POC is below the MCL, all other parameters evaluated in this demonstration will also be below their MCL).

The output files for the transient MULTIMED models are provided in Appendix B-2. The transient model data indicates that assuming the maximum impingement rate (i.e., source infiltration rate) conservatively calculated in the HELP model is constant for the full 35-year operational life of Unit 2, leachate constituents are not predicted to be detected above laboratory reporting limits (i.e., PQLs) at the POC through the operational life and post-closure period of the facility.

Table 6: MULTIMED Transient Analysis Results
DF Reciprocal Values at POC Over Unit 2 Operational Life and Post-closure Period

Time (yrs)	Maximum DF Reciprocal Limit[1][2]	DF Reciprocal
1	7.1×10^{-2}	0
5		0
10		7.8×10^{-26}
15		1.3×10^{-19}
20		7.8×10^{-18}
25		5.4×10^{-17}
30		1.6×10^{-16}
35		3.3×10^{-16}
40		5.3×10^{-16}
45		7.5×10^{-16}
50		9.8×10^{-16}
55		1.1×10^{-14}
60		1.5×10^{-11}
65		2.5×10^{-10}

Notes:
1). The DF Reciprocal Limit represents the leachate constituent concentration reduction factor from the initial concentration that results in an MCL exceedance at the POC.
2). Maximum DF Reciprocal Limit is based on leachate constituents with site-specific data; of the leachate constituents routinely analyzed at the NWLF site, 1,4-dichlorobenzene yielded the highest required DF (14).

5.0 CONCLUSIONS

This ALF presents the HELP and MULTIMED modeling performed in support of the alternative liner system proposed for Unit 2 at NWLF. The modeling efforts demonstrate that the alternative liner system proposed for the development of Unit 2 at NWLF reasonably ensures groundwater protection considering expected waste characteristics, site construction, and site setting. The modeling demonstrates that the liner system will provide a level of groundwater protection such that the MCLs listed in Table 1 of 40 CFR 258.40 will not be exceeded at the Unit 2 POC as summarized below:

- HELP modeling conservatively identified the maximum impingement rate through the alternative liner system at various waste depths and cover configurations over the life of the facility. The maximum impingement rate used as the input parameter in MULTIMED transport modeling was estimated at 0.9739 inches per year (2.474×10^{-2} m/yr).
- Steady-state MULTIMED modelling of leachate transport from the base of the alternative liner system to the POC conservatively estimated a DF reciprocal of 4.5×10^{-3} compared to the maximum required DF reciprocal of 7.1×10^{-2} (for 1,4-dichlorobenzene) to ensure MCLs are not exceed at the POC.
  - The steady-state model conservatively assumes a continuous leachate source infiltration rate (source strength and volume) through time over the full surface area of a temporary leachate collection sump and that equilibrium was reached between the fluid entering the system and the fluid leaving the system.
  - Additionally, the recharge rate of the aquifer and all potentially attenuating input parameters were set to zero, resulting in very conservative transport model results (i.e., actual DAF is higher than DF calculated in this report).
  - The radial distance of the receptor well (i.e., the POC) from the leachate source was conservatively set to 34 m, the minimum distance from the theoretical POC groundwater monitoring well to the limit of waste.
  - The general subsurface profile across the Unit 2 waste disposal footprint was modeled based on the conditions encountered at temporary well TW-10, which represents the minimum vertical separation from the alternative liners system to the uppermost continuous saturated zone (Fox Hills Sandstone). For the purposes of the steady-state model, this profile was assumed to exist at the western limit of waste and considers the Fox Hills Sandstone as a regionally extensive water-bearing zone that is laterally continuous across the NWLF site.
- Transient MULTIMED modelling of leachate transport under more representative operational site conditions estimated the following:
  - Assuming the maximum impingement rate calculated in the HELP Model is constant for the full 35-year operational life of Unit 2, leachate constituents are not predicted to be detected above laboratory reporting limits (i.e., PQLs) at the Unit 2 POC through the operational life and post-closure period of the facility.

6.0 REFERENCES

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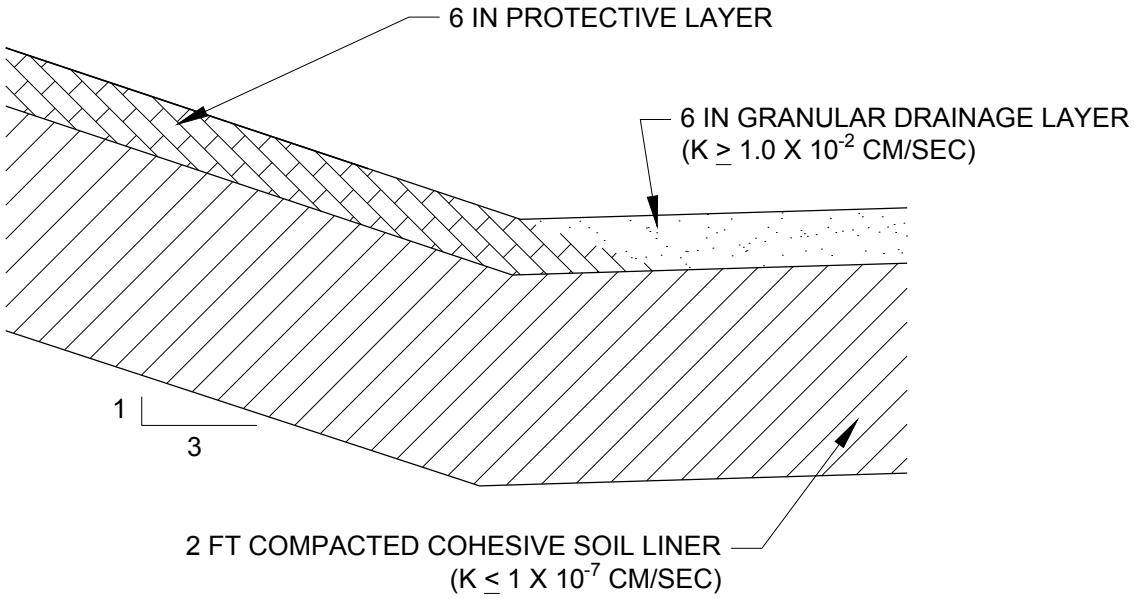
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FIGURES

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CLIENT
WASTE MANAGEMENT DISPOSAL
SERVICES OF COLORADO, INC.

