EXHIBIT K

BEDROC LIMITED
2745 N. Nellis Blvd
Las Vegas, NV 89115
(702) 369-4242 FAX (702) 459-3742

May 19, 2014

Paul Eckert, P.E.
Staff Engineer III
Bureau of Waste Management
Nevada Division of Environmental Protection
901 S. Stewart Street, Suite 4001
Carson City, NV 89701

Re: Bedroc Class I Landfill SW1722
Permit Application Technical Review Comments

Dear Mr. Eckert:

In response to your review comments dated April 22, 2014, we are providing this letter with our responses. To facilitate the Department's review, NDEP's comments have been repeated with Bedroc's italicized responses shown below each comment. The revised sections of the application are referenced in the responses to comments.

Response to Completeness Review Comments

1. Evidence of the instrument to be used for financial assurance is required as part of the application for Class I landfill. Please establish the trust fund described in your response and provide a copy to BWM. During the application process the balance may be zero. However, evidence of completion of the first payment must be provided to BWM prior to initial receipt of solid waste at the Class I facility.

   A copy of established trust fund is included in Appendix II of the Closure Plan.

Technical Review of Revised Application

2. Appendix B, Section 2.5 – the text states that the site is surrounded by public (BLM) land. Please provide a figure showing the land status within a 2-mile radius of the proposed and existing landfills;

   Drawing No. 20 has been prepared as requested and is included with this letter

3. Appendix B, Section 11 – the text states that adequate water supply exists for dust control. Please describe the water source.

   The text in section 11.1 has been revised accordingly.

4. Appendix D, Section 8.2 – for reporting of analytical results which are below the laboratory detection limit, please use one the flowing conventions:

    a. Report "<.xxx" where ".xxx" is the laboratory detection limit; or
    b. Report "ND" (non-detect) and include the laboratory detection limit for that constituent in a separate column in the report.

    The text in section 8.2 has been revised accordingly.

5. Appendix D, Section 3.2 – the text states that monitoring well screened intervals will be 10 to 20 feet in length. Please refer to the attached Division guidance for monitoring well construction. The screened interval must extend into the groundwater a minimum of 15 feet and extend a minimum of one foot above the seasonal high groundwater elevation.

    The text in section 3.2 (Appendix 2 of the GWMP) has been revised accordingly.

6. Appendix E, Section 1.0 – please confirm the total number of personnel (direct employees and contractors) that will be working at the site once the Class I landfill is operating along with the Class III facility.

    As noted in the Integrated Site Wide Contingency Plan, the following personnel are anticipated at the Class I facility:

    Facility Manager (1)
    Landfill Supervisor (1)
    Scale House Attendant (1)
    Heavy Equipment Operator (1)
    Laborers (5)

    For the Class III facility, an additional Equipment Operator and (3) Laborers are anticipated.

    All of the personnel listed above are considered to be direct employees. Contractors are used only for special projects, i.e. liner installation, and on a very limited and short term basis. Depending on the project, the number of contractor's personnel can range between 10-20 people. Currently, the facility does not employ contractors on a full time basis.

    A reference to the ISWCP has been added to Section 1.0 of the Design Report.

7. Appendix E, Section 11.1 – the overliner protecting the 60-mil HDPE liner is described in the text as 12 inches of coarse aggregate covered by 24 inches of select waste. Please consult with the HDPE liner manufacturer to confirm that, in consideration of the types of vehicles to be used to place the cover and to subsequently place waste on the cover, that the 60-mil liner will not be damaged. If changes are required to the design based on

the manufacturer's recommendation, please revise the description and applicable drawings.

Bedroc intends to use a CAT 637 wheel tractor scraper, or similar, to haul and place the drainage layer material in the proposed cell area, a CAT D5 dozer, or similar, to spread the drainage layer material. A CAT D9 will be used to spread and compact the waste material. As noted in Section 11.1, prior to placing the drainage layer material, a 16 oz/sy non-woven geotextile is placed above the 60-mil HDPE liner to provide protection against puncture from the drainage layer materials. As noted in the calculations provided with the permit application (copies are attached to this letter for reference), the 16 oz/sy non-woven geotextile has a factor of safety of 13.02 against puncture, and the factor of safety against geomembrane puncture based on the protection provided by the overlying geotextile is 5.1. Please note that the factor of safety of 13.02 against geotextile puncture assumes a tire pressure of 65 psi. The tire pressure for the CAT 637 is 55 psi. The calculation to determine the factor of safety (5.1) against geomembrane puncture, is under landfill loading conditions with a calculated loading equivalent to 12,150 psf (84.3 psi).

In accordance with the CQA Plan (section 2.4.9), during placement of the drainage/protective cover layer materials on the liner, required separation will be maintained between the equipment/vehicles and liner. Placement of the drainage/protective cover layer materials will not occur when temperatures are above 104°F. A liner manufacturer was contacted regarding temperature of the liner and concern for puncturing when placing the drainage layer. His response was that if the liner is that hot, large wrinkles would have developed from thermal expansion, and the drainage layer placement should not progress until the liner has cooled down and the wrinkles have flattened out.

8. Appendix E, Section 13.2 – the text states that the stormwater diversion system has been designed based on the 25-year, 24-hour storm event, as required by NAC 444.6885. In consideration of the fact that the geographic area in which the proposed landfill will be located has not been evaluated as a potential 100-year flood zone, BWM recommends that the design and calculations be reevaluated and, if appropriate, modified to accommodate the 100-year, 24-hour storm event. BWM recognizes that this would be an exceedance of the regulatory requirement, but considers this to be a prudent approach based on the circumstances.

   The stormwater diversion channel has been sized to accommodate the 100-year, 24-hour storm event. The drawings have been revised and are included with this letter. Revised calculations are included with the Design Report.

9. Appendix H – the plan for visual screening of the landfill activities from passers-by on the adjacent highway is not considered by BWM to be adequate. Please revise to address the following:

a. The use of waste as the base structure of the proposed berms is not acceptable. The berms must be constructed completely of soil.

Text has been revised accordingly.

b. Please provide drawings of the berm locations relative to each stage of landfill construction to demonstrate that there will be no significant visual impact from any point on the highway within 1,000 feet of the edge of the proposed landfill. This evaluation must include consideration of the maximum height of the waste and all possible angles of view from the road.

The phasing plans and Beautification Plan have been revised, and a detail prepared, to indicate the location of the perimeter berms when waste disposal activities are within 1,000 feet of Highway 93.

c. As part of this evaluation, BWM recommends that the geometry of the proposed landfill be adjusted wherever possible to maximize the setback from the highway. This may include shifting the entire footprint to the west and/or modifying the eastern boundary to run parallel to the highway instead of straight north. Please review this possibility and make adjustments to the design as appropriate.

The eastern boundary of the waste footprint has been shifted to run parallel to the highway. The setback from the highway is 700 feet. The drawings have been revised accordingly.

10. Drawing 4 – please provide a drawing showing the elevation profile of the stormwater diversion channel corresponding to the configuration shown in plan view. In addition, please describe or provide additional views/sections which clarify how the depressions in the north and west tie-in to the channels that will be constructed. Lastly, please provide cross-sections of the channel at various points showing the dimensions of the channel and the maximum depth of stormwater flow.

Drawings 21, 22 and 23 have been prepared and are included with this letter.

11. Drawing 16, Detail D – please modify the detail to extend the liner across all three sides of the anchor trench and provide material and compaction specifications for the backfill. The provision of a short, visible edge of liner at the outboard edge of the anchor trench provides a useful means of confirming by visual inspection that the liner has not pulled down the slope.

Detail D on Drawing No. 16 is related to the leachate pond. No changes are proposed to this detail.

12. Drawing 17, Details G, H, I – please modify each detail to extend the liner across all three sides of the anchor trench and provide material and compaction specifications for the backfill. The provision of a short, visible edge of liner at the outboard edge of the

anchor trench provides a useful means of confirming by visual inspection that the liner has not pulled down the slope.

We have proposed to eliminate the anchor trench and extend the liner runout length to approximately 9.5 feet with approximately 12" exposed. In addition, the thickness of soil cover would be increased from 12" to 15". This will allow for confirmation by visual inspection that the liner has not pulled down the slope. We couldn't accomplish this with the anchor trench included. As mentioned previously, the runout & anchor trench are designed to allow pullout of the geomembrane before tension failure. This is achieved with the above. The details have been revised accordingly. The operations plan has been revised to include periodic visual inspection of the visible tail of the liner for confirmation that no slippage has occurred.

In addition, the sequence of cell development has been revised. The drawings, Design Report, Closure Plan, Groundwater Monitoring Plan and associated appendices have been revised accordingly.

For your review, we have enclosed one set of the revised documents. In addition, we have included copies of the tracked changes. If you have any questions or comments regarding these responses or any of the enclosed information, please do not hesitate to contact me at (702) 250-3045 or Larry Bertolet (Joyce Engineering) at (804) 355-4520.

Sincerely,
Bedroc Limited, LLC

Ryan Williams

Ryan Williams, Manager

Enclosures

- Operating Plan– revised pages only
- Groundwater Monitoring Plan - revised pages only
- Design Report - entire plan with revised appendices only
- Decomposition Gas Monitoring Plan - revised pages only
- Closure Plan - entire plan
- Beautification Plan - entire plan
- Drawings - entire set

BEDROC LIMITED
2745 N. Nellis Blvd
Las Vegas, NV 89115
(702) 369-4242 FAX (702) 459-3742

October 24, 2013

Mr. Jon Taylor, P.E., CEM
Staff Engineer III
Bureau of Waste Management
Solid Waste Facilities Branch
901 S. Stewart St., Suite 4001
Carson City, NV 89701-5249

RE: Bedroc Landfill and Waste Management Facility
Class I Landfill Permit Application
Bedroc Limited, LLC

Dear Mr. Taylor:

Please enclosed, revisions to the Bedroc Limited, LLC (Bedroc) application for a Class I Disposal Facility application. The facility is located within the Coyote Spring Valley, adjacent to U.S. Highway 93 and the Western Elite Material Processing Facility.

The following information is included for your review:

- Class I/II Municipal Solid Waste Disposal Site Permit Application
- Operating Plan as required by NAC 444.684
- Integrated Sitewide Contingency Plan as required by NAC 444.684
- Groundwater Monitoring Plan as required by NAC 444.683
- Design Report as required by NAC 444.680
- Decomposition Gas Monitoring as required by NAC 444.667
- Closure (and post-closure) Plan as required by NAC 444.6895 and NAC 444.6896
- Beautification Plan as required by NAC 444.678
- Construction Quality Assurance Plan
- Site Characterization Report

For your review, we have enclosed one copy of the application. Should you have any questions or concerns regarding these changes, please do not hesitate to call me or Larry Bertolet at (804) 355-4520.

Sincerely,
Bedroc Limited, LLC

Ryan Williams

Ryan Williams
Manager

Enclosures

C Larry Bertolet, P.E.

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

APPLICATION FOR A CLASS I FACILITY

OCTOBER 2013
REVISED FEBRUARY 2014
REVISED MAY 2014

PROFESSIONAL ENGINEER - STATE OF NEVADA
LEONARD E. JOYCE, JR.
CIVIL
No. 13876

5/19/14

PREPARED BY:

JOYCE
ENGINEERING

1604 OWNBY LANE
RICHMOND, VIRGINIA 23220
PHONE: (804) 355-4520
FAX: (804) 355-4282
JOYCE PROJECT NO. 00383.1401.01.01

Application for a Class I Facility
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

Master Table of Contents

Design Drawings are included separately

Class I/II MUNICIPAL SOLID WASTE DISPOSAL SITE
PERMIT APPLICATION
Nevada Division of Environmental Protection
Solid Waste Branch

Instructions: Complete Sections I & II, attach the supporting information described in Section III, and sign Section IV.

1

Section I. Applicant Information

1. Land Owner

Name: Bedroc Limited, LLC
Address: 2745 N. Nellis Blvd.
City: Las Vegas State: NV Zip Code: 89115
Phone: (702) 369-4242

2. Facility Operator

Name: Bedroc Limited, LLC
Address: 2745 N. Nellis Blvd.
City: Las Vegas State: NV Zip Code: 89115
Phone: (702) 369-4242

3. Owner/Operator name under which the Permit will be issued

Name: Bedroc Limited, LLC
Address: 2745 N. Nellis Blvd.
City: Las Vegas State: NV Zip Code: 89115
Phone: (702) 369-4242

Section II. Facility Information

1. Location

Name: Bedroc Landfill and WMF

County:	Township/Range/Section:	Latitude & Longitude
Lincoln	11S 62E 24	N 36° 58' 45"

Address: US Hwy 93, Mile Marker 8, Lincoln County, NV W 114° 58' 55"
City: n/a State: NV Zip Code: 89001
Phone: (702) 369-4242

Section III Class of Facility

☑ Class I. A disposal site that is comprised of a municipal solid waste landfill unit or units and is not a Class II site.

☐ Class II. A municipal solid waste landfill unit which accepts less than 20 tons per day on an annual average of solid waste, has no evidence of ground water contamination originating from the site, serves a community that has no practicable waste management alternative, and the landfill unit is located in an area that annually receives less than, or equal to, 25 inches of precipitation.

3. **Sectors to be Served by the Facility**
   - ☑ Residential
   - ☑ Commercial
   - ☑ Industrial

4. **Special Wastes to be Managed by the Facility**
   The special wastes listed below require a management plan specific to each include as necessary.
   - ☑ NAC 444.646 Disposal of special wastes: Sewage sludge, septic tank pumpings and medical wastes
   - ☑ NAC 444.648-Disposal of special wastes: Waste tires.
   - ☑ NAC 444.650 Disposal of special wastes: Waste oils.
   - ☐ NAC 444.652 Disposal of special wastes: Construction and demolition wastes.
   - ☐ NAC 444.654 Disposal of special wastes: Septic tank pumping's and raw sewage.
   - ☐ NAC 444.656 Disposal of special wastes: Untreated sewage sludge.
   - ☐ NAC 444.976 Duties of operator who accepts asbestos. (NRS 618.775)
   - ☐ NAC 444.585 Disposal of special wastes Industrial Solid Waste

Section III. Supporting Information

Class I & II Sites

All information required by NAC.444.6769 & 677, must be submitted as supporting information to this application.

1. Proof of ownership of the land on which the site is/or will be located
2. Facility Operating Plan [NAC 444.684] should contain at a minimum:
   - i. Site Overview
   - ii. Personnel Requirements (with levels of Authority)/Training NAC 444.684
   - iii. Equipment Requirements with contingencies and descriptions NAC 444.684
   - iv. Litter/Dust control program NAC 444.684
   - v. Waste Handling and Acceptance Criteria (Special Waste Management) NAC 444.684
   - vi. Vector Control NAC 444.6678
   - vii. Cover Requirements (daily etc) NAC 444.688
   - viii. Inspections & Operating Records NAC 444.7025
   - ix. Contingency/Emergency Plan (Health & Safety) [Integrated Site Wide Contingency Plan] NAC 444.684

x. Groundwater/Methane Monitoring [Control of Explosive Gasses] NAC 444.683/NAC 444.7483/NAC 444.667 [Sampling/QAQC/Statistical Analysis Plan(s)]
xi. Leachate Management NAC 444.684
xii. Surface Water Management requirements (drainage from active areas) NAC 444.6885
xiii. Closure (Incremental where applicable) Post-Closure Procedures/Requirements With Financial Assurance
xiv. Additional Requirements for Operating (CQA Plans, etc.)
xv. Additional Site Specific Requirements
xvi. Reserved

3. The Design Report must contain all those items in NAC 444.680
4. The Investigatory Report would contain the information necessary to support the design NAC 444.680(8).

Section IV. Certification

I certify that I am familiar with the information contained in the application and I believe that the information provided in this application is complete and accurate.

Printed Name of Owner Ryan Williams Title or Authority of Signatory Manager

Legal Signature Ryan Williams Date of Signing 30 September, 2013

Printed Name of Operator Ryan Williams Title or Authority of Signatory Manager

Legal Signature Ryan Williams Date of Signing 30 September, 2013

Send the completed application and supporting information to:

Supervisor
Nevada Division of Environmental Protection
Bureau of Solid Waste
901 So. Stewart Street, Suite 4001
Carson City, NV 89701-5249
(775) 687-9467 ph
(775) 687-5856 fax

For more information, please visit http://ndep.nv.gov/bwm/swpermit.htm or call (775) 687-9467

Appendix A

ASSIGNMENT OF INTEREST IN
BEDROC LIMITED, LLC

1. For good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, WILLIAM B. PIPES, as Assignor, hereby conveys, transfers and assigns to RYWHY LIMITED PARTNERSHIP, a Nevada limited partnership, as Assignee, a 94% interest (the "Interest") in and to BEDROC LIMITED, LLC, a Nevada limited liability company (the "Company"), together with all rights, title and hereditaments appurtenant thereto. The Interest is assigned hereunder with full voting privileges.

2. Assignor hereby warrants to Assignee that, as of the date hereof, the Interest is transferred to Assignee free and clear of all claims, liens and encumbrances whatsoever.

3. The parties agree to promptly execute and deliver such additional documents and instruments as may be necessary or appropriate to effectuate the intent hereof.

4. Time is of the essence hereof. This Assignment shall be binding upon and inure to the benefit of the parties hereto, together with their respective heirs, administrators, successors and assigns. In the event of any legal action arising out of this Assignment or in connection herewith, the prevailing party shall be entitled to its costs and reasonable attorneys' fees from the other party.

IN WITNESS WHEREOF the undersigned have executed this Assignment as of this 28th day of January, 2004.

ASSIGNOR:

WILLIAM B. PIPES

ASSIGNEE:
RYWHY, LIMITED PARTNERSHIP
a Nevada limited partnership

By: Ryan Williams
Ryan Williams
Its: General Partner

F:\OFFICE\Clients\BEDROC\DOCS\ASSIGN 94% INTEREST

ASSIGNMENT OF INTEREST IN BEDROC LIMITED, LLC

1. For good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, BEDROC INC., a Nevada corporation, as Assignor, hereby conveys, transfers and assigns to RYWHY LIMITED PARTNERSHIP, a Nevada limited partnership, as Assignee, all of Assignor's 5% interest (the "Interest") in and to BEDROC LIMITED. LLC. a Nevada limited liability company (the "Company"), together with all rights, title and hereditaments appurtenant thereto. The Interest is assigned hereunder with full voting privileges.

2. Assignor hereby warrants to Assignee that, as of the date hereof, the Interest is transferred to Assignee free and clear of all claims, liens and encumbrances whatsoever.

3. The parties agree to promptly execute and deliver such additional documents and instruments as may be necessary or appropriate to effectuate the intent hereof.

4. Time is of the essence hereof. This Assignment shall be binding upon and inure to the benefit of the parties hereto, together with their respective heirs, administrators, successors and assigns. In the event of any legal action arising out of this Assignment or in connection herewith, the prevailing party shall be entitled to its costs and reasonable attorneys' fees from the other party.

IN WITNESS WHEREOF the undersigned have executed this Assignment as of this 28th day of January, 2004.

ASSIGNOR:

BEDROC, INC., a Nevada corporation

By: ______________________
William B. Pipes
Its: President

ASSIGNEE:

RYWHY, LIMITED PARTNERSHIP,
a Nevada limited partnership

By: ______________________
Ryan Williams
Its: General Partner

F:\OFFICE\Clients\BEDROC\DOCS\ASSIGN 5% INTEREST

ASSIGNMENT OF INTEREST IN BEDROC LIMITED, LLC

1. For good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, WILLIAM B. PIPES, as Assignor, hereby conveys, transfers and assigns to RYAN WILLIAMS, as Assignee, a 1% interest (the "Interest") in and to BEDROC LIMITED, LLC, a Nevada limited liability company (the "Company"), together with all rights, title and hereditaments appurtenant thereto. The Interest is assigned hereunder with full voting privileges.

2. Assignor hereby warrants to Assignee that, as of the date hereof, the Interest is transferred to Assignee free and clear of all claims, liens and encumbrances whatsoever.

3. The parties agree to promptly execute and deliver such additional documents and instruments as may be necessary or appropriate to effectuate the intent hereof.

4. Time is of the essence hereof. This Assignment shall be binding upon and inure to the benefit of the parties hereto, together with their respective heirs, administrators, successors and assigns. In the event of any legal action arising out of this Assignment or in connection herewith, the prevailing party shall be entitled to its costs and reasonable attorneys' fees from the other party.

IN WITNESS WHEREOF the undersigned have executed this Assignment as of this 28th day of January, 2004.

ASSIGNOR:	ASSIGNEE:
WILLIAM B. PIPES	RYAN WILLIAMS

F:\OFFICE\Clients\BEDROC\DOCS\ASSIGN 1% INTEREST

- File Copy -

QUITCLAIM DEED

THIS INDENTURE WITNESSETH: That WILLIAM B. PIPES and BARBARA ANN PIPES, husband and wife, "Grantor", for a valuable consideration, the receipt of which is hereby acknowledged, do hereby remise, release and forever quitclaim to BEDROC LIMITED, LLC, a Nevada Limited Liability Company, Grantee, with address of 3529 Clayton Street, North Las Vegas, Nevada 89030, all the real property situate in the County of Lincoln, State of Nevada, bounded and described as follows:

> The East Half (E 1/2), and the East Half (E 1/2) of the West Half (W 1/2) of Section 24, and the East Half (E 1/2) of the Northeast Quarter (NE 1/4) of Section 25, Township 11 South, Range 62 East, M.D.B. & M., Lincoln County, Nevada.
> A.P.N.: 08-201-02

Together with all the singular for tenements, hereditaments and appurtenances there unto belonging or in anywise appertaining.

WITNESS our hands this 27th day of July, 1995.

WILLIAM B. PIPES

BARBARA ANN PIPES

STATE OF NEVADA)
) ss:
COUNTY OF CLARK)

On the 27th day of July, 1995, personally appeared before me, Notary Public, WILLIAM B. PIPES and BARBARA ANN PIPES, personally known (or proved) to me to be the persons whose name are subscribed to the above instrument.

PATRICIA RICHARDS

NOTARY PUBLIC

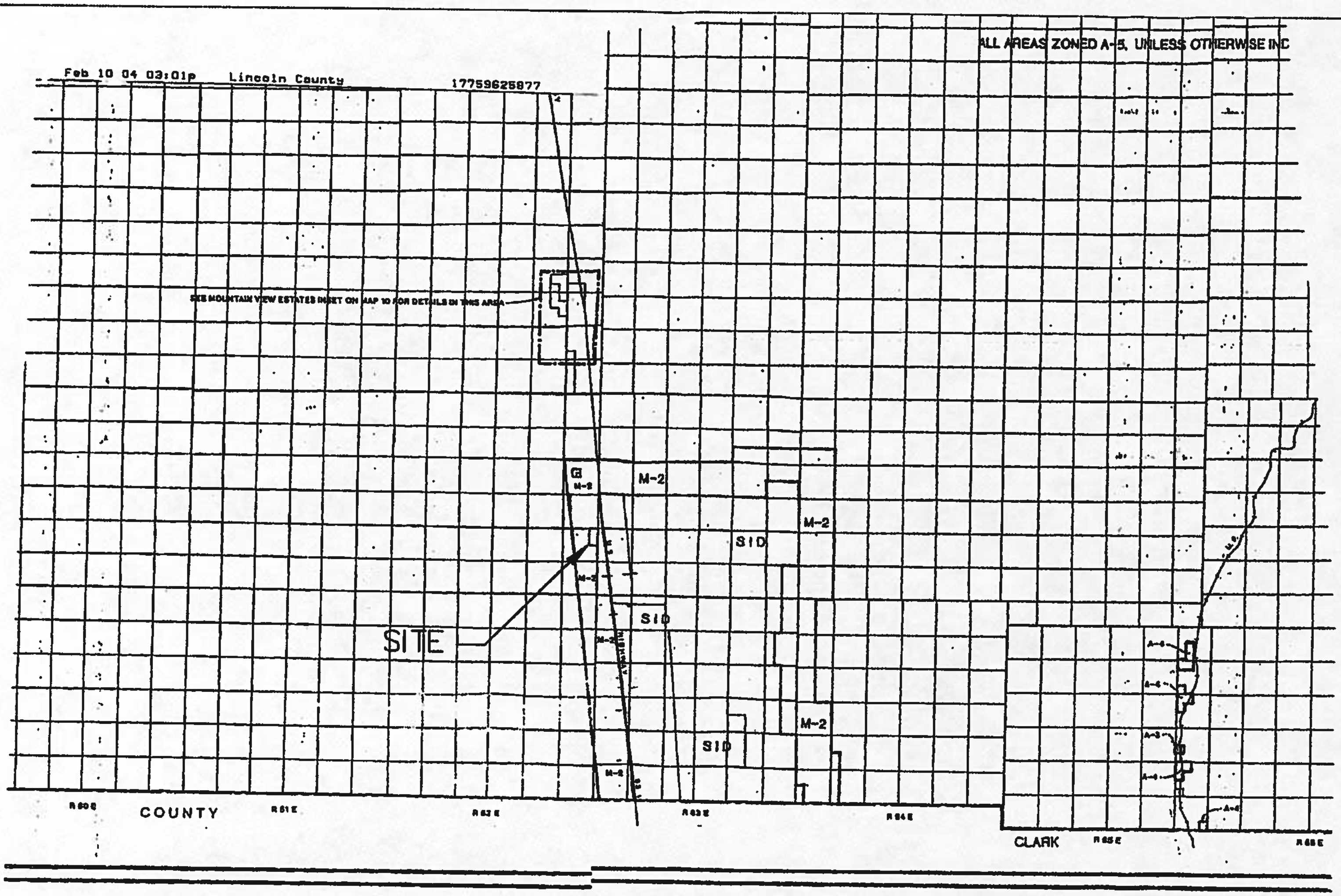
When recorded, Mail to:
BEDROC, INC.
c/o Patricia Richards
3529 Clayton Street
North Las Vegas, NV 89030

July 21, 1995
[illegible]

No. 103757
FILED AND RECORDED AT REQUEST OF
Bedroc Limited, LLC
July 27, 1995
AT 15 MINUTES PAST 2 O'CLOCK
A M. IN BOOK 114 OF OFFICIAL
RECORDS, PAGE 529 LINCOLN
COUNTY, NEVADA.
COUNTY RECORDER

BOOK 114 PAGE 529

Feb 10 04 03:01p Lincoln County 17759625877



MAP 4 APPROX. SCALE: 1 BLOCK=1 SQUARE MILE **LINCOLN** **MAP 5** **COUN**

R1	SINGLE FAMILY RESIDENTIAL
RM	MULTIPLE FAMILY RESIDENTIAL
RR-1	RURAL RESIDENTIAL (10,000 sq. ft.)
RR-2	RURAL RESIDENTIAL (12,000 sq.ft.)
RR-3	RURAL RESIDENTIAL (15,000 sq. ft.)
RR-4	RURAL RESIDENTIAL (20,000 sq. ft.)
RR-5	RURAL RESIDENTIAL (1acre)
RR-6	RURAL RESIDENTIAL (2.5 acres)
RR-7	RURAL RESIDENTIAL (5 acres)
RR-8	RURAL RESIDENTIAL (10 acres)
C1	LOCAL COMMERCIAL
C2	GENERAL COMMERCIAL
M1	LIGHT MANUFACTURING
M-2	HEAVY MANUFACTURING
SID	SPECIAL INDUSTRIAL
A-1	AGRICULTURAL (2.5 acres)
A-2	AGRICULTURAL (5 acres)
A-3	AGRICULTURAL (10 acres)
A-4	AGRICULTURAL (20 acres)
A-5	AGRICULTURAL (40 acres)
OS	OPEN SPACE
MHP	MOBILEHOME PARK
T	MOBILEHOME
HD	HISTORIC DISTRICT

THIS IS TO CERTIFY THAT THIS IS THE OFFICIAL ZONING MAP REFERRED TO IN SECTION OF THE LINCOLN COUNTY ORDINANCE CODE; STATE OF NEVADA. ADOPTED

Appendix B

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

OPERATING PLAN

OCTOBER 2013
REVISED FEBRUARY 2014
REVISED MAY 2014

PROFESSIONAL ENGINEER - STATE OF NEVADA
LEONARD E JOYCE, JR.
CIVIL
No. 13876

5/19/14

PREPARED BY:

JOYCE
ENGINEERING

1604 OWNBY LANE
RICHMOND, VIRGINIA 23220
PHONE: (804) 355-4520
FAX: (804) 355-4282

JOYCE PROJECT NO. 00383.1401.01.01

Operating Plan
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

Table of Contents

1. Overview

In accordance with the Nevada Administrative Code (NAC) 444.684, this Operating Plan has been prepared for the Bedroc Landfill and Waste Management Facility (facility). In addition, this plan addresses the compliance of the facility with the requirements presented in NAC 444.6665 through 444.6678, NAC 444.686 through 444.6887 and NAC 444.690 through 444.7025.

This operating plan also serves as a guidance document for the personnel working at the site to aid them in proper landfill operations. It is also a guide for operations supervisory personnel and sets forth contingency plans for special problems and situations that may arise. The Nevada Division of Environmental Protection (NDEP) is the solid waste management authority having jurisdiction over the facility.

2. General Information - NAC 444.677(1)

2.1. Landfill Classification:
Class I solid waste landfill.

2.2. Name and Mailing address of Landfill Owner:
Bedroc Limited, LLC
2745 N. Nellis Blvd.
Las Vegas, NV 89115

2.3. Name of Mailing address of Landfill Operator:
Bedroc Limited, LLC
2745 N. Nellis Blvd.
Las Vegas, NV 89115

2.4. Site Location:
The site is located adjacent to U.S. Highway 93, mile marker 8, Lincoln County, NV, approximately 65 miles north of Las Vegas, NV. The property's legal description is the East Half (E ½), and the East Half (E ½) of the West Half (W ½) of Section 24, Township 11 South, Range 62 East, M.D.B.&M., Lincoln County, Nevada.

2.5. Site Description:
The site is situated in the arid desert of southern Lincoln County, NV. Lands surrounding the site are public lands administered by the Bureau of Land Management. The project area and adjacent lands are zoned M 2 Heavy Manufacturing. The M 2 heavy manufacturing district is intended to provide areas for the development and operation of industrial and manufacturing uses.

The landfill site consists chiefly of barren soils supporting some desert vegetation. The area averages 300 sunny days and approximately 4 inches of rainfall per year. In accordance with NAC 444.678 (5) the facility was granted a Special Use Permit by

Lincoln County for a Class I site in 2003. The 2012 population of Lincoln County is approximately 5,400 residents.

2.6. Hours of Operation:
The landfill may operate 24-hours per day, 365 days per year.

2.7. Emergency Contacts:
Contact: Ryan Williams
702-250-3045 Cell Phone

Contact: Ron Williams
702-250-8328 Cell Phone

Lincoln County Sheriff - Alamo Substation: 775-725-3375

Lincoln County Volunteer Fire Department - Alamo Substation: 775-725-3375

Fire, Police, Ambulance Emergencies: 911

3. Location Restrictions - NAC 444.6783 through 444.6795

3.1. Airport Safety NAC 444.6783

A Class I site will be designed and operated so that it does not pose a hazard to aircraft. The owner or operator who proposes to locate a new municipal solid waste landfill unit or lateral expansion within a 5-mile radius of the end of any airport runway used by a turbojet or piston-type aircraft will notify the affected airport and the Federal Aviation Administration.

The nearest airfield is located in Alamo, NV, and is over 30 miles from the site. The landfill site is not located within a 5-mile radius of any airport runway.

3.2. Floodplains NAC 444.6785

A Class I site located in a 100-year floodplain will maintain proof that the unite or lateral expansion will not restrict the flow of the floodplain, reduce the temporary capacity of the floodplain to store water, and not result in the washout of solid waste that poses a hazard to public health and safety and the environment.

The landfill site is not located within a published 100-year floodplain. However, several natural drainage channels exist surrounding the site. Runoff from rain drains away from the landfill and intermittently through these channels. A system of berms and/or shallow ditches will divert any potential run-on away from the landfill and into these washes.

3.3. Wetlands NAC 444.679

A Class I site may not be located in wetlands unless the owner or operator satisfactorily demonstrates that the construction and operation of the landfill will not cause or contribute to violations of any applicable state water quality standard, violate any applicable toxic effluent standard or prohibition, jeopardize the continued existence of endangered or threatened species, or violate any requirement set forth in the Marine Protection, Research and Sanctuaries Act.

The landfill site is not located within any wetlands.

3.4. Fault areas NAC 444.6791

A Class I site will not be located within 200 feet of a fault that has had a displacement in Holocene time unless the owner or operator demonstrates to the solid waste management authority that an alternative setback distance of less than 200 feet will prevent damage to the structural integrity of the unit and will protect the public health and safety of the environment.

The landfill site is not located within 200 feet of a fault area.

3.5. Seismic impact zones NAC 444.6793

The site is located in a seismic impact zone as discussed in Section 12.0 of the facility's Design Report. As required by NAC 444.6793, the owner will place the proof in the operating records for the site and notify the solid waste management authority that the proof has been placed in the operating records. The calculations and design information show that the materials and the design of the landfill systems resist the maximum horizontal acceleration for the site. This information is presented in Appendix II of the Design Report.

3.6. Unstable areas NAC 444.6795

A Class I site located in an unstable area will maintain proof that engineering measures have been incorporated into the structural design of the unit or lateral expansion to ensure that the integrity of the unit or lateral expansion will not be disrupted. The owner or operator will place the proof in the design report and the operating records of the unit and notify the solid waste management authority that the proof has been placed in the operating records.

The landfill site is not located in an unstable area. The soil and geologic conditions at the site are well suited to ensure surface and subsurface stability.

4. Signage - NAC 444.690

Signs will be posted at the entrance of the landfill facility that clearly indicate the following:

- Identification of the site owner/operator
- The hours of operation
- Materials accepted and excluded

- Fees charged
- Private Property/Trespassing prohibited/Not open to the public
- Prohibitions against illegal dumping and open burning

5. Access Roads - NAC 444.678(1)

The site is easily accessible in all kinds of weather to all vehicles expected to use it. Access to the site can be achieved by an existing road, which joins US Hwy 93 at approximately mile marker 8, and travels west to the site. A fence around the perimeter of the property as well as natural barriers will limit access to the landfill to one entrance. The scale house is located at the entrance and controls access to the operating area and monitors all vehicles entering and exiting. A site attendant will be on duty to control access during hours of operation and direct vehicles appropriately. Vehicles delivering solid waste are required to cross the scales to be monitored, weighed and then they are directed to the working face. Speed limits are posted on internal roads. Public access is forbidden at this site and signage stating such is clearly posted at the entrance.

The access road is an approximately 25-ft wide and is constructed of crushed stone, rubble, or other soil materials capable of providing an all-weather driving surface. Site personnel will maintain the on-site roads for all-weather access. If conditions prohibit access to the active face during inclement weather, an all-weather access area will be constructed as near as possible to the active area. When necessary, haulers will dump waste at the edge of the designated wet weather area to allow the compactor or dozer to push the waste into the fill. Bedroc Limited, LLC (Bedroc) will maintain the access roads for the life of the landfill so that the facility will be easily accessible in all weather.

6. Plan for Operating - NAC 444.684

6.1. Personnel and Equipment

This manual has been designed to be useful both as a field reference document and as a training manual for classroom and self-instruction purposes. Every employee is expected to be familiar with its use and location at the site. All landfill employees will be given site-specific training regarding waste characterization and handling. Management personnel have been certified as having completed the Landfill Operations Course offered by the Environmental Industry Associations.

The number of employees working at the site will vary depending of the amount of waste anticipated during that day. A list of the positions, as well as, job descriptions are included in the facility's Integrated Site Wide Contingency Plan (ISWCP). Additional employees or subcontractors may be working from time to time to perform functions such as general maintenance, cell construction, liner installation, litter control, etc.

Equipment requirements may vary in accordance with the method and scope of activities on-site at any given time. The primary operating equipment may include a dozer, water truck, wheel loader, scraper, compactor or equivalent equipment. Equipment necessary for the normal landfill operation will be maintained and stored on-site.

6.2. Communication Systems

The scale house attendant, landfill supervisor and equipment operator(s) will have mobile phones to help facilitate normal day to day operations, outbreak of a fire and for other emergency purposes.

6.3. Initial Waste Placement

The initial placement of waste in a new cell will be in a careful and controlled manner where the leachate collection system and the liner are most vulnerable. Select waste, avoiding bulky and large rigid items, will be placed as the first lift. This layer will be a minimum of 2 feet thick, will not be compacted, and will serve as a protective layer to the liner and drainage system. Markers will be placed along the edge of liner so that filling operations in the Class I cells do not extend outside lined areas and adequate room is left to allow for applying the final cover.

6.4. Operation and Maintenance - NAC 444.686

The operation and maintenance of the site will be in a manner which will not create odors, unsightliness or other nuisances. An unnecessarily large working face makes it more difficult to control litter, and is unsightly. The area of the working face should be the smallest area practicable while still allowing for safe and efficient operation of vehicles and equipment. Incoming wastes are unloaded as near as possible to the working face. The unloading area is adjacent to the working face to help minimize pushing distance. With the exception of inclement weather or a new transition phase, there will be only one unloading area and one working face.

Depositing waste outside the unloading area will be prohibited. Any waste mistakenly deposited outside the unloading area will be promptly removed and transported to the working face. Once deposited in the unloading area, waste will be pushed to the working face, spread and compacted on a slope no steeper than three horizontal to one vertical. In accordance with NAC 444.686 (4), waste will be spread in thin layers that do not exceed 2 feet before compaction. Bulky waste material will not be placed within 3 feet of the final surface of the slide slopes.

Equipment operators are to operate the compactor and waste moving equipment up and down the working face and fill in any holes that develop with loose waste in order to achieve good compaction. If several types of wastes are deposited in the unloading area, the equipment operator will mix the various waste types while pushing. A high degree of compaction extends the life of the landfill, reduces cover material, and reduces wind-blown litter. The equipment for compaction is appropriately sized and will make a minimum of 2 full passes over each layer of waste.

Periodic visual inspections of the visible tail of the liner will be conducted by site personnel for confirmation that no slippage has occurred

6.5. Daily Cover - NAC 444.688(1)(a)

The site has an adequate quantity of earth cover (NAC 444.678(4)) that is workable and compactable and does not contain organic material of quantity and distribution conducive to harboring and breeding disease vectors. Cover material will be obtained from cell construction activities and adjacent borrow areas where the soil material is silty, gravelly sands. The borrow areas and soil balance are shown on Drawing No. 19 of the permit application. The cover material will be clean soil, not previously mixed with waste materials or an alternate daily cover (ADC) material that has been approved by NDEP.

A minimum of six inches of cover material will be placed over exposed compacted waste at the end of each operating day to control fires, odors and blowing litter. The integrity of the cover material will be maintained until further filling is resumed or the final cover is constructed. The cover material will be routinely inspected and erosion, cracks and depressions will be repaired as soon as possible. The cover material will be graded to promote drainage of surface water with slopes of not less than three (3) percent.

6.6. Intermediate Cover - NAC 444.688(1)(d)

Intermediate cover will consist of a minimum of a 12-inch compacted soil layer and will be placed in areas that have not reached their final closure elevations. This cover will be applied whenever another lift of waste will not be placed for more than 90 days. The cover material will be spread, compacted, and graded to promote drainage of surface water with slopes of not less than three (3) percent. Also, intermediate cover will be applied to as soon as practicable to areas which exhibit erosion, cracking, or excessive settlement. The condition of the exposed intermediate cover will be evaluated by landfill personnel on a monthly basis.

6.7. Final Cover

The final cover will be applied to areas where final elevation has been attained. Final cover will be placed in accordance with the facilities approved closure plan. The condition of the final cover will be evaluated by landfill personnel on a monthly basis.

6.8. Litter Control Plan - NAC 444.684(2)(b)

Litter at the site is controlled by several measures. Vehicles transporting waste are required to have their loads adequately covered in accordance with all transportation regulations. Once the waste is unloaded in the disposal area, it is compacted by heavy equipment and covered to prevent free blowing litter. Litter control fences/berms will be located as close as practical to the active working face. The entire facility perimeter will be inspected daily and any discovered scattered litter will be returned to the working area.

Additional litter control fences may be constructed and placed in strategic locations around the working face to capture wind-blown material. The perimeter berms will also serve to capture and contain wind blow debris from the landfill. During extremely windy conditions, all activities that could lead to blowing litter will be curtailed. In accordance with NAC 444.686(2), the working face of the landfill will be restricted in width and will be as narrow as possible.

6.9. Vector Control Plan - NAC 444.6678, NAC 444.694

An effective vector control plan involves preventing vectors from living and becoming established on the landfill by not providing sources of food, water, and/or shelter. The most important measures taken at the facility to minimized vector problems is prompt placement, compaction, cover and intermediate cover of all exposed waste. Slopes will be graded to a minimum of 3% for drainage purposes to prevent ponding of water. Waste accepted at the landfill such as dead animals and other highly putrescible wastes will be placed in a separate trench or area and covered immediately.

If vectors become a nuisance, additional measures will be taken to correct the problem. These measures may include the services of a pest control contractor who will be responsible to select the appropriate control measure(s) for the specific type of vector creating the nuisance.

7. Acceptable Waste

The following section describes the types of waste that are received at the landfill.

7.1. Acceptable Wastes

- Solid waste as defined in NRS 444.490
- Special Waste as identified in this Operations Plan

7.2. Unacceptable Wastes

No hazardous waste as defined in Title 40 of the Code of Federal Regulations (40 CFR) Part 261 or materials offering an undue hazard to landfill personnel or the landfill operations will be accepted at the facility. The following are examples of unacceptable waste.

- Liquid waste as defined by NAC 444.692(4)
- Hazardous waste, as defined by NAC 444.580 & State and Federal Regulations
- Septic tank pumpings and raw sewage as defined in NAC 444.654 (2)
- PCB waste, as defined by State and Federal Regulations

8. Special Wastes - NAC 444.684(2)(c)

8.1. Sand-Oil Separator and Waste Soaked Oils (NAC 444.650)

Sand-oil separator and oil-soaked waste will be disposed in the Class I facility. These materials will be analytically sampled at a certified laboratory before they are loaded onto any trucks destined for Bedroc's Class I landfill to ensure that they do not exceed regulated hazardous constituent levels. The hauler will be responsible for the acceptance of this material and must provide documentation and manifests to operators at Bedroc before the materials can be accepted. Bedroc requires that the generator of this material provide certified analytical results that demonstrate compliance or absence of hazardous constituent levels. It is Bedroc protocol that all wastes being unloaded at the facility be screened to insure that neither hazardous waste nor PCB wastes will be deposited at the lined, Class I landfill.

8.2. Medical Waste

Wastes generated in the medical industry consist of a wide variety of materials, ranging from office paper, packaging and food wastes to sharps, chemotherapeutic and pathological wastes. These materials are referred to as Regular Medical Waste ("RMW"). Medical waste, as defined in NAC 444.589, will be accepted at the facility. This material will not be disposed of less than 4 feet from the top of the final lift. These wastes will be accepted only by approved medical waste generators that maintain the appropriate sampling and records. Per NAC 444.646 (and the fact sheet entitled "Treatment Collection and Disposal of Infectious Medical Waste"), this waste will be managed in the same manner as Class I wastes, with the exception that when this waste arrives at the facility they will be placed and covered with a layer of suitable cover material compacted to a min uniform depth of 36 inches..

RMW is defined as described in 49 CFR pt. 173, App G.

8.3. Petroleum Contaminated Soil

Bedroc will accept petroleum contaminated soil (PCS) at the Class I facility. The generator of this material is responsible to determine the characteristics of their material and will demonstrate through sampling and analysis that it is not a hazardous waste and can be disposed of at the landfill. All loads will be inspected to ensure no free liquid is present. The volume of PCS accepted at the landfill will be a maximum of 5,000 tons per calendar year.

The generator must make an initial characterization of each source of PCS prior to potential acceptance of the material. In addition, a hazardous waste determination will also be performed on each source pursuant to 40 CFR 262.11. The analysis and hazardous waste determination of each PCS source type will be performed by a laboratory certified by the State of Nevada to perform those analyses.

The facility will consider accepting Petroleum Contaminated Soils within the Landfill Disposal Area as identified in two categories as shown below.

Categories:

- Petroleum Contaminated Soils less than < 600 PPM ORO/DRO, and < 300 PPM GRO;
- Petroleum Contaminated Soils greater than > 600 PPM ORO/DRO or > 300 PPM GRO.

Permitting and Acceptance Criteria: (Reference bullets shown below).

The generator/source of the waste must submit a Non-Hazardous Waste Determination for review and screening of the soil for acceptance. The profile will identify the material source and generator, tests results, soil quantity, and other information pertaining to the soil treatability (less < than or greater > than 600/300 PPM). Only shipments accompanied by the appropriate documentation and transported in compliance with applicable regulations will be accepted at the facility. No storage of any PCS will occur at the facility.

- Petroleum Contaminated Soils Less than < 300/600 PPM:
  Petroleum contaminated soils under 600 PPM DRO and ORO and under 300 PPM GRO accompanied by the appropriate analytical testing results as described within this plan will be accepted at the facility.

- Petroleum Contaminated Soils greater than > 300/600 PPM:
  Contaminated soils over 600 parts per million (PPM) DRO or ORO or over 300 PPM GRO as described within this plan will not be accepted at the facility.

9. Waste Screening - NAC 444.6665

The Class I landfill will have the following program in place for detecting and preventing the disposal of regulated hazardous waste, PCB wastes, and other unauthorized wastes.

9.1. Waste Delivery

The scale house is located at the entrance and controls access to the facility and monitors all vehicles entering and exiting. Signs are posted at the entrance of the facility informing customers of the acceptable and unacceptable types of waste. The scale operator is responsible to visually monitor and ensure that all incoming solid waste is weighed and appropriate records are maintained. Records include the customer name, hauling company, date, time, and quantity (weight and/or volume) of all in-coming solid waste.

9.2. Pre-Screening and Inspections

Inspection of incoming loads at a minimum will consist of a visual inspection while waste is on the vehicle. In the case of closed container trucks waste may be dumped and spread at the operating face and a visual inspection made of the contents to check for unauthorized and suspect materials. Facility personnel will be trained to identify unauthorized waste, the proper steps to take if unauthorized waste is accepted, how to report the unauthorized waste, and how to conduct the proper response actions. In addition, waste unloaded on the active face is inspected by the equipment operators before and during placement and compaction. Prior to placement, salvage operations to recover recyclable material may be performed.

Incoming loads will be inspected by facility personnel on a random basis, but no less than 4 loads per month. Drivers will be directed to dump in the area of the working face, where the waste will be spread and inspected for unauthorized wastes. Documentation of these inspections will be maintained at the landfill. Facility personnel are trained and familiar with acceptable and unacceptable wastes. In most cases, unacceptable wastes will leave the landfill on the vehicle it arrived on. An exception to this procedure may occur for explosives in which the local law enforcement officials will be called.

Every effort will be made to preclude the inadvertent acceptance of unauthorized waste through pre-screening and inspections. However, in the case of inadvertent receipt of these wastes, facility personnel will take appropriate response measures. These personnel will be trained to conduct the waste inspections, identify unauthorized waste, perform appropriate response actions, and document the incidents.

9.3. Training and Procedures

The objective of the training program is to teach facility personnel to recognize, remove and report receipt of unauthorized and hazardous solid waste. All on-site personnel involved with waste acceptance and disposal activities including, but not limited to, the site manager, scale house attendant, waste spotter, and equipment operators will be trained to identify such waste and to take the correct response. Training in these procedures will take place within three months of implementing this Program, or within three months of the date of hire.

A refresher, training course will be performed annually, and will include any changes to this Program. Employees are trained to identify and exclude materials that may be considered hazardous. Documentation of the training will be maintained in the facility Operating Record, available for review by the NDEP. The following sections discuss each component of the training program.

9.4. Recognize Unauthorized Waste

A waste inspection program will be in effect at the facility to identify unauthorized waste. Every incoming waste hauler will stop at the scale house prior to proceeding to the tipping area. The scale house attendant will review waste manifests, if applicable, to verify that only acceptable waste is listed. Facility personnel will visually examine the contents of waste hauling vehicles prior to allowing them to tip, during tipping, and while spreading and compacting with waste.

Personnel will be trained to recognize wastes that are not acceptable for disposal at the facility, such as hazardous waste and PCB waste. Some indicators of unauthorized wastes include:

- Hazardous labels and/or markings
- Waste that may be contaminated with PCBs
- Batteries
- Powders, dyes, chemical odors, smoke, solvents, paints cans
- Drums or commercial-size containers,
- Containers holding free liquids and/or excessive or unusual moisture

9.5. Removal of Unauthorized Waste

Facility personnel will be trained in the proper steps to take if unauthorized waste is accepted at the facility. The training will include procedures for segregating and containing the waste. Personnel will immediately notify the Facility Manager if unauthorized waste is discovered or accepted at the facility.

When a suspicious waste or container is detected in vehicles prior to tipping or during inspections, the driver of the vehicle will be directed to leave the site. If unauthorized waste is detected after tipping, the load will not be accepted and it will be segregated from acceptable waste. If possible, the unauthorized waste will be reloaded into the vehicle that transported the waste to the site. In the event unauthorized waste is discovered, access to the area will be restricted and the situation carefully assessed. Such waste will be adequately segregated from acceptable waste, secured and contained to prevent leakage or contamination to the environment. Such wastes will be isolated from other incoming waste using mobile equipment such as a backhoe or loader, and properly contained until it can be transported off-site for disposal or treatment at an approved facility.

If the unauthorized waste cannot be segregated using equipment, the area will be isolated and fill operations moved to another location, or halted until a licensed contractor can be contacted to properly remove the unauthorized waste. In cases where manual segregation will not pose unacceptable risk to facility personnel, under the direction of the Facility Manager, personnel may selectively segregate waste manually, while exercising caution to avoid exposure or injury. Wherever possible, positive identification of the material and its source will be obtained.

If hazardous waste or PCB waste is discovered, it will be contained to prevent spills or leaks, or any contact with other materials. If the hazardous or PCB waste is already in a container, the container will be inspected for leakage, contained by another means if necessary, and segregated from acceptable waste in an area where any spills or leaks will be contained. Facility personnel NDEP shall notify NDEP if hazardous waste or PCB waste is discovered at the facility.

All employees that are handling hazardous waste or waste of questionable character are required to use protective clothing and equipment in accordance with Occupational Safety and Health Administration (OSHA) standards. The Facility

Manager will remove the unauthorized waste from the site as soon as practicable, but not to exceed 90 days after discovery. The Facility Manager will provide to the NDEP, via the operating record, a record identifying the waste and its final disposition.

9.6. Recordkeeping

Each incident of unauthorized waste refusal or acceptance will be recorded. The records will include information such as the date and time of the incident, waste type(s), generator, hauler, facility personnel involved, response actions (including records of transportation and ultimate disposition), regulatory interaction and correspondence, and other relevant documentation. All reports and resulting correspondence will be maintained at the facility or other designated location throughout the life of the facility and the post-closure care period, and will be available to NDEP for review.

10. Run-on and Run-off Control - NAC 444.6885, NAC 444.6887

These controls are described in the design report.

11. Erosion and Dust Control - NAC 444.696

Adequate water will be available at all times from an onsite well for dust control and for compaction of cover material. The landfill site has the potential for wind erosion. Since the site receives nominal amounts of rain, hydraulic erosion poses little threat to the site.

The perimeter berm will prevent overland flow of water onto the landfill. Neither run-on of water from the surrounding area, nor run-off from the landfill area is expected to be a problem due to the design of the landfill and the low frequency of precipitation events.

The design of the final cover has taken wind erosion into consideration. The final cover has been designed to have 24 inches of native material above the flexible membrane cap with native plant species in addition to native gravels and mulch produced on site (See Closure Plan). Bedroc will inspect the landfill on a quarterly basis to evaluate the integrity of the final cover. If the integrity of final cover is damaged, Bedroc will restore the lost material and reseed.

Sources of dust at the facility include the delivery of material, material handling, and material screening. Dust from incoming vehicles will be minimized by periodic wetting of roads. Incoming loads will be sprayed down before unloading if necessary. The existing gravel driveway also minimizes dust generation. A water truck is maintained onsite to provide dust control and moisture addition to the materials. Bedroc pumps water from the onsite well to the water truck, via the standpipes located strategically on the property. Facility workers will be provided OSHA-approved dust masks upon request when working in dusty conditions.

12. Odor Control - NAC 444.686(1)

The operation and maintenance of the site is in such a manner as to not create odors, unsightliness or other nuisances. While some odor is to be expected at landfills, nuisance-level odors should not be produced at a properly managed facility. Measures taking at the facility to control odor are properly covering the waste and limiting the size of the working face. Nuisance odor problems are diminished further by prevailing on-site winds and by the absence of nearby sensitive receptors (neighbors).

13. Miscellaneous Requirements and Reports - NAC 444.702

Scavenging at the Class I facility and at the working face is prohibited. The site will be inspected daily and all scattered paper and other lightweight debris returned to the fill area and covered. Bedroc will maintain records onsite documenting the weight or otherwise adequately measuring and recording all solid waste delivered to the site. Records will be kept at the site for one month and thereafter will be stored at 2745 N. Nellis Blvd. Bedroc will prepare a quarterly report detailing the type and weight of solid waste received at the site on a form prescribed by the Division. The report will be submitted to NDEP on a quarterly basis. A volumetric survey will be conducted at least once every 5 years until the site is closed and submitted to NDEP in accordance with NAC 444.702(7).

14. Operating Records

All information contained in the operating record will be furnished upon request to NDEP or be made available at all reasonable times for inspection by NDEP. These records will be kept for the life of the facility. In accordance with NAC 444.7025, the Facility will record and retain the following documentation in the operating records:

a) <u>Any demonstration of restrictions on location required by NAC 444.678 to 444.6795</u>

NAC requires that a Class I Disposal Site be located at least one-fourth mile from the nearest inhabited domestic dwelling or place of public gathering or 1,000 feet from a public highway, unless special provisions for the beautification of the site and the control of litter and vectors are included in the design and approved by the solid waste management authority.

The Class I site is located approximately 30 miles from the nearest inhabited dwelling and place of public gathering. However, because the proposed boundary of the facility falls within the 1,000 foot setback from U.S. Highway 93, the facility has prepared a beautification plan to address the activities to provide visual screening of landfill activities from the general public. This plan will be maintained in the facilities operating record and has been submitted with this application under separate cover.

b) <u>Records of inspection, training procedures and procedures for notification required by NAC 444.6665</u>

Records of inspection, training procedures and procedures for notification identified in this operating plan are maintained in the facilities operating record.

c) Results from the monitoring of gas and any remediation plans required by NAC 444.667

A plan has been prepared for the Bedroc Landfill and Waste Management Facility to address the monitoring requirement for odors and explosive gases as required by the Nevada Administrative Code, which requires the owner/operator of Class I Disposal Facilities to provide safeguards against the uncontrolled migration of decomposition gases (methane, hydrogen sulfide, carbon dioxide), collectively referred to as landfill gas, originating from the waste being disposed of at the site.

Specifically, this plan addresses means for monitoring for the presence and concentration of decomposition gases, the concentrations limits, above which will require remedial actions for the control of decomposition gases, and establishes a schedule for the submission of a Decomposition Gas Remediation Plan in the event one is required based on routine monitoring results. The gas monitoring will be maintained in the facilities operating record and has been submitted with the application under separate cover.

d) Any documentation relating to the design of the municipal solid waste landfill unit for the placement of leachate or gas condensate as required by paragraph (b) of subsection 2 of NAC 444.692

A plan has been prepared for the Bedroc Landfill and Waste Management Facility to address the requirements established in Nevada Administrative Code and provide information regarding the design and construction of the proposed Class I Disposal Facility. A drawing set has been prepared to illustrate the proposed construction and development of the facility. The proposed Class I Disposal Facility will be equipped with a synthetic liner and leachate collection system for the disposal of waste. The report of design will be maintained in the facilities operating record and has been submitted with the application under separate cover.

e) Any demonstration, certification, finding, monitoring, testing or analytical data from the program for monitoring groundwater required by NAC 444.7481 to 444.7499, inclusive;

A Groundwater Monitoring and Reporting Plan has been prepared for the proposed landfill in accordance with the groundwater monitoring requirements of the Nevada Division of Environmental Protection (NDEP), Solid Waste Regulations (SWR). The Groundwater Monitoring and Reporting Plan is a guidance document for collection and analysis of representative groundwater samples from the uppermost aquifer beneath the proposed Class I solid waste management unit, and for managing those data. The groundwater monitoring plan will be maintained in the facilities operating record and has been submitted with this application under separate cover.

f) Plans for closure and post closure and any monitoring, testing or analytical data required by NAC 444.6891 to 444.6896, inclusive; and

A plan has been prepared for the Bedroc Landfill and Waste Management Facility to address the closure and post-closure requirements as required by the Nevada Administrative Code. This plan provides a description of the final cover and the actions associated with closure of the facility, an estimate of the area and quantity of waste subject to closure, and the maintenance and monitoring activities to be performed during the post-closure period.