CONSULTANT
Golder Associates

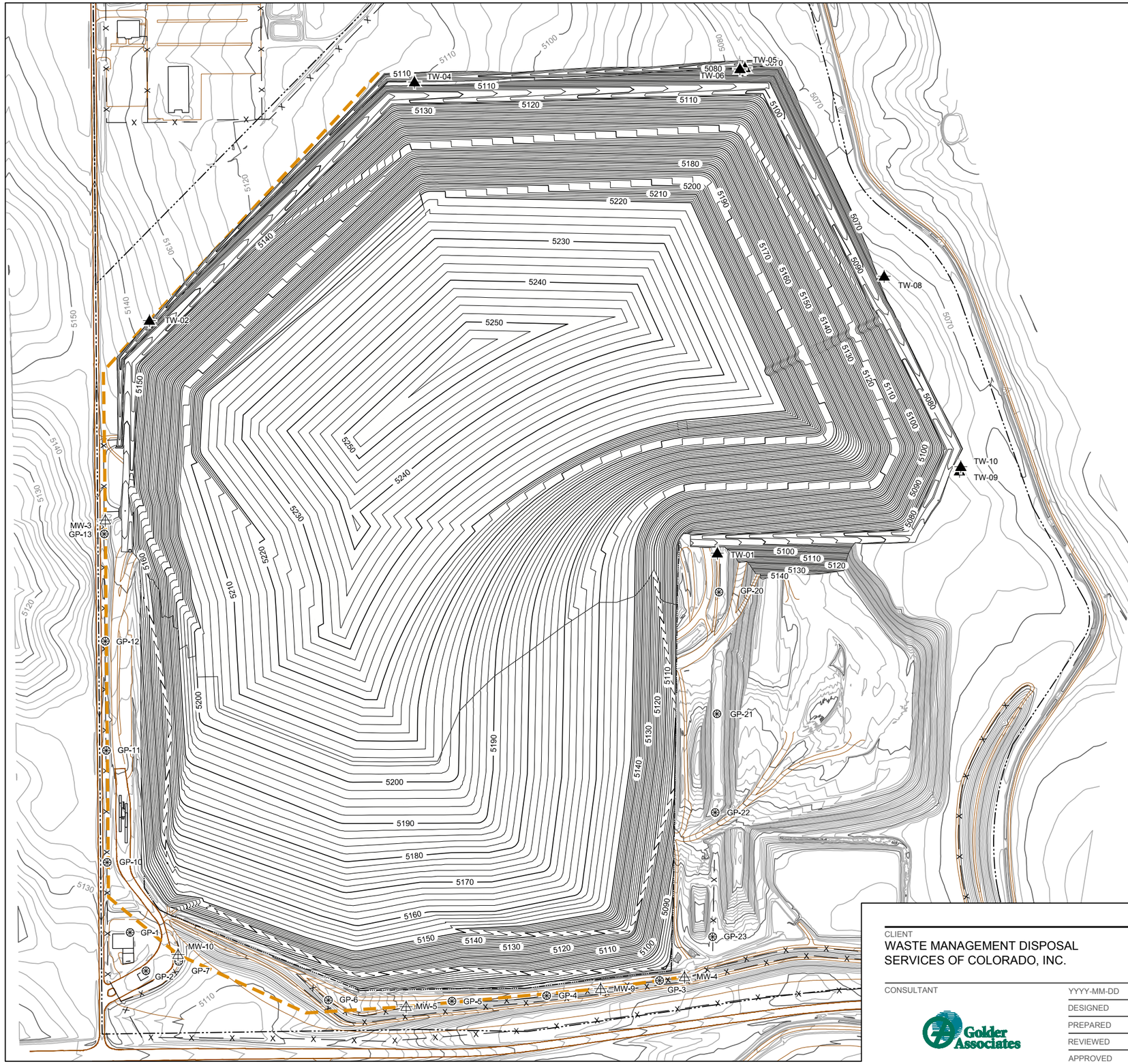
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PROJECT
NORTH WELD LANDFILL, UNIT 2
SIDE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
ALTERNATIVE LINER SYSTEM DETAIL

PROJECT NO.	CONTROL	REV.	FIGURE
1538880		A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0



LEGEND

- EXISTING TOPOGRAPHY (SEE NOTE 1)
- PROPOSED LINER SUBGRADE
- PROPERTY BOUNDARY (SEE NOTE 4)
- USR 1527 BOUNDARY
- EXISTING LIMIT OF WASTE (UNIT 1)
- EXISTING FENCE
- POINT OF COMPLIANCE
- MW-9 EXISTING MONITORING WELL LOCATION
- TW-08 TEMPORARY WELL LOCATION (SEE NOTE 5)
- GP-23 EXISTING GAS PROBE LOCATION

NOTES

1. EXISTING TOPOGRAPHY IS A COMPOSITE OF AEROMETRIC INC. PHOTOGRAPHY DATED JANUARY 26, 2012 AND MILLER CREEK AERIAL MAPPING PHOTOGRAPHY DATED FEBRUARY 21, 2016.
2. EXISTING CONTOUR INTERVAL IS 2 FEET BASED ON NAVD88 ELEVATIONS.
3. COORDINATE SYSTEM IS IN NAD27 STATE PLANE COLORADO NORTH.

0 125 250
1" = 250' FEET

CLIENT
WASTE MANAGEMENT DISPOSAL SERVICES OF COLORADO, INC.

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PROJECT
NORTH WELD LANDFILL, UNIT 2
SITE DEVELOPMENT PLANS
WELD COUNTY, COLORADO

TITLE
POINT OF COMPLIANCE

PROJECT NO.	CONTROL	REV.	FIGURE
1538880		A	2

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APPENDIX A
HELP MODEL OUTPUT

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**********************************************************************************
**********************************************************************************
**                                                                              **
**                                                                              **
**               HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                  **
**                 HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                   **
**                   DEVELOPED BY ENVIRONMENTAL LABORATORY                      **
**                     USAE WATERWAYS EXPERIMENT STATION                        **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                 **
**                                                                              **
**                                                                              **
**********************************************************************************
**********************************************************************************


PRECIPITATION DATA FILE:    C:\NWPREC1.D4
TEMPERATURE DATA FILE:      C:\NWTEMP1.D7
SOLAR RADIATION DATA FILE:  C:\NWRAD1.D13
EVAPOTRANSPIRATION DATA:    C:\NWEVAP.D11
SOIL AND DESIGN DATA FILE:  C:\NW_SD_2.D10
OUTPUT DATA FILE:           C:\NW_OUT_2.OUT


TIME:  11:43     DATE:  11/16/2016


**********************************************************************************

     TITLE:  NORTH WELD LANDFILL SCENARIO 2: 70'WASTE WITH DAILY COVER

**********************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.3930 VOL/VOL
          FIELD CAPACITY               =      0.2990 VOL/VOL
          WILTING POINT                =      0.1330 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1839 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.119999997000E-03 CM/SEC



                                  LAYER  2
                                  --------
```

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	840.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2920	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0717	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.64	PERCENT
DRAINAGE LENGTH	=	845.0	FEET

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4450	VOL/VOL
FIELD CAPACITY	=	0.3930	VOL/VOL
WILTING POINT	=	0.2770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	85.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	6.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.103	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	2.358	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.798	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	257.494	INCHES

TOTAL INITIAL WATER = 257.494 INCHES
TOTAL SUBSURFACE INFLOW = 0.00 INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
CHEYENNE WYOMING

STATION LATITUDE	= 40.59	DEGREES
MAXIMUM LEAF AREA INDEX	= 0.00	
START OF GROWING SEASON (JULIAN DATE)	= 138	
END OF GROWING SEASON (JULIAN DATE)	= 273	
EVAPORATIVE ZONE DEPTH	= 6.0	INCHES
AVERAGE ANNUAL WIND SPEED	= 7.50	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	= 52.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	= 54.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	= 50.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	= 51.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.41	0.40	0.97	1.24	2.39	2.00
1.87	1.39	1.06	0.68	0.53	0.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
26.10	29.30	32.10	41.80	52.20	62.00
68.90	66.80	57.90	47.50	34.80	29.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR CHEYENNE WYOMING
AND STATION LATITUDE = 40.59 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
RUNOFF	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
LATERAL DRAINAGE COLLECTED	0.0146	0.0013	0.0000	0.0000	0.0111	0.0919
FROM LAYER 3	0.1078	0.0879	0.0777	0.0597	0.0501	0.0399
PERCOLATION/LEAKAGE THROUGH	0.1066	0.0485	0.0015	0.0013	0.0468	0.1094
LAYER 4	0.1141	0.1125	0.1083	0.1102	0.1061	0.1086

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.265	0.026	0.000	0.000	0.202	1.730
TOP OF LAYER 4	1.965	1.603	1.463	1.088	0.943	0.726
STD. DEVIATION OF DAILY	0.095	0.036	0.000	0.000	0.288	0.349
HEAD ON TOP OF LAYER 4	0.209	0.156	0.113	0.134	0.051	0.117

****

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.28	40946.406	100.00
RUNOFF	0.117	423.764	1.03
EVAPOTRANSPIRATION	9.630	34956.262	85.37
DRAINAGE COLLECTED FROM LAYER 3	0.5419	1966.929	4.80
PERC./LEAKAGE THROUGH LAYER 4	0.973931	3535.370	8.63
AVG. HEAD ON TOP OF LAYER 4	0.8343		
CHANGE IN WATER STORAGE	0.018	64.030	0.16
SOIL WATER AT START OF YEAR	257.494	934701.875	
SOIL WATER AT END OF YEAR	257.511	934765.875	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.049	0.00

****

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.08	0.07	1.13	0.47	1.97	0.93
	2.49	0.96	1.72	0.96	0.39	0.11
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.117	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.147	0.242	0.756	0.499	1.378	0.513
	2.292	0.802	2.007	0.299	0.494	0.201
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
LATERAL DRAINAGE COLLECTED FROM LAYER 3						
TOTALS	0.0146	0.0013	0.0000	0.0000	0.0111	0.0919
	0.1078	0.0879	0.0777	0.0597	0.0501	0.0399
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.1066	0.0485	0.0015	0.0013	0.0468	0.1094
	0.1141	0.1125	0.1083	0.1102	0.1061	0.1086
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.2653	0.0258	0.0000	0.0000	0.2020	1.7300
	1.9647	1.6028	1.4633	1.0881	0.9431	0.7263
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 1

	INCHES		CU. FEET	PERCENT
PRECIPITATION	11.28	(0.000)	40946.4	100.00
RUNOFF	0.117	(0.0000)	423.76	1.035
EVAPOTRANSPIRATION	9.630	(0.0000)	34956.26	85.371
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.54185	(0.00000)	1966.929	4.80367
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.97393	(0.00000)	3535.370	8.63414
AVERAGE HEAD ON TOP OF LAYER 4	0.834	(0.000)		
CHANGE IN WATER STORAGE	0.018	(0.0000)	64.03	0.156

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.64	2323.200
RUNOFF	0.117	423.7645
DRAINAGE COLLECTED FROM LAYER 3	0.00400	14.52650
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.003722	13.51072
AVERAGE HEAD ON TOP OF LAYER 4	2.261	
MAXIMUM HEAD ON TOP OF LAYER 4	4.281	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	44.4 FEET	
SNOW WATER	0.41	1476.5393

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2614
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1330

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.0839	0.1806
2	245.2799	0.2920
3	0.4674	0.0779
4	10.6800	0.4450
SNOW WATER	0.000	

****
****

APPENDIX B
MULTIMED MODEL OUTPUT

APPENDIX B-1
STEADY-STATE MODEL RESULTS

MULTIMED V1.01

U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.50, 2005)

1
Run options
--- -------

North Weld Landfill, Unit 2

Alternative Liner Demonstration
Chemical simulated is Leachate Constituent

Option Chosen Saturated and unsaturated zone models
Run was DETERMIN
Infiltration Specified By User: 2.474E-02 m/yr
Run was steady-state
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1
UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)
NP - Total number of nodal points 240
NMAT - Number of different porous materials 4
KPROP - Van Genuchten or Brooks and Corey 1
IMSHGN - Spatial discretization option 1
NVFLAYR - Number of layers in flow model 4

OPTIONS CHOSEN
------- ------
Van Genuchten functional coefficients
User defined coordinate system
1

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	5.00	1
2	6.50	4
3	3.50	2
4	2.00	3

DATA FOR MATERIAL 1
---- --- --------
VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS		
			MEAN	STD DEV	MIN	MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	10.4	-999.	-999.	-999.
Unsaturated zone porosity	--	CONSTANT	0.437	-999.	-999.	-999.
Air entry pressure head	m	CONSTANT	0.000	-999.	-999.	-999.
Depth of the unsaturated zone	m	CONSTANT	17.0	0.000	0.000	0.000

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Residual water content	--	CONSTANT	0.570E-01	-999.	-999.	-999.
Brook and Corey exponent,EN	--	CONSTANT	-999.	-999.	-999.	-999.
ALFA coefficient	1/cm	CONSTANT	0.124	-999.	-999.	-999.
Van Genuchten exponent, ENN	--	CONSTANT	2.28	-999.	-999.	-999.

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.310E-02	-999.	-999.	-999.
Unsaturated zone porosity	--	CONSTANT	0.550	-999.	-999.	-999.

	Air entry pressure head			m	CONSTANT	
0.000	-999.	-999.	-999.			
	Depth of the unsaturated zone			m	CONSTANT	
17.0	0.000	0.000	0.000			

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

PARAMETERS	VARIABLE NAME	UNITS	DISTRIBUTION	LIMITS
MEAN	STD DEV	MIN	MAX	
	Residual water content	--	CONSTANT	
0.100E-01	-999.	-999.	-999.	
	Brook and Corey exponent,EN	--	CONSTANT	-
999.	-999.	-999.	-999.	
	ALFA coefficient	1/cm	CONSTANT	
0.200E-01	-999.	-999.	-999.	
	Van Genuchten exponent, ENN	--	CONSTANT	
1.40	-999.	-999.	-999.	

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

PARAMETERS	VARIABLE NAME	UNITS	DISTRIBUTION	LIMITS
MEAN	STD DEV	MIN	MAX	
	Saturated hydraulic conductivity	cm/hr	CONSTANT	
4.42	-999.	-999.	-999.	
	Unsaturated zone porosity	--	CONSTANT	
0.189	-999.	-999.	-999.	
	Air entry pressure head	m	CONSTANT	
0.000	-999.	-999.	-999.	
	Depth of the unsaturated zone	m	CONSTANT	
17.0	0.000	0.000	0.000	

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS		
			MEAN	STD DEV	MIN	MAX
Residual water content	--	CONSTANT	0.650E-01	-999.	-999.	-999.
Brook and Corey exponent,EN	--	CONSTANT	-999.	-999.	-999.	-999.
ALFA coefficient	1/cm	CONSTANT	0.750E-01	-999.	-999.	-999.
Van Genuchten exponent, ENN	--	CONSTANT	1.89	-999.	-999.	-999.

DATA FOR MATERIAL 4

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.230	-999.	-999.	-999.
Unsaturated zone porosity	--	CONSTANT	0.464	-999.	-999.	-999.
Air entry pressure head	m	CONSTANT	0.000	-999.	-999.	-999.
Depth of the unsaturated zone	m	CONSTANT	17.0	0.000	0.000	0.000

DATA FOR MATERIAL 4

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Residual water content	--	CONSTANT	0.680E-01	-999.	-999.	-999.
Brook and Corey exponent,EN	--	CONSTANT	999.	-999.	-999.	-999.
ALFA coefficient	1/cm	CONSTANT	0.800E-02	-999.	-999.	-999.
Van Genuchten exponent, ENN	--	CONSTANT	1.09	-999.	-999.	-999.

1

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	- Number of different layers used		4
NTSTPS	- Number of time values concentration calc		40
DUMMY	- Not presently used		1
ISOL	- Type of scheme used in unsaturated zone		2
N	- Stehfest terms or number of increments		18
NTEL	- Points in Lagrangian interpolation		3
NGPTS	- Number of Gauss points		104
NIT	- Convolution integral segments		2
IBOUND	- Type of boundary condition		1
ITSGEN	- Time values generated or input		1
TMAX	- Max simulation time	--	0.0
WTFUN	- Weighting factor	--	1.2

OPTIONS CHOSEN

Convolution integral approach
Nondecaying continuous source
Computer generated times for computing concentrations

1

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS		
			MEAN	STD DEV	MIN	MAX
Thickness of layer	m	CONSTANT	5.00	-999.	-999.	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999.	-999.
Percent organic matter	--	CONSTANT	0.000	-999.	-999.	-999.
Bulk density of soil for layer	g/cc	CONSTANT	1.45	-999.	-999.	-999.
Biological decay coefficient	1/yr	CONSTANT	0.000	-999.	-999.	-999.

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS

MEAN STD DEV MIN MAX

Thickness of layer	m	CONSTANT	6.50	-999.	-999.	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999.	-999.
Percent organic matter	--	CONSTANT	0.000	-999.	-999.	-999.
Bulk density of soil for layer	g/cc	CONSTANT	1.60	-999.	-999.	-999.
Biological decay coefficient	1/yr	CONSTANT	0.000	-999.	-999.	-999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS	
			MEAN	STD DEV	MIN	MAX
Thickness of layer	m	CONSTANT	3.50	-999.	-999.	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999.	-999.
Percent organic matter	--	CONSTANT	0.000	-999.	-999.	-999.
Bulk density of soil for layer	g/cc	CONSTANT	2.19	-999.	-999.	-999.
Biological decay coefficient	1/yr	CONSTANT	0.000	-999.	-999.	-999.

DATA FOR LAYER 4

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS	
			MEAN	STD DEV	MIN	MAX
Thickness of layer	m	CONSTANT	2.00	-999.	-999.	-999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999.	-999.
Percent organic matter	--	CONSTANT	0.000	-999.	-999.	-999.