Any changes or modifications to the Closure Plan will be approved by NDEP prior to implementation at the facility. The Closure Plan and future modifications or additions to the plan will be maintained in the facility's operating record. The closure and post closure plan will be maintained in the facilities operating record and has been submitted with this application under separate cover.

g) Any documentation of cost estimates and financial assurance required by NAC 444.685

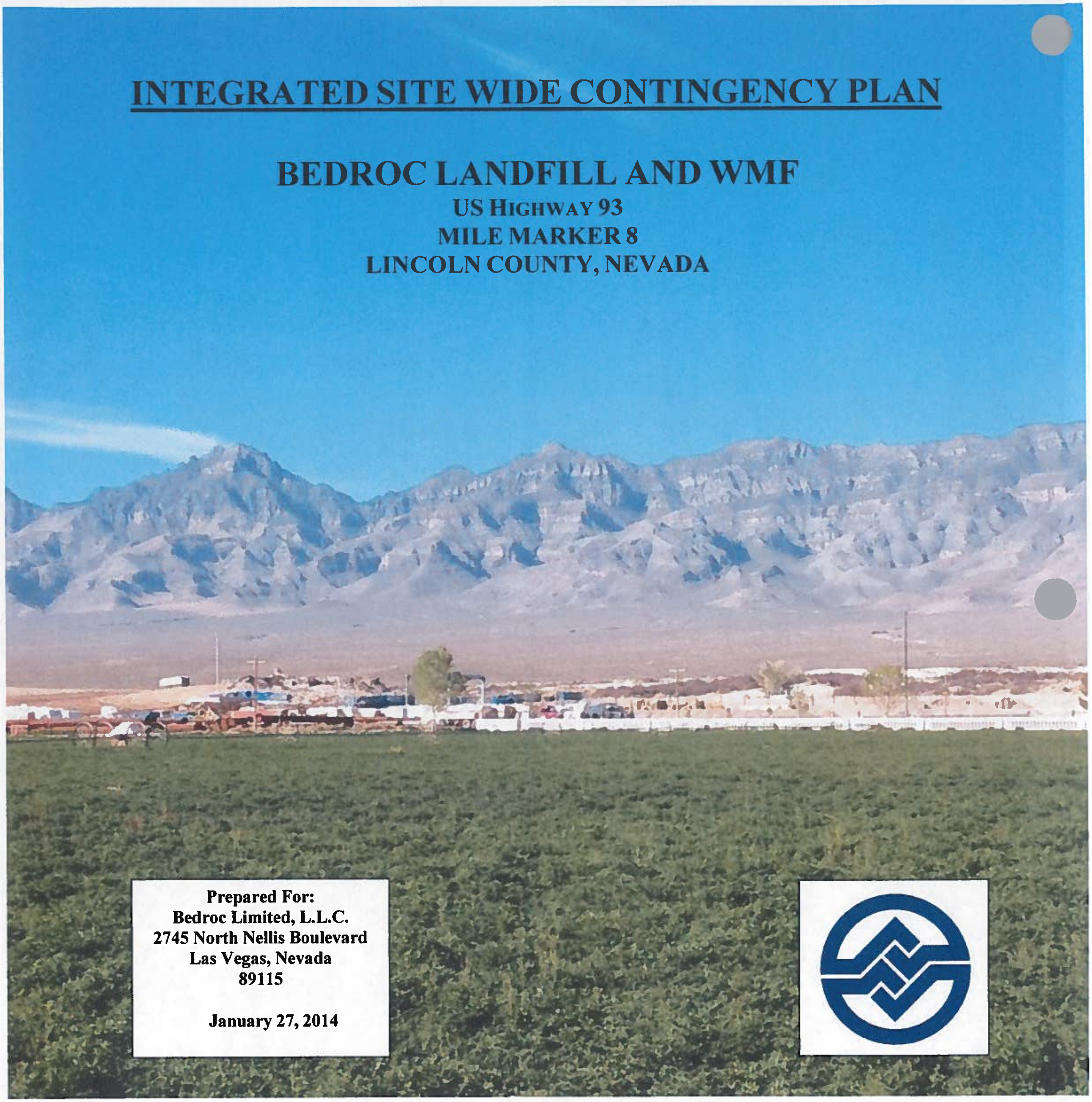
A plan has been prepared for Bedroc Landfill and Waste Management Facility to address the financial assurance requirements. This plan identifies the mechanism used to demonstrate financial assurance as well as the estimated costs for closure and post closure monitoring. The plan will be maintained in the facilities operating record and has been submitted with this application under separate cover.

Appendix C

INTEGRATED SITE WIDE CONTINGENCY PLAN

BEDROC LANDFILL AND WMF

US HIGHWAY 93
MILE MARKER 8
LINCOLN COUNTY, NEVADA



Prepared For:
Bedroc Limited, L.L.C.
2745 North Nellis Boulevard
Las Vegas, Nevada
89115

January 27, 2014

Table of Contents

REVIEW AND REVISIONS

This plan is required to be periodically reviewed and revised as necessary.

Name of person performing review	Date

1.0 INTRODUCTION

1.1 Purpose and Scope of Plan

The purpose of this Integrated Site Wide Contingency Plan (ISWCP), which was developed specifically for operations by Bedroc Limited LLC (Bedroc) at the Bedroc Landfill and WMF (Bedroc Landfill), is to assign responsibilities, mandatory safety procedures, and provide for contingencies that may arise while operations are being conducted at the site. This plan complies with, but does not replace, Federal Health and Safety Regulations as set forth in 29 CFR 1910 and 1926 and guidance established by the Nevada Division of Environmental Protection and the Nevada Division of Industrial Relations. This plan is a guidance document to be used by Bedroc staff, regulators, and visitors as a supplement to such rules and regulations. Copies of the ISWCP will be provided to employees and are available to visitors upon request.

1.2 Applicability

The provisions of the ISWCP are mandatory for all Bedroc staff and visitors engaged in activities on site which may involve health and safety hazards. The Bedroc Site Safety Officer (SSO) shall supply this ISWCP to each site subcontractor in order to fulfill Bedroc's obligation under 29 CFR 1910.120(b)(15), or State equivalent, to inform workers of site hazards. The ISWCP may be used as a guidance document by properly trained and experienced Bedroc subcontractors. However, Bedroc claims no responsibility for the use of this ISWCP by others and does not guarantee the health and safety of any person entering the site.

This ISWCP is written for the specific site conditions, purposes, and personnel specified. However, changing and/or unanticipated site conditions may require modification of this Plan in order to maintain a safe and healthful work environment. Any proposed changes to this plan should be reviewed by the Bedroc Corporate Health and Safety Officer (CHSO), or his designee, before their implementation. If this is not feasible, the SSO may modify the plan and record all changes. Under no circumstances will modifications to this plan conflict with Federal, State, or local health and safety regulations.

1.3 Recordkeeping

ISWCP Compliance Agreement: All Bedroc personnel working at the facility shall read, understand and sign the ISWCP Site Safety Compliance Agreement located in Attachment A prior to beginning work at the site.

2.0 BEDROC LANDFILL

2.1 General Facility Identification Information

The Bedroc Landfill is a Class I landfill authorized by the Nevada Division of Environmental Protection (NDEP). Prohibited wastes include hazardous waste, medical waste, polychlorinated biphenyls (PCBs), and liquids or containers with liquids.

The Bedroc Landfill is located on US Highway 93 at mile marker 8 in Lincoln County, Nevada. It is approximately 30-miles south of Alamo and 65-miles north of Las Vegas. The facility is open 24 hours per day, 365 days per year with the exception of July 4th, Thanksgiving Day, Christmas Day, and New Year's Day. The facility is approximately 140-acres in size.

2.2 Facility Name

The legal name of the facility is the Bedroc Landfill and WMF

2.3 Operator

The legal operator of the facility is Bedroc Limited LLC

The contact information for the owner is:

2745 North Nellis Boulevard
Las Vegas, NV 89115
702-369 -4242 (office phone)
702-459-3742 (fax)
Attn: Mr. Ryan Williams

2.4 Physical Address

The Bedroc Landfill is located on US Highway 93 at mile marker 8 in Lincoln County, Nevada

2.5 Mailing Address

The mailing address for the facility is:

Bedroc Limited LLC
2745 North Nellis Boulevard
Las Vegas, NV 89115
Attn: Ryan Williams

2.6 Other Identifying Information

The property's legal description is: N 1/2SE1/4; SW1/4SE1/4; NE1/4; E1/2W1/2 Lincoln County, Nevada.

APN: 008-201-13

3.0 KEY CONTACTS FOR ISWCP DEVELOPMENT AND MAINTENANCE

Operator:
Ryan Williams
Bedroc Limited LLC
2745 N. Nellis Boulevard
Las Vegas, NV 89115
702-250-3045 (office phone)
702-459-3742 (facsimile)

Consultant:
Douglas Bell, C.E.M.
Converse Consultants
731 Pilot Road, Suite H
Las Vegas, NV 89119-4429
702-376-2908 (office phone)
702-269-8353 (facsimile)

Facility:
Ron Williams (Landfill Supervisor)
Bedroc Landfill and WMF
US Highway 93, Mile Marker 8
Lincoln County, NV
702-250-8328 (office phone)
775-725-3509 (scale house)

4.0 FACILITY

4.1 Site History

The Bedroc Landfill is adjacent to the Western Elite Class III facility which was opened in 2006. The facility is located on US Highway 93 at mile marker 8 in Lincoln County, Nevada. The facility is approximately 140-acres in size. It is approximately 30-miles south of Alamo and 65-miles north of Las Vegas. It is open 24 hours per day 365 days per year with the exception of July 4th, Thanksgiving Day, Christmas Day, and New Year's Day.

4.2 Map & Descriptions

A facility map (Drawing No. 1B) which identifies the facility's layout and features including roads, buildings, chemical storage areas, and equipment storage areas is provided in Appendix A.

4.3 Photos

Photographs of the facility features have been provided in Appendix B.

4.4 Entrance Signage

Hazardous materials may also be inadvertently delivered to the landfill by customers. Signs are posted at the entrance of the facility which will inform customers and visitors of what materials are accepted and prohibited for disposal at the landfill. A copy of the landfill entrance signage is provided in Appendix C.

4.5 Accepted Wastes

The Bedroc Landfill accepts the following solid wastes:

- Municipal Solid Waste (MSW)

4.6 Prohibited Wastes

The Bedroc Landfill does not accept the following wastes:

- Hazardous Waste
- Medical Waste
- Polychlorinated Biphenyls (PCBs)
- Liquids Wastes
- Containers with Liquids (drums, pails, etc.)
- Explosives

Every effort will be made by Bedroc staff to preclude the acceptance of prohibited waste through the pre-screening process. However, in the event that prohibited wastes are inadvertently received, Bedroc staff will take the following measures:

- The Landfill Manager will be immediately notified.
- A visual inspection of the material/containers and labels will commence.
- Drums or other liquid containers will be checked for leaks.
- If no leaks are detected, the container will be removed from the working face under the supervision of the Landfill Manager and placed onto a secondary containment system.
- Containers which are observed to be leaking will be removed from the working face as quickly as possible using a wheel loader so that the contents of the container will drain into the bucket. The container should remain in the bucket until proper characterization can be performed.
- Waste which has been impacted by an unknown liquid should be removed from the working face and staged on visqueen sheeting (or another impermeable layer) on the lined area of the landfill until proper characterization can be performed.

- All incoming waste should be directed to an alternate area of the working face for tipping in the event that additional characterization and waste removal is deemed necessary.
- Bedroc will contact its environmental consultant so that a proper characterization can be performed.
- Bedroc will also contact the NDEP within 24-hours and provide the following information:
    - Name of the facility.
    - Type of prohibited waste (if known).
    - Location of the prohibited waste.
    - Condition of prohibited waste.
    - Corrective actions which are underway.

4.7 Presumed Explosives

In the event that explosives, presumed or otherwise, are encountered on the working face, the material will be cordoned off with caution tape and the Lincoln County Sherriff will be notified immediately. The landfill will also be shut down in accordance with the procedures outlined in Sections 13.7 and 13.8.

In the event that explosives, presumed or otherwise, are encountered in a vehicle during pre-screening, the Lincoln County Sheriff will be notified immediately and the vehicle operator will be informed of the situation and asked to stand by. The vehicle license plate and make/model will also be recorded in the event that the operator elects to leave the site.

4.8 Load Rejection

Each incident of load rejection will be recorded on a load rejection form which will be completed by the scale house attendant and reviewed by the Landfill Manager. The form will include the following information:

- The date and time of the incident.
- The waste type (if known).

- The generator (if known).
- The hauler (if known).
- Facility staff which are involved.
- Response/corrective action taken.
- Regulator(s) notified.
- Any other pertinent information.

Completed load rejection forms and other relevant information pertaining to the incident will be maintained at the scale house and will be available to regulators for review. Copies of "clean" load rejection forms are provided in Appendix D.

4.9 Accidental Acceptance

In the event of accidental acceptance of prohibited waste, an accidental acceptance form will be filled out by the Landfill Manager. The report will include the following information:

- The date and time the waste was discovered
- The waste type (if known)
- The waste generator (if known)
- The hauler (if known)
- Facility staff which are involved
- Response/corrective action taken
- Regulator(s) notified
- Any other pertinent information

Copies of completed accidental acceptance forms and other relevant information pertaining to the incident will be maintained at the scale house and will be available to regulators for review. Copies of "clean" accidental acceptance forms have been provided in Appendix E.

Bedroc anticipates that prohibited wastes will be discovered during the pre-screening process and will leave the landfill on the vehicle it arrived on with the exception of presumed explosives.

5.0 EMERGENCY CONTACTS/NOTIFICATION NUMBERS

The following is a listing of emergency contacts for landfill personnel, emergency response personnel, and regulatory authorities related to the Bedroc Landfill. This list is also posted in the storage building and the scale house.

Facility Manager
Ryan Williams
702-250-3045 (cellular phone)
702-459-3742 (facsimile)

Landfill Supervisor
Ron Williams
702-250-8328 (cellular phone)
702-459-3742 (facsimile)

Scale House
775-725-3509 (land line)

Lincoln County Sheriff
702-725-3375

Lincoln County Fire Department (Volunteer)
Alamo Substation
775-725-3375

Fire, Police, Ambulance
911

Nevada Division of Environmental Protection
775-687-4670 (land line)
775-687-5856 (facsimile)

6.0 HEALTH AND SAFETY PLANNING

6.1 Site Specific Health and Safety Personnel

Title	Name	Phone
Site Safety Officer	Ron Williams	(702) 250-8328
Corporate Health & Safety Officer	Ryan Williams	(702) 250-3045
Corporate Compliance Officer	Sonny Boeckman	(702) 498-3945

6.1.1 Site Safety Officer (SSO)

The SSO, who is also the Landfill Supervisor, shall direct on-site operations on a day to day basis. The SSO may delegate all or part of these duties to a properly qualified Bedroc employee. The primary responsibilities of the SSO will be:

1. Implement the ISWCP and report any deviations from anticipated conditions to the CHSO.
2. Ensure that Bedroc staff and visitors are aware of the provisions of this ISWCP, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies.
3. Ensure that Bedroc staff and visitors are aware of the potential hazards associated with site operations.
4. Monitoring the safety performance of all Bedroc staff to see that the required work practices are employed.
5. Correct any work practices or conditions that may result in injury.
6. Preparation of any accident/incident reports.
7. Halting site operations, if necessary, in case of an emergency or to correct unsafe work practices.
8. Review and approval of this ISWCP.
9. Conducts weekly safety meetings and completes the Site Safety Briefing Report (see Attachment B).
10. Assumes any other duties as assigned by the CHSO.

6.1.2 Corporate Health and Safety Officer (CHSO)

The CHSO shall:

1. Determine the need for periodic audits of the Bedroc operation to evaluate compliance with this ISWCP.
2. Provide health and safety support as requested by the SSO.

6.1.3 Corporate Compliance Officer (CCO)

The CCO shall:

1. Perform periodic audits of the Bedroc operation as directed by the CHSO.
2. Report audit results to the CHSO.

6.2 Site Personnel

Title	Name	Phone
Facility Manager (1)	Ryan Williams	(702) 250-3045
Landfill Supervisor (1)	Ron Williams	(702) 250-8328
Scale House Attendant (1)	Dawn Wade	(775) 725-3509
Heavy Equipment Operator (1)	Sergio Carillo	(775) 493-0479
Laborers (5)	N.A.	N.A.

Following are job descriptions for each staff member located at the Bedroc Landfill:

6.2.1 Facility Manager – Is responsible for managing the facility in accordance with applicable regulations and is responsible for the implementation of this ISWCP.

6.2.2 Landfill Supervisor – Opens and closes the landfill, supervises and coordinates the work of the landfill staff. Supervises improvements to the landfill and ensures that the landfill is developed in accordance with the master development plan. Responsible for the safe and efficient operation of the landfill

6.2.3 Heavy Equipment Operator – Operates and maintains heavy equipment and other site related disposal equipment. Manages the placement of MSW on the working face of the landfill and maximizes the use of the disposal space. Also responsible for performing periodic load inspections on incoming vehicles

6.2.4 Scale House Attendant – Operates scales and ensures that all incoming vehicles are Weighed or measured. Generates Weight tickets and purchase receipts. Performs load inspections of incoming waste and directs customers to the working face of the landfill. Will also remind customers to follow safety signage while on-site, including speed limit signs.

6.2.5 Laborers – May direct customers to the working face of the landfill and can assist customers with off-loading. May also perform maintenance related tasks on the landfill.

Site personnel involved in day to day operations at the landfill are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.
2. Performing only those tasks that they believe they can do safely and immediately reporting any accidents and/or unsafe conditions to the SSO.
3. Implementing the procedures set forth in the ISWCP and reporting any deviations from the procedures described in the ISWCP to the SSO.
4. Notifying the SSO of any special medical problems (i.e., allergies) and seeing that all on-site personnel are aware of any such problems.
5. Review ISWCP and signing acceptance form.

6.3 Visitors

All visitors to the Bedroc Landfill are required to sign-in at the scale house prior to entering the site. Visitors include anyone who is not considered full or part time staff at the Bedroc Landfill. This can include: haulers, regulators, contractors, and consultants. Sign in information will include; name, company represented, site entry time, site exit time, area of the landfill to be visited, and cellular phone number, if available. A copy of the Visitors Log is provided in Appendix F. Bedroc and its staff, reserve the right to deny any individual access to the facility at any time.

To protect site visitors from any adverse health effects that may result from site activities, all visitors will be required to follow the rules as set forth in this ISWCP. These rules include the following:

1. Only previously approved official visitors with a need to be at the site will be permitted on site.
2. Visitors will be advised to prearrange their visit with the SSO or CHSO.
3. Upon arrival, the SSO or his designee will instruct the visitor(s) concerning specific site hazards and the safety precautions in effect.
4. Each visitor will be required to be aware of this ISWCP and will need to provide any necessary PPE for his/her own use during the visit.

7.0 SITE RELATED HAZARDS

7.1 Chemical Hazards

The following chemicals are used for operations and maintenance purposes on the Bedroc Landfill and are stored in the vicinity of the Maintenance Building. Storage locations for these chemicals are identified on Plate 1 in Appendix G. Material Safety Data Sheets (also referred to as Safety Data Sheets) for the chemicals listed below, are also provided in Appendix H.

- Unleaded Gasoline
- Diesel Fuel
- Hydraulic Oil
- Engine Oil
- Used Oil
- Transmission Fluid
- Antifreeze
- Brake Cleaner
- Starting Fluid
- No. 2 Grease
- Marvel Mystery Oil
- Leachate

Hazardous Substance	Source	Potential Health Hazards
Unleaded Gasoline	8,000 gallon AST	Contains benzene which may cause cancer. Contains ethyl benzene and naphthalene which can also cause cancer. Product is a skin, eye, and lung irritant.
Diesel Fuel	10,000 gallon AST	Contains naphthalene which can cause cancer. Is a skin, eye, and lung irritant.
Hydraulic Oil	300 gallon AST	Product is highly refined mineral oil and is not expected to cause skin, eye, or lung irritation. If injected under the skin, seek immediate medical attention.

Hazardous Substance	Source	Potential Health Hazards
Engine Oil (30W)	300 gallon AST	Product is not expected to cause skin or lung irritation. If contact with eyes occurs, flush with fresh water.
Used Oil (30W)	300 gallon AST	Product is not expected to cause skin or lung irritation. If contact with eyes occurs, flush with fresh water.
Transmission Fluid (ATF)	1 x 55-gallon drum	Not expected to cause prolonged or significant eye or skin irritation. If contact occurs, flush with fresh water. Product is not expected to be harmful if ingested or inhaled.
Antifreeze	1 x 55-gallon drum	Contains ethylene glycol, which is harmful or fatal if ingested. Over exposure by inhalation may cause respiratory irritation, headaches, dizziness, and nausea. Also causes skin and eye irritation.
Brake Cleaner	<5 gallons	Product is a moderate eye and skin irritant. Inhalation may cause CNS excitation followed by CNS depression. Ingestion may have harmful or even fatal effects.
Starting Fluid	<5 gallons	Prolonged skin exposure may cause serious burns. Eye contact may cause blindness. Product is an aspiration hazard. Inhalation of vapors may cause loss of consciousness.
No.2 Grease	<5 gallons	Product contains a petroleum based mineral oil and is not expected to cause skin, eye, or lung irritation with short term use. If injected under the skin, seek immediate medical attention
Marvel Mystery Oil	<5 gallons	Product may cause moderate skin irritation. Can cause severe eye irritation. Inhalation can cause nasal and respiratory irritation, unconsciousness, and even asphyxiation. Ingestion can also be fatal.

7.1.1 Leachate

Unlike the maintenance related chemicals listed in Section 7.1.1, leachate is a byproduct of landfill operation. Leachate is presently not produced at the Bedroc Landfill; however, in the event leachate is generated, a brief discussion is provided below.

Decomposition of organic material/MSW in landfills can produce liquid byproducts commonly referred to as “leachate”. As leachate is created in a landfill, it migrates to the bottom of the landfill (via gravity) where it encounters the landfill liner system. Leachate then migrates to the leachate collection and recovery system (LCRS), also referred to as the leachate sump.

Visual indicators of a leachate release may include soil staining or standing liquid along the edge of the liner in the vicinity of the leachate sump. Leachate has a foul or rotten odor which can be an additional indicator that a leachate release has occurred. If visual or olfactory indicators of a leachate release are observed, the Landfill Supervisor is to be notified immediately so that leachate removal from the LCRS can be expedited. Leachate should not be ingested or inhaled. If staff or visitors accidentally come into contact with leachate, they should proceed to the storage building and thoroughly wash the exposed area of skin with warm water and soap. Emergency shower and eyewash stations are also available on site. A site map depicting the shower and eyewash locations is provided on the facility map in Appendix A.

7.1.2 Chemical Releases

Chemical releases could occur at the landfill in the form of maintenance lubricants and fuels (hydrocarbons) for facility vehicles. Lubricants and fuels are centrally located in the facility away from property boundaries. Based on the quantities of hydrocarbons maintained at the landfill, even a catastrophic chemical release would remain onsite. In the event that a hydrocarbon release did occur at the landfill, Bedroc staff would absorb the released material using soil from the barrow area, then place the impacted material into the landfill. Bedroc would also notify the NDEP (and other public agencies as required) in the event of a release of a reportable quantity.

Chemical hazards for the landfill are discussed in detail in sections 8.0 and 9.1 of the ISWCP.

7.2 Physical Hazards

Based on the nature of the site and its geographic location, the following physical hazards are present at the Bedroc Landfill. Each hazard is explained and control/response measures are defined:

- Fire
- Heavy Equipment
- Noise
- Slip, Trip, and Fall Hazards
- Heat Stress
- Hypothermia
- Lifting Hazards
- Open Excavations
- Natural Disasters
- Venomous Animals

7.2.1 Heavy Equipment

The primary physical hazard to landfill personnel and visitors at this site is haul trucks and heavy equipment. Heavy equipment includes dozers, compactors, and loaders. Haul trucks are entering the site, transporting waste to the working face of the landfill, and then exiting the site frequently. Truck drivers must follow predetermined routes to and from the working face of the landfill and must obey posted speed limits to avoid conflicts with pedestrians or smaller vehicles. Landfill laborers and other site occupants must be cognizant of approaching haul trucks and their travel patterns.

Heavy equipment spend the majority of their time on the working face of the landfill, but may also be found through the site, including the maintenance shop. All heavy equipment are equipped with OSHA backup sirens/alarms and side view and rear view mirrors. Heavy equipment operators must be cognizant of the locations of pedestrians and other vehicles at all times and obey posted speed limits. All site occupants, including vehicle operators, are required to wear fluorescent safety vests.

The operation of heavy equipment on site presents potential physical hazards to personnel. The following precautions should be observed whenever heavy equipment is in use:

- Personal protective equipment (PPE) such as steel-toed shoes, safety glasses (or goggles), and fluorescent safety vests should be worn at all times.
- Personnel should at all times be aware of the location and operation of heavy equipment and take precautions to avoid potential conflicts. Never assume that the equipment operator sees you; make eye contact and use hand signals to inform the operator of your intent.
- Fluorescent traffic safety vests are required for personnel working near mobile heavy equipment, such as loaders.
- Never walk directly behind, or to the side of, heavy equipment without the operator's knowledge.

- When an equipment operator must operate in tight quarters, BEDROC will provide a person to assist in guiding the operator's movements.
- Keep all non-essential personnel out of the working area.

7.2.2 Fire

Fire hazards exist at the Bedroc Landfill from maintenance activities using cutting torches. Fires may also start on the landfill from reactive materials or from flammable greenhouse gases which are produced by the landfill.

Should a fire occur on the landfill's surface or in any of the landfills structures, Bedroc staff will only fight incipient stage fires. Incipient stage fires are fires which are in their initial or beginning stages and can be controlled with hand held fire extinguishers or small hose systems. Hand held ABC fire extinguishers are located in the scale house, the storage building, and are located on each piece of equipment and each company vehicle. A 3,000 gallon water truck and a 4 cubic yard wheel loader are also present on site and can be used for fire suppression activities.

In the event that smoldering material or flames are observed on the working face of the landfill, the Landfill Supervisor will be notified immediately. The heavy equipment operator will use the wheel loader to remove the smoldering/burning material and transport it to an isolated area where it will be placed on the ground and then smothered with dirt. The 3,000 gallon water truck can also be used to saturate the material. A clean stock pile of soil is maintained on site for firefighting purposes. Water sources for the site include an on-site well and an approximate 1-acre pond. Once the fire has been extinguished, Bedroc staff will monitor the area for "flare-ups" for a period of 1- hour.

In the event that the fire cannot be controlled using the methods described above, the Alamo Fire Department will be summoned and Bedroc staff will stand down. All fires will be reported to the NDEP within 24-hours.

Welding activities are also performed on equipment on site. Welding activities typically take place in the vicinity of the maintenance building but may occur anywhere on site dependent upon need. To mitigate fire risks associated with welding activities, Bedroc has the following fire control guidelines for staff and visitors:

- Before any flame-producing devices, i.e., cutting torches or welding irons, are used, detailed inspection of the work area will be conducted to determine if potential fire sources exist.
- Training is provided to employees by the SSO, including how and when to use the equipment and evacuation drills.
- Any potential fire sources which are identified must be moved at least 35 feet away before work can commence.
- Two full 20 pound ABC fire extinguishers must be located at the work area when cutting/welding is being conducted.
- Upon completion of the cutting/welding activities, the area will be inspected for hot metal, slag, etc.

In the event that a fire does occur at the Bedroc Landfill, the scale attendant will close the gates to the facility and alert all inbound loads that the facility has been temporarily shut down. Inbound carriers will be advised to use alternate dump locations including the Discount Dumpsters Material Recovery Facility or the Apex Regional Landfill, if practical. Inbound carriers may choose to stage outside of the Bedroc Landfill and wait for the facility to reopen.

7.2.3 Noise

The primary noise hazard at this site is from heavy equipment. Previous surveys indicate that heavy equipment may produce continuous and impact noise at or above the OSHA action level of 85 dBA. All Bedroc staff within 25 feet of operating equipment shall wear hearing protective devices (either muffs or plugs). Hearing protection for landfill staff will be provided by Bedroc at the maintenance building.

Visitors will be required to stay at least 25-feet away from heavy equipment. Subcontractors are required to provide their own hearing protection.

7.2.4 Slip, Trip, and Fall Hazards

Slip, trip, and fall hazards may be encountered throughout the site but are most prevalent on the working face of the landfill. The heavy equipment operator and laborers should be constantly on guard to avoid uneven surfaces and trip hazards from debris located on the working face. Bedroc workers and visitors are required to wear long pants, shirts, work boots, and fluorescent safety vests while onsite and on the working face.

7.2.5 Heat Stress

Given the location of the landfill in the desert of southern Nevada, Bedroc workers and visitors are at risk of encountering this hazard. This hazard is mainly encountered during the summer months of June through September; however, this can vary. The effects of heat stress can range from transient heat fatigue, cramps, and/or exhaustion, to heat stroke which may cause serious illness or death. A number of other interacting factors, including clothing, workload, and individual characteristics of the worker, may contribute to heat stress. Bedroc provides workers and visitors with drinking stations which are located at the scale house. These locations are also air conditioned and can be used for break periods and cool down sessions. Bedroc also recommends that light colored clothing and large brimmed hats be worn while working outdoors.

7.2.6 Cold Stress

Temperatures in the southern Nevada desert can reach freezing during the winter months of November through March. This can create an environment for cold stress hazards, especially for Bedroc laborers. Cold stress, also known as hypothermia, is a condition in which core body temperature drops. Characteristics can include shivering and confusion. Factors contributing to cold stress can also include clothing, wind-chill, and individual characteristics. Bedroc recommends that warm clothing including head cover and gloves be worn during periods of cold or inclement weather. The scale house and maintenance building are heated and can be used for period breaks during periods of cold.

7.2.7 Lifting Hazards

Lifting hazards are most often associated with back injuries due to improper lifting of heavy objects; however, lifting hazards can also be encountered when lifting lighter objects. Lifting large and light objects can be cumbersome and present lifting hazards as well. Bedroc laborers and the heavy equipment operator may be exposed to this hazard during their day-to-day responsibilities. When lifting any objects, staff should ask for assistance and should always remember to keep their backs straight and lift with their legs. Lower back support/lifting belts will be provided to Bedroc employees upon request.

7.2.8 Open Excavations

Site excavation may periodically be performed at the Bedroc Landfill which will create fall hazards and confined space hazards. Bedroc does not allow their employees to enter confined spaces and does not have a confined space policy. In the event that confined space work becomes necessary onsite, Bedroc will subcontract this work to a qualified contractor.

7.2.9 Natural Disasters

Natural disasters, although infrequent, do occur and may include: earthquakes, hurricanes, tornados, floods, fires, and periods of civil unrest. In the event that one of these situations occurs, landfill staff will cease operations and the landfill will commence temporary shutdown of the landfill. Procedures for shutdown of the landfill are covered in Sections 13.7 and 13.8 of the ISWCP.

7.2.10 Venomous Animals

The Bedroc Landfill is located in the high desert of Lincoln County, Nevada. Several species of venomous snakes and insects are indigenous to this area of the state. During the summer months insects and snakes are largely nocturnal and will seek shelter beneath debris piles, vehicles, behind rocks, or any other shaded area. During the spring and fall these creatures will become more visible during the day. In order to avoid conflicts with snakes and insects, Bedroc staff and visitors are advised to do the following while working on the site:

- Be attentive when moving tools, debris or other objects that are lying on the ground.
- Avoid placing your hands in crevices and cracks, or behind objects where you cannot see.
- Be attentive for indications that snakes or insects are nearby (e.g., rattling, buzzing, or hissing)

In the event that a Bedroc staff member or a visitor does have an encounter with a snake or insect, they should report it to the SSO immediately.

8.0 HAZARD COMMUNICATION

Chemicals that are considered hazardous under the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard may be used on site during equipment maintenance and fueling. This ISWCP is intended to comply with the requirements of OSHA 1910.1200 by classifying potentially hazardous chemicals located on-site and communicating hazards and appropriate protective measures to employees.

Listed below are hazardous materials which could be encountered on site by employees. The MSDSs for the materials listed below are included in Appendix H. The SSO will make copies of these MSDSs available to any employee, subcontractor or site visitor upon request.

- Unleaded Gas
- Diesel Fuel
- Hydraulic Oil
- Engine Oil (30W)
- Transmission Fluid
- Antifreeze
- Brake Cleaner
- Starting Fluid
- No.2 Grease
- Marvel Mystery Oil

Chemical containers located on-site are labeled in accordance with the hazard communication standard and MSDSs are kept on file. New chemicals that arrive on-site will not be accepted from vendors unless accompanied by an MSDS. Employees will be periodically trained regarding the hazards associated with on-site chemicals during Bedroc weekly safety briefings.

9.0 JOB HAZARD ANALYSIS

The chemicals that staff will most likely encounter during day to day operations are unleaded gasoline and diesel fuel. The most hazardous constituents of these materials include benzene, toluene, ethylbenzene, and xylenes which may be encountered while fueling vehicles (unleaded gasoline exposure).

Physical hazards at this work site include those associated with:

- Moving vehicles and equipment
- Fire
- Noise
- Slips, trips, and falls
- Heat stress
- Cold stress
- Lifting related injuries

9.1 Chemical Hazards on Site

From an occupational safety and health standpoint, given that any potential exposure to site personnel will be only for short periods of time and likely limited to the heavy equipment operator and laborers, the levels of contaminants that may potentially be encountered during day to day activities while on site should not represent a significant concern.

Bedroc has provided an overview of the regulatory limits and guidelines as listed below.

PEL - Permissible Exposure Limit
C - Ceiling
TLV - Threshold Limit Value
TLV-STEL - Short Term Exposure Limit

OSHA Permissible Exposure Limits (PELs) and ACGIH Threshold Limit Values (TLVs), Time Weighted Averages (TWAs) are defined as concentrations for an 8-hour work day, 40-hour work week to which almost all workers can be repeatedly exposed without suffering adverse health effects.

Short Term Exposure Limit (STEL) is defined as the concentration to which workers can be exposed for short time periods without irritation, tissue damage, or narcosis sufficient to likely cause impairment of self-rescue or precipitate accidental injury. The STEL is a 15-minute time-weighted average that should not be exceeded at any time during the workday.

A ceiling value (C) is a concentration that should not be exceeded at any time in any workday.

Overviews of the hazards associated with exposure to the chemicals found on-site and listed in Section 8.0 are listed below.

Gasoline

*PEL =   TLV = 300 ppm   TLV/STEL = 500 ppm

*There is currently no PEL for gasoline

Gasoline is an eye and throat irritant at levels around the PEL, and causes narcotic effects (with symptoms including headache, nausea, dizziness, and blurred vision) at higher levels. Long term exposure can affect liver and kidney function. Some studies indicate a potential for gasoline to be an animal carcinogen, but this has not been fully established. Because gasoline is a mixture of varying proportions of dozens of hydrocarbons, a mean odor threshold has not been determined.

Benzene

PEL = 1 ppm   PEL/STEL = 5 ppm   TLV = 0.5 ppm   TLV/STEL = 2.5 ppm

Benzene is a central nervous system depressant. Symptoms include headache, nausea, tremors, and fatigue, but these typically do not occur until exposure concentrations are in excess of 150 ppm. There is significant evidence that chronic exposures are carcinogenic causing a progressively malignant disease of the blood-forming organs (leukemia). Benzene is poorly absorbed through intact skin, but contact with liquid benzene may cause blistering and dermatitis. Benzene vapors can cause transient eye irritation. The mean air odor threshold for benzene is 34 ppm, which yields unsatisfactory warning properties. Benzene's ionization potential (IP) is 9.25 eV.

Toluene

PEL/TLV = 50 ppm STEL = 500 ppm

Toluene is a central nervous system depressant. Symptoms include headache, nausea, dizziness, and fatigue; however, such symptoms typically do not occur at exposures below 200 ppm. Repeated and prolonged contact with liquid toluene may cause drying of the skin and dermatitis. Mild, transitory eye irritation may be experienced with exposure to vapors above 200 ppm. Toluene is not considered carcinogenic. ACGIH has proposed to lower the TLV to 50 ppm. Toluene's mean odor threshold is 3 ppm, which gives it good warning properties. Toluene's ionization potential (IP) is 8.82 eV and its vapor pressure is 22 mm Hg.

Ethylbenzene

PEL/TLV = 100 ppm STEL = 125 ppm

Ethylbenzene is an eye and mucous membrane irritant at levels well above the TLV. Liquid ethyl benzene is a significant skin irritant, and can cause defatting and blistering with repeated exposures. Vapor can cause transitory eye irritation at concentrations above 200 ppm. Ethylbenzene is not considered carcinogenic. The mean odor threshold is 0.5 ppm, which gives it good warning properties. Ethylbenzene's ionization potential is 8.76 eV, and its vapor pressure is 10 torr.

Xylene (o-, m-, p-isomers)

PEL/TLV = 100 ppm STEL = 150 ppm

Xylene is an eye, nose, and throat irritant at concentrations nearing 200 ppm. At higher concentrations, it is a central nervous system depressant, with symptoms including nausea, fatigue, and headaches. Liquid xylene acts on the skin as an irritant and can cause dermatitis. Exposure to vapor can cause eye irritation. Xylene is not considered carcinogenic. Xylene's mean odor threshold is 1 ppm, which gives it good warning properties. The ionization potential for the Xylene isomers are 8.56, 8.56, and 8.44 eV, respectively, and the vapor pressures range from 7 to 9 mm Hg.

Diesel Fuel (No.2))

*PEL = TLV = TLV/STEL =

*There is currently no PEL, TLV, or TLV for diesel fuel

Diesel fuel is mildly toxic by ingestion. When inhaled, many of the constituents function as central nervous system depressants, with characteristic symptoms (headaches, nausea, dizziness, uncoordinated, and vomiting). Diesel fuel has been shown to be a strong skin irritant.

Few chronic inhalation or ingestion studies of the toxic effects of diesel vapors/fuels are available. Skin painting studies of experimental animals suggest the potential for weak tumor-producing activity.

Because diesel fuel is a complex mixture of varying proportions of hydrocarbons, a mean odor threshold has not been determined.

10.0 EXPOSURE MONITORING

Heat stress, cold stress and noise, may be reasonably anticipated to be encountered on site. Chemical exposures are not anticipated since vehicle fueling and maintenance are only performed in very limited amounts. The landfill surface is not considered a chemically hazardous environment. Heat stress monitoring will not be performed since Bedroc staff will work as described in Section 7.2.5. Noise levels will also not be monitored because Bedroc staff will wear hearing protection as described in Section 7.2.3. Explosive and oxygen deficient atmospheres will also not be encountered since confined spaces are not present on site.

10.1 Special OSHA Regulated Substances

If there is a reasonable expectation that the action level for any special OSHA regulated substances (e.g., benzene, asbestos, lead, beryllium, formaldehyde, etc.) are exceeded on-site, then the CHSO should be contacted to arrange for personal air monitoring of employees potentially exposed to such materials.

10.2 Personal Protective Equipment

Minimum Level "D" personal protective equipment (PPE) will be required for Bedroc staff. Level "D" PPE will include:

- Fluorescent safety vests
- Steel-toed boots
- Hearing protection within 25 feet of heavy equipment operation
- Hard hats (optional)
- Safety glasses (optional)
- Cotton coveralls (optional)

10.3 Limitations of Protective Clothing

The PPE listed in Section 10.2 was selected to protect against the physical site hazards discussed in Section 7.2 and limited chemical exposure which is anticipated at the site. Respiratory protection will not be necessary for Bedroc staff.

In order to obtain optimum usage from PPE, the following procedures are to be followed by all Bedroc staff and visitors:

- Hardhats should be inspected for cracks and damaged cradles. Replace hardhats as necessary.
- Hardhats have expiration dates. Expired hardhats should be retired promptly.
- Fluorescent safety vests fade with age. Buckles and zippers break. Replace as necessary.
- Steel toed leather boots should be inspected for cracking and sole damage. Replace as necessary.
- Safety glasses should be replaced when lenses become scratched and impair vision.
- Cotton coveralls should be inspected for rips and tears. Replace as necessary.
- Inspect all PPE prior to and during each work shift. Replace as necessary.

11.0 GENERAL

11.1 Site Control

All entry to and exit from the Bedroc Landfill will be regulated through the front entrance on US Highway 93 and the scale house attendant.

The scale house attendant will ensure that all site visitors sign the visitors log. The SSO will provide site hazard and emergency action information to all site visitors before they enter the site and provide copies of the ISWCP upon request.

11.2 Sanitation

Potable water will be made available at the site, either from a pressurized source or commercially available bottled water. Drinking cups will be supplied so personnel will neither drink directly from the source of water nor have to share drinking cups. Sources of non-potable water shall be clearly labeled as such.

Toilet facilities are available on site in the maintenance building for Bedroc staff and visitors and their locations are identified on Drawing 1B which is provided in Appendix A.

Washing facilities will be provided on site in the maintenance building adjacent to the toilet facilities. Soap, clean water, wash basins, and single-use towels will be available for personnel use.

11.3 Equipment

Bedroc utilizes a Caterpillar wheel loader, dozer, compactor for day to day activities on the landfill. Heavy equipment is maintained and in most instances serviced by Bedroc staff onsite. In the event that a piece of equipment is unavailable for service for an extended period of time, Bedroc will make arrangements to rent equipment, until

Bedroc's equipment has been repaired. Equipment will likely be rented from a company located in Las Vegas, such as Ahern or Neff.

12.0 SAFE WORK PRACTICES

12.1 General

1. Eating, drinking, chewing gum or tobacco, and smoking are prohibited in the maintenance building. Smoking is prohibited in proximity to the chemical storage containers and compressed gas storage supplies.
2. Personnel will wash their hands and face thoroughly with soap and water prior to taking breaks and/or eating, drinking or smoking.
3. All field crew members should stay alert and use of their senses to alert them to potentially dangerous situations in which they should not become involved (i.e., moving vehicles, smoldering materials, presence of chemical fumes, irritating odors, trip hazards).
4. Only those vehicles, equipment, and personnel required to complete work tasks should be permitted in a work area.
5. Containers, such as drums or gas cylinders, will be moved only with the proper equipment and will be secured to prevent dropping or loss of control during transport.
6. Matches, lighters, welding equipment and other ignition sources will not be permitted on the working face of the landfill or in proximity to chemical storage containers.
7. Personal protective equipment will be inspected daily and replaced as necessary.
8. When handling onsite maintenance chemicals, prevent, to the extent possible, spillages. In the event that a spillage occurs, contain liquids as soon as possible.
9. Prevent splashing of onsite maintenance chemicals.
10. Personnel are to immediately notify the SSO (Landfill Manager) in the event that unusual site conditions or unauthorized visitors are observed.

13.0 EMERGENCY RESPONSE

It is Bedroc's policy to evacuate personnel from areas involved in emergency situations and to summon outside assistance from agencies with personnel trained to deal with the specific emergency. This section outlines the procedures to be followed by Bedroc personnel in case of a site emergency. These procedures are to be reviewed during the on-site safety briefings conducted by the SSO.

13.1 Injuries and Medical Emergencies

In case of physical injury or other serious medical concern to an employee, immediate first aid is to be administered. The employee should be stabilized by one group of employees while the Lincoln County Sheriff or one of the medical facilities listed in Section 13.2 is simultaneously summoned. They will arrange to transport the victim to the nearest appropriate facility. Workers with suspected neck or back injuries are NOT to be moved until professional emergency assistance arrives.

A first aid kit will be available at the site for use in case of minor injuries. If anyone receives a splash or particle in the eye, a portable eyewash station and a shower are available in the maintenance building.

13.2 Medical Facilities

In the event of an injury or non life threatening medical emergency on site, preparations should be made to transport the injured person to one of the following facilities for treatment. If injuries are life threatening, "Flight-For-Life" arrangements should be made by contacting the hospital directly or by contacting the Lincoln County Sheriff. Following is a list of the medical facilities and directions to those facilities.

Lincoln County Sheriff: 702-725-3375

Las Vegas Hospital:

Approximately 56 miles from BEDROC Landfill
Mike O'Callaghan Federal Hospital
7400 North Las Vegas Boulevard
Las Vegas, NV 89191
1-702-653-2260

Directions:

1. *Leave Bedroc Landfill and proceed south on US Highway 93 to intersection with Interstate 15 (approximately 43-miles).*
2. *Turn right (south) onto Interstate 15 and drive approximately 5.5-miles to North Las Vegas Highway (Highway 604).*
3. *Proceed south on North Las Vegas Highway 604 approximately 6.75-miles to Range Road.*
4. *Continue past Range Road approximately 0.35-miles. Entrance to the hospital is on the right hand side.*
5. *A vicinity map of the Mike O'Callaghan Federal Hospital is provided in Appendix I.*

Note: An electronic route map could not be created because Bedroc Landfill does not have a specific site address.

Mesquite Hospital:

Approximately 67 miles from Bedroc Landfill
Mesa View Regional Hospital
1299 Bertha Howe Avenue
Mesquite, NV 89027
1-702-346-8040

Directions:

6. *Leave Bedroc Landfill and proceed south on Highway 93 to intersection with Highway 168 (approximately 12.5-miles).*
7. *Turn east onto Highway 168 and drive 24-miles to Interstate 15 in Moapa.*
8. *Turn left (north) onto Interstate 15 and travel approximately 29-miles to West Mesquite Boulevard and exit.*
9. *Travel approximately 0.35-miles and turn left onto Route 170.*
10. *Travel approximately 0.6-miles and turn left onto Bertha Howe Lane, then right into Mesa View Regional Hospital.*
11. *A vicinity map of the Mesa View Regional Hospital is provided in Appendix I.*

Note: An electronic route map could not be created because Bedroc Landfill does not have a specific site address.

Caliente Medical Center:

Approximately 83 miles from Bedroc Landfill
Grover C Dils Medical Center
North Spring Street
Highway 93 North
Caliente, Nevada 89008
1-775-726-3171

Directions:

1. *Leave Bedroc Landfill and proceed north on Highway 93 to intersection with Highway 318 (approximately 42-miles).*
2. *Continue east on Highway 93 to Front Street in town of Caliente (approximately 42-miles).*
3. *Drive east on Front Street approx. 0.85-miles*
4. *Turn left onto North Spring Street and drive 0.25-miles*
5. *Turn left into Grover C Dils Medical Center.*
6. *A vicinity map of the Grover C Dils Medical Center is provided in Appendix J.*

Note: An electronic route map could not be created because Bedroc Landfill does not have a specific site address.

Emergency Phone Numbers:

Ryan Williams:	702-250-3045
Ron Williams:	702-250-8328
Scale House:	775-725-3509
Lincoln County Sheriff:	702-725-3375
Lincoln County FD:	775-725-3375
Fire, Police, Ambulance:	911
NDEP:	775-687-4670
Converse:	263-7600 xt 2012

13.3 Communication

In accordance with OSHA 1910.165, an onsite communication system is necessary to alert site personnel of emergencies and to summon outside emergency assistance. In lieu of an audible alarm system and given the limited number of personnel on-site at any time, Bedroc staff will communicate while onsite using cellular telephones. Cellular phone numbers are listed in Section 6.2. Communication with the scale attendant will be via the landline located in the scale house. Emergency telephone numbers and staff cellular telephone numbers are posted in the maintenance building and in the scale house. Staff will also program these numbers into their cellular telephones. Visitors will provide their cellular phones numbers on the visitors log prior to entering the site. The SSO is responsible for ensuring that this site communication network is enabled each day.

Where voice communication is not feasible, the following hand signals can be used by staff in case of an emergency:

Signal	Definition
Hands clutching throat	Can't breathe
Hands on top of head	Need assistance
Thumbs up	OK/I'm alright/I understand
Thumbs down	No/negative
Arms waving upright	Send help
Grip partner's wrist	Exit area immediately

13.4 Shower/Eyewash

A shower and an eyewash station are available in the maintenance building on site. The eyewash station has a 10-gallon/15-minute capacity for flushing foreign particles or contaminants out of eyes. The SSO will ensure that the unit is properly maintained.

13.5 Incident Report

In case of an injury or illness on site, work is to be stopped until the SSO and the CHSO have determined the cause of the incident and have taken the appropriate action. Any injury or illness, regardless of severity, is to be reported on an accident report form. Copies of the accident report form are provided in Attachment D.

13.6 Operational Shutdown

During certain situations such as medical emergencies or hazards, the SSO may request that site operations be temporarily suspended while the situation is corrected or controlled. During operation shutdown, all personnel and visitors will be required to assemble at the scale house and await further instruction from the SSO. The SSO will have ultimate authority for operations shutdown and restart. Operational shutdown procedures will be discussed during weekly safety briefings.

13.7 Landfill Shutdown

Under certain extreme situations, such as fire or weather, a landfill shutdown may occur. The SSO will initiate the landfill shutdown and the following procedures will apply:

- Bedroc staff will proceed to the scale house. If these individuals are aware of customers or visitors that are on site, Bedroc staff will inform them that a landfill shutdown is in progress and they are to proceed immediately to the scale house.

- The scale house attendant will review the visitor's log and perform a head count. If customers/visitors are onsite, the scale house attendant will attempt to contact them via cellular phone. If they cannot be contacted, then remaining staff will be dispatched to find the visitor(s) and direct them to the scale house.
- The scale house attendant will notify all incoming loads that the facility is shut down and to proceed to other dumping locations.

Landfill shutdown procedures will be discussed during weekly safety briefings.

13.8 Places of Refuge

In case of an offsite emergency, the SSO or the CHSO will direct the scale house attendant to close the front gates of the facility and all personnel will evacuate to the maintenance buildings.

In case of an onsite emergency requiring evacuation, all personnel will evacuate to the scale house, then at the direction of the SSO or CHSO, to a designated assembly area off site. An evacuation pathway has been provided on the facility map in Appendix A.

13.9 Chemical Spills

Chemicals that are located on site are listed in Section 9.0 of the ISWCP. Bedroc will monitor that site related chemicals are stored and dispensed in a safe and efficient manner. In the event that a chemical spill does occur on site, and the spill poses a threat to human health or the environment, the CHSO will report the incident to the NDEP within 24-hours. Bedroc will then take corrective actions in accordance with the guidelines set forth in NAC 445A.227.

13.10 Community Safety

The nearest community to the Bedroc Landfill is Alamo, Nevada, which is located approximately 30-miles to the north. The city of Las Vegas, Nevada is located approximately 65-miles to the south. Based on this information and the activities that are conducted at the Bedroc Landfill, there is very low potential for site related impacts to these communities. In the unlikely event that a significant event does occur at the facility, the appropriate state and local authorities will be notified and appropriate actions will be taken to protect the public health and mitigate the contaminant release.

14.0 TRAINING AND MEDICAL SURVEILLANCE

All Bedroc staff will review this ISWCP and sign a copy of the Safety Plan Compliance Agreement (provided in Attachment A) prior to commencement of work at the facility. The SSO will forward copies to the CHSO where they will be maintained at Bedroc's Las Vegas office.

Bedroc staff are not required to wear respiratory protection and therefore do not participate in a medical surveillance program as required under 29 CFR 1910.120(f).

On the first Monday of each month, the SSO will conduct a site safety briefing, which will include all Bedroc staff involved in site operations. At this briefing, the SSO will discuss:

- Contents of this ISWCP
- Types of hazards at the site
- Means of minimizing exposure to site hazards
- Personal protective equipment
- Site control measures, including safe operating practices and communication
- Location and use of emergency equipment
- Evacuation signals and procedures

For each briefing, the SSO will complete a site safety briefing form (provided in Attachment B) and submit the form to the CHSO for filing at the Bedroc Las Vegas office.

15.0 FORMS AND RECORDKEEPING

The SSO is responsible for site recordkeeping. The CHSO is also responsible for maintaining records at Bedroc's Las Vegas office. The Bedroc SSO and CHSO will review this ISWCP and, if there are no changes to be made, they will sign their approvals in the Review and Revisions table on Page 4 of this document.

Bedroc staff will review the ISWCP and sign the Safety Plan Compliance Agreement provided in Attachment A. Copies of these forms will be forwarded to the CHSO at Bedroc's Las Vegas office where they will be filed.

The SSO will conduct a monthly Site Safety Briefing in accordance with Section 14 and all attendees will sign the site safety briefing form provided in Attachment B. The form will be forwarded to the CHSO at Bedroc's Las Vegas office where it will be filed.

Injuries or incidents occurring on site will be reported by the SSO on an accident report form. Copies of the accident report form are provided in Attachment D. Copies of the accident report form will be forwarded by the SSO to the CHSO at Bedroc's Las Vegas office where they will be filed.

In the event of correspondence or contact with public officials, the SSO is required to forward written records of that correspondence to the CHSO at Bedroc's Las Vegas office where it will be filed.

16.0 CONTACT WITH PUBLIC OFFICIALS

If the event that an injury, incident, or emergency situation occurs at the Bedroc Landfill, it is likely that public officials will respond to the site. This may include: emergency medical personnel, firefighters, law enforcement, regulators, and even media. In the event that public officials do respond to the site, the SSO will be the designated point of contact for Bedroc, until such time that the CHSO arrives on site. No other Bedroc staff will be authorized to speak on behalf of Bedroc.

It is the policy of Bedroc to ensure that all emergency situations are immediately reported to law enforcement and support agencies. All contacts with news media should only be conducted by Ryan Williams or legal counsel.

Integrated Site Wide Contingency Plan

Glossary of Terms, Acronyms, and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
AST	Aboveground Storage Tank
C	Ceiling
Carcinogen	A substance that can cause cancer
CCO	Corporate Compliance Officer
CHSO	Corporate Health and Safety Officer
CNS	Central Nervous System
CPR	Cardio Pulmonary Resuscitation
EPA	U.S. Environmental Protection Agency
ISWCP	Integrated Site Wide Contingency Plan
MSDS	Material Safety Data Sheet
mm Hg	Millimeters of Mercury – Unit Measure of Vapor Pressure
NDEP	Nevada Division of Environmental Protection
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
ppm	Part Per Million
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value
Torr	Unit of Vapor Pressure
Bedroc	Bedroc Limited LLC

Attachment A

Safety Plan Compliance Agreement
Integrated Site Wide Contingency Plan
Bedroc Landfill and WMF
U.S. Highway 93, Mile Marker 8
Lincoln County, Nevada

I ______________________________ have received a copy of the *Integrated Site Wide Contingency Plan* for Bedroc Landfill and WMF. I have reviewed the plan, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited form working on the project for violating any of the requirements specified in the plan.

Signed: ______________________________ ____________________
(Signature) (Date)

Attachment B

Site Safety Briefing Report

Bedroc Landfill and WMF
U.S. Highway 93, Mile Marker 8
Lincoln County, Nevada

Date: ____________________

Briefing performed by: ____________________

Safety topic covered: ____________________

Attendees:

(Print/Signature)	(Title)

Attachment C

Accident Report Form

Bedroc Landfill and WMF
U.S. Highway 93, Mile Marker 8
Lincoln County, Nevada

Date accident occurred: ______________________________

Name of employee or visitor involved in accident: ______________________________

Was employee/visitor injured: ______________________________

Description of injury: ______________________________

____

____

On-site location where accident occurred: ______________________________

Description of how accident occurred (attach separate sheet of paper if necessary): ______________________________

____

____

____

____

Names of witnesses/statements (attach separate sheet of paper if necessary): ______________________________

____

____

____

____

Corrective action taken: ______________________________

____

____

Reviewed by injured: ______________________________
(Print/Signature) (Date)

Reviewed by SSO: ______________________________
(Print/Signature) (Date)

Reviewed by CHSO: ______________________________
(Print/Signature) (Date)

Appendix A

Facility Map (Drawing No. 1B)

Appendix B

Facility Photographs

Appendix C

Landfill Entrance Signage

Appendix D

Load Rejection Form

BEDROC LANDFILL AND WMF

U.S. Highway 93, Mile Marker 8
Lincoln County, Nevada

LOAD REJECTION FORM

Date: ______________________________

Time of incident: ______________________________

____

Waste Type(s): ______________________________

____

____

Generator: ______________________________

Hauler: ______________________________

Facility staff involved: ______________________________

____

Response Action: ______________________________

____

Regulators Notified: ______________________________

____

Comments: ______________________________

____

Reviewed by SSO: ______________________________

(Print/Signature) (Date)

Appendix E

Accidental Acceptance Form

BEDROC LANDFILL AND WMF

U.S. Highway 93, Mile Marker 8
Lincoln County, Nevada

ACCIDENTAL ACCEPTANCE FORM

Date of discovery:____

Time of discovery: ____
____

Waste type(s): ____
____
____

Generator (If known): ____________________________________

Hauler (If known): ______________________________________

Facility staff involved: ___________________________________
____

Response/corrective action: _______________________________
____

Regulator(s) notified: ___________________________________
____

Comments: ____
____

Reviewed by SSO:____
(Print/Signature) (Date)

Appendix F

Visitors Log

VISITORS LOG

Bedroc Landfill and WMF
U.S. Highway 93, Mile Marker 8
Lincoln County, Nevada

Date:______________________________

(Name/Company Affiliation/Cellular Ph#)

(Time in/Time out)

Appendix G

Chemical Storage Locations (Plate 1)

Appendix H

Material Safety Data Sheets

Appendix I

Hospital Vicinity Maps

Appendix J

Medical Center Vicinity Map

Appendix D

PREPARED FOR:

BEDROC LIMITED, LLC.
2745 NORTH NELLIS BOULEVARD
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

GROUNDWATER MONITORING AND REPORTING PLAN

OCTOBER 2013
REVISED MAY 2014

PROFESSIONAL ENGINEER - STATE OF NEVADA
LEONARD E. JOYCE, JR.
CIVIL
No. 13876

5/19/14

PREPARED BY:

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JOYCE PROJECT NO. 383.1401.01.01

GROUNDWATER MONITORING AND REPORTING PLAN
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

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GROUNDWATER MONITORING AND REPORTING PLAN
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

1.0 INTRODUCTION

Bedroc Limited. LLC. (Bedroc) is proposing to construct and operate a Class I solid waste landfill for the disposal of Class I materials.

This monitoring plan complies with the requirements of the Nevada Administrative Code (NAC) Chapter 444 Section 683 and the Code of Federal Regulations (40 CFR), Parts 258.51 and 258.53 and is certified by a qualified groundwater scientist in accordance with NAC 444.7483.