```
          Bulk density of soil for layer            g/cc        CONSTANT
1.92     -999.       -999.      -999.
          Biological decay coefficient             1/yr         CONSTANT
0.000     -999.       -999.      -999.
1
                                                    CHEMICAL SPECIFIC VARIABLES


          ------------------------------------------------------------------------
-------------------------------------------
                       VARIABLE NAME               UNITS      DISTRIBUTION
PARAMETERS             LIMITS

MEAN     STD DEV      MIN         MAX
          ------------------------------------------------------------------------
-------------------------------------------
          Solid phase decay coefficient             1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Dissolved phase decay coefficient         1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Overall chemical decay coefficient        1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Acid catalyzed hydrolysis rate            l/M-yr      CONSTANT
0.000     -999.       -999.      -999.
          Neutral hydrolysis rate constant          1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Base catalyzed hydrolysis rate            l/M-yr      CONSTANT
0.000     -999.       -999.      -999.
          Reference temperature                     C           CONSTANT
25.0     -999.       -999.      -999.
          Normalized distribution coefficient       ml/g        CONSTANT
0.000     -999.       -999.      -999.
          Distribution coefficient                   --         DERIVED         -
999.     -999.       -999.      -999.
          Biodegradation coefficient (sat. zone)    1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Air diffusion coefficient                 cm2/s       CONSTANT        -
999.     -999.       -999.      -999.
          Reference temperature for air diffusion   C           CONSTANT        -
999.     -999.       -999.      -999.
          Molecular weight                          g/M         CONSTANT        -
999.     -999.       -999.      -999.
          Mole fraction of solute                   --          CONSTANT        -
999.     -999.       -999.      -999.
          Vapor pressure of solute                  mm Hg       CONSTANT        -
999.     -999.       -999.      -999.
          Henry`s law constant                   atm-m^3/M      CONSTANT        -
999.     -999.       -999.      -999.
          Overall 1st order decay sat. zone         1/yr        DERIVED
0.000     0.000       0.000       1.00
          Not currently used                                    CONSTANT
0.000     0.000       0.000      0.000
          Not currently used                                    CONSTANT
0.000     0.000       0.000      0.000
1
                                                      SOURCE SPECIFIC VARIABLES


          ------------------------------------------------------------------------
-------------------------------------------
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS		
			MEAN	STD DEV	MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.247E-01	-999.	-999.	-999.
Area of waste disposal unit	m^2	CONSTANT	188.	-999.	-999.	-999.
Duration of pulse	yr	CONSTANT	30.0	-999.	-999.	-999.
Spread of contaminant source	m	DERIVED	999.	-999.	-999.	-999.
Recharge rate	m/yr	CONSTANT	0.000	-999.	-999.	-999.
Source decay constant	1/yr	CONSTANT	0.000	0.000	0.000	0.000
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	-999.	-999.
Length scale of facility	m	DERIVED	50.0	-999.	-999.	-999.
Width scale of facility	m	DERIVED	50.0	-999.	-999.	-999.
Near field dilution		DERIVED	1.00	0.000	0.000	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS		
			MEAN	STD DEV	MIN	MAX
Particle diameter	cm	CONSTANT	999.	-999.	-999.	-999.
Aquifer porosity	--	CONSTANT	0.320	-999.	-999.	-999.
Bulk density	g/cc	CONSTANT	2.25	-999.	-999.	-999.
Aquifer thickness	m	CONSTANT	20.0	-999.	-999.	-999.
Source thickness (mixing zone depth)	m	DERIVED	999.	-999.	-999.	-999.
Conductivity (hydraulic)	m/yr	CONSTANT	0.380E+04	-999.	-999.	-999.
Gradient (hydraulic)		CONSTANT	0.300E-02	-999.	-999.	-999.
Groundwater seepage velocity	m/yr	DERIVED	999.	-999.	-999.	-999.
Retardation coefficient	--	DERIVED	999.	-999.	-999.	-999.
Longitudinal dispersivity	m	FUNCTION OF X	999.	-999.	-999.	-999.
Transverse dispersivity	m	FUNCTION OF X	999.	-999.	-999.	-999.