The *Groundwater Monitoring and Reporting Plan* is a guidance document for collection and analysis of representative groundwater samples from the uppermost aquifer beneath the facility, and for managing those data.

2.0 SITE DESCRIPTION

The facility is a 115-acre facility located in Coyote Spring Valley adjacent to State Route 93, approximately 65 miles north of Las Vegas, Nevada. A site location map showing topographic features of the surrounding area is presented as Drawing 1.

The site is located in the north/south trending Coyote Spring Valley. The valley is bounded on the east by the Delamar and Meadow Valley Mountains and on the west by the Sheep Range Mountains. Surface drainage in the valley is provided by the southward draining Pahranagat Wash, which traverses the valley immediately east of the proposed landfill site. In the vicinity of the proposed landfill, the Pahranagat Wash is approximately 1 mile wide with a gentle (approximately 0.5%) slope to the south-southwest. A Site Plan, showing existing topographic features of the site, is presented as Drawing 2.

3.0 SITE GEOLOGY AND HYDROGEOLOGY

Several hydrogeological investigations have been performed at the facility and in the region surrounding the facility. These investigations include topographic mapping, drilling of soil borings, construction of monitoring and observation wells, geophysical investigations, geotechnical investigations, excavation of test pits, soil and groundwater analyses, and hydraulic parameter measurements. Based on the information compiled during these investigations, a summary of the regional and site geology and hydrogeology is present below. For more detail, the reader is referred to the *Site Characterization Report* (JEI, 2004) and the *Site Characterization Report* (GES, 2013) prepared for the site.

3.1 Regional Geology

The Coyote Springs Valley trends north-northwest. It is bounded to the west by the Sheep Range, to the northeast by the Delamar Mountains, and to the southeast by the Meadow Valley Mountains. It is separated from the Pahranagat Valley to the northwest both geologically and topographically. To the south-southeast, the valley drains into the Arrow Canyon Wash. The Sheep Range, Delamar Mountains, and Meadow Valley mountains are composed of Paleozoic rocks (Tschanz and Pampeyan, 1970; Stewart and Carlson, 1978).

The Coyote Springs Valley is located within the Basin and Range Physiographic province and topography in the area is typical of that province, with long northerly trending valleys separated by hogbacks of uplifted (relative to the valley floor) strata. Relief across the Coyote Springs Valley is approximately 4,500 feet. Regionally, there are several major fault zones, including the Las Vegas shear zone located approximately 60 miles south of the study area and the Alamo shear zone located approximately 15 miles to the north of the study area (Stewart and Carlson, 1978; Stewart, 1980). Additionally, the 2013 *Site Characterization Report* identified three mapped faults in the immediate vicinity of the site: Wildcat Wash fault, Arrow Canyon Range fault, and Sheep Range fault.

Surficial and underlying sediments in Coyote Springs Valley consist of interbedded lacustrine and alluvial deposits (Tschanz and Pampeyan, 1970; JEI, 2004). The lacustrine sediments date from the late Tertiary Period (Tschanz and Pampeyan, 1970; Stewart and Carlson, 1978), and are located toward the center of the valley floor. Alluvial gravel deposits, dating from the late Tertiary or early Quaternary Period (Tschanz and Pampeyan, 1970; Stewart and Carlson, 1978), form the bulk of the exposed sediments on the valley floor, extending from the bedrock outcropping of the bordering mountains to the center of the valley. Late Quaternary alluvial sediments overlay the older deposits and form an anastomosing belt approximately 0.5 to 1 mile wide covering much of the valley floor (Tschanz and Pampeyan, 1970).

Bedrock in the valley, primarily limited in exposure to the mountains bordering the valley axis, are primarily mapped and described as Cambrian, Ordovician, and Silurian shales, limestones, dolomites, and quartzites. To the north of the study area are rocks mapped as Tertiary volcanic rocks (Tschanz & Pampeyan, 1970; Stewart and Carlson, 1978).

3.2 Site Geology and Hydrogeology

Soils at the site are classified and mapped as the Arizo-Bluepoint Association (NRCS, 1997). These soils grade laterally from gravelly loamy sand to loamy fine sand. The soils, derived from the weathering of alluvial parent material, are very deep and well drained. These soils are rarely to occasionally flooded and have a high infiltration rate, being classified in hydrologic group A.

Characterization of the site geology and hydrogeology is outlined in the *Site Characterization Report* (JEI, 2004). Field activities included the advancement of an exploratory trench on Lot 11 (existing Class III landfill) in November 1996 for the purpose of characterizing the on-site soils. The trench, which was advanced to approximately 15 feet below grade, encountered silty loam and silty sandy loam in the upper 12 to 15 feet. A silty clay material was encountered beneath the loamy material. In October 2003, 13 test pits were advanced on and through the existing material stockpile on Lot 11 for the purpose of characterizing the stockpiled material and underlying soils.

In December 1996, Terracon Consultants, Las Vegas, Nevada, advanced two boreholes at the existing Class III landfill. One boring was advanced to a depth of 41 feet in the middle of Lot 11. The second borehole was advanced on the southeast corner of Lot 11 to 81.5 feet below grade and was subsequently completed as a monitoring well, identified as OW-1 on Drawing 3. In November and December 2003, 14 additional soil borings were advanced at the site on Lot 11 and Lot 5. Six of 14 soil borings were converted to monitoring wells, the locations of which are shown on Drawing 3, as OW-2 through OW-7.

Additionally, in August 2013, Geotechnical & Environmental Services, Inc. (GES), Las Vegas, Nevada, advanced seven boreholes at the proposed Class I landfill. The seven boreholes (OW-7R through OW-13) were advanced at the site on Lot 6, Lot 7, Lot 8, Lot 13, and Lot 14. The seven soil borings were converted to one monitoring well (Class III facility) and six observation wells, the locations of which are shown on Drawing 2. In addition to the borings used in the site charecterization study, two monitoring wells (OW-14 and OW-16) and one observation well (OW-15) was also installed.

Data obtained during these investigations confirm the presence of Tertiary and younger sedimentary deposits in the vicinity of the facility as mapped by others (Tschanz and Pampeyan, 1970; Stewart and Carlson, 1978). Based on the characteristics of the sediments and review of available literature, the sediments at the site are correlated with the Pliocene Muddy Creek Formation and younger unnamed Quaternary alluvium.

3.3 Site Hydrogeology

Historically, there have been two springs located in the vicinity of the landfill. The approximate locations of the springs are shown on Drawing 1. One of the springs, identified as "Sp-1" on Drawing 1, is located approximately 2,000 feet northwest of Lot 11. Flow from this spring re-infiltrates into the subsurface within 40 feet of emergence. The second location, identified as "Sp-2" on Drawing 1 is the location of a former spring. During the field work in November and December 2003, the spring could not be located in the field and appears to have either dried up or been covered by depositional processes.

Both spring locations have an elevation of approximately 2,520 feet above mean sea level (MSL) and are located upgradient topographically from the facility. Based on information gathered during the site investigation concerning the geologic and hydrogeologic characteristics of the site, the springs are believed to emanate from a perched water table that is present in the eastward sloping alluvial fan deposits that are interbedded with lacustrine sediments. The source of recharge for the perched water table is believed to be infiltrating precipitation to the west of the facility where the alluvial fan sediments are exposed. Based on our evaluation of the site features in the vicinity of Sp-1, the spring discharges where the lower lacustrine sediments have been exposed by erosional processes. Monitoring of the spring is not proposed herein, since the facility operations cannot impact the spring due to the topographic and hydrologic location of the spring relative to the proposed facility.

The active channel for the Pahranagat Wash is located east of Lot 11 between the facility and Highway 93. The channel exhibits intermittent characteristics, attributed to the sparse precipitation that the area receives and the highly permeable nature of the shallow alluvium in the valley. Local personnel indicate that the channel only coveys flow during extreme precipitation events. Subsequently, monitoring of the Pahranagat Wash, other than that required by the facility's National Pollutant Discharge Elimination System (NPDES) permit, is not proposed herein.

As discussed previously, two monitoring wells and seven observation wells have been constructed at the facility to monitor the uppermost aquifer below the Class I facility. Table 1 summarizes well construction details, and soil boring and well construction logs for the monitoring and observation wells constructed at the facility are presented in Appendix I. Static water level data obtained from the monitoring and observation wells indicate that the water table in the uppermost aquifer beneath the site is present at a depth of 11 to 80 feet below grade in the vicinity of the Class I facility, depending on the topographic elevation. Table 2 summarizes the available depth to water information for the site. Based on this information, the uppermost aquifer beneath the facility is contained in the sediments of the Muddy Creek Formation.

Using the static water level data obtained on September 3, 2013, a groundwater surface contour map was prepared and is presented as an overlay on Drawing 2. As presented, the water table beneath the facility ranges in elevation from 2,410 feet MSL beneath the southeastern corner of the facility to 2,445 feet MSL beneath the northwestern corner of the facility. The potentiometric surface lines indicate that groundwater flow in the uppermost aquifer is towards the east-southeast with an average gradient of approximately 2.63E-02 foot per foot. The relatively flat gradient, which was calculated as shown below, is indicative of a high hydraulic conductivity.

The gradient along the northern flow pathway was calculated as follows:

Gradient (i) = D_H (drop in the potentiometric surface) / D_L (length of flow pathway)
= (2,455 feet AMSL - 2,410 feet AMSL) / 1,520 feet
= 45 feet / 1,520 feet
= 2.96E-02 (unitless)

Similarly, the gradient along the southern flow pathway was calculated as follows:

Gradient (i) = (2,455 feet AMSL - 2,410 feet AMSL) / 1,949 feet
= 45 feet / 1,949 feet
= 2.31E-02 (unitless)

Geologic information gathered during the site investigation indicates that the uppermost water table is present in a matrix composed of both alluvial and lacustrine sediment and that the uppermost aquifer exhibits both semi-confined and unconfined characteristics locally.

Slug testing data obtained during the 2004 site investigation are summarized in Table 3. As presented, the hydraulic conductivity of the aquifer matrix in the vicinity of the monitoring wells ranges from 0.24 to 11.04 feet per day. The range is attributed primarily to the different strata that are present within the screened interval of each well. The geometric average hydraulic conductivity value for the aquifer matrix is 1.12 foot per day.

The estimated average effective porosity (n_e) for the sand and gravel deposits is 0.25 and for the lacustrine sediments 0.35 (Fetter, 1988). Using the latter estimates of effective porosity and the calculated gradients, the average estimated rate of groundwater flow beneath the study area was estimated using the algorithm below.

V_{gw} = Ki/n_e

where: V_{gw} = groundwater velocity (feet/day)
K = estimated hydraulic conductivity (feet/day)
i = hydraulic gradient
n_e = effective porosity

Minimum

V_{gw} = [(0.24) × (0.0263)]/0.35

V_{gw} = 1.80E-2 foot/day

V_{gw} = 6.6 feet/year

Average

V_{gw} = [(1.12) × (0.0263)]/0.30

V_{gw} = 9.82E-2 foot/day

V_{gw} = 35.8 feet/year

Maximum

V_{gw} = [(11.04) × (0.0263)]/0.25

V_{gw} = 1.16 foot/day

V_{gw} = 424 feet/year

As presented above, the estimated horizontal rate of groundwater flow in the uppermost aquifer beneath the facility is expected to range from approximately 7 to approximately 424 feet per year, with a site average of approximately 36 feet per year.

4.0 GROUNDWATER MONITORING NETWORK

In accordance with NAC 444.7483, the applicant has proposed a permitted groundwater monitoring network that is composed of two upgradient monitoring wells (OW-14 and OW-16) and nine downgradient monitoring wells (OW-5 and OW-17 through OW-24). The locations of the monitoring wells are shown on Drawing 2.

Elements of the groundwater monitoring plan are illustrated on the prepared Groundwater Monitoring Plan (see Drawing 2). These elements include site boundaries, site topography, potentiometric surface, and existing and future groundwater monitoring wells. The monitoring wells are located and constructed to yield groundwater samples representative of the conditions in the uppermost aquifer underlying the facility, and are generally screened within the sand and gravel deposits (ave K= 1.12 foot per day), which are expected to be the preferential pathway for groundwater flow beneath the facility. Therefore, the monitoring network monitors the most likely avenue for contaminants that may be released from the facility in the event those contaminants should impact the groundwater beneath the facility.

Proposed wells are to be phased in with the expansion of the landfill. Compliance wells will be installed at the waste management unit boundary, prior to placement of waste in associated cells. Newly constructed wells will be located hydraulically downgradient of the waste limits in accordance with NAC 444.7483. The sequence of adding and removing wells during the development of the landfill is summarized in Table 4. The locations of the wells are depicted on Drawing 2.

Future upgradient compliance wells: OW-14 and OW-16

Future downgradient compliance wells: OW-5 (former Class III facility upgradient well); and OW-17 through OW-24

Wells OW-8, OW-13, and OW-15 will be maintained as upgradient observational wells throughout the life of the facility.

4.1 Drilling Methods

Drilling and construction of additional monitoring wells as required will be performed with applicable drilling technology (either mud or air rotary or vibratory methods) in accordance with procedures recommended by the United States Environmental Protection Agency (EPA, 1991; EPA, 1993a). If additional wells are required, a qualified hydrogeologist or groundwater scientist will log the soil samples and direct the construction of each monitoring well. Information recorded during the advancement of the test borings and during construction of the monitoring wells will be used to prepare a boring and well construction log for each well. After completion, the owner or operator will transmit the boring and well construction logs, and appropriate maps to the Nevada Division of Environmental Protection (NDEP) in accordance with NAC 444.7483.5(b).

4.2 Monitoring Well Construction

Monitoring well construction will be performed in accordance with the Groundwater Monitoring Well Construction Specifications presented in Appendix II and all applicable regulations found in NAC 534.360 through 534.500. In general, all monitoring wells will be constructed of 2- or 4-inch inside diameter (ID), schedule 40 polyvinyl chloride (PVC), flush jointed riser pipe, and 2- or 4-inch ID, schedule 40 PVC, flush jointed, factory slotted 0.010- to 0.020-inch screen. Wells will be completed with standpipe well head construction where possible and flush mounted construction where required. A maximum of 20 feet of screen will be used. The filter pack will be clean sand or gravel selected based on the characteristics of the well screen and the aquifer matrix (i.e., have a smaller diameter than the surrounding soils to prevent clogging). The filter pack will be placed to approximately 2 feet above the top of the screened interval. After placement of the filter pack, a filter pack seal consisting of a minimum of 2 feet of bentonite, either granular or pellets, will be placed directly above the sand filter pack. The filter pack seal will be hydrated with potable water and allowed time for hydration prior to continuing with well installation. After placement and hydration of the filter pack seal, the remaining annular space in the borehole will be backfilled with lean cement-bentonite slurry or hydrated bentonite slurry.

All wells with standpipe construction will have a locking steel outer protective casing with a minimum diameter of 4 inches and a concrete apron for surface protection. Flush mounted wells will be equipped with a surface vault with a minimum diameter of 8 inches set in a concrete apron. The concrete apron will have a minimum thickness of 4 inches and will be centered on the well casing. The apron will be graded to provide drainage away from the well head.

4.3 Well Development

Newly constructed wells will be developed to remove drilling fluids, if used, and fine-grained sediments from the filter pack and the surrounding aquifer. Well development will be performed with disposable bailers, mechanical well developer, an air lift pump, or other approved method. Well development procedures are specified in section 5.0 of the *Groundwater Monitoring Well Construction Specifications* found in Appendix II. Groundwater samples withdrawn from the wells after development has been completed should be relatively free of fine-grained sediments.

4.4 Documentation

Documentation of groundwater monitoring well installation will be in accordance with NAC 444.7483.5(b). An example of the well construction log that will be submitted to NDEP after the installation of piezometers/monitoring wells is included in Appendix III. Horizontal and vertical control will be established by survey after installation. This information will be compiled and submitted to NDEP and will include the following:

- well location to within ± 0.5 foot in horizontal plane in reference to NAD 27 or the local Township and Range coordinates;
- ground surface elevation to within ± 0.01 foot in reference to mean sea level (MSL); and
- top of monitoring well casing elevation to within ± 0.01 foot in reference to MSL.

4.5 Monitoring Well Decommissioning

If a monitoring well is damaged or otherwise becomes unusable during the operating life the facility, EPA's well decommissioning procedures, and the applicable regulations found in NAC 534.360 through 534.500, shall be followed (EPA, 1991). These procedures are summarized below. Approval from NDEP will be obtained prior to monitoring well abandonment in accordance with NAC 444.7483.4.

4.5.1 Permanent Abandonment

Monitoring wells with a 2-inch or large diameter casing (riser pipe/screen) shall be abandoned by either:

- Over-drilling the monitoring well to remove the casing and filling the resultant open borehole with a cement-bentonite grout or bentonite slurry; or
- Grouting the monitoring well in-place with a cement-bentonite grout and then over drilling the top 10 feet of the boring to facilitate the placement of a cement plug. All monitoring wells abandoned in this manner will be cut off at the ground surface prior to abandonment.

In both cases, the bentonite content of the cement-bentonite grout shall be approximately 5%, and a tremie pipe will be used to ensure that grout is continuously placed from the bottom of the borehole/monitoring well screen and riser upward.

For each monitoring well abandoned, the following information will be provided to the NDEP:

- The name of the monitoring well;
- A description of the procedure by which the monitoring well was abandoned;
- The date when the monitoring well was considered to be taken out of service; and
- The date when the monitoring well was abandoned.

5.0 GROUNDWATER MONITORING PROGRAM

The Groundwater Monitoring Program for this facility is modeled after the Detection Monitoring Program for municipal solid waste landfills as outlined in NAC 444.7488 *et seq.* and will be implemented following receipt of the required permit for operation of the waste disposal facility. Records of the background groundwater quality data and all subsequent measurements obtained during the groundwater monitoring program, including all concentration measurements and the background values established during the Detection Monitoring Program will be kept in the facility operating record. These records will be maintained throughout the active life of the facility and the post-closure care period. For each parameter, the laboratory certificates-of-analysis will identify the analytical method detection limit, the reported concentration, and applicable laboratory quality assurance/quality control (QA/QC) data on surrogate and standards analyses.

Resulting statistical evaluations of the analytical data will be kept in the operating record for the same time period. The static water level determinations and evaluations will also be retained. A discussion of the Detection Monitoring and Assessment Monitoring Programs is presented in the following subsections. References to sampling lists include the list of 62 constituents for Detection Monitoring, as listed in Appendix I of NAC, as well as the list of 213 constituents for Assessment Monitoring, as listed in Appendix II of NAC.

5.1 Detection Monitoring Program

The Detection Monitoring Program is designed to identify the concentrations of specific organic and inorganic constituents in the upper aquifer. Components of a Detection Monitoring Program, including analytical requirements, sampling frequency, data evaluation, and reporting requirements are discussed in the following sections.

5.1.1 Constituents

The Detection Monitoring Program (Phase 1) will include monitoring for the following:

1. Total Organic Carbon (TOC)
2. Total Organic Halides (TOX)
3. pH
4. Specific Conductance
5. Chloride
6. Sulfate
7. Total Kjeldahl Nitrogen
8. Nitrate
9. Nitrite
10. Chemical Oxygen Demand (COD)

In addition to the above, a biennial sampling event for the groundwater monitoring wells and that includes Appendix II to Part 258—List of Hazardous Inorganic and Organic Constituents will be performed. Depending on what is detected in this monitoring, Bedroc will have the option to modify the frequency (either longer or shorter) and constituent list. This groundwater monitoring plan will then be revised to incorporate these modified monitoring frequencies and constituent lists. These constituents and their statistical values will be submitted to the Division for approval per NAC 444.7485.

Required analytical methods and associated estimated laboratory Limits of Quantitation (LOQs) for each constituent are presented in Appendix IV. In addition to the NAC Appendix I constituents, Bedroc proposes to monitor, periodically on an as-needed basis, for voluntarily water quality and leachate indicator parameters. A summary of the voluntary water quality and leachate indicator parameters is provided in Table 5. While in the Detection Monitoring Program, samples for all constituents will be analyzed using SW-846 methods 6000 and 7000 series as applicable, and 8011 and 8260, as updated (EPA, 1995).

5.1.2 Background Sampling

The first sampling event consists of a minimum of four independent samples from each well (background and downgradient). These samples will be obtained and analyzed for the constituents shown in Section 5.1.1. to establish background. Samples will be collected over a period of 12 consecutive quarters. The data from the first four sampling events will be used in computations to establish background levels. Subsequent sampling results will be compared with these background levels.

5.1.3 Background Sampling Reports

Following each background sampling event, the analytical results will be submitted to the NDEP within a reasonable timeframe after receiving a hard copy of the laboratory certificates-of-analysis.

5.1.4 Sampling Schedule

Once background sampling has been completed, sampling for Detection Monitoring will be conducted on a quarterly schedule (Phase 1) in accordance with the requirements of NAC 444.7488. During each sampling event, groundwater samples will be obtained from each well and analyzed for all of the constituents listed in the Phase 1 detection parameter list pursuant to NAC 444.7489.

5.1.5 Analytical Data Evaluation

There may be time lag between Phases 1 and 2 (Phase 2 is leachate sampling discussed in Section 6.0). Prior to implementing Phase 2, Phase 1 data will be collected as discussed in Section 5.1 and using statistical methods outlined in NAC 444.7485. At the conclusion of Phases 1 and 2, Bedroc will submit an evaluation, within 180 days of detecting chemical constituents (both inorganic and organic) that can be regarded as being consistently generated by the facility (i.e. leachate from the waste mass). These may therefore be considered as reliable groundwater detection parameters, for inclusion into the Detection Monitoring Program. At the conclusion of Phase 2, Phase 3 will consist of the submission of a re-evaluation of the initial parameters and the added parameters pursuant to NAC 444.7484 at the conclusion of eight quarterly groundwater sampling events.

- Groundwater data will be evaluated statistically as described in Section 8.0 of this GMRP. At the conclusion of the 12 quarters Bedroc will submit the statistical analysis required by NAC.7485 within 180 days.

The results of the statistical analyses will then be evaluated as discussed in Section 10.0 of this GMRP.

5.1.6 Reporting

An annual report will be prepared and submitted to the NDEP by March 1 of each year. The report will include the following:

- Information pertaining to the sampling events performed during the year;
- Information that is unique to each monitoring well, if applicable;
- Results of chemical analyses;
- A description of any actions taken (or proposed) to correct for suspect data;
- Results of statistical tests;
- A discussion of site conditions;
- Results of the evaluation of groundwater surface elevations measured during the year; and
- Any response to the evaluation of groundwater surface elevations.

5.2 Assessment Monitoring Program

The Assessment Monitoring Program is designed to determine the concentrations of solid waste constituents in groundwater and the rate and extent of their migration. In accordance with NAC 444.749, an Assessment Monitoring Program will be implemented at the Bedroc Landfill and Waste Management Facility whenever a confirmed statistically significant increase over background has been detected for one or more of the constituents listed in the Phase I detection parameter list pursuant to NAC 444.7489. Components of an Assessment Monitoring Program, including analytical requirements, sampling frequency, data evaluation, and reporting requirements, are discussed in the following sections.

5.2.1 Constituents

Assessment monitoring constituents are listed in Appendix II of the NAC (see Appendix IV). Required analytical methods and associated EQLs are also presented in Appendix IV. MCLs are listed for those constituents for which the EPA has established MCLs. It is recognized that existing MCLs may change without notice as directed by the EPA. While in the Assessment Monitoring Program, samples for all constituents will be analyzed using SW-846 methods 6000 and 7000 series as applicable, and 8011, 8081, 8151, 8260, and 8270, as updated (EPA, 1995).

5.2.2 Background Sampling

Within 90 days of confirming statistically significant increases in the Detection Monitoring Program, the Owner/Operator will initiate an Assessment Monitoring Program and obtain groundwater samples from each monitoring well and analyze them for all constituents listed in Appendix II of the NAC. Within 90 days of the initial NAC Appendix II event, a second round of sampling will be performed during which samples will be analyzed for NAC Appendix I constituents plus detected NAC Appendix II constituents. To complete the background database for detected NAC Appendix II constituents, two additional sampling events will be conducted on a semi-annual basis for all constituents listed in NAC Appendix I plus any additional detected constituents listed in NAC Appendix II, ensuring that at least once annually, samples are collected for analysis of the constituents in NAC Appendix II. If a constituent was first observed while the facility was monitoring under the Detection Monitoring Program, the background data for NAC Appendix I constituents established during the Detection Monitoring Program will serve as the background data for the NAC Appendix I constituents for the Assessment Monitoring Program.

After obtaining the results from the initial or subsequent sampling events required in NAC 44.749, the Owner/Operator will:

- within 14 days, notify the NDEP identifying the Assessment Monitoring constituents that have been detected;
- on at least a semi-annual or quarterly basis, as applicable, re-sample all wells and conduct analyses for all NAC Appendix I constituents and for those NAC Appendix II constituents that were previously detected;
- within 90 days of obtaining a minimum of four data points for each NAC Appendix II detect, establish background concentrations for the detected constituents; and
- within 90 days of establishing background concentrations, submit proposed Groundwater Protection Standards for all detected NAC Appendix II constituents to the NDEP.

5.2.3 Background Sampling Reports

Following each background sampling event, analytical results will be submitted to NDEP within a reasonable time period after receiving the hard copy of the laboratory certificates-of-analysis.

5.2.4 Sampling Schedule

In accordance with NAC 444.7485, one groundwater sample will be collected from each monitoring well for 12 consecutive quarters for landfills monitored under the Assessment Monitoring Program. At least once per year, samples will be analyzed for the entire NAC Appendix II list of constituents. For the other sampling event(s), the samples will be analyzed for the NAC Appendix I list plus any constituents from the NAC Appendix II list that have been detected during previous sampling events.

5.3 Record Keeping

Records of the background groundwater quality data and all subsequent measurements, including all concentration measurements and the background values established during the groundwater monitoring, will be kept at the Bedroc Limited, LLC. administrative office. These records will be maintained throughout the active life of the facility and the post-closure care period. The laboratory certificates-of-analysis will identify for each parameter the analytical method detection limit, the reported concentration, and applicable laboratory QA/QC data on surrogate and standards analyses. Resulting statistical evaluations of the analytical data will be kept for the same time period. The static water level determinations and evaluations will also be retained.

5.4 Biennial Groundwater Monitoring for Hazardous Constituents

A biennial sampling event for the groundwater monitoring wells as described in Section 5.1.1 will be conducted.

6.0 LEACHATE SAMPLE COLLECTION

This section describes the leachate collection, monitoring, and analysis program for the Bedroc Landfill and Waste Management Facility. Leachate monitoring is performed to collect information on site leachate characteristics.

6.1 Leachate Collection System

Leachate samples will be collected from the leachate holding pond. As proposed, the holding pond will receive leachate from all active and closed areas of the landfill via an underground conveyance system. The location of the leachate pond associated with the Bedroc Landfill and Waste Management Facility is shown on Drawing 2.

6.2 Leachate Sampling Parameters (Phase 2)

Sampling will include all the constituents listed in the Appendix II to Part 258—List of Hazardous Inorganic and Organic Constituents, and Appendix I of 40 CFR 258. A summary of the leachate monitoring parameters is provided in Table 6.

6.3 Leachate Monitoring Schedule

The leachate pond for the Bedroc Landfill and Waste Management Facility will be sampled on a quarterly basis (as needed) in conjunction with the scheduled groundwater sampling event. Quarterly sampling for 3 years (12 continuous quarters) of the leachate pond will be conducted to provide further information to determine the most appropriate detection monitoring program for the site. Therefore, Phase 2 monitoring will include this leachate monitoring, (i.e. sampling of the leachate pond) from the point in time leachate generation begins.

7.0 GROUNDWATER SAMPLE COLLECTION

The following sections outline procedures for obtaining and analyzing groundwater samples from the facility's groundwater monitoring network.

7.1 Sample Collection

Groundwater samples will be collected for twelve consecutive quarters in the Detection Monitoring and Assessment Monitoring Phases. At the conclusion of 12 quarters, Bedroc will submit the statistical analysis required by NAC 444.7485 within 180 days to NDEP.

7.1.1 Static Water Elevations

Static water elevation and total well depth will be measured to the nearest 0.01 foot in each well prior to each sampling event. An electronic depth meter will be used for the measurements. This device is lowered into the well and emits an audible tone when water is reached. The distance from the top of the well casing to the water surface and to the bottom of the well will be measured using the tape attached to the probe.

Once annually the total depth of each well will be gauged. If a well has a dedicated pump, the depth to water shall be measured first. Then the pump shall be removed from the well and placed on clean, plastic sheeting adjacent to the well. The distance from the top of the well casing to the bottom of the well will be measured using the tape attached to the probe. After measuring the total depth, the pump will be placed back in the well.

The rate and direction of groundwater flow will be determined each time groundwater is sampled, and reported in the scheduled monitoring report. If the evaluations show that the monitoring network is no longer in compliance with NAC 444.7483, the NDEP will be notified and the network will be modified as discussed in Section 10.0 of this Groundwater Monitoring Plan.

7.1.2 Well Evacuation

The monitoring wells at the Bedroc Landfill and Waste Management Facility will be sampled using non-dedicated or dedicated bladder pumps and micro-purge procedures. The micro-purge procedures are presented in Appendix V. Micro-purge sampling greatly reduces the volume of water that must be purged from a well before representative samples can be collected, and provides for water quality consistency between sampling events. Micro-purging is accomplished through the use of non-dedicated or dedicated low-flow sampling devices. Bailers and portable pumps are not used because they cause mixing of the standing water column within the well (Robin and Gillham, 1987; EPA, 1996). This mixing action requires removing the traditionally large purge volumes before sampling. Introducing any device into the well prior to sampling causes a surging effect that increases turbidity and interferes with the normal flow of water through the well screen. This disturbance usually remains in effect for as long as 24 to 48 hours (Kearl *et al.*, 1992).

Water quality parameters pH, temperature, turbidity, conductivity, and dissolved oxygen will be monitored during low-rate purging. The stabilization of these parameters indicates when the discharge water is representative of formation water and samples can be collected for analysis. Sampling personnel will containerize and dispose of purge water generated during sampling activities in the facility's leachate collection system.

If all of the monitoring wells in the compliance network are equipped with dedicated pumps, the potential for cross contamination between wells is minimized. If the monitoring wells in the compliance network are sampled with non-dedicated pumps, then decontamination procedures in Section 7.1.4 will be followed to avoid any potential for cross contamination between wells. To ensure consistency between sampling events, the monitoring wells will be purged and sampled from upgradient to downgradient.

7.1.3 Sample Collection

Following the completion of purge activities, samples for the required constituents (see Appendix IV for Detection and Assessment Monitoring Program analytes) will be collected immediately in the following order:

- Field measurements for pH, dissolved oxygen, specific conductance, temperature, and turbidity
- Volatile organics
- Total (unfiltered) metals
- Extractable organics (semi-volatile compounds, pesticides, herbicides, PCBs, etc.)
- Phenols
- Cyanide
- Field measurements for pH, dissolved oxygen, specific conductance, temperature, and turbidity

The purge rate during sampling shall remain the same as the rate used to achieve stabilization during the purge. Container sizes and preservatives are presented in Table 7.

7.1.4 Decontamination

Field equipment will be decontaminated using the following procedures:

When the target analytes are inorganic constituents, the equipment shall be cleaned with a phosphate-free detergent, rinsed with a dilute (0.1 N) hydrochloric or nitric acid, rinsed with potable or distilled water, and rinsed with distilled water.

When the target analytes are organic constituents, the equipment shall be cleaned with a phosphate free-detergent, rinsed with potable or distilled water, rinsed with distilled water, rinsed with pesticide quality hexane or isopropanol (or similar solvent which is not a target analyte), and rinsed with distilled water.

If the target analytes include both organic and inorganic constituents, the decontamination procedure for both inorganic and organic constituents shall be followed.

If conditions are such that the above decontamination procedures cannot be utilized, then a phosphate-free detergent wash and distilled water rinse procedure will be the acceptable alternative.

7.2 Sample Preservation and Handling

The sample container, minimum volume, chemical preservative, and holding times for each analysis type are provided in Table 7. Sample preservation methods will be used to retard biological action, retard hydrolysis, and reduce sorption effects. These methods will include chemical addition, refrigeration at 4° C, and protection from light.

7.3 Chain-of-Custody

Samples will be properly containerized, packed into pre-chilled coolers, and either hand-delivered or shipped overnight by a commercial carrier to the laboratory for analysis. The chain-of-custody program will allow for tracing sample possession and handling from the time of field collection through laboratory analysis. The chain-of-custody program will include sample labels and seals, field logbook, chain-of-custody record, and laboratory logbook.

7.3.1 Sample Labels

Legible labels sufficiently durable to remain legible when wet will contain the following information:

- Job and sample identification number;
- Monitoring well number or other location;
- Date and time of collection;
- Name of collector;
- Parameters to be analyzed; and
- Preservative, if applicable.

7.3.2 Sample Seal

The shipping container will be sealed to ensure that the samples have not been disturbed during transport to the laboratory. The tape is labeled with instructions to notify the shipper if the seal is broken prior to receipt at the laboratory.

7.3.3 Field Logbook

The field logbook will contain sheets documenting the following information:

- Identification of the well;
- Well depth;

- Static water level depth and measurement technique;
- Well yield - high or low;
- Purge volume (given in gallons or number of bailers);
- Time well was purged;
- Date and time of collection;
- Well sampling sequence;
- Types of sample containers used and sample identification numbers;
- Preservative used;
- Field analysis data and methods;
- Field observations on sampling event;
- Name of collector(s);
- Internal temperature of shipping container at the time of sample placement; and,
- Climatic conditions including air temperatures.

An example field log book sheet is provided in Appendix III of this Groundwater Monitoring Plan.

7.3.4 Chain-of-Custody Record

The chain-of-custody record is required for tracing sample possession from time of collection to time of receipt at the destination. A chain-of-custody record will accompany each individual shipment. The record will contain the following information:

- Sample destination and transporter;
- Sample identification numbers;
- Signature of collector;
- Date and time of collection;
- Sample type;
- Identification of well;
- Number of sample containers in shipping container;

- Parameters requested for analysis and preservative;
- Signature of person(s) involved in the chain of possession;
- Inclusive dates of possession; and
- Internal temperature of shipping container upon opening in laboratory (noted by the laboratory).

A copy of the completed chain-of-custody sheet will accompany the shipment and will be returned to the shipper after the shipping container reaches its destination. A sample chain-of-custody record is included in Appendix III of this Groundwater Monitoring Plan. The chain-of-custody record will be used as the analysis request sheet.

7.4 Analytical Procedures

Analytical procedures will be performed in accordance with *Test Methods for Evaluating Solid Waste - Physical/Chemical Methods*, EPA Document SW-846 as updated (EPA, 1995), or if SW-846 does not specify a method, Clean Water Act (CWA) methods shall be used. The monitoring parameters/constituents for the Detection and Assessment Monitoring Phases of the Groundwater Monitoring Program are presented in Appendix IV, along with the proposed analytical method and estimated quantitation limit (EQL). Alternate SW-846 methods may be used if they have the same or lower EQL.

Methods with higher EQLs will be considered if the concentration of the constituent is such that an alternate test method with a higher EQL will provide the same result. Alternate SW-846 methods may be used if written approval from the NDEP is received 30 days prior to their use.

7.5 Field Quality Assurance and Quality Control Program

Trip and field blanks will be collected and analyzed during each sampling event to verify that the sample collection and handling process has not affected the quality of the samples. The blanks will be prepared in the lab each time a group of bottles is prepared for use in the field. The appropriate number of bottles of each type (e.g., VOA, plastic, glass) will be filled with Type II reagent grade water, transported to the site, handled like the samples and shipped to the laboratory for analysis. In addition to being transported to the site, handled like the samples and shipped to the laboratory for analysis, the field blank will also be exposed to the sampling environment. As with all other samples, the time of the blank exposure will be recorded so that the sampling sequence is documented. The trip will be analyzed for volatile organic compounds only. The field blank will be analyzed for the same list of constituents as the groundwater samples.

If non-dedicated sampling devices are used *in lieu* of dedicated sampling devices, at least one equipment blank per day will be prepared to ensure that the non-dedicated sampling device has been effectively cleaned, and the field blank will be deleted. The equipment blank will be prepared in the field after cleaning a sampling device or prior to sampling with an office-cleaned device by filling the device with Type II reagent grade water, transferring the water to the sample bottles, and shipping the bottles to the laboratory for analysis. The time will be recorded and the blanks will be subjected to the same analyses as the groundwater samples.

The assessment of blank analysis results will be in general accordance with EPA's *National Functional Guidelines For Data Review (Organic and Inorganic)* (EPA, 1993b, EPA, 1994). No positive sample results will be reported unless the concentration of the compound in the sample exceeds 10 times the amount in any blank for common laboratory contaminants (see next paragraph), or five times the amount for other compounds. Resampling will be performed as necessary to confirm or refute suspect data; such resampling will occur within 30 days of the data review.

Concentration levels of any contaminants found in the blanks will be used to qualify the groundwater data. Any compound (other than the four listed below) detected in the sample, which was also detected in any associated blank, will be qualified "B" when the sample concentration is less than five times the blank concentration. For common laboratory contaminants (methylene chloride, acetone, 2-butanone, and common phthalate esters), the results will be qualified "B" when the reported sample concentration is less than 10 times the blank concentration. The "B" qualifier designates that the reported detection is considered to represent cross-contamination and that the reported constituent is not considered to be present in the sample at the reported concentration. If the concentration of any blank-qualified data exceeds background, the NDEP will be contacted within 14 days to determine what action, if any, will be necessary to correct the observed blank contamination, as appropriate.

7.6 Laboratory Quality Assurance and Quality Control Program

The following are general guidelines for quality assurance/quality control to be followed by laboratories analyzing samples collected at the landfill.

7.6.1 Chain-of-Custody

Information to be included on the chain-of-custody and actions to be taken by the laboratory upon receipt of the samples are discussed as follows.

- The date, time of sample collection, and analysis to be performed will be provided to the laboratory on the chain-of-custody form. The samples will be examined upon receipt to ensure collection in EPA-approved containers for the requested analysis. The sample collection date and time will also be reviewed to ensure the EPA-required sample holding time has not expired or will not expire before the sample can be processed.

- The information concerning transportation mode and manner will be reported on the form. Samples must be transported on ice or under refrigeration and received at 4+/- 2 degrees centigrade.

- The pH of each sample, and sample appearance will be recorded upon receipt. The pH for volatiles samples shall be taken following analysis (as long as a second, unopened sample remains available for back-up). Also, preservative adjustments and sample splitting must occur as required prior to distribution. Sample adjustments will be fully documented. Cyanide samples shall be tested for residual chlorine and sulfides (a spot-test is acceptable), and quenched when necessary prior to preparation and analysis.

- Any sample discrepancies (e.g., breakage, headspace in volatile samples) must be documented and Bedroc contacted immediately for further instructions. Resampling will occur within 30 days of notification to obtain sufficient samples for analysis.

7.6.2 Analysis

- During the sample analysis period, the samples will remain refrigerated. Volatile and non-volatile samples must be stored in separate refrigerated units.

- If at any point during the analysis process, the results are considered technically inaccurate, the analysis must be performed again if holding times have not been exceeded. Resampling will be performed within 30 days if holding times are exceeded.

7.6.3 Documentation

- Permanent ink must be used for all documentation.

- Documentation will be written legibly. Mistakes will be crossed out with a single line, corrected, dated, and initialed.

7.6.4 Analytical Quality Control

Analytical quality control in sample processing and data generation must be consistent with guidelines outlined in the most recent revisions to *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846, 3rd Edition, plus the most recent promulgated updates, if applicable). Quality control samples shall be performed with each batch of samples at the frequencies specified in SW-846 and as outlined below. The "analytical batch" is defined as that group of samples (not to exceed 20 field samples) prepared (aliquotted, extracted, digested, etc.) together by the same technician(s), using the same batch of glassware, equipment, standards, solvents, and other reagents during the same working shift (or concurrent shifts, if the preparation procedures extend to subsequent shifts).

A method blank and laboratory control sample (LCS, see discussion below) must be prepared with each analytical batch. The method blank and LCS must also be analyzed on each instrument involved in the field sample analyses from the batch. If, for example, the batch is divided among two GC/MS systems, the method blank and LCS must be analyzed on both instruments. The lab shall, whenever possible, make every attempt to analyze the batch on the same instrument. Exceptions will be granted, for example, when the original analytical instrument goes out-of-service midway through the batch, or is recalibrated for a different method following the initial analysis of the batch but prior to any unanticipated reinjections.

For all GC and GC/MS methods, at a minimum, the lab is required to perform a 5-point initial calibration. With each organic analytical batch, the lab must prepare and analyze a matrix spike (MS), matrix spike duplicate (MSD), method blank, and LCS. For GC/MS analysis, the method blank may double as the LCS, and the surrogates may be used as the control analytes. For GC analyses, the LCS must include surrogates as well as a representative subset (at a minimum) from the target compound list (TCL). For 8081 analysis, for example, at least six of the TCL pesticides must be included in the LCS. If PCBs are required, the target Aroclor must be used as the LCS (if more than one Aroclor congener is on the TCL, the LCS must include at least one congener from the TCL). If the target congener interferes with TCL pesticides, a separate LCS for this Aroclor must be produced with each analytical batch.

With each inorganic and classical wet chemistry analytical batch, the lab must prepare and analyze a matrix spike (MS), duplicate (DUP), method blank, and LCS. For inorganic metal analyses, the LCS must include all the Target Analyte List (TAL) metals (or those being analyzed in the associated field samples, if a subset of the full list).

The lab must maintain control charts of the LCS control analyte constituents for each method referenced in the analyte lists included in this plan. Control charts are not deliverable.

The laboratory method blanks must be examined for contaminants, and corrective actions taken as appropriate. Certain contaminants may be observed in the method blanks as a result of contamination common to most laboratories (methylene chloride, acetone, 2-butanone, and common phthalate esters). These common lab contaminants and all other target analytes must be below the laboratory quantitation limit (QL). For metals analysis, a target analyte may be present in the method blank at greater than five times the QL, so long as the associated samples contain the same metal at concentrations more than an order of magnitude (10X) higher. In each of these exceptional cases described above, the data shall be appropriately flagged and qualified in the case narrative. In all other cases, the analytical batch must be re-prepared and re-analyzed with a new method blank.

7.6.5 Data Reporting

The data will be reported in micrograms per liter using the number of significant figures appropriate to the method. The lab must include on its analytical reporting form ("Form 1" for CLP-like deliverables) the lab's QL and detection limit (DL). The QL is a value, usually a factor of 3-4 times the DL, below which the quantitation of an analyte is not possible within the method-required limits of precision and accuracy. The lab is required to report results of analytes below the lab’s QL, but above the DL, with a “J” data flag (denoting an estimated value). The lab's QLs must be at or below the MCLs (for those analytes with MCLs listed), if achievable, in the analyte tables included in this plan.

The data report shall, at a minimum, include the following information.

- Narrative: Must include a brief description of the sample group (number and type of samples, field and associated lab sample identification numbers, preparation and analytical methods used). The data reviewer shall also include a statement that all holding times and QC criteria were met, samples were received intact and properly preserved, etc., with a brief discussion of any deviations potentially affecting data usability. This includes, but is not limited to, test method deviation(s), holding time violations, out-of-control incidents occurring during the processing of QC or field samples and corrective actions taken, and repeated analyses and reasons for the re-analyses (including contamination, failing surrogate recoveries, matrix effects or dilutions, for example). If samples were analyzed on more than one instrument, the reason for doing so must be stated in the narrative. The narrative shall be signed by the laboratory director or authorized laboratory representative, signifying that all statements are true to the best of the reviewer's knowledge, the data meet the data quality objectives as described in this plan (except as noted), and the data are released to Bedroc. One narrative is required for each sample group.

- Original Chain-of Custody Form

- Target analyte list (TAL): The lab shall list all compounds that were analyzed for in the samples. The TAL is typically included as part of the analytical reporting forms.

- Blank Data: For organic analyses, the lab shall report the results of any method blanks, reagent blanks, trip blanks, field blanks, and any other blanks associated with the sample group. For inorganic analyses, the lab shall provide the results of any preparation or initial calibration blanks associated with the sample group.

- QC Summary: The lab will provide summary forms detailing laboratory QC sample results which include individual recoveries and relative percent differences (if appropriate) for the following QA/QC criteria: surrogates, matrix spike analyses, matrix spike duplicate analyses, LCS, and sample duplicate analyses. QC control limits shall also be reported; if any QC limits were exceeded, a flag or footnote shall be placed to indicate the affected samples.

Additional quality assurance data and/or other pertinent data may be reported as requested by the owner/operator of the landfill.

7.6.6 Documentation

Records of the background groundwater quality data, and all subsequent measurements, including all concentration measurements and the background values established during all three phases of the Groundwater Monitoring Plan (GMP) will be kept at the Bedroc Limited, LLC. administration office, throughout the active life of the facility and the post-closure care period.

A hardcopy of the data, and any associated non-deliverable documents, must be properly stored by the laboratory in a secured facility, under proper chain-of-custody, for at least three years following data delivery. The following data shall be readily retrievable at the request of Bedroc, at any time during this period:

- The date and reference method must be included in all analysis documentation.

- Analytical results shall include analyte concentration, sample weight, percent water (when required), and final volume of extract or diluted sample.

- Calibration curve or coefficient of the linear calibration shall be included along with the concentration/response data (or relative response data) or the calibration check standards. It shall also include the initials of the analyst and must include the date on which the calibration curve was made.

- The results of the samples, concentration units, relative percent difference for duplicates, spike/surrogate concentrations, and spike/surrogate recoveries must also be documented.

- The reference QA identification, QA true value, and QA acceptable range must be documented.

- The identity and amount of each constituent in the laboratory blank are to be reported. If the concentration of the blank exceeds the method detection limit, the source of the contamination must be determined. Reanalysis of the entire batch may be required.

- All chromatograms for the reported results shall be properly labeled with the same identification and the amount injected.

- Any additional sample preparation and its justification, and any comments or observations which can affect the results must be documented for possible further interpretation.

8.0 STATISTICAL ANALYSES

In accordance with NAC 444.7485, the groundwater monitoring data will be statistically analyzed using one of the statistical methods discussed in the following subsections in accordance with guidance issued by the United States Environmental Protection Agency (EPA, 1989; EPA 1992a).

8.1 Statistical Test Methods

The statistical test used to evaluate the groundwater monitoring data will be the tolerance or prediction interval method, unless these test are determined to be inappropriate with the background data. Possible alternate statistical test methods, as described in NAC 444.7485 are:

(1) A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method will include estimating and testing the contrasts between each compliance well's mean and the background mean levels for each constituent;

(2) An analysis of variance (ANOVA) based on ranks followed by multiple comparisons procedures to identify significant evidence of contamination. The method will include estimating and testing the contrasts between each compliance well's median and the background median levels for each constituent;

(3) A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the

level of each constituent in each compliance well is compared to the upper tolerance or prediction limit;

(4) A control chart approach that gives control limits for each constituent; or

(5) Another statistical test method that meets the performance standards specified by the NDEP. A justification for the alternate test method will be submitted to the NDEP for approval prior to use.

The statistical analysis chosen to evaluate the groundwater data will meet the following performance standards:

(1) The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of monitoring parameters or constituents. If the distribution is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(2) If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the Type I experiment-wise error rate for each testing period shall be no less than 0.05; however, the Type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, or control charts.

(3) If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. The parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration for each constituent of concern.

(4) If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentrations for each constituent of concern.

(5) The statistical method shall account for data below the limit of quantitation with one or more statistical procedures that are protective of human health and the environment. Any estimated quantitation limit (EQL) that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(6) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

8.2 Reporting of Low and Zero Values

Chemical constituents that are not present above the detection limit of the analytical procedure are reported as "<.xxx" where ".xxx" is the laboratory detection limit; or "ND" (non-detect). The laboratory detection limit for that constituent will be included in a separate column in the report. There are a variety of ways to deal with data that include values below detection. General guidelines that will be used to handle the data when less than 100 percent of the data are detected are provided in Table 8.

However, procedures referenced therein will be modified as discussed in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*, (EPA, 2009), and as agreed upon with the NDEP on a case-by-case basis. The statistical tests referenced in Table 8 are detailed in either of the following EPA guidance manuals:

1. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance*, April 1989; and
2. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance*, March 2009.

8.3 Normality Testing

The original data must be tested for normality using the Shapiro Wilk Test of Normality (either single group or multiple group version) for sample size up to 50 and the Shapiro-Francia Test of Normality for sample size more than 50, or other acceptable test methods. The following are used for decisions:

(1) If the original data show that the data are not normally distributed, then the data must be log-transformed and tested for normality using the above methods.

(2) If the original or the log-transformed data confirm that the data are normally distributed, then a normal distribution test must be applied.

(3) If neither the original nor the log-transformed data fit a normal distribution, then a distribution-free test must be applied.

8.4 Missing Data Values

Missing data values may result in an incomplete measure of environmental variability and an increased likelihood of falsely detecting contamination. Also, if Assessment Monitoring data are missing, there is a danger that the full extent of contamination may not be characterized. Therefore, resampling will occur within 30 days of the date of the laboratory data package to replace the missing data.

8.5 Outliers

Prior to making a definitive SSI determination, a thorough review of outliers will be performed. An outlier is a value that is much different from most other values in a data set for a given groundwater chemical constituent. The reasons for outliers may include:

- Sampling errors or field contamination;
- Analytical errors or laboratory contamination;
- Recording or transcription errors;
- Faulty sample preparation or preservation, or shelf-life exceedance; or
- Extreme, but accurately detected environmental conditions (e.g., spills, migration from facility).

Formal testing for outliers should be done only if an observation seems particularly high (by orders of magnitude) compared to the rest of the data set. If a sample value is suspect, one should run the outlier test described below (EPA, 1989). It should be cautioned, however, that this outlier test assumes that the rest of the data values, except for the suspect observation, are normally distributed (Barnett and Lewis, 1978). Since log-normally distributed measurements often contain one or more values that appear high relative to the rest, it is recommended that the outlier test be run on the logarithms of the data instead of the original observations. That way, one can avoid classifying a high log-normal measurement as an outlier just because the test assumptions were violated.

The procedure for evaluating data for the presence of outliers is as follows. Let the sample of data be denoted by $X_1, ..., X_n$. For specificity, assume that the data have been ordered and that the largest observation, denoted by X_n, is suspected of being an outlier. Generally, inspection of the data suggests values that do not appear to belong to the data set. For example, if the largest observation is an order of magnitude larger than the other observations, it would be suspect.

Step 1. Calculate the mean, x, and the standard deviation, S, of the data including all observations.

Step 2. Form the statistic, T_n:

$$T_n = (X_n - x) / S$$

Note that T_n is the difference between the largest observation and the sample mean, divided by the sample standard deviation.

Step 3. Compare the statistic T_n to the critical value given the sample size, n, in Table 8, Appendix B of EPA's statistical analysis document mentioned above. If the T_n statistic exceeds the critical value from the table, this is evidence that the suspect observation, X_n, is a statistical outlier.

If the test designates an observation as a statistical outlier, the sample should not be treated as such until a specific reason for the abnormal measurement can be determined. Valid reasons may include contaminated sampling equipment, laboratory contamination of the sample, or errors in transcription of the data values. Once a specific reason is documented, the sample should be excluded from any further statistical analysis. If a plausible reason cannot be found, the sample should be treated as a true but extreme value, not to be excluded from further analysis.

8.6 Comparison to Groundwater Protection Standards

NAC Appendix II constituents detected in statistically significant concentrations when compared to background concentrations shall be compared to the Groundwater Protection Standards (GPSs) established by the NDEP using one of the methods discussed in the following sections.

8.6.1 Direct Comparison

If one sample is collected for analysis during a sampling period, the result shall be compared to the GPS via direct comparison (i.e., greater than or less than the GPS).

8.6.2 Confidence Interval Comparison

If four or more independent samples are collected per downgradient well during a sampling period, the mean of the four samples may be compared to the GPS via the Confidence Interval statistical method using a lower 95% confidence level. The procedure for evaluating the downgradient well data is as follows:

- Calculate the mean, x, of the four samples;
- Calculate the standard deviation, s, of the sample;
- Determine the critical value, t_c, for a confidence level of 90% (5% on each tail) and degrees of freedom, d.f. = n-1;
- Calculate E, where $E = (t_c)*(s / (n)^{\wedge 0.5})$;
- Calculate the lower 5% Confidence Interval, $L_{0.05}CI$, where $L_{0.05}CI = (x - E)$; and
- Compare the $L_{0.05}CI$ to the GPS.

If the $L_{0.05}$CI is less than the GPS, there is no statistical increase in the mean of the downgradient monitoring data for that point-of-compliance monitoring well.

9.0 GROUNDWATER PROTECTION STANDARDS

In accordance with NAC 444.7492, the administrator of the NDEP shall determine a GPS for each NAC Appendix II constituent detected in the groundwater. The GPS shall be established using the following guidance:

(1) For constituents for which a maximum contaminant level (MCL) has been promulgated under Section 1412 of the Safe Drinking Water Act (Part 141, Title 40, Code of Federal Regulations), the MCL for that constituent will be the GPS;

(2) For constituents for which MCLs have not been promulgated, a level equal to:

  (a) The background concentration of the constituent; or

  (b) An appropriate Alternate Concentration Limit (ACL) that is based on the protection of public health and safety and complies with requirements of NAC 444.7492.1(b)2.

(3) For constituents for which the background level is higher than the MCL established by the EPA, the background concentration for that constituent will be the GPS.

9.1 Definitions

The following definitions are applied during establishment of the GPS:

Maximum Contaminant Levels: The maximum contaminant level (MCL) is the EPA Drinking Water Standard, as promulgated by the EPA under the Safe Drinking Water Act, and is subject to change without notice. MCLs are listed in the EPA's *Drinking Water Regulations and Health Advisories* (EPA, 2002).

Action Limits: *In lieu* of MCLs, action limits have been established by the EPA for copper and lead. Action limits are listed in the EPA's *Drinking Water Regulations and Health Advisories*.

Alternate Concentration Limits: Per NAC 444.7492.1(b)2, the Director of the NDEP may establish a risk-based Alternate Concentration Limit (ACL) for constituents without an established MCL.

Estimated Quantitation Limits: The Estimated Quantification Limit (EQL) is an inter-laboratory concept derived from laboratory performance of selected laboratories (not all laboratories). EQLs provide performance goals and were formerly referred to as Practical Quantitation Limits (PQL).

10.0 EVALUATION OF CHEMICAL ANALYTICAL DATA

The following decision criteria will be used to direct the GMP based on the results of the statistical analyses performed in accordance with Section 8.0.

10.1 Detection Monitoring Phase

The Detection Monitoring Program will continue until the post-closure period at the facility is terminated or until a statistically significant increase over background concentrations for one or more NAC Appendix I constituents is noted, at which time the Assessment Monitoring Program will be implemented unless a successful Alternate Source Demonstration has been submitted.

If one or more constituents listed in NAC Appendix I is shown to be present in statistically significant concentrations when compared to background, Bedroc may collect a verification sample from the affected well within the compliance monitoring period (180 days from the date of sampling for quarterly monitoring). If the verification sample is also indicative of a statistically significant increase (SSI) when compared to background, then the permittee will proceed to the Assessment Monitoring Program or submit an Alternate Source Demonstration. If the Alternate Source Demonstration is not approved by the NDEP, the owner/operator shall implement the Assessment Monitoring Program within 90 days of the disapproval. If the verification sample refutes the initial SSI, the facility shall remain in the Detection Monitoring Phase.

10.2 Assessment Monitoring Phase

If, after entering the Assessment Monitoring Phase, the concentrations of all NAC Appendix II constituents are shown to be at or below background values for two consecutive sampling events, the facility shall notify the NDEP of this finding. Furthermore, the monitoring program at the facility may revert to the Detection Monitoring Program.

If the concentration of any NAC Appendix II constituent is shown to be statistically significant when compared to established background, but the concentration is shown to be below the GPS established by the NDEP using the statistical procedures discussed in Section 8.0 of this Groundwater Monitoring Plan, the facility shall remain in the Assessment Monitoring Phase.

If the concentration of any NAC Appendix II constituent is shown to be statistically significant when compared to the GPS established by the NDEP using the statistical procedures discussed in Section 8.0 of this Groundwater Monitoring Plan, the permittee shall proceed with an Assessment of Corrective Measures in accordance with NAC 444.7491.3.

10.3 Assessment of Corrective Measures

In the event that analytical data indicate solid waste constituents are present in any downgradient monitoring well at a concentration greater than the GPS, the owner/operator shall, within 14 days of the finding, notify the NDEP and identify which constituents have exceeded the GPS. The owner/operator also shall characterize the nature and extent of the release, install and sample at least one monitoring well at the facility boundary in the direction of constituent migration, notify all persons who own the land or reside on the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site (as indicated by sampling of wells in accordance with NAC 444.7491.3), and shall initiate an assessment of corrective measures as required by NAC 444.7493.

In lieu of performing the nature and extent study and the assessment of corrective actions, the owner/operator may demonstrate an alternate source of contamination. The Alternate Source Demonstration, in the form of a written report to be certified by a qualified groundwater scientist, evaluates the possibility that a source other than the landfill caused the contamination; or that the SSI resulted from error in sampling, analysis or statistical evaluation, or from natural variation in the quality of the groundwater. Results of an Alternate Source Demonstration must be submitted to the NDEP within 90 days of determining that groundwater constituents are present in any downgradient monitoring well at concentrations greater than the GPS.

If a successful Alternate Source Demonstration is made and approved by NDEP, the permittee shall continue the Assessment Monitoring Phase. In the demonstration is unsuccessful, the facility shall implement the nature and extent investigation and the assessment of corrective measures in accordance with NAC 444.7493.

11.0 HYDROGEOLOGIC ASSESSMENT

After each sampling event, groundwater surface elevations will be evaluated to determine whether the requirements for locating the monitoring wells continue to be satisfied.

The direction of groundwater flow will be determined by comparing the groundwater surface elevations among the monitoring wells, and at least annually, constructing a groundwater surface contour map. The groundwater flow rate shall be determined using the following equation:

$$V=\frac{ik}{n_e}$$

where V = the groundwater flow rate (feet/day)
i = the hydraulic gradient, $\Delta h/\Delta l$ (foot/foot)
k = the maximum hydraulic conductivity (feet/day)
n_e = the effective porosity of the host medium (unitless)
Δh = the change in groundwater elevation between two wells (feet)
Δl = the distance between the same two wells (feet)

If the evaluation shows that the groundwater monitoring system does not satisfy the requirements of NAC 444.7483, the monitoring system will be modified to comply with those regulations after obtaining approval from the NDEP. Proposed revisions will be submitted to the NDEP within 30 days of determining that the system does not satisfy the requirements of NAC 444.7483; the modifications may include a change in the number, location, or depth of the monitoring wells.

12.0 REFERENCES

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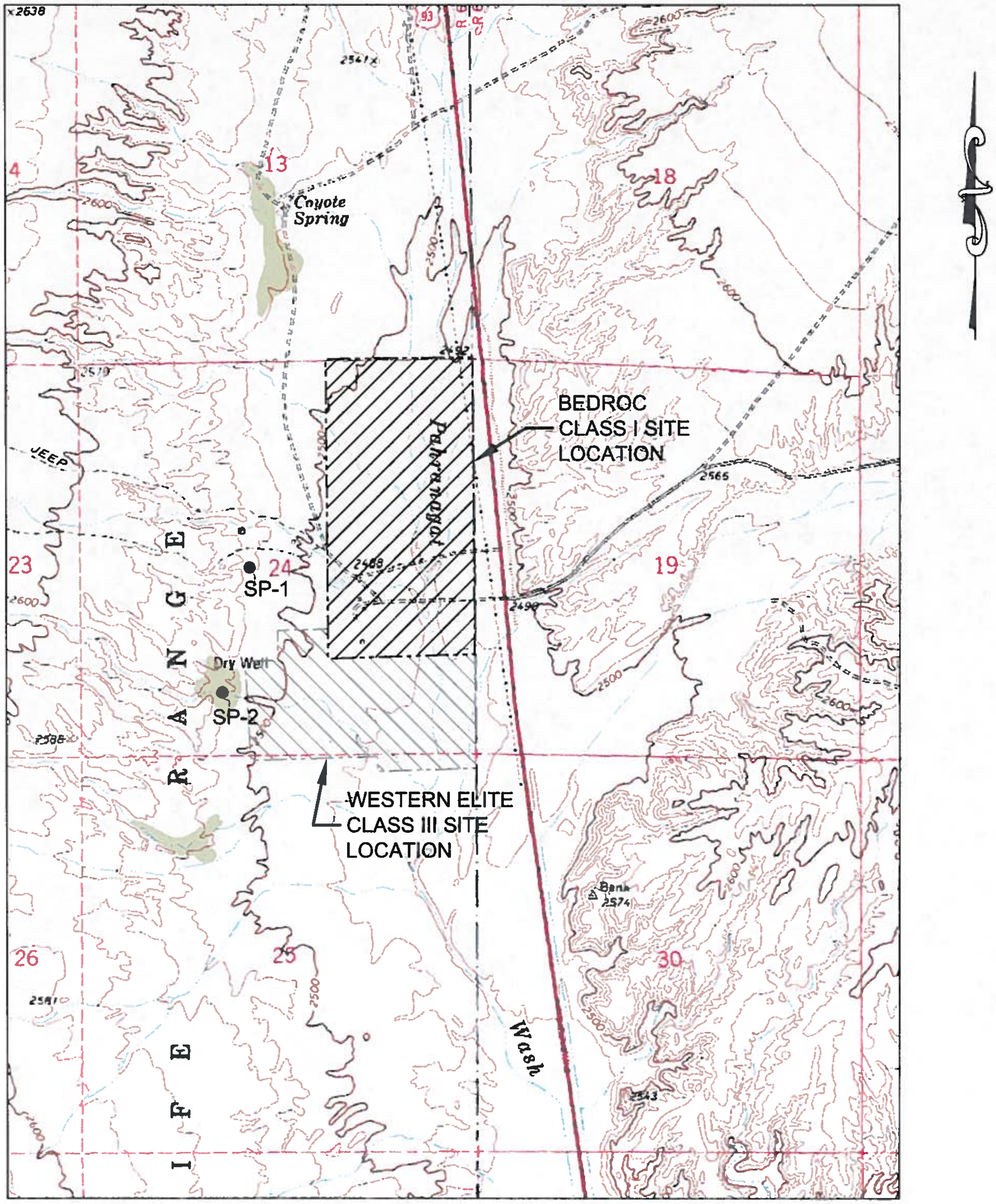
DRAWINGS



SP-1 ● = EXISTING OR FORMER SPRING LOCATION

VICINITY MAP

1"=2,000'

GRAPHIC SCALE

0 1,000 2,000 4,000

(FEET)

USGS MAP SOURCE
7.5 MIN. QUADRANGLES:
WILDCAT WASH NW, LINCOLN COUNTY, NEVADA, 1969

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

SITE LOCATION MAP

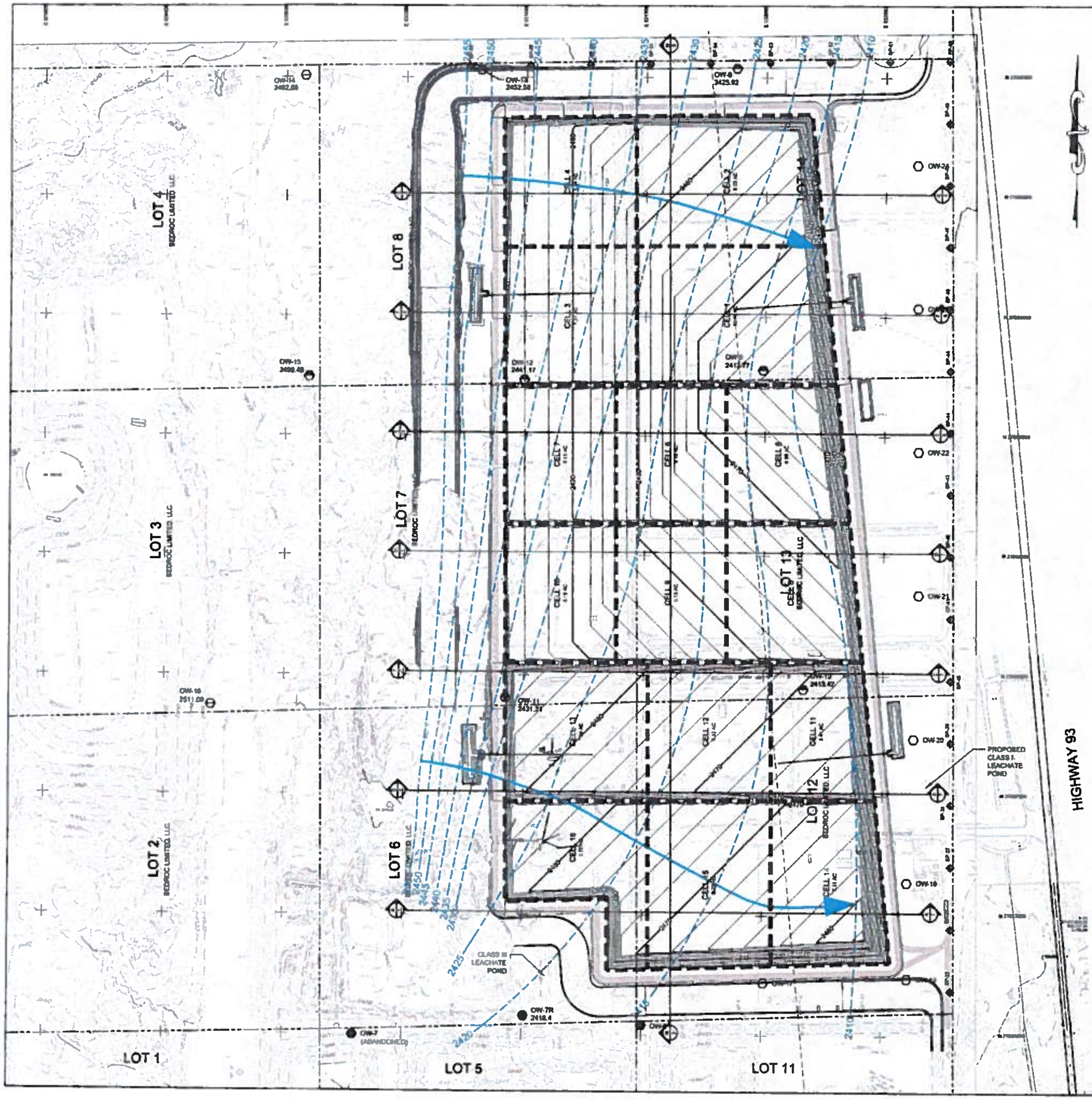
JOYCE ENGINEERING
1604 OWNBY LANE
RICHMOND, VA 23220
PHONE: (804) 355-4520

DESIGNED RLS
DRAWN DAS
CHECKED
APPROVED
DATE 10/02/13

SCALE
AS SHOWN

PROJECT NO.
383.1401.01

DRAWING NO.
1



LEGEND

— — 340 — —	EXISTING 10' TOPOGRAPHIC CONTOUR
	EXISTING 2' TOPOGRAPHIC CONTOUR
4240 — - — - —	GROUNDWATER SURFACE CONTOUR (FEET ABOVE MEAN SEA LEVEL (AMSL))
— - - — - - —	PROPERTY LINE
	EXISTING ROAD
▬ ▬ ▬ ▬	PROPOSED LIMITS OF WASTE
	CENTERLINE OF STREAM
● OW-7A 2418.4	CLASS III COMPLIANCE MONITORING WELL LOCATION WITH STATIC WATER LEVEL ELEVATION (FEET AMSL)
◒ OW-11 2431.21	OBSERVATION WELL LOCATION AND IDENTIFICATION WITH STATIC WATER LEVEL ELEVATION (FEET AMSL)
⊖ OW-16 2511.09	CLASS I FUTURE COMPLIANCE MONITORING WELL LOCATION WITH STATIC WATER LEVEL ELEVATION (FEET AMSL)
○ OW-24	CLASS I FUTURE COMPLIANCE MONITORING WELL TO BE INSTALLED
→	APPROXIMATE GROUNDWATER FLOW PATHWAY USED TO CALCULATE HYDRAULIC GRADIENT

SCHEDULE OF ADDITION AND REMOVAL OF WELLS FROM COMPLIANCE NETWORK
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

Cell No.	Monitoring Well Network Changes		Monitoring Well Network	
	Add	Abandon	Upgradient	Downgradient
Cell 1	OW-14, OW-16, OW-22, OW-23 and OW-24	OW-9	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 2	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 3	–	OW-12	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 4	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 5	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 6	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 7	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 8	OW-21	–	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 9	–	–	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 10	–	–	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 11	OW-20	OW-15	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 12	–	–	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 13	–	OW-11	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 14	OW-18 and OW-19	–	OW-14 and OW-16	OW-18, OW-19, OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 15	OW-17	–	OW-14 and OW-16	OW-17, OW-18, OW-19, OW-20, OW-21, OW-22, OW-23, and OW-24
Cell 16	OW-8 (formerly Class III facility upgradient well)	–	OW-14 and OW-16	OW-8, OW-17, OW-18, OW-19, OW-20, OW-21, OW-22, OW-23, and OW-24

NOTE:

1. GROUNDWATER CONTOURS BASED ON WATER LEVEL READINGS ON 9/3/13.
2. GROUNDWATER CONTOUR LINES PROVIDED BY GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC

GRAPHIC SCALE
0 100 200 400
(FEET)

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14	1	DAS	LBS	LBJ

LEONARD F. JOYCE JR.
CIVIL
No. 13379
5/19/14

JOYCE
ENGINEERING
1604 OWNBY LANE
RICHMOND, VA 23220
PHONE (804) 355-4520

DESIGNED RLS
DRAWN DAS
CHECKED
APPROVED
DATE 10/03/13

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

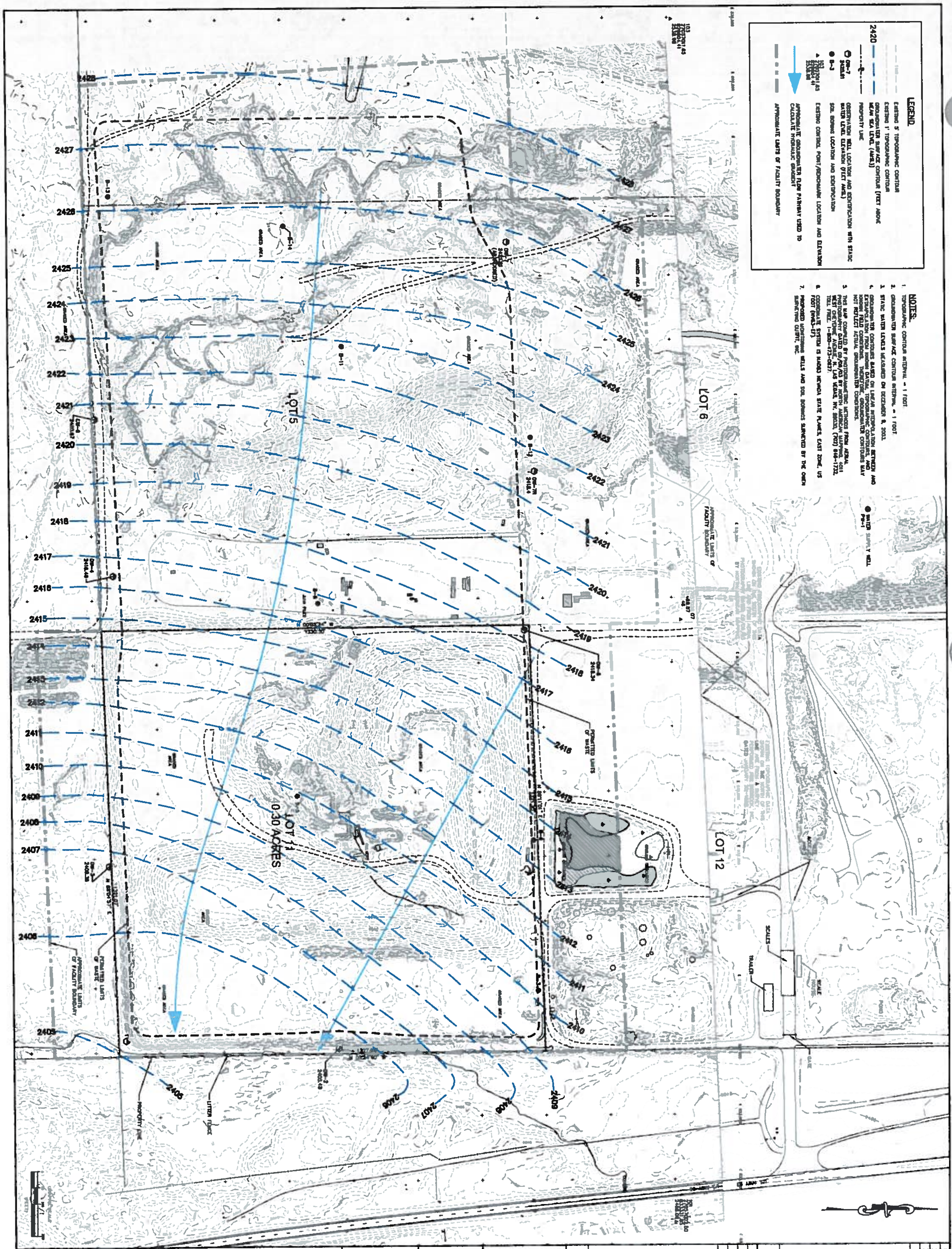
CLASS I FACILITY
GROUNDWATER MONITORING PLAN

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
2

L:\Western Elko\dwg\Northern Site Expansion\Current Working Drawings\Print Sheets\GW Monitoring Plan\Site Conditions.dwg Layout=Layout1



LEGEND

- EXISTING 5' TOPOGRAPHIC CONTOUR
- EXISTING 1' TOPOGRAPHIC CONTOUR
- 2420 GROUNDWATER SURFACE CONTOUR (FEET ABOVE MEAN SEA LEVEL (AMSL))
- PROPERTY LINE
- OW-7 2420.00 OBSERVATION WELL LOCATION AND IDENTIFICATION WITH STATIC WATER LEVEL ELEVATION (FEET AMSL)
- ● B-3 SOIL BORING LOCATION AND IDENTIFICATION
- ▲ EXISTING CONTROL POINT/BENCHMARK LOCATION AND ELEVATION
- APPROXIMATE GROUNDWATER FLOW PATHWAY USED TO CALCULATE HYDRAULIC GRADIENT
- APPROXIMATE LIMITS OF FACILITY BOUNDARY

NOTES:

1. TOPOGRAPHIC CONTOUR INTERVAL = 1 FOOT
2. GROUNDWATER SURFACE CONTOUR INTERVAL = 1 FOOT
3. STATIC WATER LEVELS MEASURED ON DECEMBER 8, 2011.
4. GROUNDWATER CONTOURS BASED ON LINEAR INTERPOLATION BETWEEN AND EXTRAPOLATION FROM KNOWN DATUM, TOPOGRAPHIC CONTOURS, AND KNOWN FIELD CONDITIONS. THEREFORE, GROUNDWATER CONTOURS MAY NOT REFLECT ACTUAL GROUNDWATER CONDITIONS.
5. THIS MAP COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 05/26/03 BY NORTH AMERICAN MAPPING, 4011 WEST CHEYENNE AVENUE, N. LAS VEGAS, NV. 89032, (702) 646-1732. TOLL FREE: 1-800-473-0877.
6. COORDINATE SYSTEM IS NAD83 NEVADA STATE PLANES, EAST ZONE, US FOOT (NV83-EF)
7. PROPOSED MONITORING WELLS AND SOIL BORINGS SURVEYED BY THE OWEN SURVEYING OUTFIT, INC.

DRAWING NO.
3

SCALE
AS SHOWN

PROJECT NO.
383.1401.01

WESTERN ELITE MATERIAL PROCESSING FACILITY
LINCOLN COUNTY, NEVADA

CLASS III FACILITY
GROUNDWATER MONITORING PLAN

JOYCE ENGINEERING
1604 EMMEY LANE
RICHMOND, VA 23230
PHONE: (804) 355-4520

DESIGNED
DRAWN CADD/SKD
CHECKED
APPROVED
DATE 12/18/12

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DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP

TABLES

TABLE 1

SUMMARY OF WELL CONSTRUCTION INFORMATION
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

Observation Well Identification	Survey Coordinates		Ground Surface Elevation (feet AMSL)	Top of PVC Casing Elevation (feet AMSL)	Boring Depth (feet bgs)	Well Depth (feet bgs)	Screened Depth (feet bgs)	Casing Inside Diameter (inches)
	Northing (Lattitude)	Easting (Longitude)						
OW-1	27,055,295.47	832,763.50	2,477.6	2,478.39	81.5	80.0	80-65	2
OW-2	27,055,957.43	832,790.96	2,479.8	2,481.56	101.5	86.4	86.4-66.4	4
OW-3	27,055,246.57	832,223.52	2,477.5	2,479.19	95.5	81.5	81.5-61.5	4
OW-4	27,055,267.61	831,324.00	2,481.7	2,484.17	85.0	79.7	79.7-59.7	4
OW-5	27,056,542.68	831,498.82	2,491.0	2,493.29	115.5	95.2	95.2-75.2	4
OW-6	27,055,214.29	830,837.53	2,488.5	2,490.88	95.5	85.6	85.6-65.6	4
OW-7	27,056,496.91	830,294.30	2,468.7	2,469.83	47.0	48.4	48.4-28.4	4
OW-7R	36.97356159	-114.98478402	2,495.1	2,497.78	95.0	95.0	95.0-75.0	2
OW-8	36.98441433	-114.98172295	2,498.5	2,500.71	90.0	90.0	90.0-70.0	2
OW-9	36.98093588	-114.98134066	2,493.0	2,493.42	95.0	95.0	95.0-75.0	2
OW-10	36.97727334	-114.98076484	2,491.8	2,494.35	95.0	95.0	95.0-75.0	2
OW-11	36.97718445	-114.98503645	2,492.9	2,495.79	76.5	75.0	75.0-55.0	2
OW-12	36.98084443	-114.98475842	2,498.4	2,501.47	75.0	75.0	75.0-55.0	2
OW-13	36.98441304	-114.98536724	2,505.6	2,508.48	75.0	75.0	75.0-55.0	2
OW-14	36.98434574	-114.98789513	2,519.7	2,522.65	47.0	47.0	47.0-27.0	2
OW-15	36.98088998	-114.98782724	2,518.0	2,520.06	38.0	38.0	38.0-18.0	2
OW-16	36.97713994	-114.98924282	2,523.2	2,525.91	31.5	31.5	31.5-11.5	2

Notes:

AMSL = above mean sea level
bgs = below ground surface
Northing and easting given for wells OW-1 through OW-7.
Latitude and longitude given for wells OW-7R through OW-16.

TABLE 2

SUMMARY OF DEPTH TO WATER MEASUREMENTS
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

Observation Well Identification	Ground Surface Elevation (feet AMSL)	Top of PVC Casing Elevation (feet AMSL)	Sample Date	Depth to Water (feet)	Static Water Level Elevation (feet AMSL)
OW-8	2,498.5	2,500.71	8/21/2013	72.30	2,426.21
			9/3/2013	74.79	2,425.92
OW-9	2,493.0	2,493.42	8/21/2013	80.18	2,412.78
			9/3/2013	80.65	2,412.77
OW-10	2,491.8	2,494.35	8/21/2013	78.16	2,413.65
			9/3/2013	80.93	2,413.42
OW-11	2,492.9	2,495.79	8/21/2013	61.54	2,431.34
			9/3/2013	64.58	2,431.21
OW-12	2,498.4	2,501.47	8/21/2013	56.96	2,441.45
			9/3/2013	60.30	2,441.17
OW-13	2,505.6	2,508.48	8/21/2013	52.66	2,452.97
			9/3/2013	55.90	2,452.58
OW-14	2,519.7	2,522.65	8/21/2013	36.98	2,482.74
			9/3/2013	40.09	2,482.56
OW-15	2,518.0	2,520.06	8/21/2013	18.26	2,499.74
			9/3/2013	20.57	2,499.49
OW-16	2,523.2	2,525.91	8/21/2013	11.50	2,511.67
			9/3/2013	14.82	2,511.09

Note: AMSL = above mean sea level

TABLE 3

SUMMARY OF SLUG TESTING RESULTS
WESTERN ELITE MATERIAL PROCESSING FACILITY
LINCOLN COUNTY, NEVADA

Observation Well	Estimated Hydraulic Conductivity		
	Falling Head Slug Test (feet/day)	Rising Head Slug Test (feet/day)	Average (feet/day)
OW-1	0.24	--	0.24
OW-2	0.22	0.78	0.50
OW-3	0.36	0.81	0.59
OW-4	1.65	1.18	1.42
OW-5	0.7	0.9	0.80
OW-6	11.42	10.65	11.04
OW-7	--	2.28	2.28
Geometric Average	0.79	1.59	1.12

SCHEDULE OF ADDITION AND REMOVAL OF WELLS FROM COMPLIANCE NETWORK
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

Cell No.	Monitoring Well Network Changes		Monitoring Well Network	
	Add	Abandon	Upgradient	Downgradient
Cell 1	OW-14, 0W-16, OW-22, OW-23 and OW-24	OW-9	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 2	--	--	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 3	--	OW-12	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 4	--	--	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 5	--	--	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 6	--	--	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 7	--	--	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 8	OW-21	--	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 9	--	--	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 10	--	--	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 11	OW-20	OW-10	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 12	--	--	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 13	--	OW-11	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 14	OW-18 and OW-19	--	OW-14 and OW-16	OW-18, OW-19, OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 15	OW-17	--	OW-14 and OW-16	OW-17, OW-18, OW-19, OW-20, OW-21, OW-22, OW-23, and OW-24
Cell 16	OW-5 (formally Class III facility upgradient well)	--	OW-14 and OW-16	OW-5, OW-17, OW-18, OW-19, OW-20, OW-21, OW-22, OW-23, and OW-24

P:\Western Elite\Western Elite Landfill\Permitting NV\2013 Class I Expansion\Record\Part B\13_Groundwater Monitoring Plan\Tables\TABLE 4 - Schedule of Well Additions rev 2014_0516

TABLE 5

SUMMARY OF GROUNDWATER MONITORING PARAMETERS
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

PHASE 1 MONITORING PARAMETERS
Total Organic Carbon (TOC)
Total Organic Halides (TOX)
Total Kjeldahl Nitrogen
Nitrate
Nitrite
Chemical Oxygen Demand (COD)
Chloride
Sulfate
pH
Specific Conductance
Dissolved Oxygen
Redox Potential
Depth to Water
Appendix II to Part 258

TABLE 6

SUMMARY OF PHASE 2 / LEACHATE MONITORING PARAMETERS
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

LEACHATE MONITORING PARAMETERS
Appendix A to Part 423 Priority Pollutants List
Appendix II to Part 258 Haz Inoganic and Organic Constituents

TABLE 7

SAMPLING AND PRESERVATION PROCEDURES FOR THE GROUNDWATER MONITORING PROGRAM
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

Parameter	Container & Volume	Preservative	Maximum Holding Time
Cyanide	P, G 500 mL	4°C, NaOH to pH>12, 0.6 g Ascorbic Acid	14 days
Sulfide	P, G; 500 mL	4°C, add Zinc Acetate	7 days
Mercury (total)	P; 300 mL	HNO_3 to pH<2	28 days
Metals (total) except mercury	P 1000 mL	HNO_3 to pH<2	6 months
Acrolein and acrylonitrile	2-40 ml VOA w/G, Teflon lined septum	4°C, 0.008% $Na_2S_2O_3$, adjust pH to 4-5	14 days
Benzidines	G, Teflon lined cap, 1000 mL	4°C, 0.008% $Na_2S_2O_3$, adjust pH to 4-5	7 days to extraction, 40 days after extraction
Haloethers	G, Teflon lined cap, 1000 mL	4°C, 0.008% $Na_2S_2O_3$	7 days to extraction, 40 days after extraction
Phthalate esters	G 1000 mL	4°C	7 days to extraction, 40 days after extraction
Nitrosamines	G, Teflon lined cap, 1000 mL	4°C, store in dark, 0.008% $Na_2S_2O_3$	7 days to extraction, 40 days after extraction
Nitroaromatics and cyclic ketones	G, Teflon lined cap, 1000 mL	4°C, store in dark, 0.008% $Na_2S_2O_3$	7 days to extraction, 40 days after extraction
PCBs	G, Teflon lined cap, 1000 mL	4°C	7 days to extraction, 40 days after extraction
Phenols	G, Teflon lined cap, 1000 mL	4°C, 0.008% $Na_2S_2O_3$	7 days to extraction, 40 days after extraction
Purgeable Aromatic Hydrocarbons	2-40 ml VOA w/G, Teflon lined septum	4°C, 0.008% $Na_2S_2O_3$, HCl to pH 2	14 days
Purgeable halocarbons	2-40 ml VOA w/G, Teflon lined septum	4°C, 0.008% $Na_2S_2O_3$	14 days
Polynuclear aromatic hydrocarbons	G, Teflon lined cap, 1000 mL	4°C, store in dark, 0.008% $Na_2S_2O_3$	7 days to extraction, 40 days after extraction
Chlorinated hydrocarbons	G, Teflon lined cap, 1000 mL	4°C	7 days to extraction, 40 days after extraction
Pesticides	G, Teflon lined cap, 1000 mL	4°C, pH 5-9	7 days to extraction, 40 days after extraction

Notes: P - Plastic, G - Glass, T – Fluorocarbon Resin (PTFE, Teflon, FEP, etc.)
Do not allow any head space in VOA container.

TABLE 8

METHODS FOR HANDLING DATA BELOW THE DETECTION LIMIT
BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

Percentage of Non-Detects in the Data Base	Statistical Analysis Method
Less than 25%	Replace NDs with DL or QL then proceed with parametric procedures: Tolerance Limits Prediction Limits Control Charts
25 to 50%	Use Cohen's or Aitchison's adjustment, then proceed with: Tolerance Limits Prediction Limits Confidence Intervals Control Charts
Greater than 50% but less than 90%	Proceed with Nonparametric Methods: Tolerance Limits Prediction Limits Wilcoxin-Rank Sum Test
90% and greater	Proceed with: Non-Parametric Prediction Limits or Tolerance Limits

APPENDIX I

WELL CONSTRUCTION LOGS

MONITORING WELL LOG 1

MW-1

CLIENT: JBR Environmental

PROJECT: Contract Drilling

WELL LOCATION: See Site Diagram

ELEVATION (ft.): Not Measured

SITE: 28 miles south of Alamo, Nevada

GRAPHIC LOG | DESCRIPTION | WELL DETAIL | DEPTH (FT.) | FORMATION

BOREHOLE DIAMETER: 8 in.
WELL DIAMETER: 2 in.

Depth	Description
1.5	SILTY SAND -sl. moist, lt. brown
3.0	SANDY SILT -sl. moist, lt. brown
9.0	SILTY SAND -sl. moist, lt. brown w/some gravel w/more sand
11.0	SANDY SILT -sl. moist, lt. brown w/more sand
15.0	SILTY SAND -sl. moist, lt. brown
15.5	SILTY SAND -sl. moist, lt. brown
21.0	SANDY SILT -sl. moist, lt. brown w/more sand
23.5	SILTY SAND -sl. moist, lt. brown
30.0	SANDY SILT -sl. moist, lt. brown

lockable well plug.

Depth (ft.)	Formation	
5		
10	R 26	
15	R 20	Grout
20	R 16	
25	R 16	
30		

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

*Sample Type: ppm = Parts Per Million
R = Ring X = Not Retrieved

CONDITIONS MAY DIFFER WITH TIME OR AT OTHER LOCATIONS. THIS SUMMARY APPLIES ONLY AT THIS LOCATION AT THE TIME OF DRILLING.

NOTES:
Water level measured at 73 ft.

Terracon

DATE DRILLED: 12-19-96

PAGE NUMBER: Page 1 of 3

PROJECT NO.: 64965477

PLATE: A-1

MONITORING WELL LOG 1

OW-1

CLIENT: JBR Environmental	PROJECT: Contract Drilling
WELL LOCATION: See Site Diagram / ELEVATION (ft.): Not Measured	SITE: 28 miles south of Alamo, Nevada

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AT THE TIME OF CONDITIONS MAY DIFFER WITH TIME OR AT OTHER LOCATIONS.

GRAPHIC LOG	DESCRIPTION
	31.0 SANDY SILT -sl. moist, lt. brown
	SILTY SAND -sl. moist, lt. brown
	34.0 SANDY SILT -sl. moist, lt. brown
	37.5 SILTY SAND -sl. moist, lt. brown w/more silt
	45.0 SILTY SAND -sl. moist, lt. brown w/more sand w/trace gravel w/more gravel
	56.0 SANDY GRAVEL -sl. moist, lt. brown
	58.0 SILTY SAND -w/gravel, sl. moist, lt. brown
	60.0

Continued Next Page

WELL DETAIL: Grout

DEPTH (FT.)	FORMATION	
35		
40	R	15
45		
50	R	32
55		
60		

(Sample above 35 ft.: R 17)

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

*Sample Type: ppm = Parts Per Million
R = Ring X = Not Retrieved

NOTES:
Water level measured at 73 ft.

Terracon

DATE DRILLED: 12-19-96	PAGE NUMBER: Page 2 of 3
PROJECT NO.: 64965477	PLATE: A-2

MONITORING WELL LOG 1

OW-1

CLIENT: JBR Environmental

PROJECT: Contract Drilling

WELL LOCATION: See Site Diagram

ELEVATION (ft.): Not Measured

SITE: 28 miles south of Alamo, Nevada

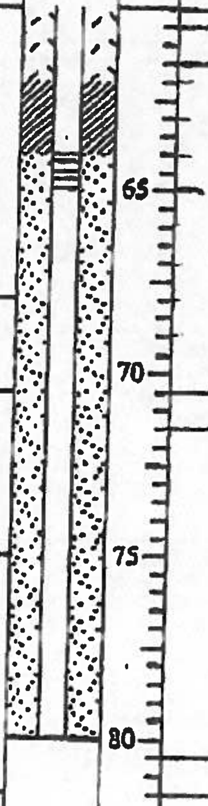
THIS SUMMARY APPLIES ONLY AT THIS LOCATION AT THE TIME OF D . CONDITIONS MAY DIFFER WITH TIME OR AT OTHER LOCATIONS.

GRAPHIC LOG

DESCRIPTION	Depth
SANDY GRAVEL -sl. moist to moist, lt. brown w/more sand trace cobbles	68.0
SILTY SAND -w/gravel, sl. moist to moist, lt. brown	70.5
SANDY GRAVEL -sl. moist to moist, lt. brown w/some cobbles, moist ⊻	75.0
SANDY GRAVEL -w/some cobbles, moist, lt. brown	81.5

Bottom at 81.5 feet

WELL DETAIL



FORMATION

R	63	Grout
		Bentonite
		Casing
R	86	Screen
R	24	

capped w/ the galvanized lockable steel
4x4 inch well cover

screen from 65' to 80'
slot size 0.02 in
sch. 40 flush joint screen and
casing [illegible] silt cap at bottom

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

*Sample Types: ppm = Parts Per Million
R = Ring X = Not Recovered

NOTES:
Water level measured at 73 ft.

Terracon

DATE DRILLED: 12-19-96

PAGE NUMBER: Page 3 of 3

PROJECT NO.: 64965477

PLATE: A-3

JOYCE ENGINEERING, INC

LOG OF BORING B-2 (OW-2)

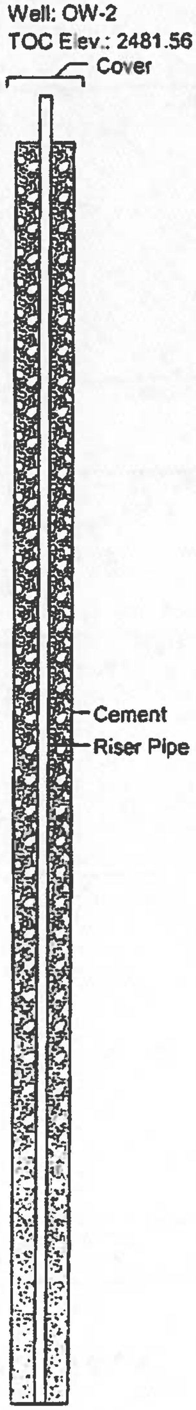
(Page 1 of 4)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/1/03	Drilling Company	: Davis Drilling
Date Completed	: 12/1/03	Northing Coord.	: 27,055,957.4
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,790.9
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2479.8	GRAPHIC	USCS	DESCRIPTION
0 5	2479 2474		SP	Fine-grained well sorted sand.
10	2469		GM	Very coarse to pebble size rock fragments. 80% black and brown chert and volcanic fragments with 20% whitish-tan soft friable fragments.
15	2464		SM	90% nodules of brown silty fine sand with thinly laminated soft fragments of brown silty sand. 10% angular rock fragments.
20	2459		SM	Brown silty fine sand with trace rock fragments. Poor sample recovery.
25	2454		SM	Brown silty fine sand with trace rock fragments. Poor sample recovery.
30			SM	Brown silty fine sand with trace rock fragments. Poor sample recovery Drill rig encounters strong resistance at 28 feet.



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/1/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 1.8 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020-inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 87.5 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-2 (OW-2)

(Page 2 of 4)

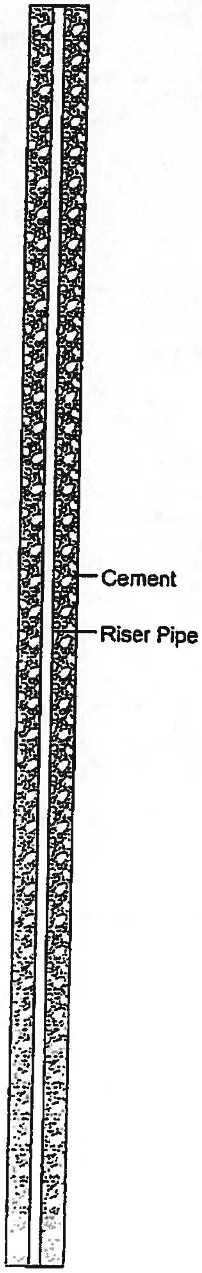
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/1/03	Drilling Company	: Davis Drilling
Date Completed	: 12/1/03	Northing Coord.	: 27,055,957.4
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,790.9
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2479.8	GRAPHIC	USCS	DESCRIPTION
30	2449		SM	
35	2444		SM	Brown silty fine sand with trace rock fragments. Poor sample recovery.
40	2439		SM	Large brown nodules of silty fine sand with trace clay with white and gray rock fragments.
45	2434		SM	Brown nodules of silty fine sand with trace rock fragments.
50	2429		GM	Bit starts grinding at 46.5 feet. Stops at 47.5 feet and then sporadically. 70% angular rock fragments and rounded pebbles. 30% brown silty fine sand nodules.
55	2424		GM	80% angular rock fragments to 54 feet. Black, gray, and brown chert and volcanic fragments. Trace clear quartz. Poor sample recovery after 54 feet. Fine sand with trace rock fragments.
60			SM	Small nodules of brownish-gray silty fine sand with trace clay. Bit starts grinding at 60 feet.

Well: OW-2
TOC Elev.: 2481.56



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/1/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 1.8 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020-inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 87.5 feet.

ENGINEERING, INC

LOG OF BORING B-2 (OW-2)

(Page 3 of 4)

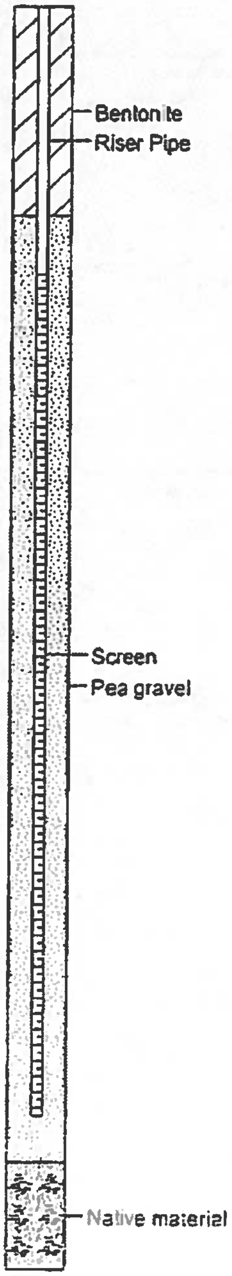
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/1/03	Drilling Company	: Davis Drilling
Date Completed	: 12/1/03	Northing Coord.	: 27,055,957.4
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,790.9
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2479.8	GRAPHIC	USCS	DESCRIPTION
60	2419		GM	
65	2414		GM	Hit a void or very soft sediment from 61.5 to 63.0 feet. Bit dropped. Small fragments of soft white rock.
70	2409		GM	Bit starts grinding hard at 67 feet. White friable chips of soft rock with 10% nodules of white silty fine sand with trace clay.
75	2404		GM	95% rock fragments, black and brown volcanics and chert with trace grayish-white glazed fragments (quartzite?). 5% nodules of white silty fine sand with clay.
80	2399		GM	90% rock fragments. Black, brown, and gray with black speckles. Trace grayish-white glazed fragments. 10% nodules of grayish-white silty coarse sand.
85	2394		GM	80% rock fragments. 20% grayish-brown silty fine sand nodules.
90			GM	85% rock fragments. 15% grayish-brown silty fine sand.

Well: OW-2
TOC Elev.: 2481.56



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/1/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 1.8 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020-inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
2. Borehole collaspsed to approximately 87.5 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-2 (OW-2)

(Page 4 of 4)

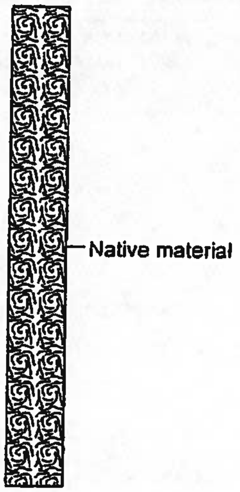
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/1/03	Drilling Company	: Davis Drilling
Date Completed	: 12/1/03	Northing Coord.	: 27,055,957.4
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,790.9
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2479.8	GRAPHIC	USCS	DESCRIPTION
90	2389		GM	
			GM	Rock fragments. Picking up 50% gray rock fragments at 94 feet.
95	2384		ML	Rock fragments with trace of whitish-gray silty fine sand. Grinding stops at 95 feet. Grayish-brown clayey silt with sand and trace rock fragments.
100	2379			Boring terminated at 101.5 feet below grade.
105	2374			
110	2369			
115	2364			
120				

Well: OW-2
TOC Elev.: 2481.56



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/1/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 1.8 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020-inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 87.5 feet.

JOYCE
ENGINEERING, INC.

LOG OF BORING B-3

(Page 1 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,056,577.2
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,615.2
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2490.4	GRAPHIC	USCS	DESCRIPTION	NOTES
0 5	2490 2485	▨	Fill	Gravel fill to 1.0 foot. Wood chips and plastic from 1.0 to 3.5 feet. Road gravel from 3.5 to 5.0 feet. Wood chips from 5.0 to 6.5 feet.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
		▨	Fill	Wood chips, plastic and styrofoam to 10.0 feet. Sand and gravel from 10.0 to 11.5 feet.	
10 15	2480 2475	⁘	GM	Angular rock fragments. Black to dark brown volcanic, chert and limestone fragments with trace of clear and gray quartz.	
		⁘	GM	Fractured rock fragments. Started picking up nodules of brown silty fine sand at 19.5 feet.	
20 25	2470 2465	░	SM	Strong brown silty fine sand. Poor sample recovery.	
30		░	SM	Brown to grayish-brown clayey silt with fine sand.	

ENGINEERING, INC.

LOG OF BORING B-3

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,056,577.2
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,615.2
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2490.4	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2460		SM		
35	2455		SM	Brown to grayish-brown clayey silt with fine sand.	
0	2450		SM	Grayish-brown clayey silt with fine sand.	
45	2445		SM	Grades to brown silty fine sand with poor recovery.	
50	2440		SM	Brown silty fine sand with trace clay.	
55	2435		SM	Brown silty fine sand. Grades to coarse sand at 55 feet.	
60			GM	Angular rock fragments with small nodules of brown clayey fine sand. Rock fragments are small black to light gray with trace clear quartz.	

ENGINEERING, INC.

LOG OF BORING B-3

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,056,577.2
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,615.2
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2490.4	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2430		GM		
65	2425		GM	50% brown silty fine sand with trace clay. 50% medium to coarse angular rock fragments.	
70	2420		GM	Bit starts grinding at 69.5 feet. 50% brown silty fine sand with trace clay. 50% medium to coarse angular rock fragments to 69.5 feet. Black and brown angular rock fragments from 69.5 to 71.5 feet.	
75	2415		GM	Angular rock fragments (volcanic, chert, limestone) with trace of clear quartz.	
80	2410		GM	Coarse angular rock fragments.	
85	2405		ML	Bit stops grinding at 82 feet. Tan clayey silt nodules with rock fragments.	
90				Boring terminated at 86.5 feet below grade.	

JOYCE ENGINEERING, INC.

LOG OF BORING B-4 (OW-3)

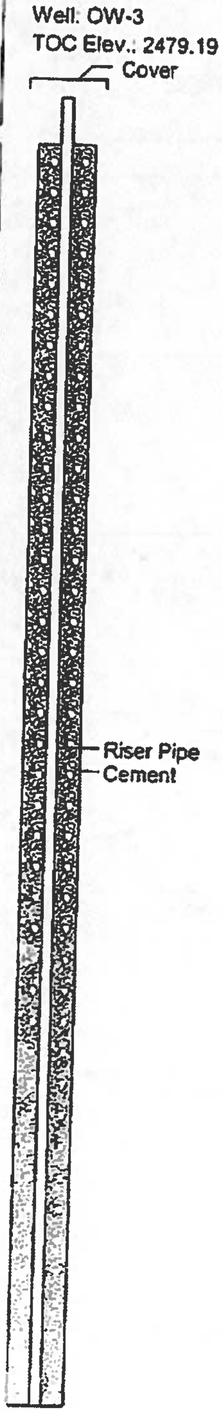
(Page 1 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/8/03	Drilling Company	: Davis Drilling
Date Completed	: 12/8/03	Northing Coord.	: 27,055,246.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,223.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2477.5	GRAPHIC	USCS	DESCRIPTION
0	2477		SP	Rock fragments with gravel and sand.
5	2472		SP	Small well sorted rock fragments.
10	2467		SP	Rock fragments to 13.0 feet. Transitioned to brown silty fine sand with trace clay.
			SC	Brown silty fine sand with trace clay.
15	2462		SC	Nodules of silty fine sand.
20	2457		SC	Nodules of silty fine sand.
25	2452		SC	Nodules of silty fine sand. Poor sample recovery.
30	2447		SC	Nodules of silty fine sand.
35				



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/8/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 1.7 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type	: Washed pea gravel

WELL SCREEN SEAL

Type	: Bentonite

ANNULUS SEAL

Type	: Cement

PROTECTIVE CSG.

Type	: 6-inch steel

WELL PAD

Type	: Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 82 feet.

JOYCE ENGINEERING, INC

LOG OF BORING B-4 (OW-3)

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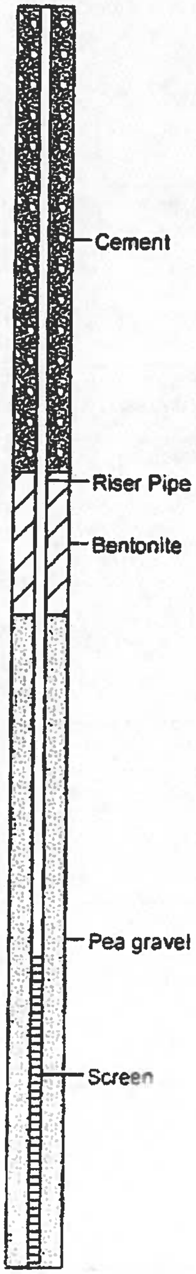
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/8/03	Drilling Company	: Davis Drilling
Date Completed	: 12/8/03	Northing Coord.	: 27,055,246.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,223.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2477.5	GRAPHIC	USCS	DESCRIPTION
35	2442		SC	
			SC	Nodules of silty fine sand.
40	2437		SC	Nodules of silty fine sand.
45	2432		GM	Bit starts grinding at 46 feet. Poorly sorted black rock fragments with 10% nodules of brown clayey fine sand and silt.
50	2427		GM	Large black rock and brown sandstone fragments. Possible conglomerate.
55	2422		GM	Rock fragments, trace rounded pebbles.
60	2417		GM	Rock fragments, trace rounded pebbles.
65	2412		GM	Rock fragments.
70				

Well: OW-3
TOC Elev.: 2479.19



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/8/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 1.7 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collapsed to approximately 82 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-4 (OW-3)

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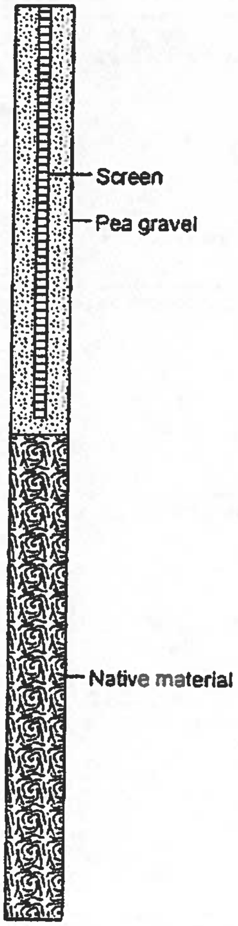
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/8/03	Drilling Company	: Davis Drilling
Date Completed	: 12/8/03	Northing Coord.	: 27,055,246.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,223.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2477.5	USCS	DESCRIPTION
70	2407	GM	
		GM	Large rock fragments.
75	2402	GM	Grinding stops at 78 and starts again at 80 feet. Rock fragments.
80	2397	SP	Rock fragments with 50% brownish-gray nodules of silty fine sand. Start picking up tannish-white clay nodules at 84 feet.
85	2392	SP	Brown nodules of clayey silt with fine sand with 40% rock fragments.
90	2387	SP	Brown nodules of clayey silt with fine sand with 40% rock fragments.
95	2382		Boring terminated at 95.5 feet below grade.
100	2377		
105			

Well: OW-3
TOC Elev.: 2479.19



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/8/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 1.7 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 82 feet.

JOYCE
ENGINEERING, INC.

LOG OF BORING B-5

(Page 1 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/24/03	Drilling Company	: Davis Drilling
Date Completed	: 11/24/03	Northing Coord.	: 27,055,833.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,009.3
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2471.9	GRAPHIC	USCS	DESCRIPTION	NOTES
0	2471		Fill	Stockpiled material to four feet. Wood chips and plastic. Transitioned to reddish-brown clayey silt with trace sand.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
5	2466		SC		
10	2461		SC	Brown clayey silt nodules with trace of sand.	
15	2456		SC	Brown clayey silt nodules with trace of sand.	
20	2451		SC	Brown clayey silt nodules with trace of sand.	
25	2446		SC	Brown clayey silt nodules with trace of sand.	
30			SC	Brown clayey silt nodules with trace of sand. Bit balling up with clay at 28 feet.	

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LOG OF BORING B-5

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/24/03	Drilling Company	: Davis Drilling
Date Completed	: 11/24/03	Northing Coord.	: 27,055,833.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,009.3
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2471.9	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2441		SC		
35	2436		SC	Brown clayey silt nodules with trace of sand.	
			SC	Angular rock fragments with 10% rounded pebbles. Gravel encountered at 39 feet.	
40	2431		GM		
45	2426		GM	Angular rock fragments. Black and brown chert and volcanic fragments.	
50	2421		SM	50% light brownish-gray clayey silt nodules with fine sand. 50% angular rock fragments.	
55	2416		SM	Poor sample recovery. Nodules of silty sand with trace clay, rock fragments, and rounded small pebbles.	
60			GM	Bit starts grinding at 57 feet. Angular chert, volcanic, and limestone rock fragments with trace of clear quartz.	

JOYCE ENGINEERING, INC.

LOG OF BORING B-5

(Page 3 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/24/03	Drilling Company	: Davis Drilling
Date Completed	: 11/24/03	Northing Coord.	: 27,055,833.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,009.3
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2471.9	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2411		GM		
65	2406		GM	Angular dark gray to brown and black chert and volcanic rock fragments.	
			GM	Bit stops grinding at 69 feet. Angular rock fragments with nodules of brown clayey silt.	
70	2401		SC		
75	2396		SC	Brown nodules of clayey fine sand with 20% rock fragments.	
80	2391		SC	Brown nodules of clayey fine sand.	
				Boring terminated at 81.5 feet below grade.	
85	2386				
90					

JOYCE ENGINEERING, INC.

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

LOG OF BORING B-6

(Page 1 of 3)

Date Started	: 11/24/03	Drilling Company	: Davis Drilling
Date Completed	: 11/24/03	Northing Coord.	: 27,058,566.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,149.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2489.9	GRAPHIC	USCS	DESCRIPTION	NOTES
0		▨	Fill	Gravel fil to 1.5 foot. Stockpiled wood chips from 1.5 to 6.5 feet.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
	2489				
5					
	2484				
		▨	Fill	Stockpiled wood chips and plastic material to 11.0 feet.	
0					
	2479				
		▒	SC	Yellowish-brown clayey fine sand with small rounded pebbles.	
15					
	2474				
		▒	SC	Brown clayey fine sand.	
20					
	2469				
		▒	SC	Brown clayey fine sand.	
25					
	2464				
		▒	SC	Brown silty fine sand with trace clay. Poor sample recovery.	
30					

JOYCE
ENGINEERING, INC

LOG OF BORING B-6

(Page 2 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started : 11/24/03
Date Completed : 11/24/03
Hole Diameter : 8.25-inches
Drilling Method : OD mud rotary
Sample Method : washed grab

Drilling Company : Davis Drilling
Northing Coord. : 27,056,566.0
Easting Coord. : 832,149.5
Survey By : Owens Surveying Outfit
Logged By : Mike Williams

Depth in Feet	Surf. Elev. 2489.9	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2459		SC		
35	2454		SC	Brown silty fine sand. Poor sample recovery. Lost circulation at 35 feet. Thickened drilling mud.	
40	2449		SC	Brown silty fine sand with trace clay. Poor sample recovery.	
45	2444		SC	Brown silty fine sand with trace clay. Poor sample recovery.	
50	2439		SC	Lost circulation again at 46.5 feet. Thicken mud some more. Brown silty fine sand with trace clay.	
55	2434		SC	Lost circulation at 55.8 feet. Thicken drilling mud. Brown silty fine sand with trace clay. Poor sample recovery.	
			SC	Bit starts grinding at 59.0 feet. 60% brown silty fine sand with trace clay. 40% coarse rock fragments. Cobbles at 59 feet. Bit stops grinding at 61.5 feet.	
60			SP		

JOYCE ENGINEERING, INC.

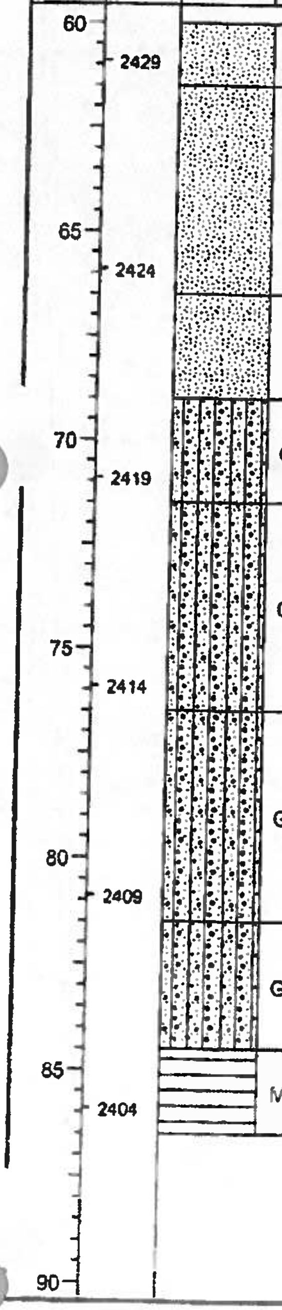
LOG OF BORING B-6

(Page 3 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/24/03	Drilling Company	: Davis Drilling
Date Completed	: 11/24/03	Northing Coord.	: 27,056,566.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 832,149.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams



USCS	DESCRIPTION	NOTES
SP		
SP	60% brown silty fine sand with trace clay. 40% coarse rock fragments.	
SP	80% light brown silty fine sand with trace clay. 20% rock fragments.	
GM	Bit grinding at 69 feet, stops at 70.5 feet, and starts again at 71 feet.	
GM	80% angular rock fragments with trace of obsidian and clear quartz. 20% brown clayey silt with fine sand.	
GM	Rock fragments (chert, volcanic, and light gray fragments) with trace of clear quartz.	
GM	80% rock fragments. Bit stops grinding at 84.5 feet. Clayey fine sand nodules in last foot of drilling.	
ML		

Boring terminated at 86.5 feet below grade.

ENGINEERING, INC.

LOG OF BORING B-7 (OW-4)

(Page 1 of 3)

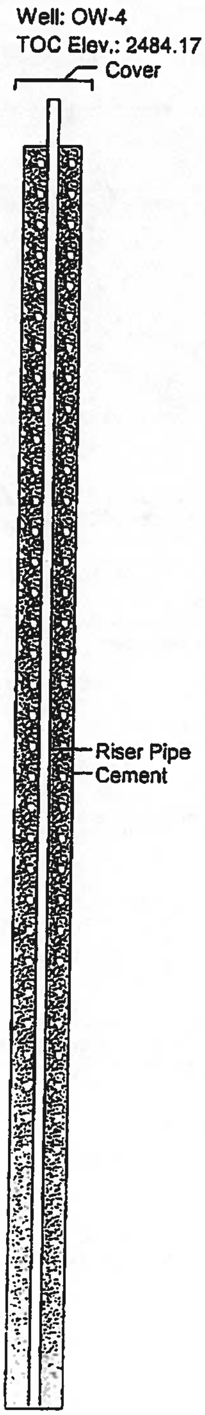
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/20/03	Drilling Company	: Davis Drilling
Date Completed	: 12/2/03	Northing Coord.	: 27,055,267.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,324.0
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2481.7
0	2481
5	2476
10	2471
15	2466
20	2461
25	2456
30	

USCS	DESCRIPTION
GM	Poorly sorted angular rock fragments. Yellow and brown chert, black to gray volcanic, clear quartz and gray rock fragments.
SC	Bit grinding hard from 6 to 7.5 feet. Rock fragments and reddish-brown clayey silt.
SC	Reddish-brown clayey silt with sand.
SC	Reddish-brown clayey silt with sand.
GM	Bit start grinding hard at 21 feet. Well sorted whitish-gray limestone, gray to brown chert, with trace of quartz fragments.
GM	Well sorted whitish-gray limestone, gray to brown chert, with trace of quartz fragments.