Vertical dispersivity				m	FUNCTION OF X
999.	-999.	-999.	-999.		
Temperature of aquifer				C	CONSTANT
13.3	-999.	-999.	-999.		
pH				--	CONSTANT
7.66	-999.	-999.	-999.		
Organic carbon content (fraction)					CONSTANT
0.500	-999.	-999.	-999.		
Well distance from site				m	CONSTANT
34.0	-999.	-999.	-999.		
Angle off center				degree	CONSTANT
0.000	0.000	0.000	0.000		
Well vertical distance				m	CONSTANT
0.000	0.000	0.000	0.000		

CONCENTRATION AFTER SATURATED ZONE MODEL 0.4530E-02

APPENDIX B-2
TRANSIENT MODEL RESULTS

MULTIMED V1.01

U. S. E N V I R O N M E N T A L P R O T E C T I O N A G E N C Y

E X P O S U R E A S S E S S M E N T

M U L T I M E D I A M O D E L

MULTIMED (Version 1.50, 2005)

1
Run options
--- -------

North Weld Landfill, Unit 2

Alternative Liner Demonstration
Chemical simulated is Leachate Constituent

Option Chosen Saturated and unsaturated zone models
Run was DETERMIN
Infiltration Specified By User: 2.474E-02 m/yr
Run was transient
Well Times: Entered Explicitly
Reject runs if Y coordinate outside plume
Reject runs if Z coordinate outside plume
Gaussian source used in saturated zone model
1
1
UNSATURATED ZONE FLOW MODEL PARAMETERS
(input parameter description and value)
NP - Total number of nodal points 240
NMAT - Number of different porous materials 4
KPROP - Van Genuchten or Brooks and Corey 1
IMSHGN - Spatial discretization option 1
NVFLAYR - Number of layers in flow model 4

OPTIONS CHOSEN
------- ------
Van Genuchten functional coefficients
User defined coordinate system
1

Layer information

LAYER NO.	LAYER THICKNESS	MATERIAL PROPERTY
1	5.00	1
2	6.50	4
3	3.50	2
4	2.00	3

DATA FOR MATERIAL 1
---- --- --------

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS		
			MEAN	STD DEV	MIN	MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	10.4	-999.	-999.	-999.
Unsaturated zone porosity	--	CONSTANT	0.437	-999.	-999.	-999.
Air entry pressure head	m	CONSTANT	0.000	-999.	-999.	-999.
Depth of the unsaturated zone	m	CONSTANT	17.0	0.000	0.000	0.000

DATA FOR MATERIAL 1

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Residual water content	--	CONSTANT	0.570E-01	-999.	-999.	-999.
Brook and Corey exponent,EN	--	CONSTANT	-999.	-999.	-999.	-999.
ALFA coefficient	1/cm	CONSTANT	0.124	-999.	-999.	-999.
Van Genuchten exponent, ENN	--	CONSTANT	2.28	-999.	-999.	-999.

DATA FOR MATERIAL 2

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.310E-02	-999.	-999.	-999.

Unsaturated zone porosity				--	CONSTANT		
0.550	-999.	-999.	-999.				
Air entry pressure head				m	CONSTANT		
0.000	-999.	-999.	-999.				
Depth of the unsaturated zone				m	CONSTANT		
17.0	0.000	0.000	0.000				

DATA FOR MATERIAL 2

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME				UNITS	DISTRIBUTION	PARAMETERS	LIMITS
MEAN	STD DEV	MIN	MAX				
Residual water content				--	CONSTANT		
0.100E-01	-999.	-999.	-999.				
Brook and Corey exponent,EN				--	CONSTANT	-	
999.	-999.	-999.	-999.				
ALFA coefficient				1/cm	CONSTANT		
0.200E-01	-999.	-999.	-999.				
Van Genuchten exponent, ENN				--	CONSTANT		
1.40	-999.	-999.	-999.				

DATA FOR MATERIAL 3

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME				UNITS	DISTRIBUTION	PARAMETERS	LIMITS
MEAN	STD DEV	MIN	MAX				
Saturated hydraulic conductivity				cm/hr	CONSTANT		
4.42	-999.	-999.	-999.				
Unsaturated zone porosity				--	CONSTANT		
0.189	-999.	-999.	-999.				
Air entry pressure head				m	CONSTANT		
0.000	-999.	-999.	-999.				
Depth of the unsaturated zone				m	CONSTANT		
17.0	0.000	0.000	0.000				

DATA FOR MATERIAL 3

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS		
			MEAN	STD DEV	MIN	MAX
Residual water content	--	CONSTANT	0.650E-01	-999.	-999.	-999.
Brook and Corey exponent,EN	--	CONSTANT	999.	-999.	-999.	-999.
ALFA coefficient	1/cm	CONSTANT	0.750E-01	-999.	-999.	-999.
Van Genuchten exponent, ENN	--	CONSTANT	1.89	-999.	-999.	-999.

DATA FOR MATERIAL 4

VADOSE ZONE MATERIAL VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS		
			MEAN	STD DEV	MIN	MAX
Saturated hydraulic conductivity	cm/hr	CONSTANT	0.230	-999.	-999.	-999.
Unsaturated zone porosity	--	CONSTANT	0.464	-999.	-999.	-999.
Air entry pressure head	m	CONSTANT	0.000	-999.	-999.	-999.
Depth of the unsaturated zone	m	CONSTANT	17.0	0.000	0.000	0.000

DATA FOR MATERIAL 4

VADOSE ZONE FUNCTION VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS	LIMITS		
			MEAN	STD DEV	MIN	MAX
Residual water content	--	CONSTANT	0.680E-01	-999.	-999.	-999.
Brook and Corey exponent,EN	--	CONSTANT	999.	-999.	-999.	-999.
ALFA coefficient	1/cm	CONSTANT	0.800E-02	-999.	-999.	-999.

```
          Van Genuchten exponent, ENN               --          CONSTANT
1.09     -999.       -999.      -999.
1
```

UNSATURATED ZONE TRANSPORT MODEL PARAMETERS

NLAY	- Number of different layers used		4
NTSTPS	- Number of time values concentration calc		40
DUMMY	- Not presently used		1
ISOL	- Type of scheme used in unsaturated zone		2
N	- Stehfest terms or number of increments		18
NTEL	- Points in Lagrangian interpolation		3
NGPTS	- Number of Gauss points		104
NIT	- Convolution integral segments		2
IBOUND	- Type of boundary condition		2
ITSGEN	- Time values generated or input		1
TMAX	- Max simulation time	--	0.0
WTFUN	- Weighting factor	--	1.2

OPTIONS CHOSEN

Convolution integral approach
Nondecaying pulse source
Computer generated times for computing concentrations

```
1
```