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 11/20/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 2.5 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type	: Washed pea gravel

WELL SCREEN SEAL

Type	: Bentonite

ANNULUS SEAL

Type	: Cement

PROTECTIVE CSG.

Type	: 6-inch steel

WELL PAD

Type	: Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 80 feet.

JOYCE ENGINEERING, INC

LOG OF BORING B-7 (OW-4)

(Page 2 of 3)

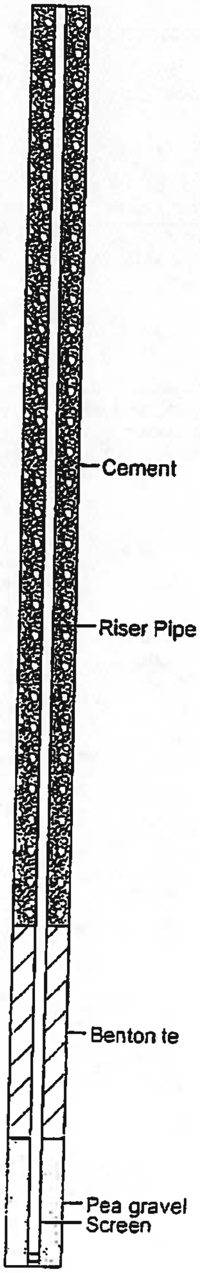
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/20/03
Date Completed	: 12/2/03
Hole Diameter	: 8.25-inches
Drilling Method	: OD mud rotary
Sampling Method	: washed grab
Drilling Company	: Davis Drilling
Northing Coord.	: 27,055,267.8
Easting Coord.	: 831,324.0
Survey By	: Owens Surveying Outfit
Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2481.7	GRAPHIC	USCS	DESCRIPTION
30	2451		GM	Fine grained well sorted rock fragments.
35	2446		GM	Fine grained well sorted rock fragments.
40	2441		GM	Fine grained well sorted rock fragments.
45	2436		SM	Bit stops grinding at 46 feet. Light brown silty fine sand with trace clay.
50	2431		SM	Light brown silty fine sand with trace clay.
55	2426		GM	Bit starts grinding at 56 feet. Large angular rock fragments, trace iron staining.
60				

Well: OW-4
TOC Elev.: 2484.17



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 11/20/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 2.5 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 80 feet.

ENGINEERING, INC

LOG OF BORING B-7 (OW-4)

(Page 3 of 3)

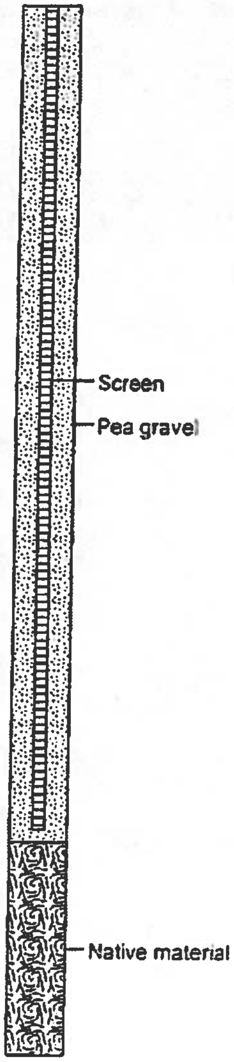
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/20/03	Drilling Company	: Davis Drilling
Date Completed	: 12/2/03	Northing Coord.	: 27,055,267.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,324.0
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2481.7	GRAPHIC	USCS	DESCRIPTION
60	2421		GM	Large angular rock fragments, trace iron staining.
65	2416		GM	Bit stops grinding at 69 feet. Large angular rock fragments with nodules of brown clayey fine sand.
70	2411		SP	Bit alternating between grinding and not. 8 to 15 inch intervals. Large rock fragments and nodules of light brown clayey fine sand.
75	2406		SP	Large rock fragments, trace rounded gravel, and nodules of light brown clayey fine sand.
80	2401		SP	Large angular rock fragments to 81 feet. Nodules of light gray clayey silt from 81 to 85 feet.
			ML	Light gray clayey silt.
85	2396			Boring terminated at 85 feel below grade
90				

Well: OW-4
TOC Elev.: 2484.17



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 11/20/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 2.5 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U S. Foot (NV83-EF)

2 Borehole collaspsed to approximately 80 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-8

(Page 1 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/26/03	Drilling Company	: Davis Drilling
Date Completed	: 11/26/03	Northing Coord.	: 27,055,902.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,412.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2483.4	GRAPHIC	USCS	DESCRIPTION	NOTES
0	2483		SM	Medium-grained rock fragments and sand with trace brown silt.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
5	2478		SM	Nodules of brown clayey silt with fine sand starting at 8.5 feet.	
10	2473		SC		
15	2468		SC	Nodules of brown clayey silt with fine sand.	
20	2463		SP	Bit starts grinding at 18 feet. 90% small nodules of brown clayey silt with fine sand to 18 feet. Medium to coarse angular rock fragments from 18 to 21.5 feet.	
25	2458		SP	Grinding gets harder and then stops at 25.5 feet. 20% nodules of brown silty fine sand, 80% medium to coarse rock fragments.	
30			GM	Medium to coarse angular rock fragments. Black volcanic, brown and black chert, trace clear and gray quartz.	

ENGINEERING, INC.

LOG OF BORING B-8

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/26/03	Drilling Company	: Davis Drilling
Date Completed	: 11/26/03	Northing Coord.	: 27,055,902.0
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,412.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2483.4	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2453	▥	GM		
35	2448	░	SP	Rig stops chattering at 32.5 feet. 40% nodules of brown silty fine sand. 60% rock fragments.	
		░	SP	60% nodules of brown silty fine sand, 40% rock fragments. Bit starts grinding at 40 feet.	
40	2443	▥	GM		
45	2438	░	SP	Hard drilling at 42.5 feet. 40% nodules of brown silty fine sand. 60% angular rock fragments.	
50	2433	☰	ML	Bit balling up with clay at 48.5 feet. 80% nodules of brown clayey silt with fine sand. 20% rock fragments.	
55	2428	☰	ML	Bit balling up with clay at 52 and 54 feet. Nodules of brown clayey silt with fine sand. 20% rock fragments.	
60		☰	ML	Nodules of brown silty fine sand. Bit starts grinding at 61.0 feet.	

JOYCE
ENGINEERING, INC

LOG OF BORING B-8

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/26/03
Date Completed	: 11/26/03
Hole Diameter	: 8.25-inches
Drilling Method	: OD mud rotary
Sample Method	: washed grab
Drilling Company	: Davis Drilling
Northing Coord.	: 27,055,902.0
Easting Coord.	: 831,412.5
Survey By	: Owens Surveying Outfit
Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2483.4	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2423		ML		
65	2418		ML	Bit balling up at 62 feet. Brown nodules of clayey to silty fine sand.	
70	2413		ML	Bit starts grinding lightly at 72 feet. Whitish-gray nodules of clayey fine sand with soft white rock fragments.	
75	2408		ML	Nodules of shitish-gray clayey fine sand. Transitions to nodules of brown clayey silt with fine sand at 74.5 feet.	
80	2403		ML	Bit balling up with clay at 78.5 feet. Grayish-light brown clayey silt with fine sand.	
85	2398		ML	Light grayish-brown nodules of clayey silt with fine sand and trace rock fragments.	
90				Boring terminated at 86.5 feet below grade.	

JOYCE ENGINEERING, INC

LOG OF BORING B-9 (OW-5)

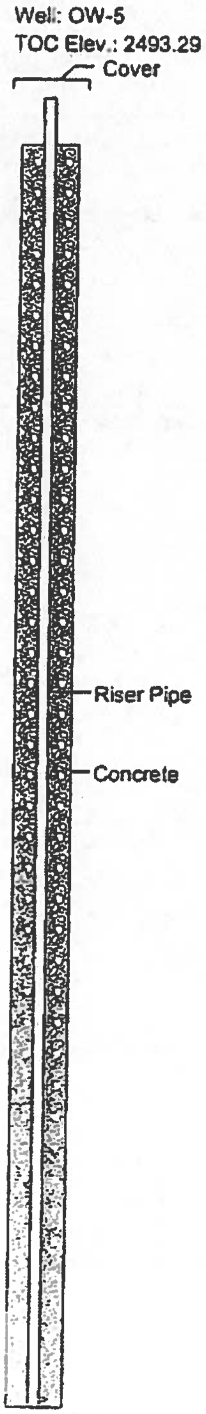
(Page 1 of 4)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/5/03	Drilling Company	: Davis Drilling
Date Completed	: 12/5/03	Northing Coord.	: 24,058,542.7
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,498.8
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2490.97	GRAPHIC	USCS	DESCRIPTION
0	2490		SM	Brown silty fine sand.
5	2485		SM	Brown silty fine sand.
10	2480		SM	Brown silty fine sand.
15	2475		SM	Brown silty fine sand.
20	2470		SM	Brownish-gray mottled white clayey silt nodules.
25	2465		SM	Brownish-gray mottled white clayey silt nodules. Bit starts grinding at 29 feet. Start picking up black rock fragments.
30			GM	Black and brown rock fragments.



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/5/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 2.3 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 95 feet.

ENGINEERING, INC.

LOG OF BORING B-9 (OW-5)

(Page 2 of 4)

Western Elite Material Processing Facility
Lincoln County, Nevada

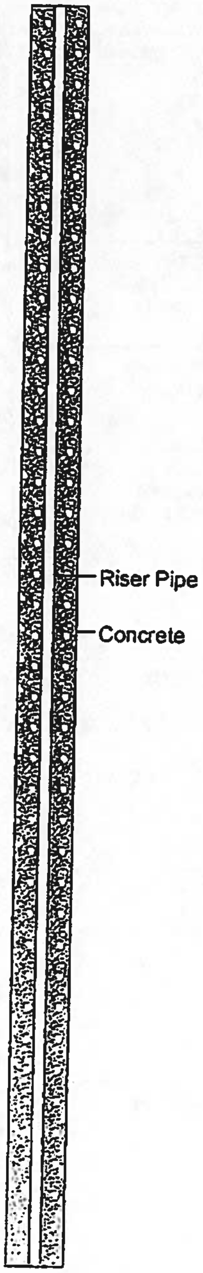
JEI Project No. 383.00, Task 10

Date Started : 12/5/03
Date Completed : 12/5/03
Hole Diameter : 8.25-inches
Drilling Method : OD mud rotary
Sampling Method : washed grab

Drilling Company : Davis Drilling
Northing Coord. : 24,056,542.7
Easting Coord. : 831,498.8
Survey By : Owens Surveying Outfit
Logged By : Mike Williams

Depth in Feet	Surf. Elev. 2490.97	GRAPHIC	USCS	DESCRIPTION
30	2460		GM	
35	2455		GM	Black and brown rock fragments. Rig stops chattering at 40 feet.
0	2450		GM	Black and brown small to medium-grained rock fragments.
45	2445		GM	Black and brown small to medium-grained rock fragments.
50	2440		GM	Black and brown small rock fragments. Bit stops grinding at 53.5 feet.
55			SM	
	2435		SM	Small nodules of grayish-brown silty fine sand with trace clay. Bit starts grinding at 58.5 feet. Black and brown rock fragments with nodules of brown silty fine sand with trace clay.
60			GM	

Well: OW-5
TOC Elev.: 2493.29



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/5/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 2.3 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 95 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-9 (OW-5)

(Page 3 of 4)

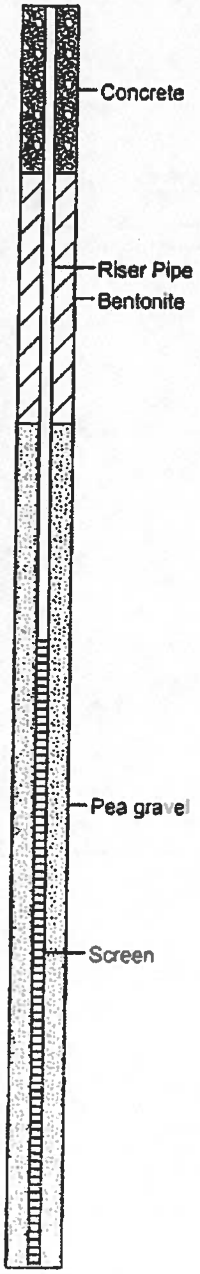
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/5/03	Drilling Company	: Davis Drilling
Date Completed	: 12/5/03	Northing Coord.	: 24,056,542.7
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,498.8
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2490.97	GRAPHIC	USCS	DESCRIPTION
60			GM	
	2430		GM	Black and brown rock fragments with trace gray and clear quartz.
65	2425		GM	Black and brown rock fragments with trace gray and clear quartz. Trace amount of carbonate cemented sandstone.
			SM	50% grayish-white nodules of silty fine sand at 67.5 feet.
70	2420		SM	Brownish-gray nodules of silty fine sand with clay grading to silt with sand and 30% rock fragments. Bit balling up at 71 feet.
75	2415		SM	Brownish-gray nodules of silty fine sand with clay with 20% rock fragments. Bit balling up at 75.5 feet.
80	2410		SM	Brownish-gray nodules of silty fine sand with clay with 10% rock fragments.
85	2405		SM	Brownish-gray nodules of silty fine sand with clay with 10% rock fragments.
90				

Well: OW-5
TOC Elev.: 2493.29



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/5/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 2.3 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 95 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-9 (OW-5)

(Page 4 of 4)

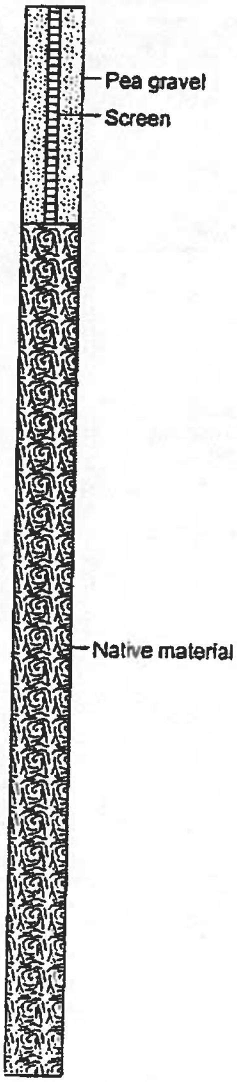
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/5/03	Drilling Company	: Davis Drilling
Date Completed	: 12/5/03	Northing Coord.	: 24,056,542.7
Hole Diameter	: 8.25-inches	Easting Coord.	: 831,498.8
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2490.97	GRAPHIC	USCS	DESCRIPTION
90			SM	
	2400		SM	Brownish-gray silty fine sand with clay.
95	2395		SM	Brownish-gray silty fine sand with clay.
100	2390		SM	Brownish-gray silty fine sand with clay.
105	2385		GM	Bit starts grinding at 106 feet. Brown clayey silt nodules with 40% rock fragmetnts.
110	2380		GM	Brown clayey silt nodules with 50% rock fragments.
115	2375			Boring terminated at 115.5 feet below grade.
120				

Well: OW-5
TOC Elev.: 2493.29



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/5/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 2.3 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed to approximately 95 feet.

ENGINEERING, INC.

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

LOG OF BORING B-10 (OW-6)

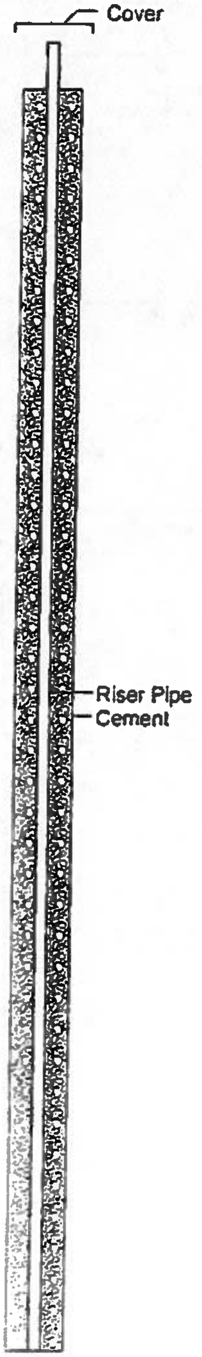
(Page 1 of 4)

Date Started : 12/3/03
Date Completed : 12/3/03
Hole Diameter : 8.25-inches
Drilling Method : OD mud rotary
Sampling Method : washed grab

Drilling Company : Davis Drilling
Northing Coord. : 27,055,214.3
Easting Coord. : 830,837.5
Survey By : Owens Surveying Outfit
Logged By : Mike Williams

Depth in Feet	Surf. Elev. 2488.5	GRAPHIC	USCS	DESCRIPTION
0	2488		GM	SILTY CLAY, Well sorted coarse sand with trace rock fragments. Bit starts grinding at 4.5 feet.
5	2483		GM	Rock fragments.
10			SM	Start picking up small nodules of light brown fine sand at 9.5 feet.
	2478		SM	Light brown small nodules of silty fine sand with trace clay. 10% coarse-grained rock fragments.
15	2473		SM	Dark coarse-grained rock fragments with 40% light brown small nodules of silty fine sand with trace clay.
20	2468		SM	Dark coarse-grained rock fragments with 40% light brown small nodules of silty fine sand with trace clay.
25	2463		SM	Coarse rock fragments with 30% light brown silty fine sand nodules. Bit grinding from 25.5 to 26.5 feet.
30				

Well: OW-6
TOC Elev.: 2490.88



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/3/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 2.4 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed at approximately 87 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-10 (OW-6)

(Page 2 of 4)

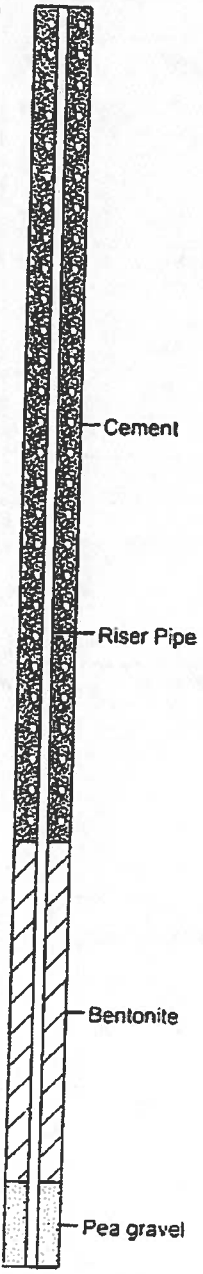
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/3/03	Drilling Company	: Davis Drilling
Date Completed	: 12/3/03	Northing Coord.	: 27,055,214.3
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,837.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2488.5	USCS	DESCRIPTION
30		SM	
	2458	SM	50% coarse sand and small pebble size rock fragments and 50% brown nodules of silty fine sand with trace clay.
35	2453	SM	Coarse-grained rock fragments with 10% brown nodules of silty fine sand.
40	2448	SP	Coarse-grained rock fragments with 25% light grayish-brown nodules of silty fine sand.
		GM	Rock fragments.
45	2443	GM	Rock fragments.
50	2438	GM	Rock fragments. Bit is grinding hard at 54 feet.
55	2433	GM	Rock fragments with 10% light brown to whitish-gray nodules of silty fine sand with trace clay.
60			

Well: OW-6
TOC Elev.: 2490.88



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/3/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 2.4 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed at approximately 87 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-10 (OW-6)

(Page 3 of 4)

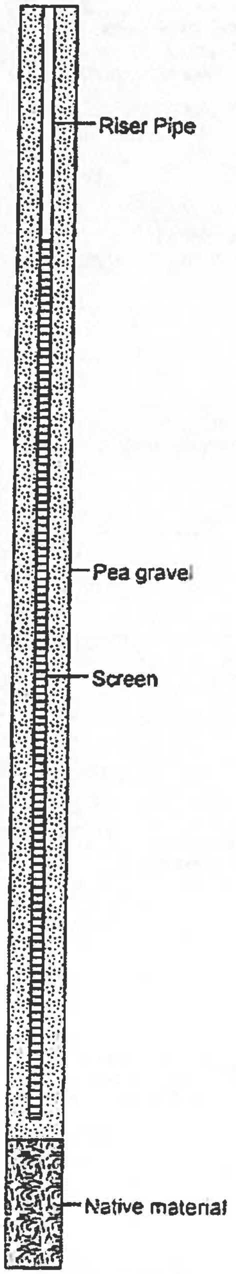
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/3/03	Drilling Company	: Davis Drilling
Date Completed	: 12/3/03	Northing Coord.	: 27,055,214.3
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,837.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2488.5	GRAPHIC	USCS	DESCRIPTION
60	2428		GM	
			GM	Rock fragments with 20% brown nodules of silty fine sand.
65	2423		GM	Rock fragments with 10% brown nodules of silty fine sand with trace clay.
70	2418		GM	Rock fragments with 10% brown nodules of silty fine sand with trace clay.
75	2413		GM	Rock fragments with 10% brown nodules of silty fine sand with trace clay.
80	2408		ML	Grinding stops at 81 feet. Large nodules of brown clayey silt with fine sand.
85	2403		ML	Light brown clayey fine sand with 10% rock fragments
90				

Well: OW-6
TOC Elev.: 2490.88



Well Construction Information

WELL CONSTRUCTION
Date Compl. : 12/3/03
Hole Diameter(s) : 8.25-inches
Drilling Method(s) : mud rotary
Company Rep. : Mike Davis

WELL CASING
Material : PVC
Diameter : 4-inch
Joints : Flush
Apprx. Csg. Stickup : 2.4 feet

WELL SCREEN
Material : PVC
Diameter : 4-inch
Joints : Flush
Opening : 0.020 inch

GRAVEL PACK
Type : Washed pea gravel

WELL SCREEN SEAL
Type : Bentonite

ANNULUS SEAL
Type : Cement

PROTECTIVE CSG.
Type : 6-inch steel

WELL PAD
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

2. Borehole collaspsed at approximately 87 feet.

JOYCE ENGINEERING, INC.

LOG OF BORING B-10 (OW-6)

(Page 4 of 4)

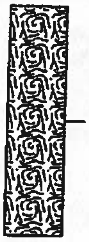
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/3/03	Drilling Company	: Davis Drilling
Date Completed	: 12/3/03	Northing Coord.	: 27,055,214.3
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,837.5
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2488.5	GRAPHIC	USCS	DESCRIPTION
90	2398		ML ML	Light brown clayey fine sand with 10% rock fragments.
95	2393			Boring terminated at 95.5 feet below grade.
0	2388			
105	2383			
110	2378			
115	2373			
120				

Well: OW-6
TOC Elev.: 2490.88



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/3/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 2.4 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
2. Borehole collaspsed at approximately 87 feet.

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LOG OF BORING B-11

(Page 1 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,055,982.2
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,615.1
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2460.9	GRAPHIC	USCS	DESCRIPTION	NOTES
0	2460		GM	Poorly sorted gravel and sand with angular rock fragments. Rock fragments are primarily limestone, chert, and basalt, with trace of quartz.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
5	2455		GM	Well sorted angular tannish-gray limestone rock fragments with angular black and gray basalt, chert, and quartz fragments.	
0	2450		GM	Well sorted angular rock fragments with trace of well rounded small pebbles. 80% light tannish-gray limestone, 20% black to dark gray basalt, chert, and quartz.	
15	2445		SM	80% Nodules of light brown silty sand with trace of angular black and dark gray rock fragments and chert.	
20	2440		SM	80% Nodules of light brown to gray silt sand with trace clay. 20% angular clear quartz and dark chert and rock fragments.	
25	2435		GM	60 to 70% angular well sorted dark gray to black rock fragments composed of quartz, chert, and basalt, trace clear quartz. 30 to 40% nodules of gray silty fine sand with trace clay.	
30					

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LOG OF BORING B-11

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03
Date Completed	: 11/25/03
Hole Diameter	: 8.25-inches
Drilling Method	: OD mud rotary
Sample Method	: washed grab
Drilling Company	: Davis Drilling
Northing Coord.	: 27,055,982.2
Easting Coord.	: 830,615.1
Survey By	: Owens Surveying Outfit
Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2460.9	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2430		GM	Angular well sorted rock fragments. 90 to 95% dark gray to black rock fragments composed of quartz, chert, and basalt, 5 to 10% light gray limestone fragments and trace clear quartz.	
35	2425		GM	65% dark gray to black angular well sorted rock fragments with chert. 30% gray to black rounded coarse sand and pebbles. 5% clear quartz chips and light gray limestone and quartzite fragments.	
40 45	2420		GM	Rig encounters stiff resistance at 41 feet. Well sorted coarse angular black and gray rock fragments.	
	2415		ML	Drill bit starts to ball up with clay at 46 feet. Well sorted coarse angular black and gray rock fragments.	
50	2410		ML	Nodules of light brown to tan clayey silt with fine sand. Trace dark brown to black rock fragments.	
55 60	2405		ML	Nodules of light brown to tan clayey silt with fine sand. Trace dark brown to black rock fragments.	

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LOG OF BORING B-11

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,055,982.2
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,615.1
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2460.9	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2400	▤	ML	Nodules of light brown to tan clayey silt with fine sand. Trace dark brown to black rock fragments.	
65	2395			Boring terminated at 65 feet below grade. Recovery water level depth approximately 38 feet after bailing drilling mud from borehole.	
70	2390				
75	2385				
80	2380				
85	2375				
90					

JOYCE ENGINEERING, INC.

LOG OF BORING B-12

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,056,565.8
Hole Diameter	: 8.25 inches	Easting Coord.	: 830,901.1
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2485.3	GRAPHIC	USCS	DESCRIPTION	NOTES
0 5	2485 2480		SM	Brown silty fine sand with trace clay. Bit starts grinding at 6.0 feet.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
10	2475		GM	60% brown silty fine sand nodules and 40% rock fragments to 9.5 feet. Bit starts grinding hard at 9.5 feet. Angular rock fragments from 9.5 to 11.5 feet.	
15	2470		GM	Large angular rock fragments.	
20	2465		GM	Angular rock fragments, chert, volcanic, quartz, and limestone.	
25	2460		GM	Angular rock fragments. Bit stops grinding at 25.5 feet.	
30			SM	60% angular rock fragments. 40% brown silty fine sand.	

JOYCE ENGINEERING, INC.

LOG OF BORING B-12

(Page 2 of 3)

Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,058,565.8
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,901.1
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2485.3	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2455	▒	SM		
35	2450	▒	SM	60% angular rock fragments. 40% brown silty fine sand. Bit balling up with clay.	
40	2445	▒	SM	50% nodules of brown silty fine sand. 50% rock fragments. Bit starts grinding hard at 40.5 feet.	
45	2440	▒	SM	50% nodules of brown silty fine sand. 50% rock fragments.	
		▒	SM	Bit starts grinding at 49.5 feet. 40% nodules of brown silty sand, 60% rock fragments.	
50	2435	▦	GM		
55	2430	▦	GM	Angular rock fragments.	
60		▦	GM	Hard drilling. Angular rock fragments.	

ENGINEERING, INC

LOG OF BORING B-12

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 11/25/03	Drilling Company	: Davis Drilling
Date Completed	: 11/25/03	Northing Coord.	: 27,056,565.8
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,901.1
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2485.3	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2425	▨	GM		
		▨	SC	20% nodules of brown silty fine sand and 80% angular rock fragments. Rig stops chattering at 61.5 feet.	
65	2420				
				Boring terminated at 66.5 feet below grade.	
0	2415				
75	2410				
80	2405				
85	2400				
90					

JOYCE ENGINEERING, INC

LOG OF BORING B-13

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,055,262.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,144.6
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2496.95	GRAPHIC	USCS	DESCRIPTION	NOTES
0	2496	▨	GM	Fine-grained black, brown, gray, and light yellowish-brown angular rock fragments.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
5	2491	▨	GM	Fine to medium-grained angular rock fragments with trace of angular clear quartz.	
0	2486	▨	GM	Bit starts grinding hard at 10.5 feet. Medium to coarse-grained, well sorted, angular black, brown, light gray rock fragments with clear quartz.	
15	2481	▨	GM	Angular well-sorted medium to fine-grained dark brown to gray rock fragments with trace of clear quartz.	
20	2476	▨	GM	Angular well-sorted medium to coarse-grained rock fragments with trace of clear quartz fragments.	
25	2471	▥	ML	Angular well-sorted medium to coarse-grained rock fragments with trace of clear quartz fragments. Start picking up nodules of brownish-gray clayey silt at 26 feet. 60% clayey silt nodules, 40% rock fragments.	
30					

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LOG OF BORING B-13

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,055,262.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,144.6
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2496.95	GRAPHIC	USCS	DESCRIPTION	NOTES
30			ML		
	2466		GM	Bit grinding hard between 31 and 32 feet. 80% angular rock fragments, 20% light brown clayey silt nodules.	
35	2461		GM	95% coarse-grained dark gray to brown and light gray rock fragments, 5% light brown nodules of clayey silt.	
40	2456		GM	50% nodules of light gray clayey silt with sand. 50% angular rock fragments.	
45	2451		GM	50% nodules of light gray clayey silt with sand. 50% angular rock fragments.	
50	2446		ML	Bit balling up with clay at 50 feet. 80% light brown fine sandy clay nodules, 20% rock fragments.	
55	2441		ML	Light brown nodules of clayey silt with trace fine sand. 5% rock fragments.	
60					

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LOG OF BORING B-13

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,055,262.6
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,144.6
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2496.95	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2436		ML	Bit balling up with clay at 61 and 63 feet. Nodules of light brown clayey silt with trace sand, 5% rock fragments.	
65	2431		ML	Bit balling up with clay at 66 feet. Nodules of light brown silty clay with trace sand.	
70 75	2426		ML	Nodules of light brown silty clay with trace sand.	
	2421		GM	Bit starts grinding at 76 feet. 60% angular rock fragments, 40% nodules of light brown silty clay with trace sand.	
80	2416			Boring terminated at 80 feet below grade.	
85	2411				
90					

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LOG OF BORING B-14

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,055,805.3
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,240.4
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2473.3	GRAPHIC	USCS	DESCRIPTION	NOTES
0	2473		GM	Medium grained well sorted sand and rock fragments. Bit starts grinding at 5.0 feet.	1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)
5	2468		GM	Rock fragments to 9.5 feet. Small hard fragments of grayish-brown thinly bedded rock.	
10	2463		GM	Bits grinding hard between 13 and 15 feet. Light brown thinly bedded siltstone fragments and nodules of silty fine sand with 20% dark rock fragments.	
15	2458		GM	Light brown thinly bedded siltstone fragments and nodules of silty fine sand to 17.5 feet. Bit starts grinding hard at 17.5 feet. Small well sorted rock fragments.	
20	2453		GM	Small well sorted rock fragments.	
25	2448				
			SC	Black, brown, and yellow rock fragments with 20% light brown silty fine sand nodules and trace fragments of light brown thinly laminated siltstone.	
30					

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LOG OF BORING B-14

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,055,805.3
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,240.4
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2473.3	GRAPHIC	USCS	DESCRIPTION	NOTES
30	2443		SC		
			SC	50% dark rock fragments with small nodules of light brown silty fine sand with trace clay.	
35	2438		SC	50% dark rock fragments with small nodules of light brown silty fine sand with trace clay.	
0	2433		ML	Brown clayey silt with fine sand with 30% dark rock fragments.	
45	2428		ML	Brown clayey silt with fine sand with 20% dark rock fragments.	
50	2423		ML		
			GM	Bit starts grinding at 52 feet. Large nodules of light brown mottled white clayey silt with fine sand.	
55	2418		GM	Black and brown rock fragments with 40% large nodules of brown clayey silt. Bit grinding hard.	
60					

ENGINEERING, INC.

LOG OF BORING B-14

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Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,055,805.3
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,240.4
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sample Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2473.3	GRAPHIC	USCS	DESCRIPTION	NOTES
60	2413	▨	GM		
		▨	GM	Large dark brown and black rock fragments with 10% clayey silt nodules.	
65	2408				
				Boring terminated at 65.5 feet below grade.	
70	2403				
75	2398				
80	2393				
85	2388				
90					

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LOG OF BORING B-15 (OW-7)

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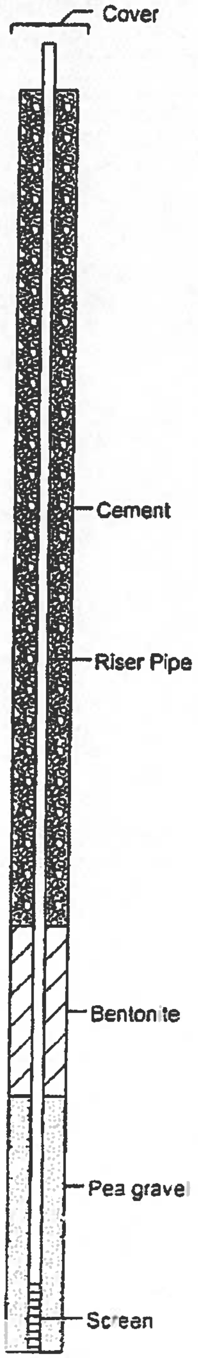
Western Elite Material Processing Facility
Lincoln County, Nevada

JEI Project No. 383.00, Task 10

Date Started	: 12/4/03	Drilling Company	: Davis Drilling
Date Completed	: 12/4/03	Northing Coord.	: 27,056,496.9
Hole Diameter	: 8.25-inches	Easting Coord.	: 830,294.3
Drilling Method	: OD mud rotary	Survey By	: Owens Surveying Outfit
Sampling Method	: washed grab	Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2468.7	GRAPHIC	USCS	DESCRIPTION
0	2468		GM	Rock fragments with light gray silty fine sand.
5	2463		SC	Gray silty fine sand with hard chips of the same, calcareous.
10	2458		SC	Gray silty fine sand with hard chips of the same, calcareous.
15	2453		SC	Gray silty fine sand with hard chips of the same, calcareous.
20	2448		SC	Gray silty fine sand with hard chips of the same and trace black rock fragments.
25	2443		ML	Light brown silty fine sand with trace clay with 30% thin white soft limestone fragments.
30				

Well: OW-7
TOC Elev.: 2469.83



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/4/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 1.2 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

JOYCE ENGINEERING, INC.

LOG OF BORING B-15 (OW-7)

(Page 2 of 2)

Western Elite Material Processing Facility
Lincoln County, Nevada

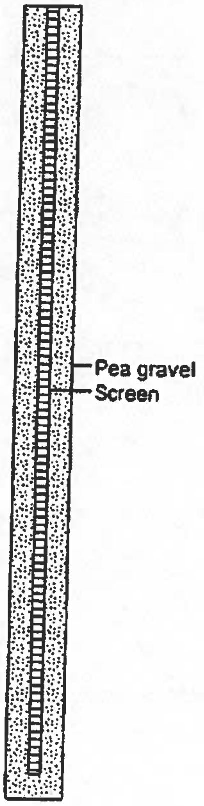
JEI Project No. 383.00, Task 10

Date Started	: 12/4/03
Date Completed	: 12/4/03
Hole Diameter	: 8.25-inches
Drilling Method	: OD mud rotary
Sampling Method	: washed grab

Drilling Company	: Davis Drilling
Northing Coord.	: 27,056,496.9
Easting Coord.	: 830,294.3
Survey By	: Owens Surveying Outfit
Logged By	: Mike Williams

Depth in Feet	Surf. Elev. 2468.7	GRAPHIC	USCS	DESCRIPTION
30	2438		ML ML	Light brown silty fine sand with trace clay.
35	2433		GM	Bit starts grinding at 36.5 feet. Brown and black rock fragments with 20% nodules of brown silty fine sand with trace clay.
40	2428		GM	Brown and black rock fragments with 10% nodules of brown silty fine sand with trace clay.
45	2423		GM	Rock fragments. Hard drilling.
50	2418			Boring terminated at 49 feet below grade.
55	2413			
60				

Well: OW-7
TOC Elev.: 2469.83



Well Construction Information

WELL CONSTRUCTION

Date Compl.	: 12/4/03
Hole Diameter(s)	: 8.25-inches
Drilling Method(s)	: mud rotary
Company Rep.	: Mike Davis

WELL CASING

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Apprx. Csg. Stickup	: 1.2 feet

WELL SCREEN

Material	: PVC
Diameter	: 4-inch
Joints	: Flush
Opening	: 0.020 inch

GRAVEL PACK

Type : Washed pea gravel

WELL SCREEN SEAL

Type : Bentonite

ANNULUS SEAL

Type : Cement

PROTECTIVE CSG.

Type : 6-inch steel

WELL PAD

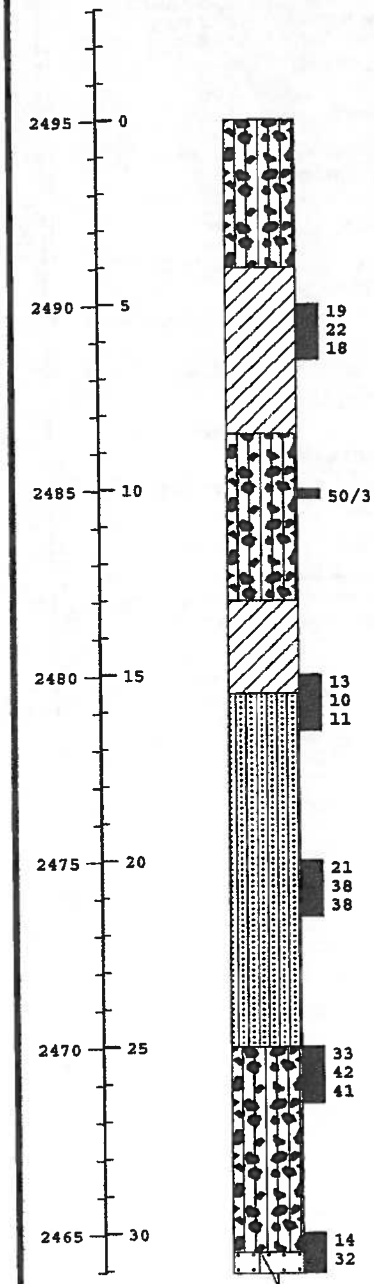
Type : Concrete

1. Coordinates based on Nevada State Plane, East Zone, U.S. Foot (NV83-EF)

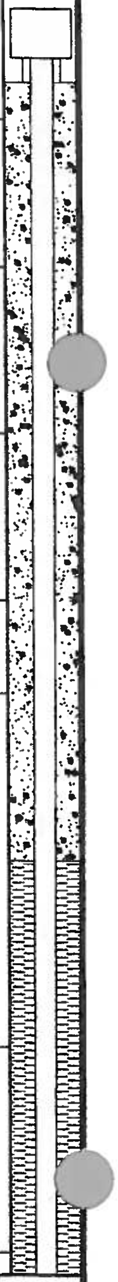
EXPLORATION LOG
OW-7R

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.97356 W:114.98478
EXPLORATION DATE: 9/3/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2495.06 Feet
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 80.0 Feet
DATE MEASURED: 9/3/13
FINAL DEPTH TO WATER: 76.6 Feet
DATE MEASURED: 9/4/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		GM	Brown silty GRAVEL with sand, moist and medium dense.						
	19 22 18	CL	Medium brown sandy lean CLAY, dry and very stiff.						
	50/3	GM	Brown silty GRAVEL with sand, some cobbles, dry and very dense.						
		CL	Brown sandy lean CLAY, dry and very stiff.						
	13 10 11 21 38 38	SM	Brown silty SAND, dry and medium dense. ...some gravel. ...dense.						
	33 42 41 14 32	GM	Light brown silty GRAVEL with sand, trace cobbles, dry and dense.						



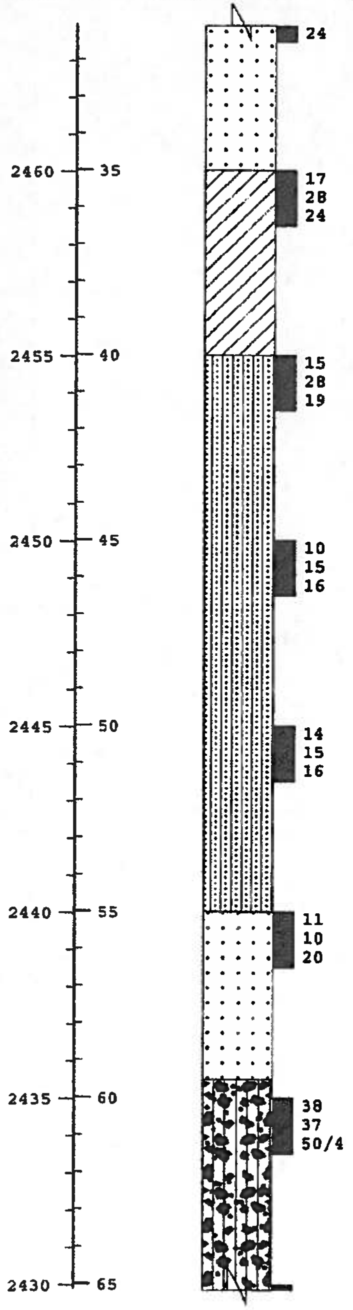
The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

EXPLORATION LOG
OW-7R

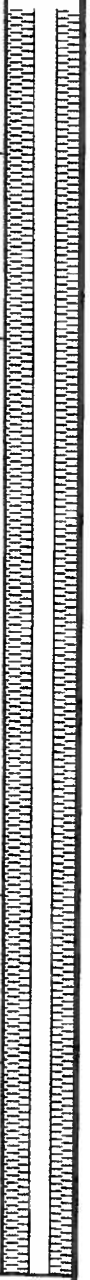
PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.97356 W:114.98478
EXPLORATION DATE: 9/3/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2495.06 Feet
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 80.0 Feet
DATE MEASURED: 9/3/13
FINAL DEPTH TO WATER: 76.6 Feet
DATE MEASURED: 9/4/13

ELEVATION/ DEPTH | SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
SP	Light gray poorly graded SAND, dry and dense.						
CL	Light brown sandy lean CLAY, some cemented nodules, moist to dry, very stiff.						
SM	Light brown silty SAND, moist and medium dense. ...increasing clay fraction in lenses with clean sand (varved deposits).						
SP	Medium brown poorly graded SAND, moist and dense.						
GW-GM	Dark brown well graded GRAVEL with silt and sand, moist and very dense.						



The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

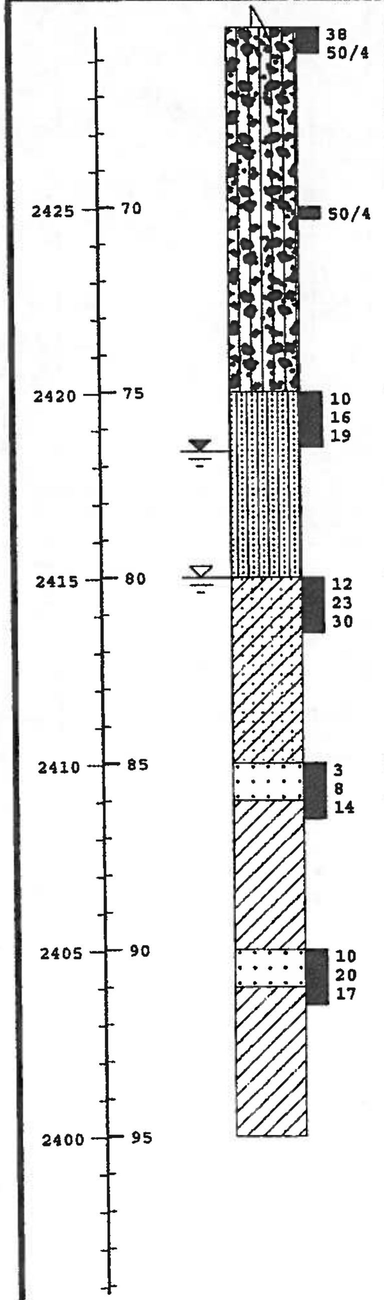
EXPLORATION LOG
OW-7R

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.97356 W:114.98478
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2495.06 Feet

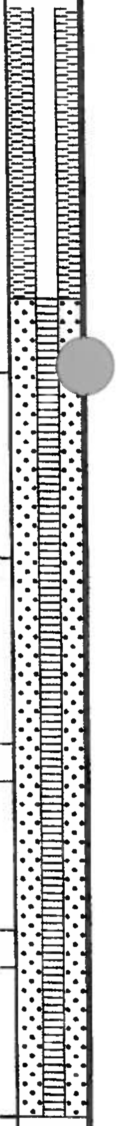
PROJECT NO.: 20133247V1
EXPLORATION DATE: 9/3/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 80.0 Feet
FINAL DEPTH TO WATER: 76.6 Feet

DATE MEASURED: 9/3/13
DATE MEASURED: 9/4/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
	38 50/4								
2425 70	50/4								
2420 75	10 16 19	SM	Brown silty SAND, moist to wet and medium dense. ...layers of sandy lean clay.						
2415 80	12 23 30	SC	Brown clayey SAND, moist and dense.						
2410 85	3 8 14	SP	Dark brown poorly graded SAND with trace gravel, wet and medium dense.						
		CL	Light brown sandy lean CLAY, cemented clay nodules, wet and very stiff.						
2405 90	10 20 17	SP	Dark brown poorly graded SAND, wet and medium dense.						
		CL	Light brown sandy lean CLAY, wet and very stiff.						
2400 95			**END OF BORING AT 95.0 FEET**						



GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

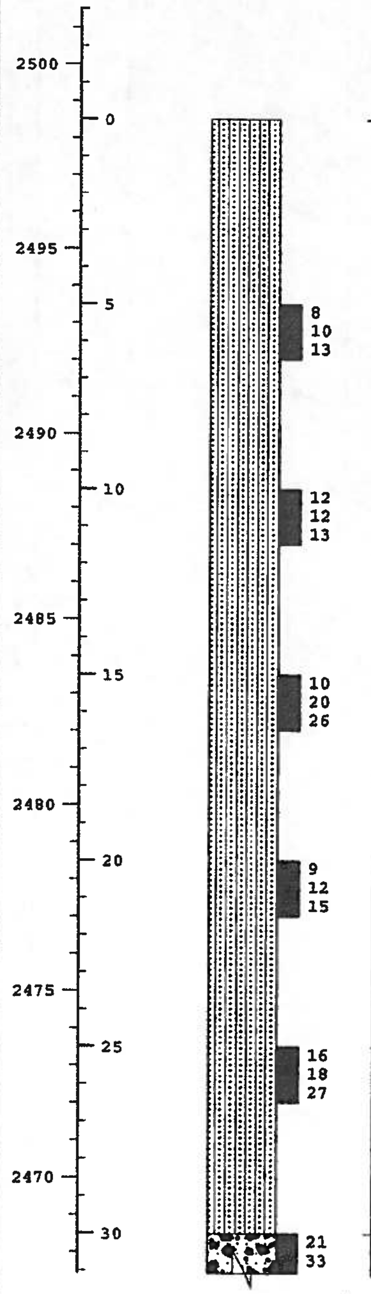
EXPLORATION LOG
OW-8

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98441 W:114.98172
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.51 Feet

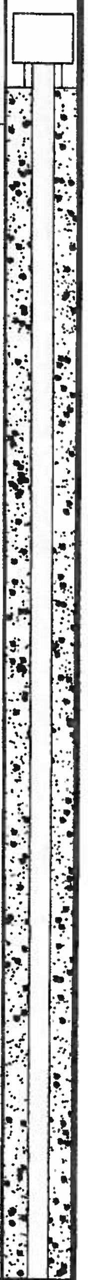
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/7/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 75 Feet
FINAL DEPTH TO WATER: 72.3 Feet

DATE MEASURED: 8/7/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SM	Light Brown silty SAND, dry, very loose.					
	...medium dense.					
	...slight increase in silt.					
GW	Light brown well graded GRAVEL with sand,					



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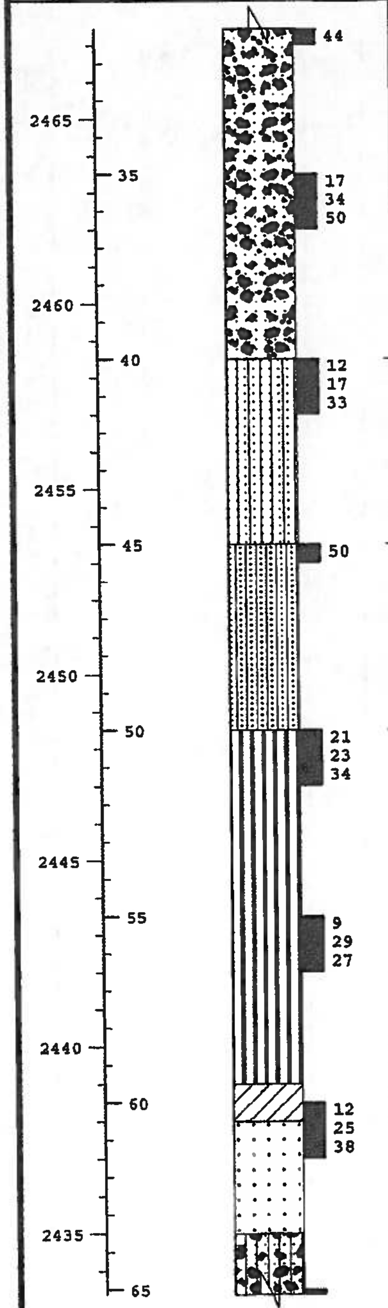
EXPLORATION LOG
OW-8

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98441 W:114.98172
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.51 Feet

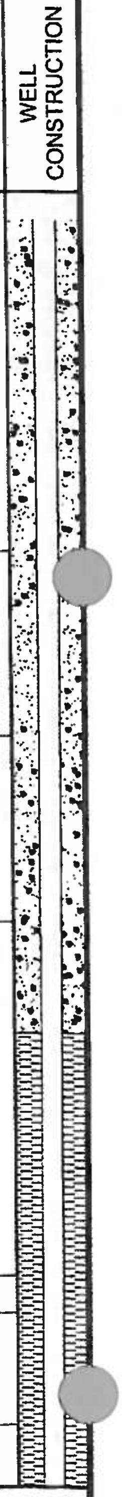
INITIAL DEPTH TO WATER: 75 Feet
FINAL DEPTH TO WATER: 72.3 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/7/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

DATE MEASURED: 8/7/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
	dry, dense.					
SW-SM	White to brown well graded SAND with silt, dry, dense.					
SM	Light brown silty SAND, dry, very dense.					
MH	Light grey elastic SILT, dry, very stiff, small clay fraction.					
CL	Green to brown sandy lean CLAY, dry, very stiff.					
SP	Red to brown poorly graded SAND, moist, dense.					
GM	Red to brown silty GRAVEL with sand, dry, very dense.					



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

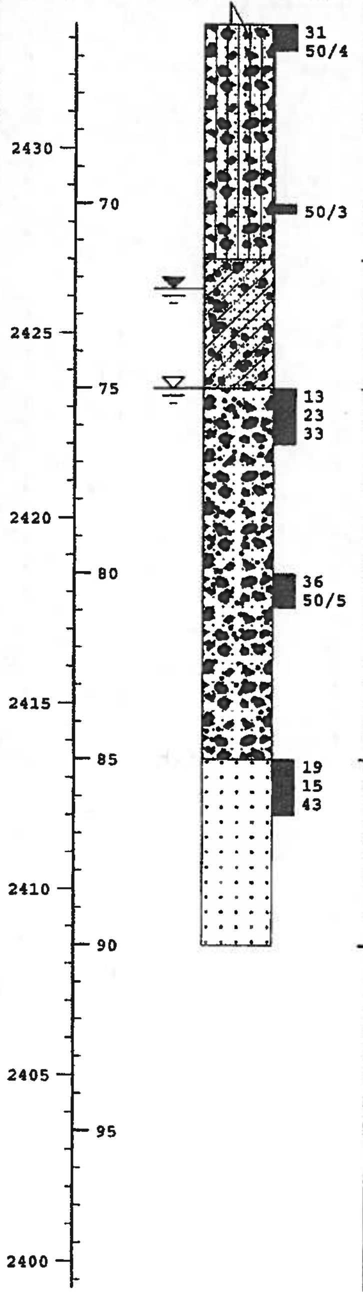
EXPLORATION LOG
OW-8

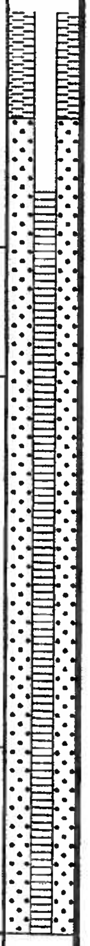
PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98441 W:114.98172
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.51 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/7/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 75 Feet
FINAL DEPTH TO WATER: 72.3 Feet

DATE MEASURED: 8/7/13
DATE MEASURED: 8/21/13





ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		GP-GC	Light brown poorly graded GRAVEL with clay and sand, dry, dense.						
		GW	Dark brown well graded GRAVEL with sand, wet, dense.						
			...very dense.						
		SP	Dark brown poorly graded SAND, wet, dense.						
			END OF BORING AT 90.0 FEET						

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

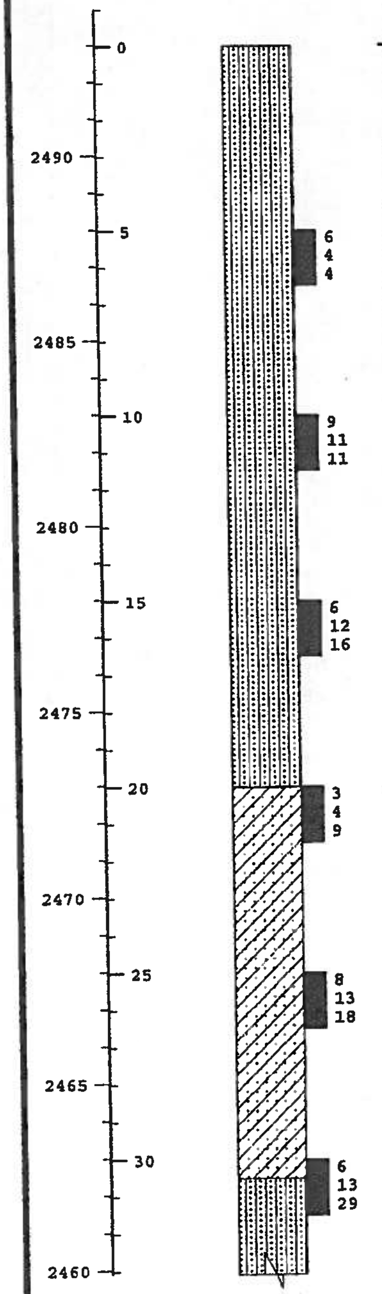
EXPLORATION LOG
OW-9

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98094 W:114.98134
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2492.96 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/9/2013
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 83 Feet
FINAL DEPTH TO WATER: 80.18 Feet

DATE MEASURED: 8/9/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SM	Dark brown silty SAND, moist, loose.					
	...slight clay fraction.					
	...medium dense.					
SC	Red to brown clayey SAND, moist, loose.					
	...medium dense.					
SM	Light brown silty SAND, dry, medium dense.					

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

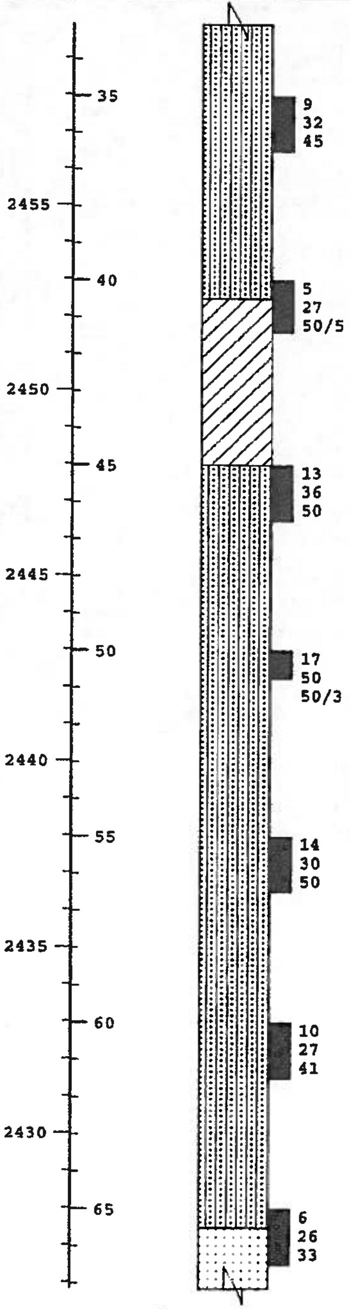
EXPLORATION LOG
OW-9

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98094 W:114.98134
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2492.96 Feet

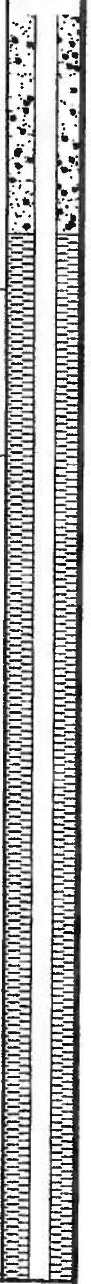
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/9/2013
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 83 Feet
FINAL DEPTH TO WATER: 80.18 Feet

DATE MEASURED: 8/9/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
	...dense.					
CL	Dark brown lean CLAY with sand, dry, very stiff.					
SM	Dark brown silty SAND, dry, dense.					
	...very dense.					
	...dense.					
SW	Light brown well graded SAND with gravel, dry, dense.					



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

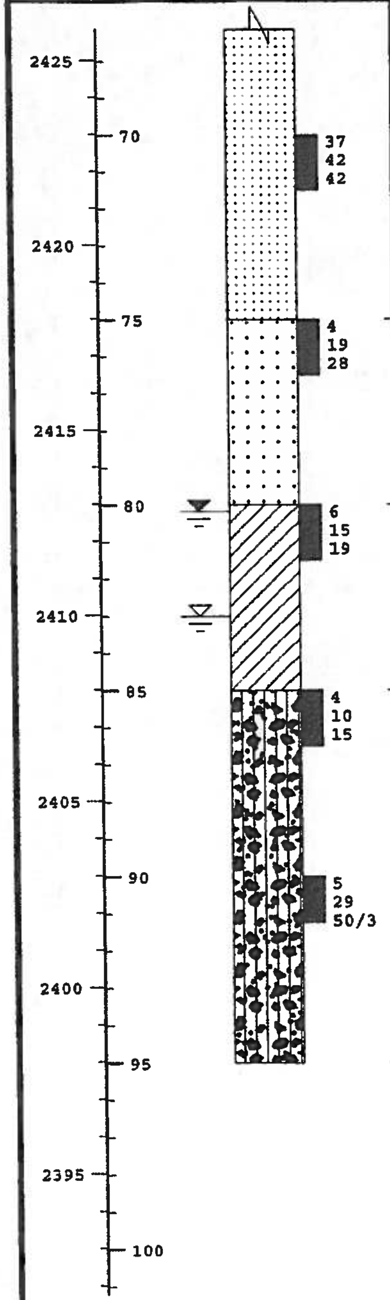
EXPLORATION LOG
OW-9

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98094 W:114.98134
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2492.96 Feet

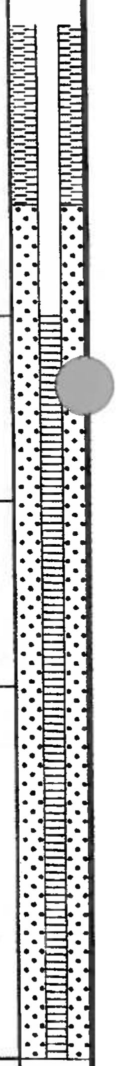
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/9/2013
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 83 Feet
FINAL DEPTH TO WATER: 80.18 Feet

DATE MEASURED: 8/9/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
	...moist.					
SP	Light brown poorly graded SAND, moist, medium dense.					
CL	Dark brown lean CLAY with sand, moist, very stiff.					
GW-GM	Light brown well graded GRAVEL with silt and sand, wet, medium dense.					
	END OF BORING AT 95.0 FEET					



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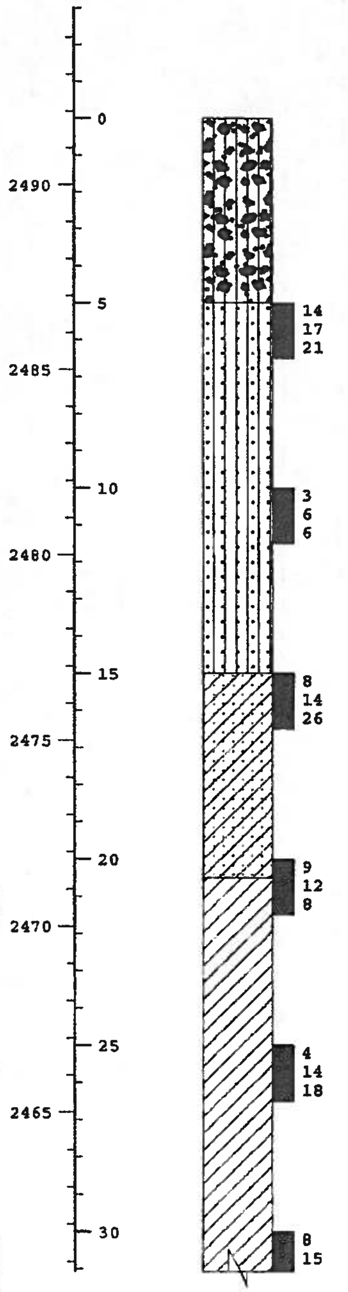
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

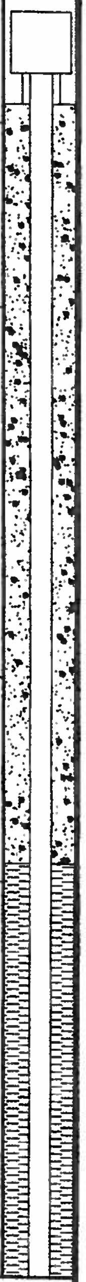
EXPLORATION LOG
OW-10

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.97727 W:114.98076
EXPLORATION DATE: 8/15/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2,491.81 Feet
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 78.23 Feet
DATE MEASURED: 8/15/13
FINAL DEPTH TO WATER: 78.16
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		GW-GM	Light brown well graded GRAVEL with silt and sand, dry, loose.						
		SP-SM	Dark brown poorly graded SAND with silt, dry, medium dense. ...loose.						
		SC	Dark brown clayey SAND, dry, medium dense.						
		CL	Dark brown lean CLAY with sand, dry, stiff. ...very stiff.						



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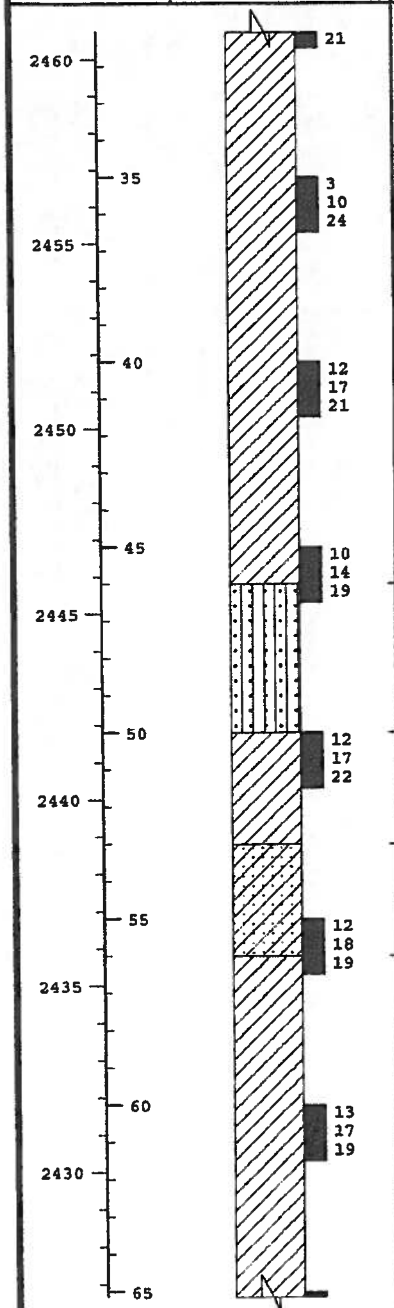
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
Figure No.

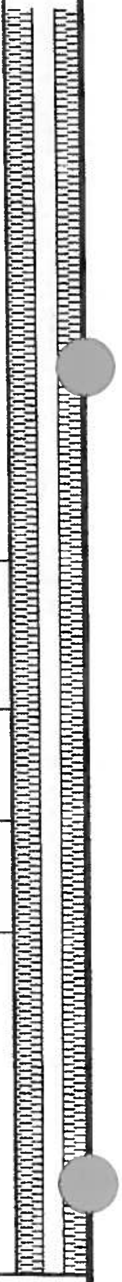
EXPLORATION LOG
OW-10

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.97727 W:114.98076
EXPLORATION DATE: 8/15/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2,491.81 Feet
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 78.23 Feet
DATE MEASURED: 8/15/13
FINAL DEPTH TO WATER: 78.16
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SP-SM	Dark brown poorly graded SAND with silt and gravel, dry, medium dense.					
CL	Dark brown lean CLAY with sand, moist, very stiff.					
SC	Dark brown clayey SAND, dry, medium dense.					
CL	Grey to brown lean CLAY with sand, dry, very stiff.					



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

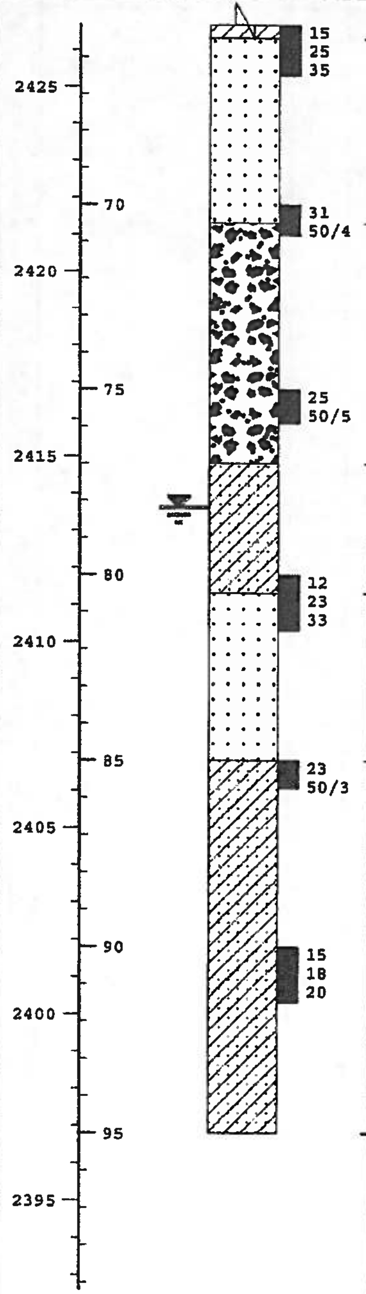
EXPLORATION LOG
OW-10

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.97727 W:114.98076
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2,491.81 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/15/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

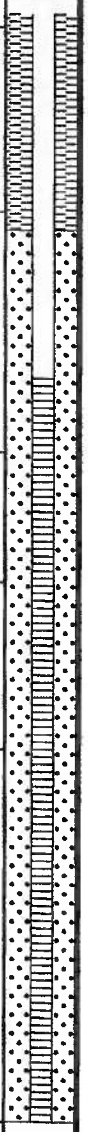
INITIAL DEPTH TO WATER: 78.23 Feet
FINAL DEPTH TO WATER: 78.16

DATE MEASURED: 8/15/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SP	Grey to brown poorly graded SAND, moist, dense.					
GW	Dark brown well graded GRAVEL with sand, moist, very dense.					
SC	Dark brown clayey SAND, moist, medium dense.					
SP	Dark brown poorly graded SAND with gravel, wet, dense.					
SC	Dark brown clayey SAND, wet, very dense. ...medium dense.					
	END OF BORING AT 95.0 FEET					

WELL CONSTRUCTION



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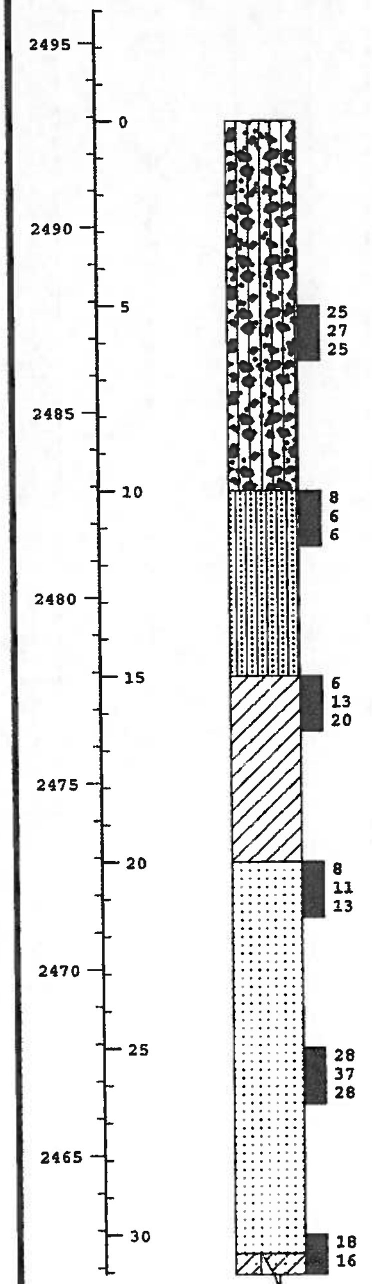
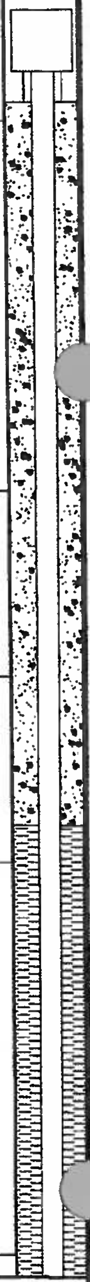
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. Figure No.

EXPLORATION LOG
OW-11

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.97718 W:114.98504
EXPLORATION DATE: 8/16/13
EXPLORATION SIZE (dia.): 7" O.D HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2492.88 Feet
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 63 Feet
DATE MEASURED: 8/16/13
FINAL DEPTH TO WATER: 61.54 Feet
DATE MEASURED: 8/21/13





ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		GW-GM	Dark brown well graded GRAVEL with silt and sand, dry, medium dense.						
			...dense.						
		SM	Dark brown silty SAND sry, loose.						
		CL	Green to brown lean CLAY with sand, dry, very stiff.						
		SW	Dark brown well graded SAND with gravel, dry, medium dense.						
			...moist, dense.						

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

EXPLORATION LOG
OW-11

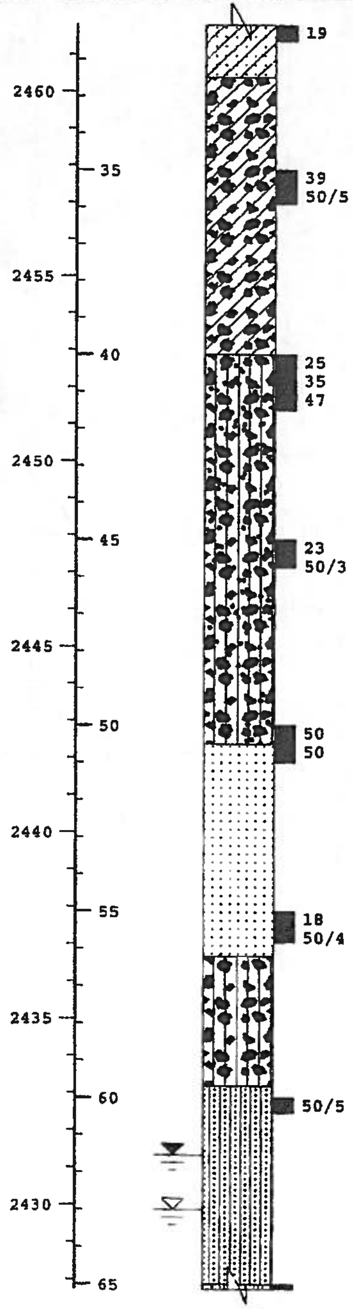
PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.97718 W:114.98504
EXPLORATION SIZE (dia.): 7" O.D HSA
ELEVATION: 2492.88 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 63 Feet
FINAL DEPTH TO WATER: 61.54 Feet

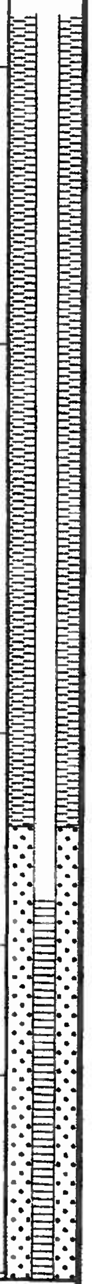
DATE MEASURED: 8/16/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH | SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SC	Dark brown clayey SAND, dry, medium dense.					
GC	Dark brown clayey GRAVEL with sand, moist, very dense ...increasing gravel. ...decreasing clay fraction.					
GW-GM	Dark brown well graded GRAVEL with silt and sand, moist, dense. ...very dense. ...drilling smoothed out at 48 feet.					
SW	Dark brown to black well graded SAND with gravel, moist and very dense. ...gravel layer. ...smoothed out.					
GM	...gravel layer. ...more consistent grinding.					
SM	Light brown weakly cemented silty SAND, moist, very dense. ...wet.					

WELL CONSTRUCTION



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

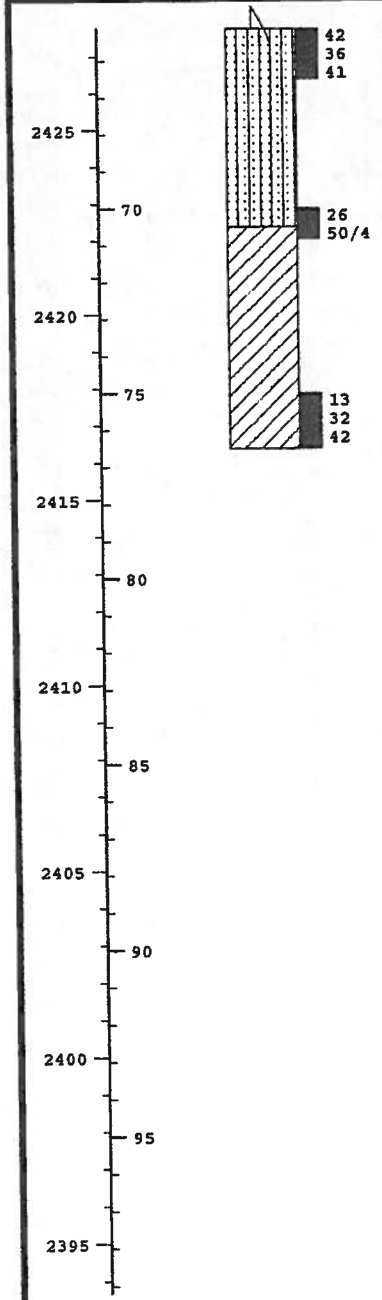
EXPLORATION LOG
OW-11

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.97718 W:114.98504
EXPLORATION SIZE (dia.): 7" O.D HSA
ELEVATION: 2492.88 Feet

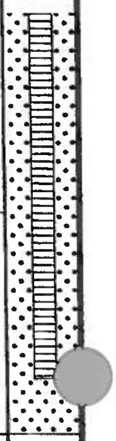
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 63 Feet
FINAL DEPTH TO WATER: 61.54 Feet

DATE MEASURED: 8/16/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SW-SM	Brown well graded SAND with silt and gravel, wet, dense.						
		CL	Light brown nodular sandy lean CLAY, wetto moist, very stiff. ...moist.						
			END OF BORING AT 76.5 FEET						



GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

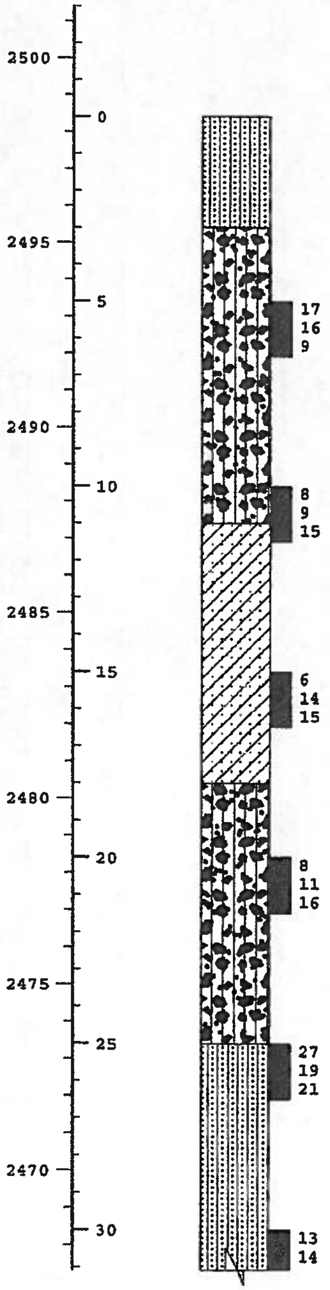
Figure No.

EXPLORATION LOG
OW-12

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.9808 W:114.98476
EXPLORATION DATE: 8/14/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2498.41 Feet
LOGGED BY: Robbins/Dorris

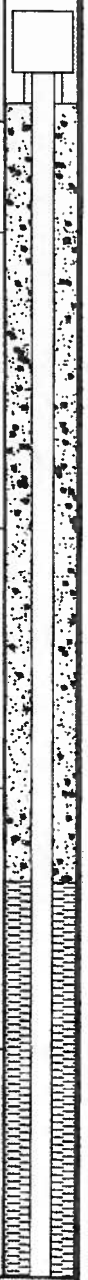
INITIAL DEPTH TO WATER: 61.16 Feet
DATE MEASURED: 8/14/13
FINAL DEPTH TO WATER: 56.96 Feet
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH | SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SM	Light brown silty SAND with gravel, loose, dry.					
GW-GM	Dark brown well graded GRAVEL with silt and sand, dry, medium dense.					
SC	Green to brown clayey SAND, dry, medium dense.					
GW-GM	Dark brown well graded GRAVEL with silt and sand, moist, medium dense.					
SM	Dark brown silty SAND, dry, medium dense.					

WELL CONSTRUCTION



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. Figure No.

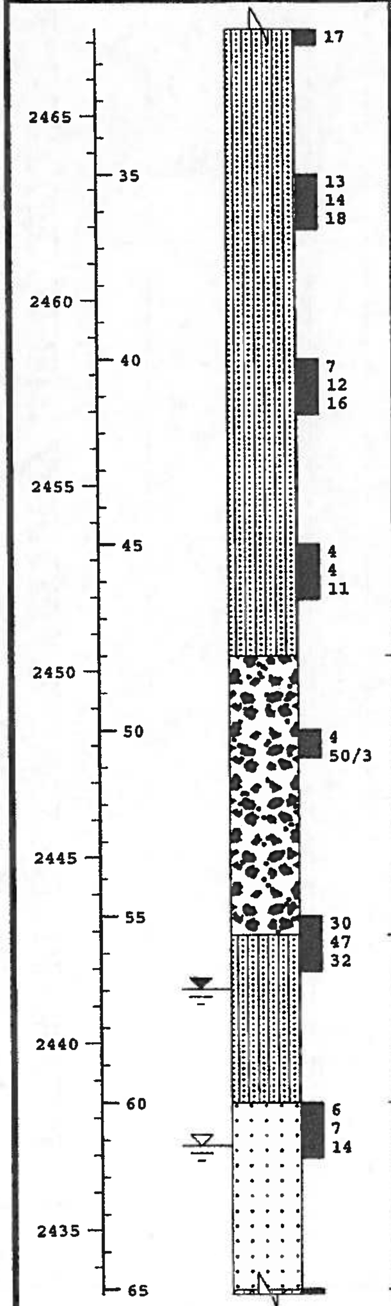
EXPLORATION LOG
OW-12

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.9808 W:114.98476
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.41 Feet

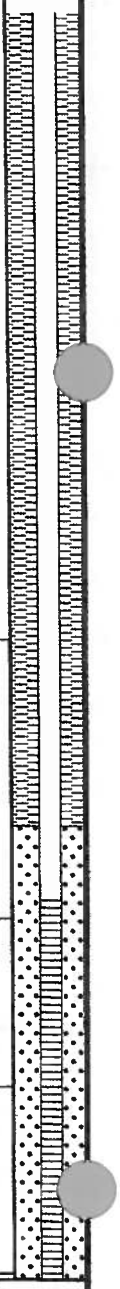
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/14/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 61.16 Feet
FINAL DEPTH TO WATER: 56.96 Feet

DATE MEASURED: 8/14/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
	...increasing clay fraction.					
	...loose.					
GW	Grey to brown well graded GRAVEL with sand, dry, very dense.					
SM	Dark brown silty SAND with gravel, moist, dense.					
SP	Dark brown poorly graded SAND, wet, medium dense.					



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

EXPLORATION LOG
OW-12

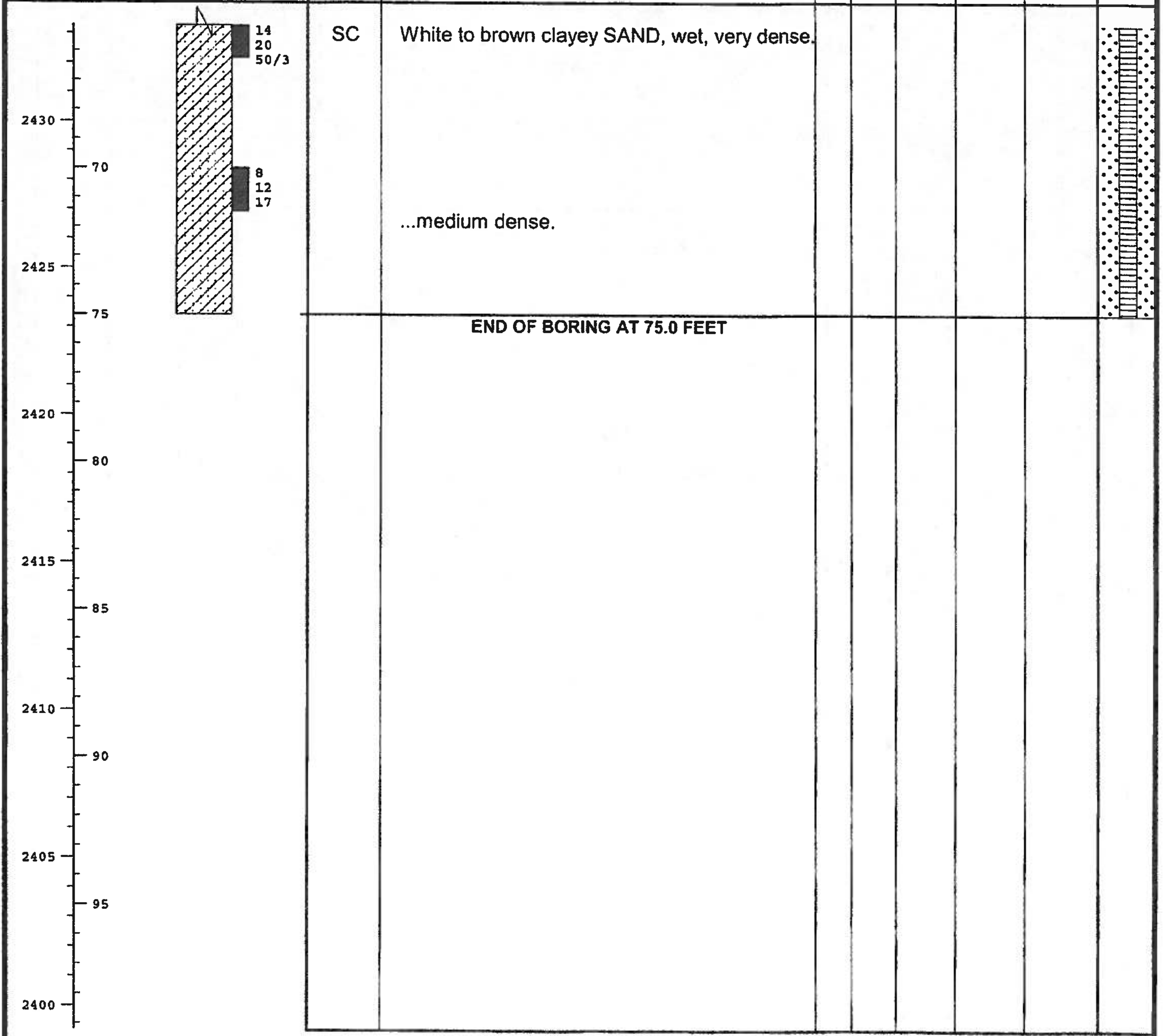
PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.9808 W:114.98476
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.41 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/14/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 61.16 Feet
FINAL DEPTH TO WATER: 56.96 Feet

DATE MEASURED: 8/14/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
	14 20 50/3	SC	White to brown clayey SAND, wet, very dense.						
	8 12 17		...medium dense.						
			END OF BORING AT 75.0 FEET						



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

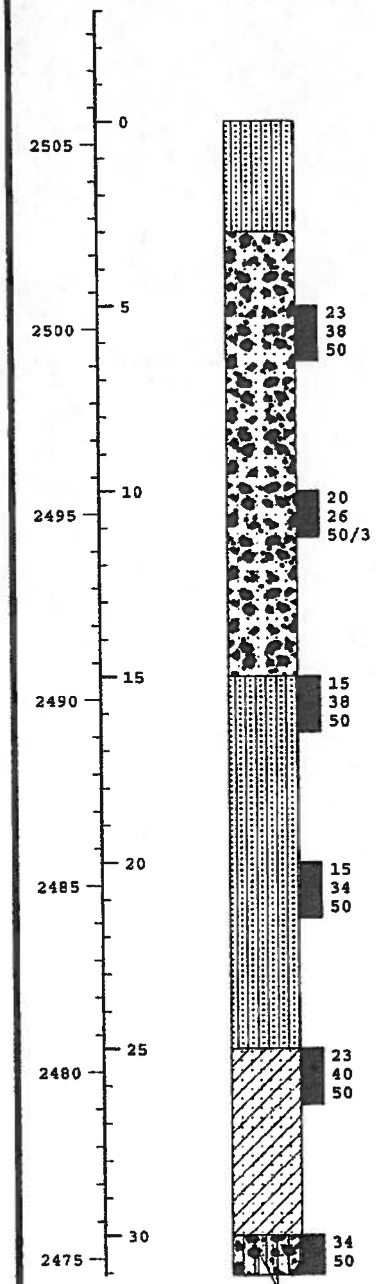
EXPLORATION LOG
OW-13

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98441 W:114.98537
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2505.63 Feet

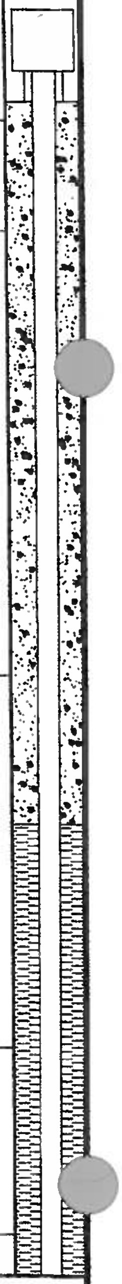
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/13/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 58.45 Feet
FINAL DEPTH TO WATER: 52.66 Feet

DATE MEASURED: 8/13/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
0		SM	Light brown silty SAND, dry, loose.						
	23 38 50 20 26 50/3	GW	Light brown well graded GRAVEL with sand, dry, dense. ...very dense.						
15	15 38 50 15 34 50	SM	Dark brown silty SAND, dry, dense.						
25	23 40 50	SC	Light brown clayey SAND, dry, very dense.						
30	34 50	GW-	Dark brown well graded GRAVEL with silt and						



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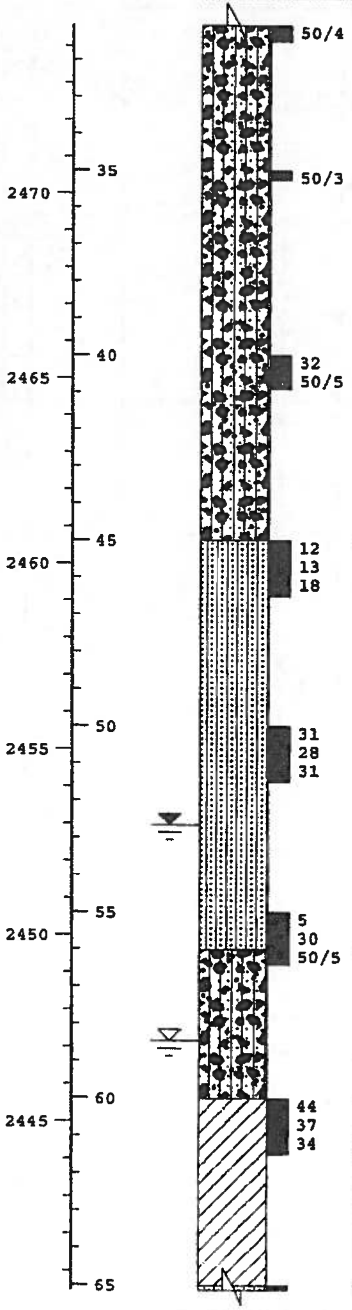
EXPLORATION LOG
OW-13

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98441 W:114.98537
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2505.63 Feet

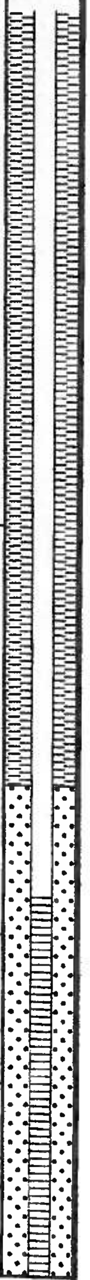
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/13/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 58.45 Feet
FINAL DEPTH TO WATER: 52.66 Feet

DATE MEASURED: 8/13/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
GM	sand, dry, very dense. ...moist.						
SM	Dark brown silty SAND, moist, medium dense. ...dense.						
GW-GM	Light brown well graded GRAVEL with silt and sand, moist, very dense.						
CL	Light brown lean CLAY with sand, wet, very stiff.						



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

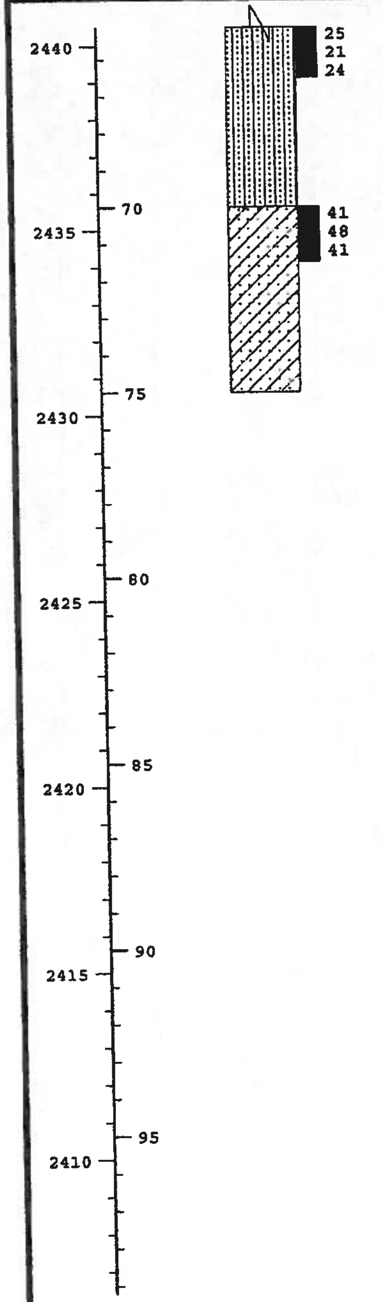
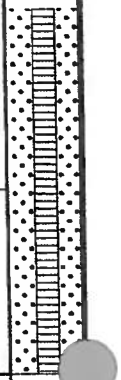
EXPLORATION LOG
OW-13

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98441 W:114.98537
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2505.63 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/13/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 58.45 Feet
FINAL DEPTH TO WATER: 52.66 Feet

DATE MEASURED: 8/13/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SM	Dark brown silty SAND, wet, medium dense.						
		SC	Light brown clayey SAND, wet, dense.						
			END OF BORING AT 75.0 FEET						

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

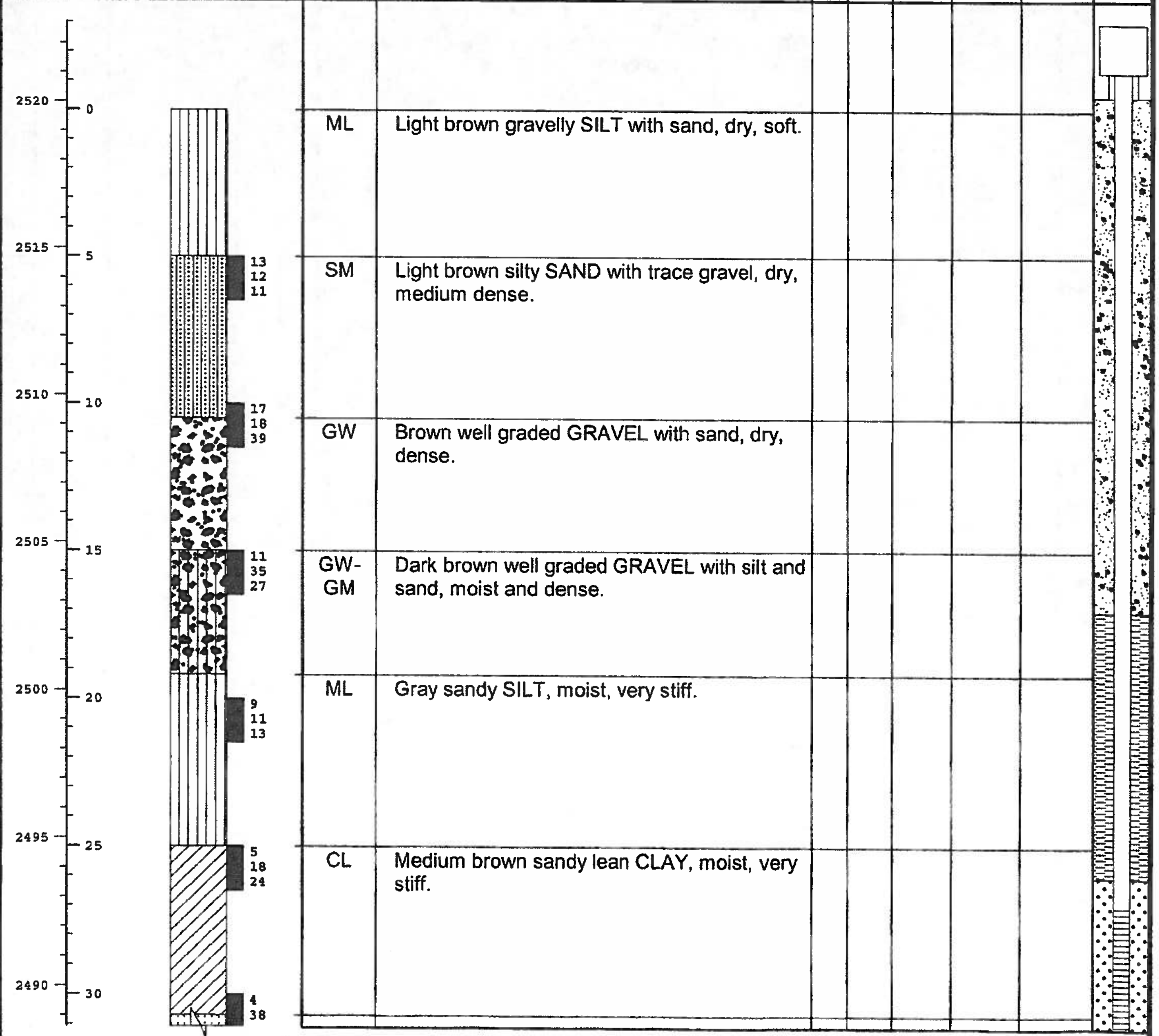
EXPLORATION LOG
OW-14

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98436 W:114.9878
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2519.72 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 38 Feet
FINAL DEPTH TO WATER: 36.98 Feet

DATE MEASURED: 8/19/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		ML	Light brown gravelly SILT with sand, dry, soft.						
	13 12 11	SM	Light brown silty SAND with trace gravel, dry, medium dense.						
	17 18 39	GW	Brown well graded GRAVEL with sand, dry, dense.						
	11 35 27	GW-GM	Dark brown well graded GRAVEL with silt and sand, moist and dense.						
	9 11 13	ML	Gray sandy SILT, moist, very stiff.						
	5 18 24 4 38	CL	Medium brown sandy lean CLAY, moist, very stiff.						

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. Figure No.

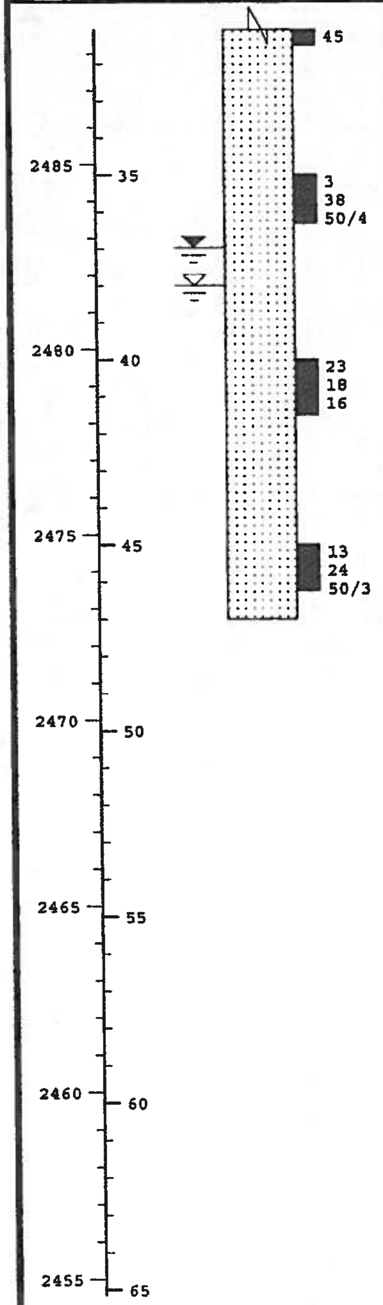
EXPLORATION LOG
OW-14

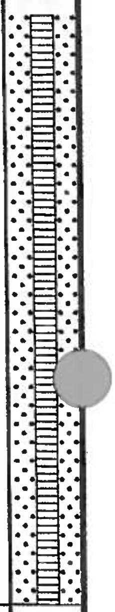
PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98436 W:114.9878
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2519.72 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 38 Feet
FINAL DEPTH TO WATER: 36.98 Feet

DATE MEASURED: 8/19/13
DATE MEASURED: 8/21/13





ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SW	Dark brown well graded SAND with gravel, moist and dense.						
			...very dense.						
			...wet.						
			...some lenses of fine sand, medium dense.						
			...increasing gravel fraction.						
			END OF BORING AT 47.0 FEET						

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

EXPLORATION LOG
OW-15

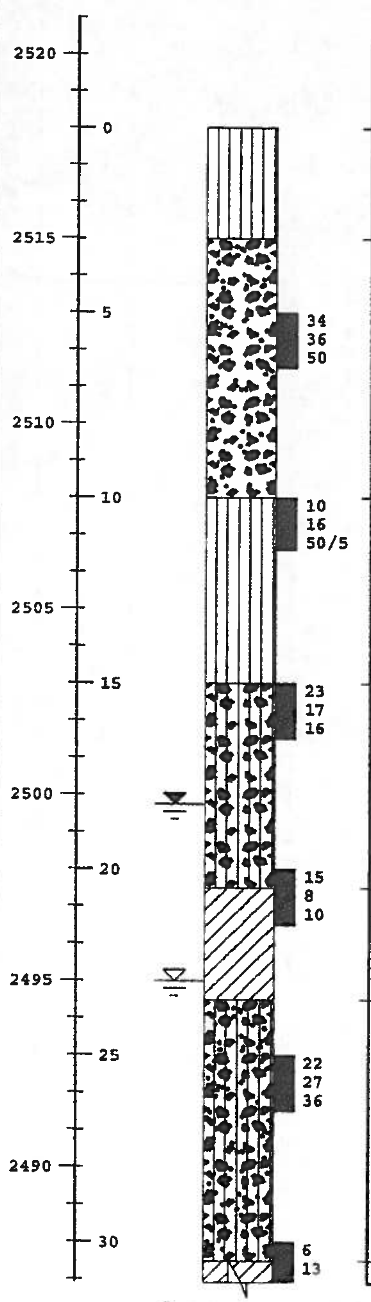
PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.98089 W:114.987827
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2517.99 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/20/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 23 Feet
FINAL DEPTH TO WATER: 18.26 Feet

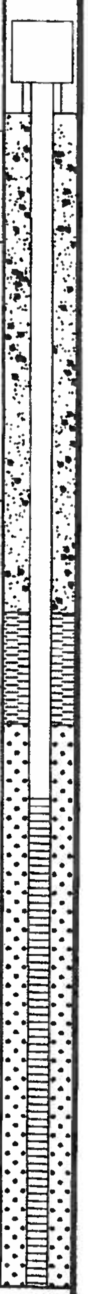
DATE MEASURED: 8/20/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH | SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
ML	Light brown sandy SILT, dry, loose.					
GW	...gravel layer at 3 feet. brown well graded GRAVEL with sand, dry, dense. ...increasing silt fraction.					
ML	Dark brown sandy SILT with gravel, moist, dense.					
GM	Dark brown silty GRAVEL with sand, moist to wet, medium dense.					
CL	Blue-green sandy lean CLAY, moist, stiff. ...wet.					
GW-GM	...grinding on gravel. Dark brown well graded GRAVEL with silt and sand, wet and dense.					

WELL CONSTRUCTION



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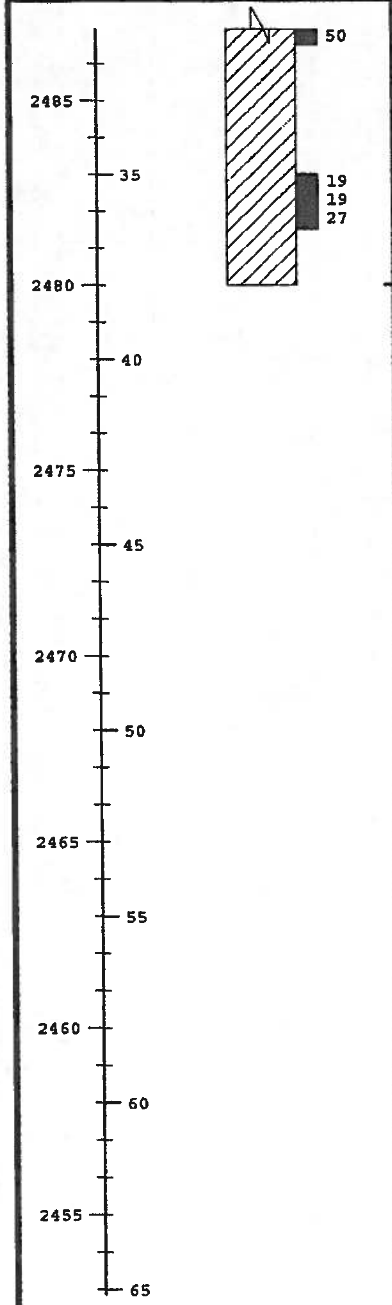
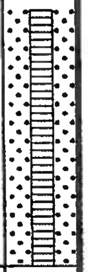
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. **Figure No.**

EXPLORATION LOG
OW-15

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.98089 W:114.987827
EXPLORATION DATE: 8/20/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2517.99 Feet
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 23 Feet
DATE MEASURED: 8/20/13
FINAL DEPTH TO WATER: 18.26 Feet
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
CL	Light brown nodular CLAY, moist, very stiff. ...trace gravel.						
	END OF BORING AT 38.0 FEET						

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. **Figure No.**

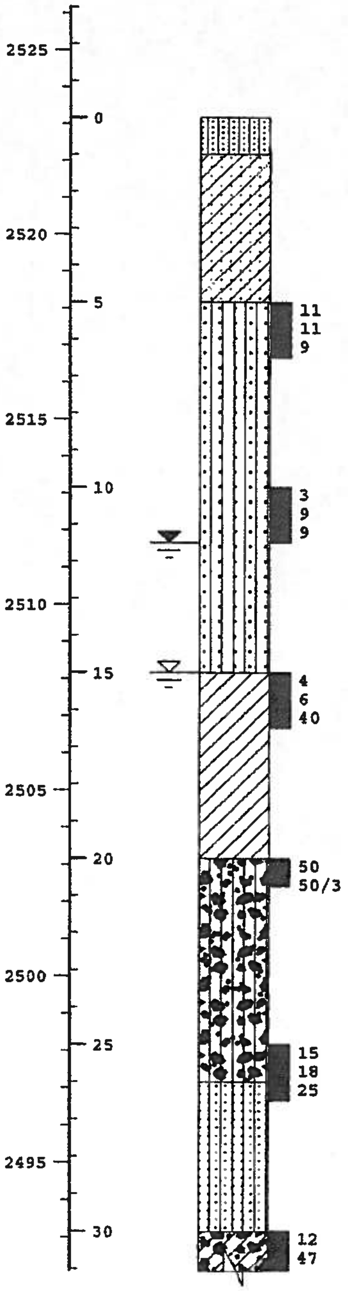
EXPLORATION LOG
OW-16

PROJECT: Site Investigation Western Elite Landfill
EXPLORATION LOCATION: N:36.97714 W:114.98924
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2523.17 Feet (

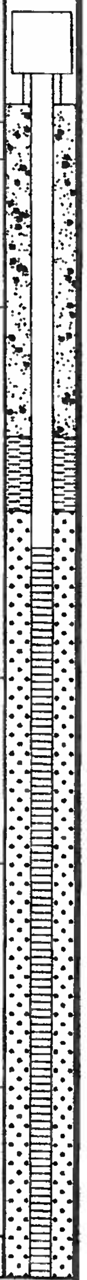
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/8/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 15 Feet
FINAL DEPTH TO WATER: 11.5 Feet

DATE MEASURED: 8/8/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
0		SM	Light brown silty SAND, very loose, dry.						
		CL	Light brown lean CLAY with sand, dry and soft.						
5	11 11 9	SP-SM	White to brown poorly graded SAND with silt and gravel, dry and medium dense.						
10	3 9 9		...slight clay fraction, moist.						
15	4 6 40	CL	White to brown lean CLAY with gravel,wet and very stiff.						
20	50 50/3	GW-GM	Light brown well graded GRAVEL with silt and sand, wet and very dense.						
25	15 18 25	SW-SM	Dark brown well graded SAND with silt and gravel, wet and dense.						
30	12 47	GW-GC	Light brown well graded GRAVEL with clay						



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC

Figure No.

EXPLORATION LOG
OW-16

PROJECT: Site Investigation Western Elite Landfill
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.97714 W:114.98924
EXPLORATION DATE: 8/8/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2523.17 Feet (
LOGGED BY: Robbins/Thompson
INITIAL DEPTH TO WATER: 15 Feet
DATE MEASURED: 8/8/13
FINAL DEPTH TO WATER: 11.5 Feet
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
	▨ 38		and sand, wet and dense.						
			END OF BORING AT 31.5 FEET						
2490									
35									
2485									
40									
2480									
45									
2475									
50									
2470									
55									
2465									
60									
2460									
65									

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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No.

APPENDIX II

GROUNDWATER MONITORING WELL CONSTRUCTION SPECIFICATIONS

GROUNDWATER MONITORING WELL CONSTRUCTION SPECIFICATIONS

1.0 DRILLING

1.1 Nominal Boring Diameter

In all cases where the diameter of the well pipe will be 2 inches, the minimum nominal borehole diameter of borings advanced through soil materials will be 6 inches in order to help ensure that the minimum width of the annulus around the well pipe will be 2 inches.

1.2 Drilling Methods

All borings should be advanced using appropriate drilling technology suitable for the geologic terrain and the collection and any required soil samples.

1.3 Cuttings

Drilling will be performed in a manner that minimizes the spreading of soil cuttings. Disposition of cuttings upon project completion will be the responsibility of Owner/Operator or the Owner/Operator's designated representative. Cuttings will be disposed of in accordance with the NDEP's Investigative Derived Waste Disposal Policy.

2.0 SOIL SAMPLING

2.1 Split Spoon Sampling

During hollow stem auger drilling, subsurface strata should sampled using means appropriate for the drilling technology being used..

At a minimum, samples should be taken at 5.0-foot intervals between the surface and the bottom of the hole, excepting nested locations where surficial conditions have already been identified. Each well and/or piezometer in the nest will be installed in a separate borehole. Only one well or piezometer will be installed in each borehole.

2.2 Cuttings

The driller will keep cuttings clear of the borehole.

2.3 Sample Disposition

Disposition of sample material upon completion of the project will be the responsibility of the Owner/Operator or the Owner/Operator's designated representative.

3.0 WELL CONSTRUCTION

3.1 Construction Method

In the event that the borehole stands open, the well may be constructed in the open borehole. In the event that the borehole fails upon removal of the drill stem, then a temporary casing shall be advanced into the borehole to facilitate the well construction activities.

3.2 Well Pipe and Screen

Each monitoring well will be constructed of pre-cleaned Schedule 40 PVC pipe having a minimum inner diameter of 2 inches and a maximum inner diameter of 4 inches.

The screen in each monitoring well will extend a minimum of 15 feet into groundwater and extend a minimum of one foot above the seasonal high groundwater elevation. Screens will be factory-slotted. Slots will be 0.010 or 0.020 inch in width as determined by the onsite hydrogeologist based on their evaluation of the aquifer matrix. A five foot section of pipe will extend below the perforation.

The driller will wear clean surgical-type gloves whenever handling PVC well pipe, and the pipe will be maintained in a clean manner.

In order to provide a clean cut, a PVC pipe cutter will be used whenever it is necessary to shorten sections of the PVC well pipe; a hacksaw will not be used.

3.3 Filter Pack

The filter pack will be constructed from clean sand or gravel of proper size in relation to the screen slots to prevent its passage into the well.

Filter material will be placed in the annulus around the well riser and to a point approximately 2 feet above the top of the screen. A tremie pipe will be used as feasible.

3.4 Bentonite Seal

The annulus around the well pipe will be sealed with a layer of hydrated bentonite pellets, to be placed directly above the sand filter pack. The minimum thickness of the bentonite layer will be approximately 2 feet. The bentonite pellets will be allowed a minimum time of 24 hours for hydration prior to continuing with well construction. A tremie pipe will be used as feasible

3.5 Grout

Following hydration of the bentonite seal, each boring will be sealed with a Portland Type I bentonite/cement slurry, using the tremie pipe method.

Bentonite content in the slurry will be 2 to 5 percent by weight to help reduce shrinkage.

3.6 Surface Completion

The driller will be prepared for either manhole or stickup surface completions.

In the case of manhole installations, suitable surface completion will consist of capped PVC riser and steel manhole.

The PVC riser will be provided with a lockable, watertight, expansion cap. The driller will provide a lock for each cap. All locks will be keyed identically and all keys relinquished to the owner.

The manhole will be placed in a manner that permits surface water to runoff and drain away from the manhole cover.

In the case of stickup installations, suitable surface completion will consist of a concrete apron, capped PVC well riser, and outer protective casing. The apron will be constructed in such a manner that surface water will not return to it.

The concrete apron will have the following minimum dimensions: 3 feet x 3 feet x 3.5 inches, and will be centered with respects to the riser. A form will be used in constructing the apron. The form will be centered with respect to the PVC riser. The upper surface of the apron will be graded to provide drainage away from the PVC riser. A spike will be set into the pad for surveying purposes.

The inner PVC riser (well pipe) will extend to an approximate height of 1.75 feet above the top of the concrete pad. A vent hole having a diameter of 0.25 inches will be drilled through the PVC riser at a point 2 inches below its top. Shavings generated by drilling the PVC riser will be prevented from falling into the well. The PVC riser will be provided with a slip on PVC cap.

The outer protective casing will be constructed of steel pipe having a diameter, or diagonal, of not less than 8 inches. The top of the outer protective casing, when uncovered, will be placed at a point between 0.5-inch above the top of the PVC well pipe and 0.5-inch below the top of the PVC pipe. A drain hole having a diameter of 0.5-inch will be drilled through the outer protective casing near the top of the concrete apron. Shavings generated by drilling the steel casing will be prevented from falling into the well. The casing will be marked for surveying purposes.

The outer protective casing will be lockable. The driller will provide a lock for each protective casing cap. All locks will be keyed identically.

4.0 SURVEYING

Well elevation will be surveyed by a licensed surveyor. Survey point(s) will include:

- concrete pad (marked with a spike);
- outer protective steel casing, when open (engraved mark);
- inner PVC well pipe (engraved mark);
- ground surface (not marked);
- well location to within ± 0.5 foot in horizontal plane;
- ground surface elevation to within ± 0.01 foot;
- surveyor's pin elevation on concrete apron within ± 0.01 foot;
- top of monitoring well casing elevation to within ± 0.01 foot; and,
- top of protective steel casing elevation to within ± 0.01 foot.

5.0 WELL DEVELOPMENT AND INSPECTION

The driller will develop each well until sediment free water with stabilized field constituents (i.e., temperature, pH and specific conductance) is obtained.

Development will be conducted using a surge block followed by pumping or bailing. The surge block may be used as a means of assessing the integrity of the well screen and riser.

All well development equipment (bailers, pumps, surge blocks) and any additional equipment that contacts subsurface formations will be decontaminated prior to on site use, between consecutive on site uses, and/or between consecutive well installations, as directed by Owner/Operator or Owner/Operator's designated representative.

6.0 ANCILLARY REQUIREMENTS

6.1 Extraneous Material

The driller will take all reasonable care to ensure that each boring is free from all materials other than those required for well construction. Materials required for well construction is here defined to include polyvinyl chloride (PVC), sand, bentonite, Portland cement and natural soil materials. All other materials accidentally or purposely placed in the hole will be removed by driller prior to well completion.

6.2 Decontamination

All drilling equipment (drill steel, bits, casing materials) and any additional equipment, that contacts subsurface formations will be decontaminated prior to on site use, between consecutive on site uses, and/or between consecutive well installations, as directed by Owner/Operator or Owner/Operator's designated representative.

Appropriate decontamination procedure will consist of steam cleaning with potable water and biodegradable detergent (e.g., Liquinox) approved by Owner/Operator or Owner/Operator's designated representative. Steam cleaning will be conducted in a manner that minimizes over-spray and runoff.

6.3 Disposition of Waste Water

If drilling fluids are used or monitoring wells constructed in an area of suspected contamination, well development wastewater will be placed in 55-gallon drums at the well site and subsequently transported to a publicly operated treatment works (POTW) for disposal.

6.4 Site Safety Plan

The driller is responsible for maintaining the personal safety of his employees while on site. The driller will keep a fire extinguisher (in good working condition) and first aid kit at the site at all times during which the site is occupied by his employees.

The driller will be responsible for providing any personal protective equipment that might be required by state and federal occupational safety and health agencies, including, but not necessarily limited to, hard hats, hearing protection and steel-toed boots, for all personnel employed by the driller.