DATA FOR LAYER 1

VADOSE TRANSPORT VARIABLES

```
          ------------------------------------------------------------------------------
-----------------------------------------------
                      VARIABLE NAME               UNITS      DISTRIBUTION
PARAMETERS              LIMITS

MEAN     STD DEV      MIN         MAX
          ------------------------------------------------------------------------------
-----------------------------------------------
          Thickness of layer                        m           CONSTANT
5.00     -999.       -999.      -999.
          Longitudinal dispersivity of layer        m           DERIVED         -
999.     -999.       -999.      -999.
          Percent organic matter                    --          CONSTANT
0.000     -999.       -999.      -999.
          Bulk density of soil for layer            g/cc        CONSTANT
1.45     -999.       -999.      -999.
          Biological decay coefficient            1/yr          CONSTANT
0.000     -999.       -999.      -999.
```

DATA FOR LAYER 2

VADOSE TRANSPORT VARIABLES

```
          ------------------------------------------------------------------------------
-----------------------------------------------
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS		
			MEAN	STD DEV	MIN MAX
Thickness of layer	m	CONSTANT	6.50	-999.	-999. -999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999. -999.
Percent organic matter	--	CONSTANT	0.000	-999.	-999. -999.
Bulk density of soil for layer	g/cc	CONSTANT	1.60	-999.	-999. -999.
Biological decay coefficient	1/yr	CONSTANT	0.000	-999.	-999. -999.

DATA FOR LAYER 3

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS		
			MEAN	STD DEV	MIN MAX
Thickness of layer	m	CONSTANT	3.50	-999.	-999. -999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999. -999.
Percent organic matter	--	CONSTANT	0.000	-999.	-999. -999.
Bulk density of soil for layer	g/cc	CONSTANT	2.19	-999.	-999. -999.
Biological decay coefficient	1/yr	CONSTANT	0.000	-999.	-999. -999.

DATA FOR LAYER 4

VADOSE TRANSPORT VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS		
			MEAN	STD DEV	MIN MAX
Thickness of layer	m	CONSTANT	2.00	-999.	-999. -999.
Longitudinal dispersivity of layer	m	DERIVED	-999.	-999.	-999. -999.

```
          Percent organic matter                    --          CONSTANT
0.000     -999.       -999.      -999.
          Bulk density of soil for layer            g/cc        CONSTANT
1.92      -999.       -999.      -999.
          Biological decay coefficient            1/yr          CONSTANT
0.000     -999.       -999.      -999.
1
                                                  CHEMICAL SPECIFIC VARIABLES


          ------------------------------------------------------------------------
-------------------------------------------
                       VARIABLE NAME               UNITS      DISTRIBUTION
PARAMETERS             LIMITS

MEAN      STD DEV      MIN         MAX
          ------------------------------------------------------------------------
-------------------------------------------
          Solid phase decay coefficient             1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Dissolved phase decay coefficient         1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Overall chemical decay coefficient        1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Acid catalyzed hydrolysis rate            l/M-yr      CONSTANT
0.000     -999.       -999.      -999.
          Neutral hydrolysis rate constant          1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Base catalyzed hydrolysis rate            l/M-yr      CONSTANT
0.000     -999.       -999.      -999.
          Reference temperature                     C           CONSTANT
25.0      -999.       -999.      -999.
          Normalized distribution coefficient       ml/g        CONSTANT
0.000     -999.       -999.      -999.
          Distribution coefficient                   --         DERIVED         -
999.      -999.       -999.      -999.
          Biodegradation coefficient (sat. zone)    1/yr        CONSTANT
0.000     -999.       -999.      -999.
          Air diffusion coefficient                 cm2/s       CONSTANT        -
999.      -999.       -999.      -999.
          Reference temperature for air diffusion   C           CONSTANT        -
999.      -999.       -999.      -999.
          Molecular weight                          g/M         CONSTANT        -
999.      -999.       -999.      -999.
          Mole fraction of solute                   --          CONSTANT        -
999.      -999.       -999.      -999.
          Vapor pressure of solute                  mm Hg       CONSTANT        -
999.      -999.       -999.      -999.
          Henry`s law constant                  atm-m^3/M       CONSTANT        -
999.      -999.       -999.      -999.
          Overall 1st order decay sat. zone         1/yr        DERIVED
0.000      0.000       0.000       1.00
          Not currently used                                    CONSTANT
0.000      0.000       0.000      0.000
          Not currently used                                    CONSTANT
0.000      0.000       0.000      0.000
1
                                                    SOURCE SPECIFIC VARIABLES
```

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Infiltration rate	m/yr	CONSTANT	0.247E-01	-999.	-999.	-999.
Area of waste disposal unit	m^2	CONSTANT	0.118E+04	-999.	-999.	-999.
Duration of pulse	yr	CONSTANT	35.0	-999.	-999.	-999.
Spread of contaminant source	m	DERIVED	-999.	-999.	-999.	-999.
Recharge rate	m/yr	CONSTANT	0.000	-999.	-999.	-999.
Source decay constant	1/yr	CONSTANT	0.000	0.000	0.000	0.000
Initial concentration at landfill	mg/l	CONSTANT	1.00	-999.	-999.	-999.
Length scale of facility	m	DERIVED	50.0	-999.	-999.	-999.
Width scale of facility	m	DERIVED	50.0	-999.	-999.	-999.
Near field dilution		DERIVED	1.00	0.000	0.000	1.00

1

AQUIFER SPECIFIC VARIABLES

VARIABLE NAME	UNITS	DISTRIBUTION	PARAMETERS LIMITS			
			MEAN	STD DEV	MIN	MAX
Particle diameter	cm	CONSTANT	-999.	-999.	-999.	-999.
Aquifer porosity	--	CONSTANT	0.320	-999.	-999.	-999.
Bulk density	g/cc	CONSTANT	2.25	-999.	-999.	-999.
Aquifer thickness	m	CONSTANT	20.0	-999.	-999.	-999.
Source thickness (mixing zone depth)	m	DERIVED	-999.	-999.	-999.	-999.
Conductivity (hydraulic)	m/yr	CONSTANT	0.380E+04	-999.	-999.	-999.
Gradient (hydraulic)		CONSTANT	0.300E-02	-999.	-999.	-999.
Groundwater seepage velocity	m/yr	DERIVED	-999.	-999.	-999.	-999.
Retardation coefficient	--	DERIVED	-999.	-999.	-999.	-999.
Longitudinal dispersivity	m	FUNCTION OF X	-999.	-999.	-999.	-999.