6.5 Cleanup

The driller will be responsible for removing all refuse from each well site. Such refuse typically includes, but is not limited to, PVC pipe wrappers, sand bags, bentonite bags, cement bags, beverage containers, food wrappers and other forms of litter. Smoking on site will not be permitted.

The driller will be responsible for providing the following information to the Owner/Operator's designated representative after well installation has been performed:

- date and time of construction;
- drilling method and fluid used (if applicable);
- boring diameter;
- well pipe (inner casing) specifications;
- well depth (+/-0.01 ft.);
- drilling/lithologic logs;
- specifications for other casing materials (if applicable);
- screen specifications;
- well pipe/screen joint type;
- filter pack specifications (material, size);
- filter pack volume and calculations;
- filter pack placement methods;
- bentonite seal specifications;
- bentonite seal volume;
- bentonite seal placement method;
- grout specifications;
- grout volume;
- grout placement method;
- surface completion specifications; and,
- well development procedure.

APPENDIX III

EXAMPLE WELL CONSTRUCTION LOG
EXAMPLE MICROPURGE SAMPLE LOG
EXAMPLE CHAIN-OF-CUSTODY

JOYCE
ENGINEERING, INC

LOG OF BORING MW-________

(Page 1 of 1)

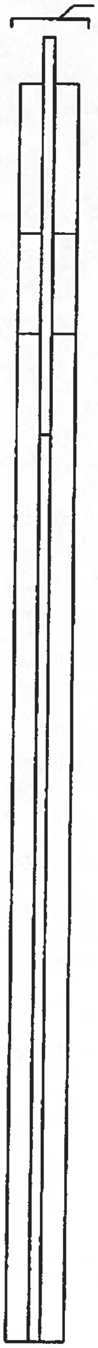
____
______________, Permit # ______
____________________, Virginia
JEI Project No. ___________, Task _____

Date Started :
Date Completed :
Hole Diameter :
Drilling Method :
Sampling Method :

Drilling Company :
Northing Coord. :
Easting Coord. :
Survey By :
Logged By :

Depth in Feet	Surf. Elev.	Blow Count	% Rec.	USCS	DESCRIPTION
0					
5					
10					
15					
20					
25					

Well: MW-______
TOC Elev.: __________



Well Construction Information

WELL CONSTRUCTION
Date Compl.
Hole Diameter(s)
Drilling Method(s)
Company Rep.

WELL CASING
Material
Diameter
Joints
Apprx. Csg. Stickup

WELL SCREEN
Material
Diameter
Joints
Opening

GRAVEL PACK
Type

WELL SCREEN SEAL
Type

ANNULUS SEAL
Type

PROTECTIVE CSG.
Type

WELL PAD
Type

1.

DATE: ____________

JOYCE
ENGINEERING, INC.

MICROPURGE SAMPLING LOG

Project Name: ____________________ **Project No./Task No.:** ____________________
Well ID: ____________________ **Sampler(s):** ____________________
Well Diameter: ____________ **inches** **Initial Depth to Water:** ____________ **feet**
Depth to Bottom: ____________ **feet** **Water Column Thickness:** ____________ **feet**
Well Location: ____
Equipment: ____
____

Time	PH s.u.	Temp. °C	Cond. u.s.	Dis. O_2 mg/l	Turb. ntu	ORP mv	DTW feet

Comments (weather conditions, color, silt, type of sample, purgewater management, etc.): ________
____
____

Signature: ____________________ Date: ____________________

QA/QC Sign Off: ____________________ Date: ____________________

s:\groundwater\sop\2002 sops\2002 low-flow gw sampling sog ver. 2.0.doc

Chain of Custody Record

Temperature on Receipt ______

Drinking Water? Yes ☐ No ☐

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

TAL-4124 (1007)

Client

Address

City | State | Zip Code

Project Name and Location (State)

Contract/Purchase Order/Quote No.

Project Manager

Telephone Number (Area Code)/Fax Number

Site Contact | Lab Contact

Carrier/Waybill Number

Date

Lab Number

Chain of Custody Number 247408

Page ______ of ______

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix				Containers & Preservatives						Analysis (Attach list if more space is needed)												Special Instructions/ Conditions of Receipt
			Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH													

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)

1. Relinquished By | Date | Time | 1. Received By | Date | Time

2. Relinquished By | Date | Time | 2. Received By | Date | Time

3. Relinquished By | Date | Time | 3. Received By | Date | Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

APPENDIX IV

ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR THE DETECTION AND ASSESSMENT MONITORING PROGRAMS

Monitoring Parameters and Analytical Methods
Detection Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix I)

PARAMETER	CLASS	CAS RN	METHOD	ECL (ug/L)	MCL (ug/L)	Notes
Acetone	volatile	67-64-1	8260	100.00	-	
Acrylonitrile	volatile	107-13-1	8260	5.00	-	
Antimony	metal	Total	7041	30.00	6.00	
Arsenic	metal	Total	7060	10.00	50.00	
Barium	metal	Total	6010	10.00	2,000.00	
Benzene	volatile	71-43-2	8260	1.00	5.00	
Beryllium	metal	Total	6010	2.00	4.00	
Bromochloromethane	volatile	74-97-5	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
Bromodichloromethane	volatile	75-27-4	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
Bromoform	volatile	75-25-2	8260	1.00	-	
Cadmium	metal	Total	7131	1.00	5.00	
Carbon disulfide	volatile	75-15-0	8260	100.00	-	
Carbon tetrachloride	volatile	56-23-5	8260	1.00	5.00	
Chlorobenzene	volatile	108-90-7	8260	1.00	100.00	
Chloroethane	volatile	75-00-3	8260	1.00	-	
Chloroform	volatile	67-66-3	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
Chromium	metal	Total	7191	10.00	100.00	
Cobalt	metal	Total	7201	10.00	-	
Copper	metal	Total	7211	10.00	1,300.00	Listed MCL represents an EPA action limit
Dibromochloromethane	volatile	124-48-1	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
1,2-Dibromo-3-chloropropene (DBCP)	volatile	96-12-8	8011	0.10	0.20	
1,2-Dibromoethane (EDB)	volatile	106-93-4	8011	0.10	0.05	
o-Dichlorobenzene / 1,2-Dichlorobenzene	volatile	95-50-1	8260	1.00	600.00	
p-Dichlorobenzene / 1,4-Dichlorobenzene	volatile	106-46-7	8260	1.00	75.00	
trans-1,4-Dichloro-2-butene	volatile	110-57-6	8260	100.00	-	
1,1-Dichloroethane	volatile	75-34-3	8260	1.00	-	
1,2-Dichloroethane	volatile	107-06-2	8260	1.00	5.00	
1,1-Dichloroethylene	volatile	75-35-4	8260	1.00	7.00	
cis-1,2-Dichloroethylene	volatile	156-59-2	8260	1.00	70.00	
trans-1,2-Dichloroethylene	volatile	156-60-5	8260	1.00	100.00	
1,2-Dichloropropane	volatile	78-87-5	8260	1.00	5.00	
cis-1,3-Dichloropropene	volatile	10061-01-5	8260	5.00	-	
trans-1,3-Dichloropropene	volatile	10061-02-6	8260	5.00	-	
Ethylbenzene	volatile	100-41-4	8260	1.00	700.00	
2-Hexanone / Methyl butyl ketone (MBK)	volatile	591-78-6	8260	50.00	-	
Lead	metal	Total	7421	10.00	15.00	
Methyl bromide / Bromomethane	volatile	74-83-9	8260	1.00	-	
Methyl chloride / Chloromethane	volatile	74-87-3	8260	1.00	-	
Methyl ethyl ketone / 2-Butanone (MEK)	volatile	78-93-3	8260	100.00	-	
Methyl iodide	volatile	74-88-4	8260	5.00	-	
4-Methyl-2-pentanone / Methyl isobutyl ketone	volatile	108-10-1	8260	50.00	-	
Methylene bromide / Dibromomethane	volatile	74-95-3	8260	1.00	-	
Methylene chloride / Dichloromethane	volatile	75-09-2	8260	1.00	5.00	
Nickel	metal	Total	6010	150.00	-	
Selenium	metal	Total	7740	20.00	50.00	
Silver	metal	Total	7761	2.00	-	
1,1,1,2-Tetrachloroethane	volatile	630-20-6	8260	1.00	-	
1,1,2,2-Tetrachloroethane	volatile	79-34-5	8260	1.00	-	
Tetrachloroethylene (PCE)	volatile	127-18-4	8260	1.00	5.00	
Thallium	metal	Total	7841	10.00	2.00	
Toluene	volatile	108-88-3	8260	1.00	1,000.00	
1,1,1-Trichloroethane	volatile	71-55-6	8260	1.00	200.00	
1,1,2-Trichloroethane	volatile	79-00-5	8260	1.00	5.00	

Monitoring Parameters and Analytical Methods
Detection Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix I)

PARAMETER	CLASS	CAS RN	METHOD	EQL (ug/L)	MCL (ug/L)	Notes
Trichloroethylene	volatile	79-01-6	8260	1.00	5.00	
Trichlorofluoromethane (CFC-11)	volatile	75-69-4	8260	1.00	-	
1,2,3-Trichloropropane	volatile	96-18-4	8260	1.00	-	
Vanadium	metal	Total	7911	40.00	-	
Vinyl acetate	volatile	108-05-4	8260	50.00	-	
Vinyl chloride	volatile	75-01-4	8260	1.00	2.00	
Xylenes (total)	volatile	see note	8260	1.00	10,000.00	Includes o-xylene, p-xylene, and unspecified xylenes (dimethyl benzenes)(CAS RN 1330-20-7).
Zinc	metal	Total	7951	0.50	-	

Notes:
- Class. General type of compound
  - PNA. polynuclear aromatic
- CAS RN: Chemical Abstracts Service Registry Number. Where 'Total' is entered, all species that contain the element are included.
- Method: Analytical Method from EPA SW-846 Methods for Evaluating Solid Waste.
- EQL: Estimated Quantitation Limit. The EQL is an interlaboratory concept and is derived from laboratory performance, under ideal conditions, of selected laboratories (not all). The EQL provides routine performance goals that many labs must strive to achieve. The EQL was formerly referred to as the practical quantitation limit (PQL).
- MCL: Maximum Contaminant Level. EPA drinking water standard. Subject to change without notice as directed by the EPA. Where no MCL has been established, a '-' appears in the table.

Monitoring Parameters and Analytical Methods

Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	ECL (ug/L)	MCL (ug/L)	Notes
Acenaphthene	semi-volatile	83-32-9	8270	10.00	-	
Acenaphthylene	semi-volatile	208-96-8	8270	10.00	-	
Acetone	**volatile**	**67-64-1**	**8260**	**100.00**	**-**	
Acetonitrile (methyl cyanide)	volatile	75-05-8	8260	100.00	-	
Acetophenone	semi-volatile	98-86-2	8270	10.00	-	
2-Acetylaminofluorene	semi-volatile	53-96-3	8270	20.00	-	
Acrolein	volatile	107-02-8	8260	5.00	-	
Acrylonitrile	**volatile**	**107-13-1**	**8260**	**5.00**	-	
Aldrin	pesticide	309-00-2	8081	0.34	-	
Allyl chloride	volatile	107-05-1	8260	5.00	-	
4-Aminobiphenyl	semi-volatile	92-67-1	8270	20.00	-	
Anthracene	PNA	120-12-7	8270	10.00	-	
Antimony	**metal**	**Total**	**7041**	**30.00**	**6.00**	
Arsenic	**metal**	**Total**	**7060**	**10.00**	**50.00**	
Barium	**metal**	**Total**	**6010**	**10.00**	**2,000.00**	
Benzene	**volatile**	**71-43-2**	**8260**	**1.00**	**5.00**	
Benz[a]anthracene; Benzanthracene	PNA	56-55-3	8270	10.00	-	
Benzo[b]fluoranthene	PNA	205-99-2	8270	10.00	-	
Benzo[k]fluoranthene	PNA	207-08-9	8270	10.00	-	
Benzo[ghi]perylene	PNA	191-24-2	8270	10.00	-	
Benzo[a]pyrene	PNA	50-32-8	8270	10.00	0.20	
Benzyl alchohol	semi-volatile	100-51-6	8270	20.00	-	
Beryllium	**metal**	**Total**	**6010**	**2.00**	**4.00**	
alpha-BHC	pesticide	319-84-6	8081	0.11	-	
beta-BHC	pesticide	319-85-7	8081	0.23	-	
delta-BHC	pesticide	319-86-8	8081	0.24	-	
gamma-BHC (Lindane)	pesticide	58-89-9	8081	0.25	0.20	
Bis (2-chloroethoxy) methane	semi-volatile	111-91-1	8270	10.00	-	
Bis (2-chloroethyl) ether;	semi-volatile	111-44-4	8270	10.00	-	
Bis (2-chloro-1-methylethyl) ether	semi-volatile	108-60-1	8270	10.00	-	
Bis (2-ethylhexyl) phthalate	semi-volatile	117-81-7	8270	10.00	6.00	
Bromochloromethane	volatile	74-97-5	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
Bromodichloromethane	volatile	75-27-4	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
Bromoform	volatile	75-25-2	8260	1.00	-	
4-Bromophenyl phenyl ether	semi-volatile	101-55-3	8270	10.00	-	
Butyl benzyl phthalate	semi-volatile	85-68-7	8270	10.00	-	
Cadmium	metal	Total	7131	1.00	5.00	

Monitoring Parameters and Analytical Methods
Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	EQL (ug/L)	MCL (ug/L)	Notes
Carbon disulfide	volatile	75-15-0	8260	100.00	-	
Carbon tetrachloride	volatile	56-23-5	8260	1.00	5.00	
Chlordane	pesticide	see note	8081	0.37	2.00	This entry includes alpha-chlordane (CAS RN 5103-71-9), beta chlordane (CAS RN 5103-74-2), gamma-chlordane (CAS RN 566-34-7), and constituents of chlordane (CAS RN 57-74-9 and 12672-29-6).
p-Chloroaniline	semi-volatile	106-47-8	8270	20.00	-	
Chlorobenzene	volatile	108-90-7	8260	1.00	100.00	
Chlorobenzilate	semi-volatile	510-15-6	8270	10.00	-	
p-Chloro-m-cresol	semi-volatile	59-50-7	8270	20.00	-	
Chloroethane	volatile	75-00-3	8260	1.00	-	
Chloroform	volatile	67-66-3	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
2-Chloronaphthalene	semi-volatile	91-58-7	8270	10.00	-	
2-Chlorophenol	semi-volatile	95-57-8	8270	10.00	-	
4-Chlorophenyl phenyl ether	semi-volatile	7005-72-3	8270	10.00	-	
Chloroprene	volatile	126-99-8	8260	5.00	-	
Chromium	metal	Total	7191	10.00	100.00	
Chrysene	PNA	218-01-9	8270	10.00	-	
Cobalt	metal	Total	7201	10.00	-	
Copper	metal	Total	7211	10.00	1,300.00	Listed MCL represents an EPA action limit
m-Cresol	semi-volatile	108-39-4	8270	10.00	-	
o-Cresol	semi-volatile	95-48-7	8270	10.00	-	
p-Cresol	semi-volatile	106-44-5	8270	10.00	-	
Cyanide		57-12-5	9012	20.00	-	
2,4-Dichlorophenoxyacetic acid (2,4-D)	herbicide	94-75-7	8151	2.00	70.00	
4,4'-DDD	pesticide	72-54-8	8081	0.50	-	
4,4'-DDE	pesticide	72-55-9	8081	0.50	-	
4-4'-DDT	pesticide	50-29-3	8081	0.81	-	
Diallate	semi-volatile	2303-16-4	8270	10.00	-	
Dibenz[a,h]anthracene	PNA	53-70-3	8270	10.00	-	
Dibenzofuran	semi-volatile	132-64-9	8270	10.00	-	
Dibromochloromethane	volatile	124-48-1	8260	1.00	80.00	Trihalomethanes have a cumulative MCL of 80 ug/l
1,2-Dibromo-3-chloropropane (DBCP)	volatile	96-12-8	8011	0.10	0.20	
1,2-Dibromoethane (EDB)	volatile	106-93-4	8011	0.10	0.05	
Di-n-butyl phthalate	semi-volatile	84-74-2	8270	10.00	-	
o-Dichlorobenzene / 1,2-Dichlorobenzene	volatile	95-50-1	8260	1.00	600.00	
m-Dichlorobenzene / 1,3-Dichlorobenzene	volatile	541-73-1	8260	1.00	-	
p-Dichlorobenzene / 1,4-Dichlorobenzene	volatile	106-46-7	8260	1.00	75.00	
3,3'-Dichlorobenzidine	semi-volatile	91-94-1	8270	20.00	-	

Monitoring Parameters and Analytical Methods
Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	ECL (ug/L)	MCL (ug/L)	Notes
trans-1,4-Dichloro-2-butene	volatile	110-57-6	8260	100.00	-	
Dichlorodifluoromethane	volatile	75-71-8	8260	1.00	-	
1,1-Dichloroethane	volatile	75-34-3	8260	1.00	-	
1,2-Dichloroethane	volatile	107-06-2	8260	1.00	5.00	
1,1-Dichloroethylene	volatile	75-35-4	8260	1.00	7.00	
cis-1,2-Dichloroethylene	volatile	156-59-2	8260	1.00	70.00	
trans-1,2-Dichloroethylene	volatile	156-60-5	8260	1.00	100.00	
2,4-Dichlorophenol	semi-volatile	120-83-2	8270	10.00	-	
2,6-Dichlorophenol	semi-volatile	87-65-0	8270	10.00	-	
1,2-Dichloropropane	volatile	78-87-5	8260	1.00	5.00	
1,3-Dichloropropane	volatile	142-28-9	8260	1.00	-	
2,2-Dichloropropane	volatile	594-20-7	8260	1.00	-	
1,1-Dichloropropene	volatile	563-58-6	8260	1.00	-	
cis-1,3-Dichloropropene	volatile	10061-01-5	8260	5.00	-	
trans-1,3-Dichloropropene	volatile	10061-02-6	8260	5.00	-	
Dieldrin	pesticide	60-57-1	8081	0.14	-	
Diethyl phthalate	semi-volatile	84-66-2	8270	10.00	-	
O,O-Diethyl O-2-pyrazinyl phosphorothioate	OP pesticide	297-97-2	8270	20.00	-	
Dimethoate	OP pesticide	60-51-5	8270	20.00	-	
p-(Dimethylamino)azobenzene	semi-volatile	60-11-7	8270	10.00	-	
7,12-Dimethylbenz[a]anthracene	semi-volatile	57-97-6	8270	10.00	-	
3,3'-Dimethylbenzidine	semi-volatile	119-93-7	8270	10.00	-	
2,4-Dimethylphenol	semi-volatile	105-67-9	8270	10.00	-	
Dimethyl phthalate	semi-volatile	131-11-3	8270	10.00	-	
m-Dinitrobenzene	semi-volatile	99-65-0	8270	20.00	-	
4,6-Dinitro-o-cresol	semi-volatile	534-52-1	8270	50.00	-	
2,4-Dinitrophenol	semi-volatile	51-28-5	8270	50.00	-	
2,4-Dinitrotoluene	semi-volatile	121-14-2	8270	10.00	-	
2,6-Dinitrotoluene	semi-volatile	606-20-2	8270	10.00	-	
Dinoseb (DNBP); 2-sec-Butyl-4,6-dinitrophen	herbicide	88-85-7	8151	1.98	7.00	
Di-n-octyl phthalate	semi-volatile	117-84-0	8270	10.00	-	
Diphenylamine	semi-volatile	122-39-4	8270	10.00	-	
Disulfoton	OP pesticide	298-04-4	8270	10.00	-	
Endosulfan I	pesticide	959-98-8	8081	0.30	-	
Endosulfan II	pesticide	33213-65-9	8081	0.40	-	
Endosulfan sulfate	pesticide	1031-07-8	8081	0.35	-	
Endrin	pesticide	72-20-8	8081	0.39	2.00	

Monitoring Parameters and Analytical Methods
Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	ECL (ug/L)	MCL (ug/L)	Notes
Endrin aldehyde	pesticide	7421-93-4	8081	0.50	-	
Ethylbenzene	volatile	100-41-4	8260	1.00	700.00	
Ethyl methacrylate	semi-volatile	97-63-2	8260	5.00	-	
Ethyl methanesulfonate	semi-volatile	62-50-0	8270	20.00	-	
Famphur	semi-volatile	52-85-7	8270	20.00	-	
Fluoranthene	PNA	206-44-0	8270	10.00	-	
Fluorene	PNA	86-73-7	8270	10.00	-	
Heptachlor	pesticide	76-44-8	8081	0.40	0.40	
Heptachlor epoxide	pesticide	1024-57-3	8081	0.32	0.20	
Hexachlorobenzene	semi-volatile	118-74-1	8270	10.00	1.00	
Hexachlorobutadiene	semi-volatile	87-68-3	8260	1.00	-	
Hexachlorocyclopentadiene	semi-volatile	77-47-4	8270	10.00	50.00	
Hexachloroethane	semi-volatile	67-72-1	8270	10.00	-	
Hexachloropropene	semi-volatile	1888-71-7	8270	10.00	-	
2-Hexanone / Methyl butyl ketone (MBK)	volatile	591-78-6	8260	50.00	-	
Indeno (1,2,3-cd) pyrene	PNA	193-39-5	8270	10.00	-	
Isobutyl alcohol	volatile	78-83-1	8260	100.00	-	
Isodrin	volatile	465-73-6	8270	20.00	-	
Isophorone	semi-volatile	78-59-1	8270	10.00	-	
Isosafrole	semi-volatile	120-58-1	8270	10.00	-	
Kepone	pesticide	143-50-0	8270	20.00	-	
Lead	metal	Total	7421	10.00	15.00	
Mercury	volatile metal	Total	7470	2.00	2.00	
Methacrylonitrile	volatile	126-98-7	8260	5.00	-	
Methapyrilene	semi-volatile	91-80-5	8270	100.00	-	
Methoxychlor	pesticide	72-43-5	8081	2.00	40.00	
Methyl bromide / Bromomethane	volatile	74-83-9	8260	1.00	-	
Methyl chloride / Chloromethane	volatile	74-87-3	8260	1.00	-	
3-Methylcholanthrene	semi-volatile	56-49-5	8270	10.00	-	
Methyl ethyl ketone / 2-Butanone (MEK)	volatile	78-93-3	8260	100.00	-	
Methyl iodide	volatile	74-88-4	8260	5.00	-	
Methyl methacrylate	volatile	80-62-6	8260	5.00	-	
Methyl methanesulfonate	semi-volatile	66-27-3	8270	10.00	-	
2-Methylnaphthalene	semi-volatile	91-57-6	8270	10.00	-	
Methyl parathion	semi-volatile	298-00-0	8270	10.00	-	
4-Methyl-2-pentanone / Methyl isobutyl keto	volatile	108-10-1	8260	50.00	-	
Methylene bromide / Dibromomethane	volatile	74-95-3	8260	1.00	-	

Monitoring Parameters and Analytical Methods
Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	ECL (ug/L)	MCL (ug/L)	Notes
Methylene chloride / Dichloromethane	volatile	75-09-2	8260	1.00	5.00	
Naphthalene	volatile	91-20-3	8260	1.00	-	
1,4-Naphthoquinone	semi-volatile	130-15-4	8270	10.00	-	
1-Naphthylamine	semi-volatile	134-32-7	8270	10.00	-	
2-Naphthylamine	semi-volatile	91-59-8	8270	10.00	-	
Nickel	metal	Total	6010	150.00	-	
o-Nitroaniline	semi-volatile	88-74-4	8270	50.00	-	
m-Nitroaniline	semi-volatile	99-09-2	8270	50.00	-	
p-Nitroaniline	semi-volatile	100-01-6	8270	20.00	-	
Nitrobenzene	semi-volatile	98-95-3	8270	10.00	-	
o-Nitrophenol	semi-volatile	88-75-5	8270	10.00	-	
p-Nitrophenol	semi-volatile	100-02-7	8270	50.00	-	
N-Nitrosodi-n-butylamine	semi-volatile	924-16-3	8270	10.00	-	
N-Nitrosodiethylamine	semi-volatile	55-18-5	8270	20.00	-	
N-Nitrosodimethylamine	semi-volatile	62-75-9	8270	10.00	-	
N-Nitrosodiphenylamine	semi-volatile	86-30-6	8270	10.00	-	
N-Nitrosodipropylamine	semi-volatile	621-64-7	8270	10.00	-	
N-Nitrosomethylethylamine	semi-volatile	10595-95-6	8270	10.00	-	
N-Nitrosopiperidine	semi-volatile	100-75-4	8270	20.00	-	
N-Nitrosopyrrolidine	semi-volatile	930-55-2	8270	40.00	-	
5-Nitro-o-toluidine	semi-volatile	99-55-8	8270	10.00	-	
Parathion	OP pesticide	56-38-2	8270	10.00	-	
Pentachlorobenzene	semi-volatile	608-93-5	8270	10.00	-	
Pentachloronitrobenzene	semi-volatile	82-68-8	8270	20.00	-	
Pentachlorophenol	semi-volatile	87-86-5	8081	0.76	1.00	
Phenacetin	semi-volatile	62-44-2	8270	20.00	-	
Phenanthrene	PNA	85-01-8	8270	10.00	-	
Phenol	semi-volatile	108-95-2	8270	10.00	-	
p-Phenylenediamine	semi-volatile	106-50-3	8270	10.00	-	
Phorate	OP pesticide	298-02-2	8270	10.00	-	
Polychlorinated Biphenyls (PCBs)	PCB	see note	8082	9.00	0.50	This category contains congener chemicals, including constituents of Araclor 1016 (CAS RN 12674-11-2), Aroclor 1221 (CAS RN 11104-28-2), Araclor 1232 (CAS RN 11141-16-5), Araclor 1242 (CAS RN 53469-21-9), Araclor 1248 (CAS RN 12672-29-6), Araclor 1254 (CA
Pronamide	semi-volatile	23950-58-5	8270	10.00	-	
Propionitrile	volatile	107-12-0	8260	100.00	-	
Pyrene	PNA	129-00-0	8270	10.00	-	
Safrole	semi-volatile	94-59-7	8270	10.00	-	

Monitoring Parameters and Analytical Methods
Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	ECL (ug/L)	MCL (ug/L)	Notes
Selenium	metal	Total	7740	20.00	50.00	
Silver	metal	Total	7761	2.00	-	
Silvex (2,4,5-TP)	herbicide	93-72-1	8151	0.75	50.00	
Styrene	volatile	100-42-5	8260	1.00	100.00	
Sulfide	inorganic	18496-25-8	9030	4,000.00	-	
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	herbicide	93-76-5	8151	0.80	-	
1,2,4,5-Tetrachlorobenzene	semi-volatile	95-94-3	8270	10.00	-	
1,1,1,2-Tetrachloroethane	volatile	630-20-6	8260	1.00	-	
1,1,2,2-Tetrachloroethane	volatile	79-34-5	8260	1.00	-	
Tetrachloroethylene (PCE)	volatile	127-18-4	8260	1.00	5.00	
2,3,4,6-Tetrachlorophenol	semi-volatile	58-90-2	8270	10.00	-	
Thallium	metal	Total	7841	10.00	2.00	
Tin	metal	Total	6010	40.00	-	
Toluene	volatile	108-88-3	8260	1.00	1,000.00	
o-Toluidine	semi-volatile	95-53-4	8270	10.00	-	
Toxaphene	pesticide	see note	8081	0.86	3.00	Includes congener chemicals contained in technical toxaphene (CAS RN 8001-35-2) such as chlorinated camphene.
1,2,4-Trichlorobenzene	volatile	120-82-1	8260	1.00	70.00	
1,1,1-Trichloroethane	volatile	71-55-6	8260	1.00	200.00	
1,1,2-Trichloroethane	volatile	79-00-5	8260	1.00	5.00	
Trichloroethylene	volatile	79-01-6	8260	1.00	5.00	
Trichlorofluoromethane (CFC-11)	volatile	75-69-4	8260	1.00	-	
2,4,5-Trichlorophenol	semi-volatile	95-95-4	8270	10.00	-	
2,4,6-Trichlorophenol	semi-volatile	88-06-2	8270	10.00	-	
1,2,3-Trichloropropane	volatile	96-18-4	8260	1.00	-	
O,O,O-Triethyl phosphorothioate	semi-volatile	126-68-1	8270	10.00	-	
1,3,5 (semi-Trinitrobenzene	semi-volatile	99-35-4	8270	10.00	-	
Vanadium	metal	Total	7911	40.00	-	
Vinyl acetate	volatile	108-05-4	8260	50.00	-	

Monitoring Parameters and Analytical Methods
Assessment Monitoring Phase - Groundwater Monitoring Parameters (NDEP Appendix II)

PARAMETER	CLASS	CAS RN	METHOD	EQL (ug/L)	MCL (ug/L)	Notes
Vinyl chloride	volatile	75-01-4	8260	1.00	2.00	
Xylenes (total)	volatile	see note	8260	1.00	10,000.00	Includes o-xylene, p-xylene, and unspecified xylenes (dimethyl benzenes)(CAS RN 1330-20-7).
Zinc	metal	Total	7951	0.50	-	

Notes
- Class General type of compound
  - PNA polynuclear aromatic
- CAS RN. Chemical Abstracts Service Registry Number. Where 'Total' is entered, all species that contain the element are included.
- Method Analytical Method from EPA SW-846 Methods for Evaluating Solid Waste.
- EQL Estimated Quantitation Limit. The EQL is an interlaboratory concept and is derived from laboratory performance, under ideal conditions, of selected laboratories (not all). The EQL provides routine performance goals that many labs must strive to achieve. The EQL was formerly referred to as the practical quantitation limit (PQL).
- MCL. Maximum Contaminant Level. EPA drinking water standard. Subject to change without notice as directed by the EPA. Where no MCL has been established, a '-' appears in the table.

APPENDIX V

JOYCE ENGINEERING STANDARD OPERATING GUIDANCE FOR LOW-FLOW (MICRO-PURGING) GROUNDWATER PURGING AND SAMPLING

VERSION 2.0

JOYCE ENGINEERING'S STANDARD OPERATING GUIDANCE

LOW-FLOW GROUNDWATER PURGING AND SAMPLING

VERSION 2.0

JULY 2002

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JOYCE ENGINEERING'S STANDARD OPERATING GUIDANCE
LOW-FLOW GROUNDWATER PURGING AND SAMPLING

SCOPE: This operating guidance describes the procedures to be followed for collecting groundwater samples using low-flow sampling procedures. This guidance is generally consistent with, but has been modified from the guidance issued by the United States Environmental Protection Agency [USEPA (April 1996)]. A copy of the USEPA's Guidance is provided in Attachment 1.

PURPOSE: The purpose of this procedure is to assure consistency and uniformity between different personnel at Joyce Engineering (JOYCE) during the collection of groundwater samples when using low-flow sampling procedures.

Low-flow sampling is the preferred purging and sampling procedure for JOYCE's clients. However, each site should be sampled in accordance with the approved *Groundwater Monitoring Plan* and the facility's permit. Low-flow purging reduces the amount of purge water generated during sampling events; increases the consistency in the analytical data between sampling events, allowing for the early identification of trends; and results in the collection of water samples that are more representative of true groundwater quality.

When using low-flow purging and sampling procedures, the required samples are collected immediately after stabilization of the required parameters is achieved.

EQUIPMENT NEEDED:

- Copies of the facility's *Groundwater Monitoring Plan* and the project specific *Health and Safety Plan*. Both plans should be reviewed by sample personnel prior to leaving the office;
- Copy of this Standard Operating Guidance;
- Copies of JOYCE's *Micropurge Sampling Log* (Attachment 2); or for those clients that require us to fill out their logs, copies of those logs;
- Calibrated Water Quality Instruments. At a minimum, temperature, pH, specific conductance, and dissolved oxygen;
- Bladder pump (preferably dedicated), or Peristaltic pump or Grunfos pump (inorganic constituents only);
- Well Wizard purging system;
- Water level measurement equipment;
- De-ionized/distilled water dispenser bottle;
- Decontamination Equipment (e.g. Alconox) dispenser bottles;

- Personal protection equipment as specified in the site specific;
- Field book and chain-of-custody form;
- Sample bottles;
- Nitrile sampling gloves;
- Labels for sample containers;
- Waterproof pen;
- Calculator;
- Plastic trash bags;
- Coolers with ice;
- Purge buckets
- Well keys; and
- Chemical-free paper towels.

PROCEDURES:

1. Prior to beginning, all non-dedicated downhole equipment must be decontaminated in accordance with the procedures in the facility's *Groundwater Monitoring Plan*. If there are no procedures in the *Groundwater Monitoring Plan*, decontaminate equipment in accordance with JOYCE's *Equipment Decontamination Standard Operating Guidance*.

2. All water quality parameters shall be calibrated in accordance with the manufacturer's specifications using approved standards. Calibration information should be documented in the instrument's calibration logbook, the field book, and on the notes section of Low-Flow Sample Logs.

3. Obtain a depth-to-water measurement using an electronic water level indicator capable of recording the depth to 0.01 foot. Determine if the water table is located within the screened interval of the well, or if not, how much drawdown can be achieved before the screen is intersected. If the water table is located within the screened interval, total drawdown should not exceed 1 foot so as to minimize the amount of aeration and turbidity. If the water table is located above the top of the screened interval, the amount of drawdown should be minimized to keep the screen from being exposed.

4. If the purging equipment is non-dedicated, lower the equipment into the well, taking care to minimize the disturbance to the water column. If conditions (i.e., water column height and well yield) allow, place the pump in the uppermost portion of the water column (minimum of 18 inches of pump submergence is recommended).

5. Determine the minimum time period for obtaining independent Water Quality Parameter Measurements (WQPM). The minimum time period is determined based on the stabilized flow rate and the amount of volume in the pump and the discharge tubing (alternatively, the volume of the flow cell can be used, provided

it is greater than the volume of the pump and discharge tubing). Volume of the bladder pump should be obtained from the manufacturer. Volume of the discharge tubing is as follows:

½-inch outside diameter tubing:	20 milliliters per foot
3/8-inch outside diameter tubing:	10 milliliters per foot
¼-inch outside diameter tubing:	5 milliliters per foot

6. Once the volume of the flow-cell or the pump and the discharge tubing has been calculated, begin purging the well. If the well has been sampled with low-flow procedures previously, start the purge using the stabilization flow rate that was used previously. If the well has never been purged using the low-flow procedure, initiate purging at no more than 500 milliliters per minute and adjust flow rate downward as required to maintain a stable head level within the well.

7. Obtain an initial round of WQPM from the flow-cell. Record the measurements on the field log.

8. After obtaining the initial round of WQPM, adjust the flow rate until drawdown in the well stabilizes. Flow rate is measured using a calibrated measuring cup and the number of pumping cycles per minute (i.e., 4 cycles per minute with 125 milliliters per cycle equals a flow rate of 500 milliliters per minute).

9. Once the stabilized purging rate has been determined, calculate the minimum time period required for obtaining independent WQPM. If the purge rate has been reduce to 50 milliliters or less and the head level in the well continues to decline, the required water samples should be collected following stabilization of the WQPM based on the criteria presented below. If neither the head level or the WQPM stabilize, the field crew should contact the project manager for guidance to determine if a passive sample should be collected.

   Passive sampling (sampling before WQMP have stabilized or if the well yield is low enough that the well will purge dry at the lowest possible purge rate (generally 50 milliliters per minute or less) should only be performed with the concurrence of the state regulatory agency responsible for the facility.

10. Continue to collect WQPM at the required frequency. Verify the stabilized water level with periodic measurements (every other WQPM round is recommended) of the depth-to-water. Adjust the flow rate as required to maintain a stabilized water level. Record WQPM and depth-to-water measurements on the field form.

11. WQPM stabilization is defined as follows:

pH:	+/- 0.2 S.U.
Conductance	+/- 10% of reading

Dissolved Oxygen	+/- 10% of reading or 0.2 mg/L (whichever is greater)
Turbidity	+/- 10% of reading (optional if using dissolved oxygen)
Temperature	Must be measured, but no stabilization requirement since its value is independent of formation versus stagnant water.

Dissolved Oxygen measurements should be crosschecked against the attached table to ensure the dissolved oxygen measurements are realistic.

Turbidity measurements should be recorded whether the parameter is used for stabilization or not. At a minimum, turbidity measurements should be recorded at the beginning of purging, following the stabilization of the WQPMs, and following the collection of the samples. The optimal turbidity range for micropurge is 25 NTU or less. Turbidity measurements above 25 NTU are generally indicative of an excessive purge rate.

Stabilization of the WQPMs should occur in most wells within five to six rounds of measurements. If non-dedicated equipment is being used, stabilization may take twice as long. In some wells, stabilization may not occur. If stabilization does not occur following the removal of a purge volume equal to three well volumes, the field team should contact the project manager for guidance to determine if a passive sample should be collected.

12. Each well is to be sampled immediately following stabilization of the WQPM. The sampling flow rate must be maintained at a rate that is less than or equal to the purging rate.

13. Sample first for volatile analyses, taking care to remove all air bubbles from the vials and minimize agitation. The collection order is as follows:

- WQPM and Turbidity
- Volatile Organics
- Total (unfiltered) metals
- Dissolved (filtered) metals
- Purgeable organic carbon (POC)
- Purgeable organic halogens (POX)
- Total organic halogens (TOX)
- Total organic carbon (TOC)
- Extractable organics
- Phenols
- Cyanide
- Sulfate
- Chloride
- Nitrate
- Ammonia
- WQPM and Turbidity

14. Label each sample container with project, date, time, sample number or location, the name of collector, and constituent(s) to be analyzed.

Preservation of groundwater sample containers may be done by the analytical laboratory or in the field according to approved procedures in the *Handbook for Sampling and Sample Preservation of Water and Wastewater (EPA-600/4-82-029).*

Groundwater samples collected for dissolved metals analyses will be filtered prior to being placed in sample containers as described in the *Field Procedures Standard Operating Guidance*.

ATTACHMENT 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES, APRIL 1996

United States
Environmental Protection
Agency

Office of
Research and
Development

Office of Solid Waste
and Emergency
Response

EPA/540/S-95/504
April 1996

Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

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I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in th[illegible] subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

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chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of suffic accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. A evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

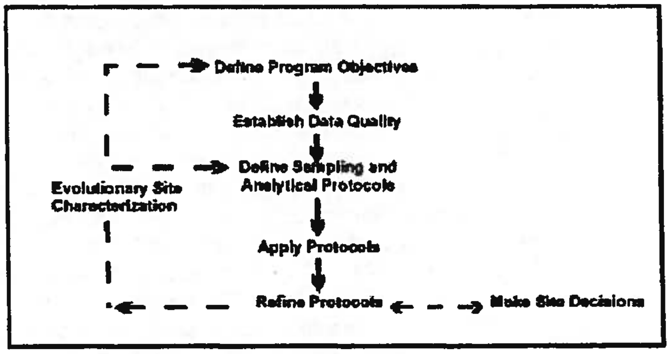

Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should b used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipme less time spent in preparation of sampling as well as time the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:
- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action.*

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g. , pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:
- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over <u>any</u> other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provid[illegible] better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters sh[illegible] be continuously monitored during purging. The water qua[illegible] indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

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ATTACHMENT 2

JOYCE ENGINEERING
MICROPURGE SAMPLING LOG

DATE: ____________

JOYCE
ENGINEERING, INC.

MICROPURGE SAMPLING LOG

Project Name: ____________________

Project No./Task No.: ____________________

Well ID: ____________________

Sampler(s): ____________________

Well Diameter: ____________ **inches**

Initial Depth to Water: ____________ **feet**

Depth to Bottom: ____________ **feet**

Water Column Thickness: ____________ **feet**

Well Location: ____

Equipment: ____

____

Time	PH s.u.	Temp. °C	Cond. u.s.	Dis. O_2 mg/l	Turb. ntu	ORP mv	DTW feet

Comments (weather conditions, color, silt, type of sample, purgewater management, etc.): ________

____

____

Signature: ____________________ Date: ____________________

QA/QC Sign Off: ____________________ Date: ____________________

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Appendix E

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

DESIGN REPORT

OCTOBER 2013
REVISED FEBRUARY 2014
REVISED MAY 2014

PROFESSIONAL ENGINEER - STATE OF NEVADA
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CIVIL
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5/19/14

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JOYCE PROJECT NO. 00383.1401.01.01

Design Report
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

Table of Contents

List of Appendices

Design Drawings are included separately

1.0 GENERAL INFORMATION

This plan has been prepared for the Bedroc Landfill and Waste Management Facility (facility) to address the requirements established in Nevada Administrative Code (NAC) 444.680 and provide information regarding the design and construction of the permitted disposal facility. A drawing set has been prepared to illustrate the proposed construction and development of the facility.

The facility is equipped with a soil and synthetic liner and leachate collection system for the disposal of wastes. The cells proposed for the acceptance of Class I materials at the facility will be constructed in phases, and when completed, will cover approximately 115 acres.

The facility will include the following (per NAC 444.700 "Facilities for personnel." - NRS 444.560):

- An administrative trailer;
- An equipment maintenance shop; and
- A break-room (shelter and sanitary) trailer for equipment operators and laborers.

The locations of the equipment maintenance shop, and administrative and break-room trailers are anticipated to be temporary and may be relocated on the site as the landfill is developed. Specifically, the equipment maintenance shop and break-room trailer are likely to be periodically relocated near the active disposal area to reduce the travel time for equipment and site personnel. The administration trailer and break-room will provide potable water and restrooms for site personnel. A list of the positions, as well as, job descriptions are included in the facility's Integrated Site Wide Contingency Plan (ISWCP).

2.0 LOCATION AND LAND USE

The facility is located within the Coyote Spring Valley, adjacent to U.S. Highway 93. The project site is located in Lincoln County, approximately 30 miles south of Alamo and 65 miles north of Las Vegas. The facility will serve as a disposal facility for Southern Nevada, specifically, Lincoln, Clark and surrounding counties. The metropolitan Clark County Area and the surrounding counties have a total population of approximately 2 to 2.5 million. Refuse from Las Vegas will comprise more than 95% of the waste stream, which is estimated to be up to an average of 2,000 tons/day.

The site will accept only municipal solid waste (MSW). The waste will be comprised of residential, commercial and selected special wastes as defined in the facility's Operating Plan. No hazardous wastes will be accepted. WEI anticipates that the majority of the waste stream will be comprised of municipal solid waste from residential and commercial sources. The estimated breakdown of the MSW and the special wastes are summarized as follows:

- Residential and Commercial MSW: 70% to 100%
- Special Wastes: 0 to 30%

The property's legal description is the East Half (E ½), and the East Half (E ½) of the West Half (W ½) of Section 24, and the East Half (E ½) of the Northeast Quarter (NE ¼) of Section 25, Township 11 South, Range 62 East, M.D.B.&M., Lincoln County, Nevada. A.P.N.: 08-201-02. Copies of the Assignment of Interest in the property are provided in Appendix A.

The initial cell (Cell 1) is located in Lot 12. As additional cells are constructed, the disposal facility will expand northward and westward, and will eventually encompass Lots 13 and 14 and portions of Lot 6, 7 and 8.

The facility is located in excess of ¼ mile from the nearest inhabited dwelling and place of public gathering. The Pahranagat Wildlife Refuge is located approximately 14 miles northeast of the site. Lands surrounding the project site are public lands administered by the Bureau of Land Management. These lands are undeveloped and considered open space.

The project area and adjacent lands are zoned M-2 Heavy Manufacturing. Other lands within one-mile of the site are zoned A-5 Agricultural and SID Special Industrial. The M-2 heavy manufacturing district is intended to provide areas for the development and operation of industrial and manufacturing uses. Uses permitted within this zone subject to a special use permit include salvage yards, recycling facilities and operations involving use, recovery or residue of hazardous materials and/or wastes. A zoning map is included in Appendix A.

3.0 HYDROGEOLOGIC CHARACTERISTICS

Soils at the existing facility, as described from outcrops, test pits, and borings, range from poor to well sorted sand and gravel of alluvial origin to fine silty-sand grading to silty-clay of lacustrine orgin. Generally the lacustrine deposits are weakly consolidated and the alluvial deposits are unconsolidated to weakly cemented. Bed thicknesses vary across the site due to the processes by which the sediments were deposited; however, the thickest units are generally less than 30 feet thick.

Based on the static water level data obtained on September 3, 2013, the water table beneath the proposed facility ranges in elevation from 2,410 feet above MSL in the southeastern corner to 2,455 feet above MSL beneath the northwestern corner of the study area. The potentiometric surface lines indicate that groundwater flow in the uppermost aquifer is towards the east-southeast with an average gradient of approximately 0.02 foot per foot. Geologic information gathered during the site investigation indicates the uppermost water table is present in a soil matrix composed of both alluvial and lacustrine sediment.

Prepared pursuant to the Nevada Administrative Code (NAC) 444.680.8.b, the Site Characterization Report documents the geologic and hydrogeologic conditions specific to the terrain underlying the proposed facility and the surrounding region. A copy of the Site Characterization Report is included in Appendix J of the facility's application for a permit to operate a Class I disposal site.

4.0 CLIMATE

Due to extreme temperatures and low average annual precipitation, the climatic conditions in southern Nevada at elevations below 5,000 feet are extremely dry and are classified as part of the Mojave Desert province (Jaegar, 1957).

The precipitation rate averages approximately 0.34 inch per month or 4.1 inches per year, with the "wet" season occurring between November and March. Temperatures in the region range from an average high of 106 degree Fahrenheit in July to an average low of 34 degrees Fahrenheit in December and January, with a mean average daily temperature of 67 degrees Fahrenheit.

At low elevations in the region, vegetation is generally limited to drought and heat tolerant species. Published literature indicates that the regional vegetation primarily consists of agave, a variety of cactuses and yucca, black brush, creosote bush, and Joshua trees (Jaeger, 1957).

5.0 TOPOGRAPHY

The site is located within the Coyote Spring Valley. The valley is bounded by the Sheep Range to the west, and the Delamar and Meadow Valley Mountains to the east. The Pahranagat Wash is located within Coyote Spring Valley and transects portions of the project area. At the location of the proposed landfill, the wash is approximately one mile wide, forming a relatively wide and flat floor of the valley.

No defined flow channel is present in Coyote Springs Valley in the vicinity of the proposed landfill site. The gravel pits associated with the sand and gravel operation west of the proposed site location, an elevated east-west roadway, and other earthen structures isolate the segment of Coyote Springs Valley in the vicinity of the landfill from surface water flow that may be generated upstream in the valley. Given the highly permeable nature of the shallow alluvium in the valley, it appears that water flow is confined to the subsurface in all but the most unusual of precipitation events.

6.0 DESIGN

The facility will ultimately cover approximately 115 acres. The landfill will be constructed in lifts will have a final slope of 3H:1V on all four sides. Ten-foot benches will be constructed at vertical intervals of approximately 30 feet. When completed the top of the landfill will be approximately 150 feet above existing grade. Access roads to the site already exist. A perimeter road will be constructed for landfill development and access. Haul roads will be constructed to access the working face.

6.1 Cell Development

All cells will be constructed with a soil and synthetic liner and leachate collection system. To facilitate leachate collection and removal, the overall base grade for the disposal area is generally sloped either toward the southeast corners of Cells 1, 11 and 14, and the northeast corners of Cells 5 and 8. The Class I landfill will be located in Lots 6-8 and 12-14. Landfill development will generally follow the phasing described below.

The initial cell, Cell 1, will be constructed in the southwest corner of Lot 14. The base grade for Cell 1 slopes toward the southeast. A side slope riser pipe and pump removes the leachate that accumulates in the southeast corner of Cell 1. Collected leachate will flow via forcemain to the leachate pond proposed along the eastern side of the facility. Cell 2 will be constructed north and adjacent to Cell 1. The base grade for Cell 2 is sloped toward Cell 1. Waste placement in Cell 2 piggybacks onto Cell 1. Cell 3 will be constructed in the southeast corner of Lot 8, west and adjacent to Cell 1. The base grade for Cell 3 slopes toward the east. Waste placement in Cell 3 will piggyback onto Cell 1. Cell 4 will be constructed in the northeast corner of Lot 8, west and adjacent to Cell 2. The base grade for Cell 4 slopes toward the east. Waste placement in Cell 4 will piggyback onto Cells 1, 2 and 3.

The base grade for Cell 5 slopes toward the northeast. A side slope riser pipe and pump remove the leachate that accumulates in the northeast corner of Cell 5. Collected leachate will flow via forcemain to the leachate pond proposed along the eastern side of the facility. Cells 6 and 7 will be constructed west of Cell 5. The base grades for both cells slope toward the east toward the leachate removal pump in the northeast corner of Cell 5. Waste placement in Cells 6 and 7 will piggyback onto Cells 1, 3 and 5.

Cell 8 will be constructed in the southeast corner of Lot 13, south and adjacent to Cell 5. The base grade for Cell 8 slopes toward the northeast. A side slope riser pipe and pump remove the leachate that accumulates in the northeast corner of Cell 8. Collected leachate will flow via forcemain to the leachate pond proposed along the eastern side of the facility. Waste placement in Cell 8 will piggyback onto Cell 5. Cells 9 and 10 will be constructed west of Cell 8. The base grades for both cells slope toward the east and northeast toward the leachate removal pump in the southeast corner of Cell 8. Waste placement in Cells 9 and 10 will piggyback onto Cells 5, 6, 7 and 8.

Cell 11 will be constructed in the northeast corner of Lot 12 and southeast corner of Lot 13, south and adjacent to Cell 8. The base grade for Cell 11 slopes toward the southeast. A side slope riser pipe and pump remove the leachate that accumulates in the southeast corner of Cell 11. Collected leachate will flow via forcemain to the leachate pond proposed along the eastern side of the facility. Waste placement in Cell 11 will piggyback onto Cell 8. Cells 12 and 13 will be constructed west of Cell 11. The base grades for both cells slope toward the southeast toward the leachate removal pump in the southeast corner of Cell 11. Waste placement in Cells 12 and 13 will piggyback onto Cells 8, 9, 10 and 11.

Cell 14 will be constructed in the southeast corner of Lot 12, south and adjacent to Cell 11. The base grade for Cell 14 slopes toward the southeast. A side slope riser pipe and pump remove the leachate that accumulates in the southeast corner of Cell 14. Collected leachate will flow via force main to the leachate pond proposed along the eastern side of the facility. Waste placement in Cell 14 will piggyback onto Cell 11. Cells 15 and 16 will be constructed west of Cell 14. The base grades for both cells slope toward the southeast toward the leachate removal pump in the southeast corner of Cell 14. Waste placement in Cells 15 and 16 will piggyback onto Cells 11 and 12.

6.2 Waste Placement

The initial placement of waste in a new cell will be in a careful and controlled manner where the leachate collection system and the liner are most vulnerable. Select waste, avoiding bulky and large rigid items, will be placed as the "operations layer". This operations layer will be a minimum of 2 feet thick, will not be compacted, and will serve as a protective layer to the liner and drainage system. Markers will be placed along the edge of liner so that filling operations in the cells do not extend outside lined areas and adequate room is left to allow for applying the final cover.

In accordance with NAC 444.686 (4) waste will be spread in thin layers not to exceed 2 feet thick and compacted with a heavy tracked dozer or compactor. The process of placing and compacting 2 foot layers of waste will be repeated until a lift thickness of approximately 20 feet is reached. At the end of each operating day or when the lift of waste is completed, a minimum of six inches of cover soil will be placed over exposed compacted waste. Cover material will come from cell construction activities and adjoining land owned by Bedroc Limited, LLC (Bedroc) if necessary. Waste will be placed in this manner until final elevations are reached. Waste slopes that make up the exterior slope of the landfill will be constructed with slopes no greater than 3:1 and benches per the application drawings.

Initial lifts of waste will be placed on the cell floor. As the base grades are below the surrounding ground surface, initial waste placement activities will be screened from U.S. Highway 93. As the elevation of the working face reaches the grade of the surrounding ground surface, perimeter berms will be constructed on the northern, eastern and southern slopes of the landfill when disposal activities are within 1,000 feet of Highway 93. As necessary, the berms will be extended laterally beyond the waste limits to prevent the working face from being visible from the highway. These berms, approximately 10-15 feet in height and consisting of soil material, will generally be constructed in advance of waste placement activities as necessary to provide visual screening of landfill operations from U.S. Highway 93.

6.3 Drawings

The drawing set attached to this application presents the existing topography and the proposed Class I facility design and development of the site. These drawings were prepared to address the requirements of NAC 444.680(3).

The Existing Site Conditions Plan (Drawing No. 3) shows existing site conditions prior to development of the proposed Class I area.

The Base Grading Plan (Drawing No. 4) shows the Class I base grades before installation of the liner and drainage layer.

The Leachate Collection/Removal Plan (Drawing No. 5) shows the location of the proposed leachate collection/removal piping in the Class I cells, proposed leachate force mains and storage ponds.

The Final Grading Plan (Drawing No. 6) shows the final grades of the site area after installation of the final closure cap.

There are three Cross Section Plans (Drawing Nos. 7, 8 and 9) showing seven sections cut east-to-west and one section cut north-to-south. Shown on the cross sections are the proposed base grades and final grades, existing grades and groundwater surface.

There are five Phasing Plans (Drawing Nos. 10 thru 14) reflecting the progressive development of the Class I landfill. The proposed Class I Landfill will consist of 16 separate cells.

There is one Site Monitoring Plan (Drawing No. 15) reflecting the installation of vents and boundary probes for the Class I landfill.

There are three detail sheets (Drawing Nos. 16, 17 and 18).

Drawing No. 19 provides the soil balance information and location of borrow areas.

Drawing No. 20 identifies the property owners within a 2-mile radius of the site.

Drawings Nos. 21, 22 and 23 provide cross sections and profile of the stormwater diversion channel.

The following is a complete list of permitted drawings that makes up the set of drawings for the Report for Design:

Drawing #	**Title**
1	Cover Sheet
2	Legend Sheet
3	Existing Conditions Plan
4	Base Grading Plan

5	Leachate Collection/Removal Plan
6	Final Grading Plan
7	Sections A-A to D-D
8	Sections E-E to G-G
9	Section H-H
10	Phasing Plans, Phases I-IV
11	Phasing Plans, Phases V-VIII
12	Phasing Plans, Phases XI-XII
13	Phasing Plans, Phases XIII-XVI
14	Phasing Plans, Phases XVII-XIX
15	Site Monitoring Plan
16	Details
17	Details
18	Details
19	Location of Borrow Area
20	Adjacent Property Owners
21	Stormwater Channel Sections
22	Stormwater Channel Sections
23	Stormwater Profile

7.0 SITE LIFE & CAPACITY

The following is a list of the waste acceptance areas, design capacities and life estimates for each cell:

Cell	Total Lined Area	Design Capacity* (cy)	Site Life**
	(ac)	(cy)	(yr)
1	10.8	2,033,845	10.2
2	9.5	1,202,177	6.0
3	7.3	1,002,039	5.0
4	6.8	700,416	3.5
5	6.5	980,368	4.9
6	6.2	1,490,505	7.5
7	6.2	743,137	3.7
8	7.2	1,051,218	5.3
9	6.2	1,437,009	7.2
10	6.2	728,598	3.6
11	5.4	690,857	3.5
12	6.8	1,646,807	8.2
13	7.9	1,186,439	5.9
14	7.3	867,768	4.3

15	8.2	1,366,592	6.8
16	6.8	606,826	3.0
Total	**115.2**	**17,734,601**	**89**

* Design Capacity is the volume of airspace available for waste and soil cover and is determined by extending the cell limit vertically to the top of the intermediate cover.

** Estimated site life is based on an annual gate volume of 600,000 cubic yards reduced at 3:1 to reflect compaction and volume reduction.

8.0 WASTE TYPES

The waste accepted at the facility results from household/Class I municipal solid waste, construction/demolition and debris (hereafter referred to as "Allowed Waste") of buildings or other structures. Bedroc accepts Allowed Waste solely from known and pre-approved suppliers. Approved waste material cleanup contractors, will initially pick up this material at the construction sites in Las Vegas. Minimal pre-sorting to remove non-construction debris materials will be performed at the construction sites for disposal at an approved site. Additional sorting occurs at the cleanup contractor's facility prior to transport to the Class I landfill. The Operating Plan provides additional details on the waste types currently accepted and proposed to be accepted at the Class I landfill.

9.0 SITE ACCESS

The site is easily accessible in all kinds of weather to all vehicles expected to use it. Access to the site can be achieved by an existing road, which joins US Hwy 93 at approximately mile marker 8, and travels west to the site. A fence around the perimeter of the property as well as natural barriers will limit access to the landfill to one entrance. The scale house is located at the entrance and controls access to the operating area and monitors all vehicles entering and exiting. A site attendant will be on duty to control access during hours of operation and direct vehicles appropriately. Vehicles delivering solid waste are required to cross the scales to be monitored, weighed and then they are directed to the working face. Speed limits are posted on internal roads. Public access is forbidden at this site and signage stating such is clearly posted at the entrance.

The access road is a minimum of 25-ft wide and is constructed of crushed stone, rubble, or other soil materials capable of providing an all-weather driving surface. Site personnel will maintain the on-site roads for all-weather access. If conditions prohibit access to the active face during inclement weather, an all-weather access area will be constructed as near as possible to the active area. When necessary, haulers will dump waste at the edge of the designated wet weather area to allow the compactor or dozer to push the waste into the fill. Bedroc will maintain the access roads for the life of the landfill so that the facility will be easily accessible in all weather.

10.0 BORROW AND STOCKPILE AREAS

Cell construction activities and adjacent land owned by Bedroc will be utilized to provide the fill soil needed to achieve the base grade elevations.

Stockpile areas will vary from time to time and must be left up to the discretion of the landfill operator. Drawing No. 19 shows the location of the borrow areas and the soil balance.