```
          Transverse dispersivity                    m           FUNCTION OF X   -
999.     -999.       -999.      -999.
          Vertical dispersivity                      m           FUNCTION OF X   -
999.     -999.       -999.      -999.
          Temperature of aquifer                     C           CONSTANT
13.3     -999.       -999.      -999.
          pH                                         --          CONSTANT
7.66     -999.       -999.      -999.
          Organic carbon content (fraction)                      CONSTANT
0.500     -999.       -999.      -999.
          Well distance from site                    m           CONSTANT
708.     -999.       -999.      -999.
          Angle off center                         degree        CONSTANT
0.000     -999.       -999.      -999.
          Well vertical distance                     m           CONSTANT
0.000     -999.       -999.      -999.
1
```

TIME	CONCENTRATION
0.100E+01	0.00000E+00
0.500E+01	0.00000E+00
0.100E+02	0.77870E-25
0.150E+02	0.12612E-18
0.200E+02	0.78095E-17
0.250E+02	0.54167E-16
0.300E+02	0.16369E-15
0.350E+02	0.33079E-15
0.400E+02	0.53470E-15
0.450E+02	0.75499E-15
0.500E+02	0.97517E-15
0.550E+02	0.11056E-13
0.600E+02	0.15046E-10
0.650E+02	0.25359E-09

APPENDIX J

CDPHE APPROVAL WITH CONDITIONS TO USE GLASS CULLET FOR LEACHATE COLLECTION SYSTEM

STATE OF COLORADO

Bill Ritter, Jr., Governor
Martha E. Rudolph, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

http://www.cdphe.state.co.us

Laboratory Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

Colorado Department
of Public Health
and Environment

March 3, 2010

Mr. Tom Schweitzer
Waste Management of Colorado, Inc.
2400 West Union Avenue
Englewood, CO 80110

Re: Final Agency Action: Approval With Conditions to Use Glass Cullet for Leachate Collection System

Dear Mr. Schweitzer:

The Colorado Department of Public Health & Environment, Hazardous Materials and Waste Management Division (the "Division") has considered your proposal requesting the use of glass cullet in lieu of natural sand and gravel materials for leachate collection drainage layers and drain lines in Waste Management of Colorado, Inc. (WM) clay-lined municipal solid waste landfills.

The proposal was received in our office on September 9, 2009. On November 19, 2009 the Division sent comments to WM concerning the proposal. A meeting between the Division and WM and their consultant (Golder Associates) was held December 18, 2009 to address the comments and discuss other issues. A formal written response from WM was received on January 5, 2010. In the interim, several telephone calls and emails were also exchanged between WM and the Division.

Based upon the information provided in the proposal along with the follow-up discussions, the Division hereby approves, as final agency, WM's use of glass cullet for leachate collection drainage layers and drain lines with the following conditions:

1. As described in the letters to the Division, WM should perform pre-construction hydraulic conductivity testing to verify that the glass planned for use will achieve the desired hydraulic conductivity. The frequencies for testing should be the same as those approved for each facility's specific Engineering Design and Operations Plan (EDOP).

2. The glass cullet layer thickness should be increased so that upon final loading the minimum design thickness is still maintained. This concept is described in the proposal submitted to the Division.

3. Each WM facility that proposes to use the glass cullet shall amend their respective EDOPs to reflect the change. The amended EDOP shall be submitted to the Division for review and approval.

In closing, The Division is authorized to bill for its review of technical submittals at $125 per hour, pursuant to Section 1.7 of the solid waste regulations 6 CCR 1007-2. An invoice for the Division's review of the above referenced document will be sent under separate cover.

Should you have any questions regarding this letter, or would like to discuss any of the items contained in this letter, I can be reached at 303-692-3384 or email at larry.bruskin@state.co.us.

Sincerely,

Larry Bruskin
Solid Waste and Material Management Unit
Hazardous Materials and Waste
Management Division

cc: Mark McClain, Golder

file: sw/ara/dad/2.7

APPENDIX K

ALTERNATIVE DAILY COVER MATERIALS CDPHE AND WCDPHE APPROVAL LETTERS

RECEIVED OCT 1 2 1993

AD/NUSL
8.3

DEPARTMENT OF HEALTH
1517 - 16 AVENUE COURT
GREELEY, COLORADO 80631
ADMINISTRATION (303) 353-0586
HEALTH PROTECTION (303) 353-0635
COMMUNITY HEALTH (303) 353-0639

October 5, 1993

Bill Hedberg
Waste Services Corporation
6037 77th Avenue
Greeley, Colorado 80634

Alan Scheere
Waste Services Corporation
6037 77th Avenue
Greeley, Colorado 80634

Dear Mr. Hedberg and Mr. Scheere:

The Environmental Protection Division of the Weld County Health Department has reviewed your letter dated September 3, 1993, regarding daily cover and alternative daily cover at both the Central Weld Sanitary Landfill and the North Weld Sanitary Landfill, Weld County.

The Division approves of the use of soil as a daily cover material, including contaminated soils and street sweepings, provided it is applied to a depth of at least six (6) inches. The Division also approves of the use of a synthetic alternative daily cover, provided:

1) The material controls disease vectors, fires, odors, blowing litter, scavenging and other nuisance conditions without presenting a threat to human health and the environment.

2) An adequate soil stockpile is readily available in the event of extreme conditions.

The facility also requested approval for the use of shredded tire chips (two inch nominal thickness) and Sanifoam or an equivalent foam ADC material (two inch nominal thickness). The Division will consider approval for each of these materials after adequate demonstration from the facility that these materials can adequately control disease vectors, fires, odors, blowing litter, scavenging and other nuisance conditions without presenting a threat to human health and the environment.

If you have any questions, please contact Trevor Jiricek at 353-0635.

Sincerely,

Trevor Jiricek

Trevor Jiricek, Supervisor
Environmental Protection Services

TJ/cs-2031

cc: Roger Doak, Colorado Department of Health

STATE OF COLORADO

Bill Owens, Governor
Douglas H. Benevento, Executive Director

Dedicated to protecting and improving the health and environment of the people of Colorado

4300 Cherry Creek Dr. S.
Denver, Colorado 80246-1530
Phone (303) 692-2000
TDD Line (303) 691-7700
Located in Glendale, Colorado

http://www.cdphe.state.co.us

Laboratory and Radiation Services Division
8100 Lowry Blvd.
Denver, Colorado 80230-6928
(303) 692-3090

Colorado Department
of Public Health
and Environment

February 11, 2003

Mr. Alan Scheere
Waste Management
7780 E. 96th Avenue
Henderson, CO 80640

RE: Alternative Daily Covers Request for North Weld Landfill (NWLF)

Dear Mr. Scheere,

This is a Hazardous Materials and Waste Management Division (Division) response to your (and Bill Hedberg's) January 21, 2003 letter that requests approval for the use of the following alternative daily cover materials at NWLF:

- Ash from municipal waste combustors and utility companies;
- Compost-based materials;
- Foundry sand;
- Yard waste such as lawn clippings, leaves and tree branches;
- Sludge-based materials (i.e., sludge treated with lime and mixed with ash or soil);
- Construction and demolition debris;
- Shredded tires;
- Discarded carpets;
- Grit from municipal wastewater treatment plants;
- Shredder fluff from salvage yards;
- Glass Cullet; and
- Geotextile fabric.

The Division approves of your request with the following conditions:

1. At least one day a week a minimum six-inch thick earthen cover will be placed over the waste. This earthen cover shall remain in place. This statement is designed to ensure that an earthen layer remains in place as opposed to common practice of removing the previous day's earthen cover at the beginning of a new day of operation. The Division feels that this

requirement is reasonable because of the amount of air space gained from using materials that would normally be disposed of in the landfill, as daily cover.

2. Should there be any complaints of trash blowing out of the landfill, this approval may be revoked.

3. Should there be any complaints related to vermin such as flies and/or a noticeable increase in bird activity, this approval may be revoked.

4. Hazardous wastes shall not be used as daily cover.

5. If the total alpha activity of the sludge exceeds 40 picocuries per gram of dry sludge, the sludge generator shall contact the Colorado Department of Public Health and Environment's Laboratory and Radiation Services Division for further guidance regarding its use as an alternative daily cover material.

6. Hazardous Substances Response Fund is to be paid on these materials.

7. Approval from Weld County must be obtained.

Please contact me at 303-692-3389 if you have any questions.

Sincerely,

Douglas M. Ikenberry

Douglas M. Ikenberry
Solid Waste Unit
Compliance Program

Cc: Bill Hedberg, North Weld Landfill
Cindi Etcheverry, Weld County Department of Public Health and Environment

FILE: SW WLD NWC 2.5

DEPARTMENT OF PUBLIC HEALTH & ENVIRONMENT
1555 N. 17th Avenue
Greeley, CO 80631
WEBSITE: www.co.weld.co.us
ADMINISTRATION: (970) 304-6410
FAX: (970) 304-6412
PUBLIC HEALTH EDUCATION & NURSING: (970) 304-6420
FAX: (970) 304-6416
ENVIRONMENTAL HEALTH SERVICES: (970) 304-6415
FAX: (970) 304-6411

March 17, 2003

Alan Scheere
Waste Management
7780 E. 96th Avenue
Henderson, CO 80233

Bill Hedberg
North Weld Sanitary Landfill
40,000 Weld County Road 25
Ault, CO 80610-9748

Subject: North Weld Sanitary Landfill - Request for Use of Alternative Daily Cover

The Weld County Department of Public Health and Environment (WCDPHE) has reviewed your letter dated January 21, 2003 requesting the use of ash from municipal waste combustors and utility companies, compost-based materials, foundry sand from the manufacturing process of discarding used dies, yard waste such as lawn clippings, leaves and tree branches, sludge-based materials (i.e. sludge treated with lime and mixed with ash or soil), construction and demolition debris, shredded automobile tires, discarded carpets, grit from municipal wastewater treatment plants, shredder fluff from salvage yards, class cullet, and geotextile fabric as alternative daily cover (ADC) materials. The proposed ADC materials would be used at the above referenced facility located at 40000 Weld County Road 25.

As you state in your letter, the Colorado Department of Public Health and Environment (CDPHE) requested a comprehensive list of potential daily cover materials proposed for use as daily cover to eliminate the need for future individual approvals. Included in your letter is an approval letter from the CDPHE, dated November 15, 2002 for the Colorado Springs and Midway Landfills, which approves the above mentioned ADC materials provided that at least one day a week a six-inch earthen cover be placed over the waste, if complaints of trash blowing out of the landfill occur the approval may be revoked, and providing the governing body gives an approval.

The materials that you have requested to use as ADC at the North Weld Sanitary Landfill are listed below.

1. Ash from municipal waste combustors and utility companies,
2. Compost- based material,
3. Foundry sand from the manufacturing process of discarding used dies,
4. Yard waste such as lawn clippings, leaves, and tree branches,
5. Sludge based materials (i.e., sludge treated with lime and mixed with ash or soil),

6. Construction and demolition debris,
7. Shredded tires,
8. Discarded carpets,
9. Grit from municipal wastwater treatment plants,
10. Shredder fluff from salvage yards,
11. Glass Cullet, and
12. Geotextile fabric.

Providing that you abide by the conditions in the CDPHE letter and Doug Ikenberry's approval letter dated February 11, 2003, WCDPHE approves the use of the above listed materials for use as ADC. However, in the event that a nuisance condition or an operational problem associated with the use of above materials is determined, WCDPHE reserves the right to revoke our approval.

Should you have any questions regarding this letter, please contact me at (970) 304-6415, extension 2220.

Sincerely,

Cindi Etcheverry

Cindi Etcheverry
E. H. Supervisor
Environmental Health Services

cc: Trevor Jiricek, Director, Environmental Health Services (via email)
Doug Ikenberry, Colorado Department of Pubic Health and Environment
Glen Mallory, Colorado Department of Public Health and Environment (via email)
Lee Morrison, Weld County Attorneys Office (via email)
Kim Ogle, Department of Planning Services (via email)

COLORADO
Department of Public
Health & Environment

Dedicated to protecting and improving the health and environment of the people of Colorado

May 28, 2015

Mr. Bruce Clabaugh, M.S., R.S.
Waste Management
5500 South Quebec Street, Suite 250
Greenwood Village, CO 80111

Re: **Revised Approval With Conditions:** Request Dated November 12, 2014 to Use Street Sweepings as Alternative Daily Cover at Waste Management of Colorado, Inc., Landfills: North Weld Landfill, Buffalo Ridge Landfill, Denver Arapahoe Disposal Site, Colorado Springs Landfill, Midway Landfill, Montrose Landfill, CSI Landfill

Files: SW/WLD/NWC 2.2
SW/WLD/BRL 2.2
SW/ARA/DAD 2.2
SW/ELP/CSL 2.2
SW/ELP/MLF 2.2
SW/MOT/MON 2.2
SW/ADM/CSI 2.2

Dear Mr. Clabaugh:

The Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division (the "Division") reviewed your request to allow street sweepings to be used as alternative daily cover ("ADC") at the seven above-reference landfills. Based on this review, the Division provided an approval letter with conditions dated December 24, 2014. Waste Management subsequently requested clarification of several of the conditions. The Division herby **approves** the request to use street sweepings as ADC with the following **revised conditions**:

1. Street sweepings generated from a spill/release response should be properly characterized and disposed and should not be used as ADC.

2. Pursuant to Section 2.1.3 of the Regulations Pertaining to Solid Waste Sites and Facilities, 6 CCR 1007-2, Part 1 ("Solid Waste Regulations") street sweepings must be managed in a manner such that dust does not constitute a hazard to human health.

3. Stormwater that comes in contact with refuse, street sweepings, and other ADC must be managed separately in accordance with each facility's stormwater management plan and leachate management plan.

4. Street sweepings used as ADC must be applied in the smallest practical area pursuant to Section 2.1.10 of the Solid Waste Regulations.

5. A six-inch layer of soil cover must be placed over street sweepings and other ADC at least one day per week. Soil cover placed over ADC shall not be removed.

In closing, the Division is authorized to bill for its review of technical submittals at $125 per hour, pursuant to Section 1.7 of the Solid Waste Regulations. An invoice for the Division's review of the above-referenced document will be sent under separate cover.

Should you have any questions regarding this letter, I may be reached by phone at 303-692-2295 or email at curtis.stovall@state.co.us.

Sincerely,

Curt Stovall, P.E.
Solid Waste Permitting Unit
Solid Waste & Materials Management Program
Hazardous Materials & Waste Management Division

cc: Heather Barbare, Weld County Department of Public Health and Environment
James Taloumis, Weld County Department of Public Health and Environment
Diane DeLillio, City and County of Denver
Deanne Kelly, Tri-County Health Department
Mark Gebhart, El Paso County Development Services
Ken Winckler, Montrose County
Jennifer Rutter, Adams County Planning and Development Department

ec: Jerry Henderson, HMWMD
Bob Peterson, HMWMD
Jace Driver, HMWMD
Andy Todd, P.E., HMWMD