11.0 LINER

The Class I facility will be designed and constructed in accordance with NAC 444.681. The liner will be constructed as shown in the following sections.

11.1 Liner System

The liner system on the cell bottom will consist of the following components (from top to bottom):

a. Operations layer consisting of 24 inches of select loose (uncompacted) waste from incoming gate waste;
b. Drainage layer consisting of 12 inches of coarse aggregate with permeability no less than 0.5 cm/sec;
c. Protective cushion consisting of a non-woven, 16 oz./s.y. geotextile;
d. Flexible membrane liner (60-mil textured HDPE);
e. Compacted Soil Liner consisting of 36 inches of low-permeability soil (permeability less than or equal to 1 x 10-7 cm /sec); and,
f. Prepared 12 inch subgrade, with the surface smooth and generally free of rocks larger than ¾".

The liner system on the interior side slopes will consist of the following components (from top to bottom):

a. Operations layer consisting of 24 inches of select loose (uncompacted) waste from incoming gate waste;
b. Protective layer consisting of 12 inches of native soil of unspecified permeability;
c. Geocomposite
d. Flexible membrane liner (60-mil textured HDPE);
e. Compacted Soil Liner consisting of 36 inches of low-permeability soil (permeability less than or equal to 1 x 10-7 cm /sec);
f. Prepared subgrade, with the surface smooth and generally free of rocks larger than ¾".

11.2 Installation

Technical specifications (Appendix VI) and the Construction Quality Assurance (CQA) Plan (Appendix VII) address such things as preparation of the subgrade, visual inspections of the prepared subgrade and acceptance by the liner installer prior to installation of liner, quality control testing during liner installation, FML layout plan, and seaming methods. Construction Quality Assurance (CQA) will be completed during the liner construction activities to ensure that the construction complies with the liner design plans and specifications. Following each liner construction project, a certification report will be prepared and submitted to provide documentation that the construction activities were completed in accordance with the design plans and applicable federal and state regulations. A Nevada registered civil engineer will supervise CQA activities and certify the report.

Typical CQA activities will include, but are not limited to the following:

a. Verification of the low-permeability soil materials including material quality, thickness, and compaction;
b. Verification of the LCRS gravel including material quality and thickness;

c. Observation and inspection of the geosynthetic materials for conformance with the engineering plans and specifications;
d. Conformance testing of soil and geosynthetic materials; Documentation of construction procedures, and identification and resolution of construction problems; Preparation of a CQA report providing documentation that the closure activities and construction complied with the project plans and specifications.

The bullets below summarize the minimum CQA Plan requirements.

a. A delineation of the CQA management organization, including a chain of command
b. A detailed description of the level of experience and training of the contractor, work crew, and CQA inspectors.
c. Description of the CQA testing protocols.
d. CQC manufacturer data on all geosynthetics utilized
e. CQA documentation requirements
f. Subgrade inspection and testing procedures including compaction testing frequency.
g. Low-hydraulic-conductivity soil layer inspection and testing procedures and frequencies including field and laboratory testing. At a minimum include field compaction testing, permeability testing (field and/or laboratory), and laboratory testing for particle-size distribution, Atterberg limits, soil classification, and Proctor compaction.
h. LCRS layer inspection and laboratory testing procedures and frequencies. At a minimum include laboratory testing for permeability, particle-size distribution, and soil classification.\Geosynthetic layers (geomembrane, geotextiles, and geocomposites):
i. Preconstruction quality control program
j. Conformance testing procedures and frequencies
k. Inspection of subgrade surface
l. Inspection of placement
m. Seam testing procedures and frequencies for geomembranes
n. Inspections of installation of anchors and seals

11.3 Location Relative to Groundwater Surface

Groundwater surface elevations within the limits of the proposed Class I Disposal Facility range from approximately 47 to 81 feet below base grades (bottom of 36-inch Compacted Soil Liner). Water level measurements, obtained in September 2013, were used to generate groundwater contours. These contours are shown on the Base Grading Plan. The base grades have been designed to maximize the separation between the bottom of the liner system and groundwater. Accordingly, the base grades result in the following groundwater separation distances (measured between groundwater and the bottom of waste):

- A minimum of 51 feet at the sump locations;
- A maximum of 85 feet at the edge of the landfill; and
- An average separation distance of approximately 55 feet.

12.0 STABILITY

Pursuant to NAC 444.6795, the stability of the facility was evaluated by examining potential deep rotational failure through the waste and subgrade (bearing capacity), shallow rotational failure through the waste and subgrade, sliding block failure along the liner interface, veneer failure between components of proposed liner, and veneer failure between components of the cap. Please note that the facility is not located in a fault or unstable area.

Seismically, the California-Nevada border is one of the more active areas in the southwestern portion of the United States. In the vicinity of the site, seismic activity is less significant, with published United States Geologic Survey peak acceleration maps showing a 2% probability of exceeding a peak seismic acceleration of 0.27g of occurring in 50 years, and a 10% probability of exceeding a peak seismic acceleration of 0.12g of occurring in 50 years (USGS, 2002). Per NAC 444.6793, a seismic impact zone is defined as an area with a 10 percent or greater probability that the maximum horizontal acceleration in lithified earth material will exceed 10 percent of the earth's gravitational pull in 250 years. The site is in a seismic impact zone. According to NAC 444.6793.1 a new municipal solid waste landfill unit or lateral expansion may not be located in a seismic impact zone, unless the owner or operator submits proof to the solid waste management authority that all structures for containment, including liners, systems for the collection of leachate and systems for the control of surface water, are designed to resist the maximum horizontal acceleration in lithified earth material for the site. The calculations and design information show that the materials and the design of the landfill systems resist the maximum horizontal acceleration for the site. This information is presented in Appendix II and IIA.

The maximum seismic displacement for the liner system was calculated (see Appendix IIA). For potential failure along the liner, and the permanent seismically induced displacement was calculated to range from 0.01 inches to 0.47 inchesbe approximately 4 inches. Displacements of up to 6 to 12-inches along the liner system are generally accepted as being within the tolerance limits of liner systems without resulting in adverse damage. Potential failure of the foundation soils is not a critical failure mode since the shear strengths of the native soils are considerably higher than the assumed liner interface shear strength. Results of the evaluation are presented in Appendix II.

The site is not located in an "unstable area" which is defined by as "areas exhibiting soil and/or bedrock conditions prone to differential settlement and/or mass wasting (i.e. landsliding) (NAC 444.6795).

13.0 LIQUIDS MANAGEMENT SYSTEMS

13.1 Leachate Collection and Control

13.1.1 Leachate Flow

Extensive leachate generation rates have been evaluated using the EPA's Hydrologic Evaluation of Landfill Performance (HELP) Model - version 3.07 computer modeling program. In order to determine the expected leachate generation rate from the Class I cells, the HELP model was run using the design proposed in this application (i.e., liner details, leachate piping spacing etc) Synthetically generated climatologically and precipitation data from Las Vegas, Nevada were used to execute the program. This program simulates the actual field conditions and calculates the water balance considering surface run-off, evapotranspiration, and material permeability.

For modeling purposes, the liner system is identical to that described in Section 11.1. The waste material selected was municipal solid waste with channeling, which has a low porosity and initial water content.

Since the proposed based grades are less than 100 feet from the underlying groundwater table, the maximum daily percolation through the HDPE liner was evaluated. For this analysis, the liner system was modeled with a waste lift of 10 feet above it, which is the worst case condition, resulting in a maximum head on the liner of approximately 2.504 inches. As shown in the attached calculations, the average annual percolation through the 36" soil liner is 0.062 gallons per acre per year. On an average daily basis, the resulting leakage potential is 0.0002 gpad, which is effectively a negligible rate.

To determine the estimated annual leachate generated and collected per acre over the life of the facility, seven different HELP model scenarios were run:

1. Average waste depth of 10 feet with 6 inches of cover soil (12" stone, 60-mil HDPE liner, 36" low-permeability soil liner, 12" recompacted subgrade), 2% bottom slope, 263' pipe spacing;

2. Average waste depth of 20 feet with 6 inches of cover soil (12" stone, 60-mil HDPE liner, 36" low-permeability soil liner, 12" recompacted subgrade), 2% bottom slope, 263' pipe spacing;

3. Average waste depth of 40 feet with 6 inches of cover soil (12" stone, 60-mil HDPE liner, 36" low-permeability soil liner, 12" recompacted subgrade), 2% bottom slope, 263' pipe spacing;

4. Average waste depth of 60 feet with 6 inches of cover soil (12" stone, 60-mil HDPE liner, 36" low-permeability soil liner, 12" recompacted

subgrade), 2% bottom slope, 263' pipe spacing;

5. Average waste depth of 100 feet with 6 inches of cover soil (12" stone, 60-mil HDPE liner, 36" low-permeability soil liner, 12" recompacted subgrade), 2% bottom slope, 263' pipe spacing;

6. Average waste depth of 100 feet with 12 inches of intermediate cover soil (12" stone, 60-mil HDPE liner, 36" low-permeability soil liner, 12" recompacted subgrade), 2% bottom slope, 263' pipe spacing; and,

7. Final cap over an average waste depth of 100 feet (24" soil, geocomposite drainage layer, 40 mil-LLDPE liner, geocomposite, 12" intermediate cover), 33% sideslopes.

Each of the above scenarios was evaluated for a period of 100 years. From the results of the HELP model runs, the average annual leachate collected by the 12-inch stone drainage layer in inches per acre was used to calculate the leachate generation (Appendix III).

Given the results of the HELP model runs, presented in Appendix III, the daily leachate flows generated in the peak average month in gallons per acre where multiplied by the actual acreage operating for each scenario, to obtain the estimated quantity of leachate collected during the facility's operational life. These results are summarized in Appendix III). Over the life of the facility, the maximum daily leachate flow is estimated to be approximately 3,500 gallons/day. This occurs during waste placement activities in Cell 15.

As described above, HELP model results were used to estimate the amount of leachate generated and collected over the operating life of the facility. This value was used to size the leachate collection piping and leachate ponds. The leachate generated in the landfill will be discharged to a lined leachate pond, where it will be transported off-site to an existing wastewater treatment plant for disposal, if necessary. Tabulated summaries of the HELP model results and supporting calculations are included in Appendix III. A summary of how each of the main components of the leachate collection system where designed is presented in the sections below.

13.1.2 General Leachate Collection and Removal System

The Leachate Collection and Removal System (LCRS) has been designed to meet the minimum requirements of the Nevada Solid Waste Disposal Regulations (Chapter 444). Plans, cross-section views, details, and specifications are included in the design plans and design report. The LCRS described herein includes the following components:

- Aggregate drainage layer;
- Leachate collection piping;

- Downslope pipes and pumps; and,
- Leachate storage ponds.

Leachate generated in the disposal unit will flow through the drainage layer, which consists of 12 inches of granular material on the bottom. The granular material will achieve a minimum permeability of 0.5 cm/sec. Each Class I cell will be graded so that drainage will flow into perforated HDPE leachate collection laterals, with no more than 263 feet between laterals. These lateral pipes will then flow into perforated HDPE leachate header pipes running through the expansion area at a minimum of 1.3% downward grade. Due to this slope, leachate will flow into these pipes everywhere it is generated in the cell, even at the extremities of the landfill. These pipes will carry leachate by gravity to one of four sump areas. From the sumps, leachate will be pumped into the lined leachate ponds. Leachate will be pumped from the pond into tanker trucks for transport to a local wastewater treatment plant for treatment and disposal, if necessary.

13.1.3 Aggregate Drainage Layer

The Class I drainage layer is comprised of an 12-inch thick layer of coarse aggregate with a permeability of 0.5 cm/sec or greater. Using this permeability, an analysis was performed using the HELP Model to verify that no more than 12 inches of leachate would accumulate above the liner. The data obtained from the HELP Model indicate that the peak daily head developed on the liner with 10-feet of waste is 2.504 inches. This model was run using a 2% bottom slope for conservativeness. A 16-oz/sy non-woven geotextile will be placed above the synthetic liner to provide adequate cushion to the liner from construction and operational loads.

The drainage media will be sloped to allow leachate to drain into the LCRS system. The drainage layer will conform to the bottom slope of the disposal unit which is a minimum of 2.0 % from the leachate collection lateral pipes to the header pipes, and a minimum 1.3% from the header pipes toward the sump areas. The base grades of each Class I cell were designed to account for the calculated differential settlement of the foundation. The grades of each of the cells toward the sumps were designed to slope at a sufficient grade to allow positive drainage after the maximum final settlement.

The aggregate drainage layer will have sufficient bearing strength to support expected loads and not puncture the HDPE liner material. The resulting factor of safety was calculated to be 23.2 using conservative fracture strength of 2,000 pounds per square inch (psi) for the stone and the calculated expected loading of 75 pounds per cubic foot (pcf).

13.1.4 Leachate Collection Piping

The leachate collection lateral pipes and header pipes will be constructed of high-density polyethylene (HDPE) SDR-15.5 (minimum). The piping for the leachate trunkline will be HDPE sewer grade pipe. This material has been chosen based on its chemical resistivity and strength. The wall thickness and diameter have been chosen for the strength requirements and provide enough area to carry the anticipated flows.

The six-inch diameter leachate collection lines have been sized to handle the maximum flow based on the worst case daily leachate flow rate during peak average month from the largest contributing area. The resulting factor of safety is 15. Calculations have been performed to determine the adequacy of the perforations on the leachate collection pipes. Using 8 holes (3/8-inch diameter) per linear foot of pipe, results in a factor of safety of 800. The maximum flow rate used in the analysis in the permit was 2,852 gallons per day. The piping was analyzed for strength requirements to verify that it would not crush or buckle under the waste placed above it. Static forces from approximately 160 feet of waste were calculated to be about 88 psi. The factor of safety against wall crushing was calculated to be 2.4. The factor of safety against pipe buckling was calculated to be 1.9. The leachate collection piping was also analyzed to determine resistance to deflection. The resulting factor of safety was 10.3.

The gradation of drainage media, and spacing and size of pipe perforations were chosen to minimize clogging during the active life of the facility and the post-closure care period. The aggregate drainage layer will also slope toward the sump area to allow for the drainage of leachate in the event the leachate collection pipe network ever becomes clogged.

To facilitate cleaning and inspection, the pipe diameter is a minimum of six inches. In addition, each collection line has a cleanout as shown on the design plans to provide access for mechanically, hydraulically or chemically cleaning the leachate collection pipe network.

13.1.5 Pump Stations

Each of the four leachate pumps will be sized to handle the highest average monthly flow rate from the respective contributing areas. The pumps will cycle on and off as necessary so that the depth of leachate does not exceed 12" above the liner.

13.1.6 Leachate Storage Ponds

The leachate storage pond was designed to provide storage for 7 days of the maximum daily leachate flow, approximately 25,000 gallons (as determined by the HELP model and supporting calculations discussed previously). The capacity of the proposed leachate storage pond is approximately 140,000 gallons with 1-foot of freeboard.

The leachate pond will be lined with a 60-mil HDPE liner over a prepared base grade. Leachate will be pumped from the ponds, as necessary, into tanker trucks for transport to a local wastewater treatment plant for treatment and disposal.

13.2 Run-on Control System

NRS 444.6885 requires that a system is provided to control run-on during the peak discharge from a 25-year flow. The run-on control system for the proposed facility has been designed to intercept and divert the upland run-on for at least a 100 year, 24-hour storm event. The SCS TR-55 method was used to calculate peak flows and storage volumes. Approximately 170 sq. mi. primarily north and west of the site will be collected in a perimeter stormwater conveyance channel along the northern and western toe of the landfill that will convey the run-on around the site and will discharge the flows at the southeast corner of the site. The discharged stormwater will be collected in the Pahranagat Wash, a tributary to the Muddy River, which bypasses the facility on the east but flows onsite south of the facility on Lot 10. A map showing these areas is provided in Appendix V.

Run-on from the west will be detained in the areas below elevation 2490, along the western side of the facility. These areas has the capacity equal to 160 ac-ft. The anticipated runoff associated with a 100 year, 24-hour storm event is approximately 624 ac-ft. Similar to the four stormwater detention ponds that will handle run-off from the landfill, run-on that will flow into the detention areas will infiltrate through the bottom of the pond or evaporate. The trapezoidal channel to the south of the facility will carry the overflow from the onsite detention areas and discharge to the Pahranagat Wash, south of the facility on Lot 10.

The peak discharge from the 170 sq. mi. to the north and west of the facility for a 100 year, 24-hour storm event was calculated to be approximately 1,510 cubic feet per second (cfs). The proposed perimeter ditch (to control run-on) is a trapezoidal ditch with 2H:1V side slopes, a varying bottom width of 105 feet to 140 feet, and a varying flow line slope of 0.15% to 0.23% . This design provides a flow capacity of approximately 3,300 cfs. Thus, the resulting factor of safety for the 100 year, 24-hour storm event was calculated to be 1.02. The run-on control system and details are shown on the design drawings. All supporting calculations are included in Appendix V.

The proposed expansion area has been designed to prevent run-on from entering the active disposal area.

13.3 Run-off Control System

Run-off controls consist of containing sheet flow off of the top deck of the landfill and transmitting it to down slope drains. Run-off from diversion benches flows along the toe of the overlying bench and discharge into the down slope drains. The down slope drains transmit water from the diversion benches and discharge at the downgradient toe of the Landfill. A ditch along the perimeter of the landfill transmits run-off to naturally lined detention ponds. There are four stormwater detention ponds associated with the facility.

Run-off from the site will be carried by a system of ditches along the side slope benches and downslope drains into one of four stormwater detention ponds. The SCS TR-55 method was used to calculate peak flows and storage volumes. A 25-year, 24-hour storm event was used as the design basis for all of the proposed run-off control systems as required by NAC 444.6885.

The proposed ditch design is a V-shaped ditch, 2 feet deep, 3H:1V sideslopes on the uphill side and 2H:1V side slopes on the downhill side. The designed will provide drainage capacity providing at least a foot of freeboard and a factor of safety of 100+.

The sideslope ditches convey water to one of four 18-inch diameter corrugated HDPE downslope drains, which provides a flow capacity of approximately 39 cfs. Each downslope drain collects run-off from approximately a quarter of the expansion area thus, collecting approximately 4.5 cfs each. The resulting factor of safety is approximately 8.7.

Finally, the downslope drains discharge into one of the on-site stormwater detention ponds. To be most conservative, the stormwater detention ponds design was based on the final grades of the landfill. Using SCS TR-55, the estimated storage volume necessary to collect and store this flow from each drainage area were calculated. Each pond has a total storage volume of approximately 1 acre-ft; thus, providing a factor of safety of approximately 1.6. It is assumed, based on the soils and climate at the site that the stormwater collected in the detention ponds will infiltrate through the bottom of the basin or evaporate. As a result, a discharge structure from the area is not needed. Emergency spillways will be provided for addition safety. Supporting calculations are provided in Appendix V.

14.0 LANDFILL GAS VENTING AND MANAGEMENT SYSTEM

A gas control system will be used to collect and dispose of landfill gas. At a minimum, the gas control will comply with Federal New Source Performance Standards (NSPS) and Emission Guidelines and require a Title V Permit (40 CFR Part 70 and NAC 445B) prior to operating the gas controls. Conceptually, the landfill gas system will consist of a system of vertical gas vents, HDPE collection and header pipes, and condensate sumps. These vents will be installed as the refuse is placed, or alternatively drilled into the refuse after refuse placement. Operation of the gas control system will not occur until there is sufficient amount of methane to operate a flare disposal system. For landfills that receive 12 to 20 inches of annual precipitation in the western U.S., this typically requires 1 to 2 million tons of refuse in place and a minimum of 2 to 4 years of decomposition. Due to the arid climate of the Bedroc Landfill and Waste Management Facility, a longer time period may be required before sufficient gas is generated for flare operations.

A landfill gas monitoring program has been developed in accordance with NAC 444.667. Details of the landfill gas monitoring program can be found in the Decomposition Gas Management Plan submitted with this permit application.

15.0 GROUNDWATER MONITORING SYSTEM

A groundwater monitoring program has been developed in accordance with NAC444.683. Details of the groundwater monitoring program are contained in the Groundwater Monitoring Plan submitted this permit application.

Appendix I

Bedroc Landfill & Waste Management Facility
Estimated Quantities for Liner and Cap Construction

Cell #	Total Area (acres)	Cell Floor (sf)	Toe of Slope (LF)	Geomembrane (liner) (sf)	Geomembrane (cap) (sf)	Geocomposite (cap) (sf)	Geocomposite (liner) (sf)	Geotextile 16 oz/sy (sf)	Geotextile 10 oz/sy (sf)	Protective Cover Soil (liner) (cy)	Infiltration Layer (cap) (cy)	Topsoil (cap) (cy)	Drainage Layer (liner) (cy)	6" Perforated Pipe (LF)	6" Solid Pipe (LF)	18" Side Slope Riser (LF)
1	10.79	470012	1,299	470,012	470,012	940,025	22,083	470,012	16,887	337	26,112	8,704	17,408	3,195	282	102
2	9.53	415127	1,153	415,127	415,127	830,254	19,601	415,127	14,989	299	23,063	7,688	15,375	2,133	316	0
3	7.31	318424	1,104	318,424	318,424	636,847	18,768	318,424	14,352	286	17,690	5,897	11,793	1,924	34	0
4	6.84	297950	1,018	297,950	297,950	595,901	17,306	297,950	13,234	264	16,553	5,518	11,035	1,313	111	0
5	6.5	283140	1,355	283,140	283,140	566,280	23,035	283,140	17,615	351	15,730	5,243	10,487	1,737	263	101
6	6.15	267894	460	267,894	267,894	698,847	7,820	267,894	5,980	119	14,883	4,961	9,922	1,969	0	0
7	6.15	267894	1,460	267,894	267,894	695,836	24,820	267,894	18,980	379	14,883	4,961	9,922	2,537	63	0
8	7.2	313632	1,516	313,632	313,632	627,264	25,772	313,632	19,708	393	17,424	5,808	11,616	1,960	190	77
9	6.15	267894	924	267,894	267,894	535,788	15,708	267,894	12,012	240	14,883	4,961	9,922	1,611	0	0
10	6.15	267894	917	267,894	267,894	535,788	15,589	267,894	11,921	238	14,883	4,961	9,922	2,011	60	0
11	5.41	235660	1,192	235,660	235,660	471,319	20,264	235,660	15,496	309	13,092	4,364	8,728	1,503	255	110
12	6.82	297079	1,027	297,079	297,079	594,158	17,459	297,079	13,351	266	16,504	5,501	11,003	1,545	0	0
13	7.88	343253	1,612	343,253	343,253	686,506	27,404	343,253	20,956	418	19,070	6,357	12,713	1,656	144	0
14	7.31	318424	1,326	318,424	318,424	636,847	0	318,424	17,238	0	17,690	5,897	11,793	2,077	393	105
15	8.22	358063	1,135	358,063	358,063	716,126	19,295	358,063	14,755	294	19,892	6,631	13,262	1,545	0	0
16	6.78	295337	1,753	295,337	295,337	590,674	29,801	295,337	22,789	454	16,408	5,469	10,938	1,340	212	0
Totals	115.19	5,017,676	19,251	5,017,676	5,017,676	10,358,460	304,725	5,017,676	250,263	4,647	278,760	92,920	185,840	30,056	2,323	495

Appendix II

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LINER VENEER STATIC SLOPE STABILITY

OBJECTIVE

To demonstrate that a factor of safety (FS) greater than or equal to 1.25 (for interim conditions) exists, with respect to the liner components failing along the proposed liner sideslopes of the landfill. Also, determine the required transmissivity of a geocomposite such that an adequate factor of safety with respect to drainage exists for long term conditions.

Additionally, demonstrate that the specified Apparent Opening Size (AOS) of the geocomposite geotextile is acceptable considering the available soil types at the facility.

REFERENCES

"Design of Lateral Drainage Systems for Landfills" by Gregory N. Richardson and Aigen Zhao, 1999.

"*Designing with Geosynthetics*" by Robert Koerner, 1994.

GRI Standard – GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite

METHODOLOGY

The analytical method used to calculate veneer slope stability FS is taken from a report entitled "Design of Lateral Drainage Systems for Landfills" by Gregory N. Richardson and Aigen Zhao, 1999. The method analyzes the ability of the drainage geocomposite to adequately transmit infiltrating rain flow, and also considers the stability of the liner sideslope soils considering seepage forces. Exceeding the drainage capacity of the geocomposite could potentially cause the final cover soil to become saturated and possibly unstable.

The method used is a two-part method. The first part of the calculation determines the FS with respect to drainage. A factor of safety less than 1 indicates that the transmissivity of the geocomposite is inadequate and that the final cover soil is completely saturated and subject to seepage forces. For conservatism, the transmissivity of the geocomposite used in the design will be calculated assuming a factor of safety of 1.25 (for interim conditions) for drainage and also includes reduction factors based on information provided within GRI Standard – GC8, and *Designing with Geosynthetics*.

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The second part of the calculation determines the FS with respect to slope failure. The most critical interface friction angle will be varied such that the FS is greater than or equal to 1.25 (for interim conditions).

The proposed 3H:1V liner slopes is presented in this analysis. The liner slope will be have a longest sideslope length of approximately 100 feet.

An industry accepted design approach for establishing a soil retention design is to use the soil's grain size characteristics and compare them to the 95% opening size (O_{95}) of the geotextile. The term, apparent opening size (AOS) is equivalent to O_{95}.

PROPOSED LINER SYSTEM

The Liner System is outlined below, from top to bottom:

- 12-inch thick Soil Protective Cover Layer;
- Geocomposite Drainage Layer (geotextile heat bonded to both sides of a geonet);
- Geomembrane Liner;
- 36-inch thick Compacted Clay Liner; and,
- Prepared Subgrade.

ADDITIONAL MATERIAL PROPERTIES

Assumed unit weight of liner protective cover layer: γ_S = 130 **pcf**
Assumed permeability of the Soil Protective Cover Layer = 1.0×10^{-3} **cm/sec**

VARIABLES DEFINED

θ = Transmissivity of the geocomposite;
β = Sideslope angle;
k_{cs} = Permeability of protective cover layer soil;
γ_{sat} = Saturated Unit weight of the protective cover layer soil;
γ_b = Saturated Unit weight of the protective cover layersoil – Unit Weight of water (62.4 pcf)
L = Length of sideslope measured along the Geocomposite = 100 feet;
β = Sideslope angle;
i = slope gradient;
δ = Minimum contact interface friction angle of the geosynthetics along the liner sideslope;

Q_{in} = Flow into the geocomposite; and
Q_{out} = Flow out of the geocomposite.

CALCULATIONS

The FS for drainage is calculated by:

$$FS_d = Qout/Qin = (\theta_{req} * i) / (k_{cs} * L) *(\cos \beta)$$

As stated above, the Required Transmissivity will be calculated considering a FS = 1.25. This assumes that the geocomposite is capable of handling 1.25 times the design flow, a conservative assumption. A Factor of safety of 1 indicates a steady state condition where the amount of water infiltrating the protective cover layer is equal to the amount of water draining out of the geocomposite. Having a FS<1 equates to fully saturated conditions where seepage forces can build up.

Rearranging the equation yields:

$$\theta_{req} = (\cos \beta)\ (k_{cs} * L * FS_d) / i$$

For long term conditions, this transmissivity will be further reduced using reduction factors based on GRI Standard – GC8 *and Designing with Geosynthetics.*

$$\theta_{ult} = \theta_{req} * (RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC})$$

Where :

RF_{IN} = Reduction Factor for geotextile intrusion;
RF_{CR} = Reduction Factor for creep deformation;
RF_{CC} = Reduction Factor for chemical clogging; and
RF_{BC} = Reduction Factor for biological clogging.

The following reduction factors for chemical clogging ($RF_{CC} = 1.5$), intrusion ($RF_{IN} = 1.5$), biological clogging ($RF_{BC} = 1.5$), and creep deformation ($RF_{CR} = 1.4$) are applied below to result in the specification for leachate collection geocomposite transmissivity.

The following spreadsheet is utilized for the calculations:

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CALCULATION OF θreq

$\theta_{req} = (\cos \beta)\ (k_{cs} * L * FS_d)/i$

θ_{req} =	Required long term transmisivity	
β =	Slope Angle	
k_{cs} =	Permeability of the final cover soil	
L =	Length of slope	
FS_d =	Factor of Safety for Drainage	
i =	Gradient = sin β	
β =	18.43	
k_{cs} =	1.00E-03 cm/sec	
L =	100 feet	3048 cm
FS_d =	1.25	
i =	0.316146	
θ_{req} =	**1.14E-03** m²/sec	

CALCULATION OF θult

$\theta_{ULT} = \theta req * (RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC})$

RF_{IN} =	Reduction Factor for geotextile intrusion
RF_{CR} =	Reduction Factor for creep deformation
RF_{CC} =	Reduction Factor for chemical clogging
RF_{BC} =	Reduction Factor for biological clogging
RF_{IN} =	1.5
RF_{CR} =	1.4
RF_{CC} =	1.5
RF_{BC} =	1.5
θ_{ult} =	**5.40E-03 m²/sec**

The value of 5.40×10^{-3} m²/sec is the transmissivity of the geocomposite that will be specified in the Geocomposite Technical Specifications.

FS against slope failure is calculated by:

$$FS_f = (\gamma_b * \text{Tan } \delta) / (\gamma_{sat} * \text{Tan } \beta)$$

During conditions where a FS for drainage is greater than or equal to 1.0, the soil is not saturated, and therefore γ_b can be substituted for γ_{sat}. Thus, the equation for FS against slope failure is reduced to:

$$FS_f = \text{Tan } \delta / \text{Tan } \beta$$

Since the assumed FS against slope failure is 1.25, the equation is rearranged to solve for Tan δ and the resulting δ will be the minimum interface friction angle required within all of the final cover system components.

$$\text{Tan } \delta = (FS_f) * \text{Tan } (\beta)$$

Solving: $\text{Tan } \delta = (1.25) * \text{Tan } (18.43) = 0.42$

$\delta = \text{Tan}^{-1}\ 0.42 = 22.6$ *degrees*

Verification Of AOS Specification

As suggested in *Designing with Geosynthetics*, the AOS of a geotextile to be used in a soil retention or separation function can be calculated as a function of the grain size of the soil. This is given by the following equation:

$AOS < (2 \text{ to } 3)*d_{85}$

Where d_{85} = the particle size in mm for which 85% of the total soil is finer.

Assuming an AOS equivalent to a US sieve size of 70 (0.212 mm), the d_{85} of the cover soil must be:

$d_{85} > AOS/2$

$d_{85} > (0.212 \text{ mm} /2)$

$d_{85} > 0.106 \text{ mm}$

CONCLUSIONS

Since exceeding the capacity of the geocomposite to drain the liner slope could potentially cause the protective cover soil to become saturated and possibly unstable in the interim condition, a method was utilized to determine the required transmissivity of a geocomposite which would provide a factor of safety for drainage equal to 1.25. Reduction factors were then applied to the required transmissivity to obtain an ultimate transmissivity of 2.54×10^{-3} **m^2/sec** that will be required for long term performance.

Considering the factor of safety for drainage and all reduction factors, the required transmissivity results in an overall factor of safety for transmissivity equal to:

$1.25 * 1.5 * 1.4 * 1.5 * 1.5 = \mathbf{5.9}$

To model field conditions, the selected geocomposite shall be tested with a normal load of **300** psf, which is a conservative estimate based on the anticipated loading due to 1.0 feet of protective cover and erosion soils. Testing shall also be performed at a hydraulic gradient of 0.32 ft/ft with site specific boundary conditions.

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During the second part of the analysis, a FS against slope failure of 1.25 was assumed, and the value of the minimum interface friction angle of the components proposed to be placed along the liner sideslope was solved for. The minimum interface friction angle required for a FS of 1.25 was determined to be 22.6 **degrees.**

The AOS for the geotextile component of the geocomposite will be specified as a maximum of **0.212 mm**, which corresponds US Sieve size of **70**. Therefore, the d_{85} of the cover soils must be greater than **0.106 mm.** This AOS and d_{85} will be listed in Technical Specifications for the Geocomposite.

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Subject: Liner Veneer Seismic Stability
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LINER VENEER SEISMIC SLOPE STABILITY

OBJECTIVE

The objective of this calculation is to perform a seismic slope stability analysis for the liner protective cover system of the landfill.

METHODOLOGY

A spreadsheet taken from a report prepared by the Geosynthetic Research Institute (GRI), Drexel University, entitled "Cover Soil Stability Involving Geosynthetic Interfaces", by Te-Yang Soong and Robert M. Koerner is utilized to perform the calculation. This method analyzes the situation where a uniform layer of cover soil lies along a finite length of landfill side slope.

The seismic coefficient used within the stability analysis was obtained from the "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (site: NEHRP B-C boundary)" published by the U.S.G.S in 2008 and Figure 9-9 of the "Geotechnical and Stability Analyses for Ohio Waste Containment Facilities" September 14, 2002, which are included here. As suggested, the factor of safety for the worst-case slope and most critical interface must be greater than or equal to 1.0.

VARIABLES DEFINED

The shear strength envelope of the most critical interface in the liner system was calculated in the "Liner Veneer Static Slope Stability" calculation.

The seismic coefficient, Cs, is defined as follows:

Cs = Seismic Coefficient, or the yield acceleration, Ky, which is expressed as a percentage of g, (acceleration due to gravity)

The seismic coefficient is multiplied by the weight of the active and passive blocks to produce a horizontal force resulting from the seismic acceleration. (F = ma)

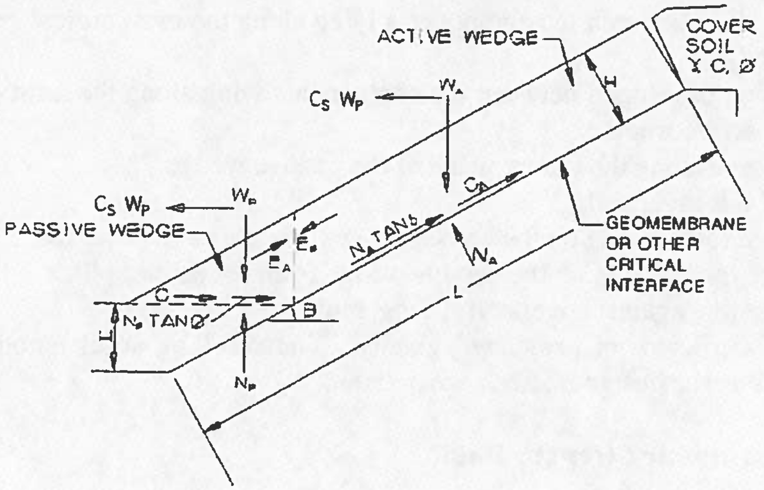


Figure 1, Side Slope Geometry & Free Body Diagram

Slope Dimensions	
Maximum Slope Length	100 feet
Slope Orientation	3H:1V or 18.43 degrees

The proposed liner system along the landfill sideslope is outlined below, from top to bottom:

- 12-inch thick Protection Cover Layer;
- Geocomposite Drainage Layer (geotextile heat bonded to both sides of a geonet);
- Geomembrane Liner;
- 36-inch thick Compacted Clay Liner;
- Prepared Subgrade.

W_A = Total weight of the active wedge;
W_P = Total weight of the passive wedge;
N_A = Effective force normal to the failure plane of the active wedge;
N_P = Effective force normal to the failure plane of the passive wedge;
γ = Unit weight of the cover soil;
h = Thickness of the cover soil;
L = Length of slope measured along the geomembrane;
β = Soil slope angle beneath the geomembrane;
ϕ = Internal angle of friction within the cover soil;
δ = Interface friction angle between the most critical geosynthetic interface;

C_a = Adhesive force between the components lying along the most critical geosynthetic interface of the active wedge;

c_a = The adhesion developed between the components lying along the most critical geosynthetic interface of the active wedge;

C = Cohesive force along the failure plane of the passive wedge;

c = cohesion of the cover soil;

E_A = Interwedge force acting on the active wedge from the passive wedge;

Ep = Interwedge force acting on the passive wedge from the active wedge;

FS = Factor of safety against cover soil sliding down the slope; and

Cs = Seismic coefficient in percent of gravity. The resulting acceleration at the crest of the landfill is based on the design bedrock acceleration.

Relevant Geosynthetic Strength Data

As determined in the "Final Cover Veneer Static Slope Stability" calculation, the minimum shear strength envelope required in the liner system was determined to be **δ = 26.6°** with no adhesion.

Additional Material Properties

Assumed unit weight of the liner protective cover layer material: $\gamma_S = 130$ pcf

The liner protective cover soils were modeled as one layer with a thickness of 1.0 feet and assigned the average values for cohesion and friction angle.

Internal angle of friction: $\phi = 27°$

Equations Used

The forces illustrated in Figure 1 are resolved below to produce a FS:

$$W_a = \gamma h^2 \left[\frac{L}{h} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2} \right]$$

$$N_a = W_a \cos\beta$$

$$C_a = c_u \left[L - \frac{h}{\sin\beta} \right]$$

Balancing the forces in the horizontal direction, the following formulation results:

$$E_A \cos\beta + \frac{N_A \tan\delta + C_a}{FS} \cos\beta = C_S W_A + N_A \sin\beta$$

The interwedge force acting on the active wedge is:

$$E_A = \frac{FS \cdot (C_S W_A + N_A \sin\beta) - (N_A \tan\delta + C_a)\cos\beta}{FS \cos\beta}$$

The passive wedge can be considered in a similar manner:

$$W_p = \frac{\gamma h^2}{\sin 2\beta}$$

$$N_p = W_p + E_p \sin\beta$$

$$C = \frac{c\,h}{\sin\ \beta}$$

Balancing the forces in the horizontal direction produces:

$$E_p \cos\beta + C_S W_P = \frac{C + N_p \tan\phi}{FS}$$

The interwedge force acting on the passive wedge is:

$$E_p = \frac{C + W_p \tan\phi - C_S W_P (FS)}{\cos\beta (FS) - \sin\beta \tan\phi}$$

Setting $E_A = E_p$, the equation can be arranged in the form of the following quadratic equation:

$$a(FS)^2 + b(FS) + c = 0$$

Where the coefficients a, b and c are equal to the following expressions:

$$a = (C_S W_A + N_A \sin\beta)\cos\beta + C_S W_p \cos\beta$$

$$b = -[(C_S W_A + N_A \sin\beta)\sin\beta \tan\phi + (N_A \tan\delta + C_a)\cos^2\beta + \cos\beta(C + W_p \tan\phi)]$$

$$c = (N_A \tan\delta + C_a)\sin\beta \cos\beta \tan\phi$$

The quadratic equation is then used to calculate the FS:

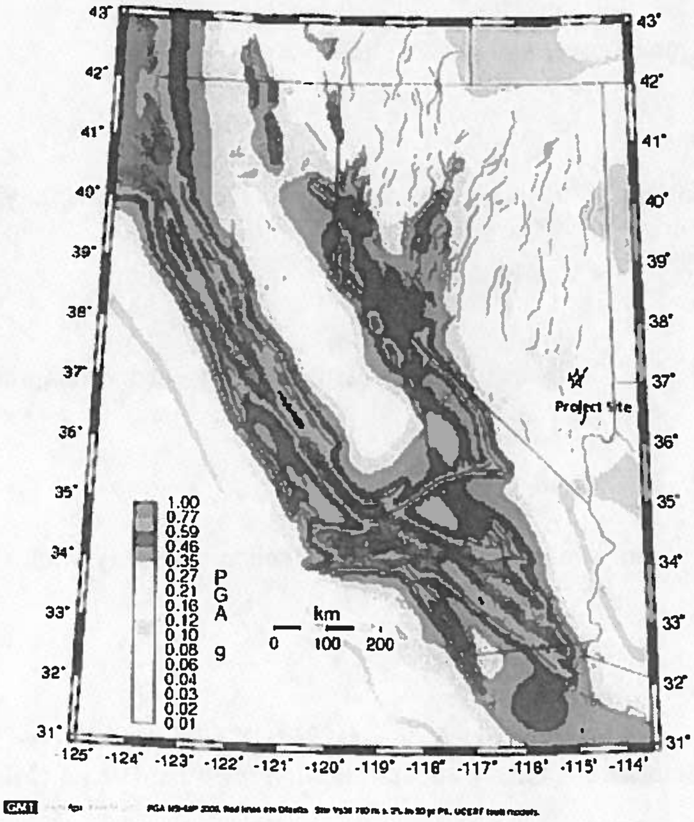
$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

For the ease of calculation the above quadratic equation was input into a spreadsheet format to produce a FS corresponding to a given set of input parameters. A copy of the spreadsheet calculations displaying the results is included in Attachment A.

Seismic Analysis

The shear wave acceleration is modeled within the stability analysis by inputting a coefficient, (Cs) that is some fraction of gravity. The peak acceleration for the site is estimated to be 0.27 g which is taken from the "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (site: NEHRP B-C boundary)" published by the U.S.G.S in 2008 shown below. The USGS has determined that ground motion values having a 2% probability of exceedance in 50 years are approximately the same as those having a 10% probability of being exceeded in 250 years.

Calif NV, PGA w/2%PE50yr. 760 m/s Rock



The parameters used in the seismic analysis are stated below:

h = Thickness of protective cover soil = 1.0 ft

L = Length of slope measured along the geocomposite = 100 ft

γ = Unit weight of the cover soil = 130.0 lb/ft^3

δ = Critical interface friction angle = 22.6 degrees

ca = The adhesion developed between the components lying along the most critical geosynthetic interface of the active wedge. ca = 5 lb/ft^2

D = Thickness of cover soil along the bottom of the slope = 1.0 ft

ϕ = Friction angle of the cover soil layer = 27 degrees

c = Cohesion of cover soil = 500.0 lb/ft^2

CALCULATIONS

The spreadsheet printout of the seismic stability analysis considering yield acceleration is included in Attachment A.

RESULTS

The results of the seismic stability analyses to determine the yield acceleration is presented below:

Cs = 0.27 g, FS = 1.00

Therefore, the liner system should be stable during seismic activity with a factor of safety of **1.00**.

REFERENCES

1. Soong, Te-Yang and Koerner, R.M., (1996) "Cover Soil Slope Stability Involving Geosynthetic Interfaces", Geosynthetic Research Institute, Drexel University, GRI Report #18

2. Ohio EPA, (September 14, 2002), "Geotechnical and Stability Analyses for Ohio Waste Containment Facilities".

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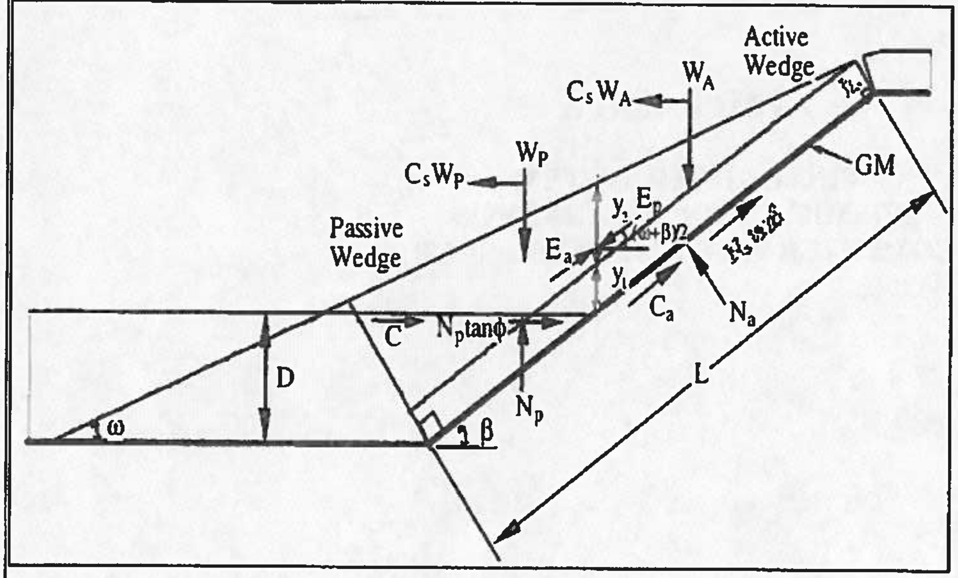
ATTACHMENT A

FINAL COVER SYSTEM SEISMIC STABILITY ANALYSIS COMPUTER SPREADSHEET RESULT

BEDROC LANDFILL

Uniform and/or Tapered Cover Soil with Consideration of Seismic Forces



Calculation of FS

Active Wedge:

Wa= *12567.1 lb*

Na= *11922.6 lb*

Ca= *484.2 lb*

Passive Wedge:

Wp= *216.7 lb*

C= *1581.5 lb*

$$\boxed{FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}}$$

a= *6850.6*

b= *-7661.5861*

c= *832.4*

FS= 1.00

(Note: for uniform cover soil thickness the input value of ω = β)

thickness of cover soil at top (crest) of the slope = hc = 1.00 ft

thickness of cover soil along the bottom of the site = D = 1.00 ft

soil slope angle beneath the geomembrane = β = 18.43 ° *= 0.32 (rad.)*

finished cover soil slope angle = ω = 18.43 ° *= 0.32 (rad.)*

length of slope measured along the geomembrane = L = 100.0 ft

y2= 0.00 (ft)

y1= 1.05 (ft)

(ω+β)/2= 0.322 (rad.)

(= 18.4 °)

unit weight of the cover soil = γ = 130.0 lb/ft^3

friction angle of the cover soil = ϕ = 27.0 ° *= 0.47 (rad.)*

cohesion of the cover soil = c = 500.0 lb/ft^2

critical interface friction angle = δ = 22.6 ° *= 0.39 (rad.)*

adhesion between cover soil and geocomposite = ca = 5.0 lb/ft^2

seismic coefficient = Cs = 0.270 g

Note: numbers in boxes are input values

numbers in Italics are calculated values

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DETERMINATION OF LOW NORMAL LOAD INTERFACE STRENGTH FOR THE LINER SYSTEM

OBJECTIVE

Calculate the shear strength that will provide an unsaturated veneer slope stability FS ≥ 1.25 with respect to the leachate collection / protective cover layer failing along the cell baseliner 3H:1V sideslopes. The calculation will also consider the presence of moving equipment placing and spreading protective cover material across the sideslope.

METHODOLOGY

The analytical method used to calculate the veneer slope stability FS is taken from a report prepared by the Geosynthetic Research Institute (GRI), Drexel University:

1) "*Cover Soil Slope Stability Involving Geosynthetic Interfaces*", (GRI REPORT #18), by Te-Yang Soong and Robert M. Koerner, December 9, 1996

GRI Report #18 is used to consider the presence of equipment on top of the protective cover layer and provides a FS based on the most critical interface shear strength of baseliner components. The spreadsheet calculates a FS by dividing the protective cover material along the 3H:1V sideslope into two blocks:

1) an active wedge of protective cover material along the length of the sideslope; and
2) a passive wedge of protective cover material at the toe of the sideslope.

A freebody diagram is then drawn identifying the forces on each wedge and static equilibrium equations are resolved in terms of vertical and horizontal components. Expressions are derived that quantify the magnitude of both the passive and active interwedge forces. Subsequently, the interwedge force equations are set equal to each other and are arranged in the form of a quadratic equation that can be solved to calculate a FS.

This calculation analyzes the greatest difference between perimeter berm height and cell floor corresponding to a longest length of 3H:1V sideslope. Figure 1 illustrates the proposed geometry of the baseliner sideslope and the freebody of the forces acting along the sideslope.

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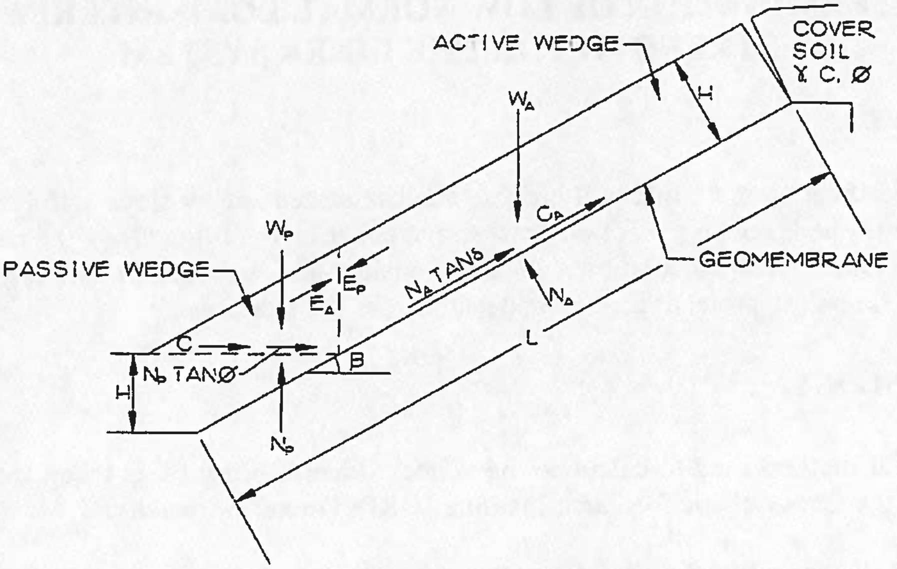

Figure 1, Side Slope Geometry & Free Body Diagram

Slope Dimensions	
Maximum Length of Baseliner Sideslope (along the length of the geomembrane)	100 feet
Baseliner Sideslope Orientation	3H:1V or 18.43 degrees

This veneer slope stability FS calculation is prepared proposing the following assumptions:

- The presence of moving equipment (dynamic loading) along the 3H:1V protective cover sideslope is analyzed within GRI Report #18.
- The shear strength component of adhesion developed between material layers is ignored.
- The protective cover material provides a buttress at the toe of the slope, i.e. the passive soil wedge.
- The anticipated granular nature of the proposed protective cover material suggests that cohesive strength does not exist, therefore only the internal angle of friction will be utilized.
- Weight of the geosynthetic component is negligible compared to the weight of protective cover material and therefore are not considered in the calculations.
- All calculations will utilize a 1-foot unit width of sideslope.

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PROPOSED BASELINER

The proposed baseliner system along the landfill cell sideslope is outlined below, from top to bottom:

- 12 inches of Protective Cover Layer;
- Geocomposite Drainage Layer;
- HDPE Textured Geomembrane;
- 36-inch thick Compacted Clay Liner;
- Prepared Subgrade

PROTECTIVE COVER MATERIAL PARAMETERS

Unit weight: $\gamma_{Total} = 130$ pcf;

Cohesion: $c = 0$ psf; and
Internal angle of friction: $\phi_i = 27$ degrees, a conservative value a based upon NAVFAC Design Manual 7.2, 1986, which lists the following friction angles for soil:

USCS GROUP	SOIL TYPE	FRICTION ANGLE
SM	Silty Sand	34
GM	Silty Gravel	34

REQUIRED SHEAR STRENGTH PARAMETERS

The calculation spreadsheet presented within GRI Report #18 will be used to determine the shear strength parameter (contact interface friction angle, $\delta_{interface\ friction}$) that corresponds to a FS $\geq$ 1.25 under drained conditions for all geosynthetic interfaces. The input variables of baseliner sideslope length, protective cover, and LGP equipment will be held constant within the spreadsheet while the contact interface friction angle, $\delta_{interface\ friction}$, is varied until a FS of $\geq$ 1.25 is achieved. Cohesion values of 500 psf will be entered.

The calculated $\delta_{interface\ friction}$ that corresponds to the FS $\geq$ 1.25 represents laboratory data where a straight line is drawn from the origin through the first data point (i.e. c = 0 psf) that corresponds to the lowest normal load within the given data set. The lowest normal load models the shear strength of protective cover material under relatively light normal loads that are anticipated to be initially encountered in the field during placement of the material. With respect to the protective cover, normal loads representative of 1.0 foot of protective cover are appropriate. The proposed critical contact interface will undergo ASTM D-5321-92 Direct Shear Testing and will be required to meet the minimum calculated contact interface friction angle corresponding to the first normal load.

The resulting contact interface friction angles will be included with other minimum shear strength parameters specified within the Construction Quality Assurance (CQA) Plan and/or specifications.

VARIABLES DEFINED

W_A = Total weight of the active wedge;
W_P = Total weight of the passive wedge;
N_A = Effective force normal to the failure plane of the active wedge;
N_P = Effective force normal to the failure plane of the passive wedge;
γ = Unit weight of the leachate collection/protective cover material;
h = Thickness of the leachate collection/protective cover material;
L = Length of slope measured along the geomembrane;
β = Soil slope angle beneath the geomembrane;
ϕ = Internal angle of friction within the protective cover soil;
δ = Interface friction angle between the most critical geosynthetic interface;
C_a = Adhesive force between the components lying along the most critical geosynthetic interface of the active wedge;
c_a = The adhesion developed between the components lying along the most critical geosynthetic interface of the active wedge;
C = Cohesive force along the failure plane of the passive wedge;
c = cohesion of the protective cover soil;
E_A = Interwedge force acting on the active wedge from the passive wedge;
E_P = Interwedge force acting on the passive wedge from the active wedge; and
FS = Factor of safety against protective cover soil sliding down the slope.

CALCULATIONS

It is proposed that a Low Ground Pressure (LGP) bulldozer will be used to place protective cover material across the sideslope. The pressure exerted upon the top of the geosynthetic layers by a bulldozer is modeled as illustrated in Figure 2 thus the bulldozer will not operate over the geosynthetic layers until the 18-inch thick protective cover material layer is placed.

During waste placement above the sideslopes, the length of slope beneath the compaction equipment will be buttressed from the toe of the sideslope.

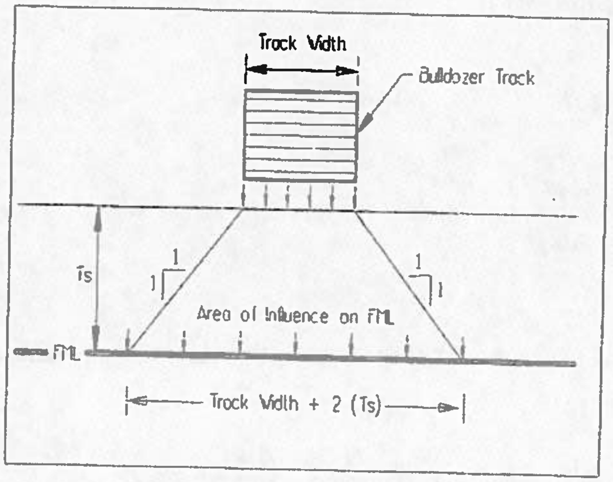

Figure 2, Stress Distribution of the LGP Bulldozer upon the Geosynthetic Layers

The following typical LGP Bulldozer equipment specifications are used within the GRI Report #18.

- 2 tracks
- Track length = 9.4 feet
- Track width = 3.0 feet
- Operating weight = 38,300 lbs
- One Track Contact area = 28.2 ft^2
- One Track Contact pressure = 19,150 lbs / 28.2 ft^2 = 679.1 psf

Subsequently, the forces illustrated in Figure 1 are resolved below to produce a veneer slope stability FS. The equations presented are taken from pages 13 and 14 of GRI Report #18.

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$$W_a = \gamma h^2 \left[\frac{L}{h} - \frac{1}{\sin \beta} - \frac{\tan \beta}{2} \right]$$

$$N_a = W_a \cos \beta$$

$$C_a = c_a \left[L - \frac{h}{\sin \beta} \right]$$

Balancing the forces in the vertical direction, the following formulation results:

$$E_A \sin \beta = W_A - N_A \cos \beta - \frac{N_A \tan \delta + C_a}{FS} \sin \beta$$

The interwedge force acting on the active wedge is:

$$E_A = \frac{FS \cdot (W_A - N_A \cos \beta) - (N_A \tan \delta + C_a) \sin \beta}{\sin \beta \, FS}$$

The passive wedge can be considered in a similar manner:

$$W_p = \frac{\gamma h^2}{\sin 2\beta}$$

$$N_p = W_p + E_p \sin \beta$$

$$C = \frac{c\, h}{\sin \beta}$$

Balancing the forces in the horizontal direction produces:

$$E_p \cos\beta = \frac{C + N_p \tan\phi}{FS}$$

The interwedge force acting on the passive wedge is:

$$E_p = \frac{C + W_p \tan\phi}{\cos\beta(FS) - \sin\beta\tan\phi}$$

Setting $E_A = E_p$ the equation can be arranged in the form of the quadratic equation:

$$a(FS)^2 + b(FS) + c = 0$$

Where the coefficients a, b and c are equal to the following expressions:

$$a = (W_A - N_A \cos\beta)\cos\beta$$

$$b = -[(W_A - N_A \cos\beta)\sin\beta\tan\phi + (N_A \tan\delta + C_a)\sin\beta\cos\beta + \sin\beta(C + W_p \tan\phi)]$$

$$c = (N_A \tan\delta + C_a)\sin^2\beta\tan\phi$$

The quadratic equation is then used to calculate the FS:

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

For the ease of calculations the above quadratic equation was input into a spreadsheet format to produce a FS corresponding to a given set of input parameters. A copy of the spreadsheet calculations displaying the results is included in Attachment A.

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CONCLUSIONS

Utilizing a contact interface shear strength friction angle of 22.6 degrees within GRI Report #18 resulted in a veneer slope stability FS equal to 1.59. This is the critical interface friction angle for all baseliner interfaces. While the equipment is placing the protective cover, a veneer slope stability FS equal to 1.33 was calculated. Additional assumptions include:

- The presence of an equipment load along the baseliner sideslope, equipment pushes material from toe towards the crest;
- Geosynthetic materials are not in tension;
- Cohesion does not exist within the 12-inch thick protective cover layer at the toe of the slope; and,
- Calculations consider that the 12-inch thick protective cover layer is entirely in-place along the longest length of baseliner sideslope approximately 47 feet along the length of the geomembrane.

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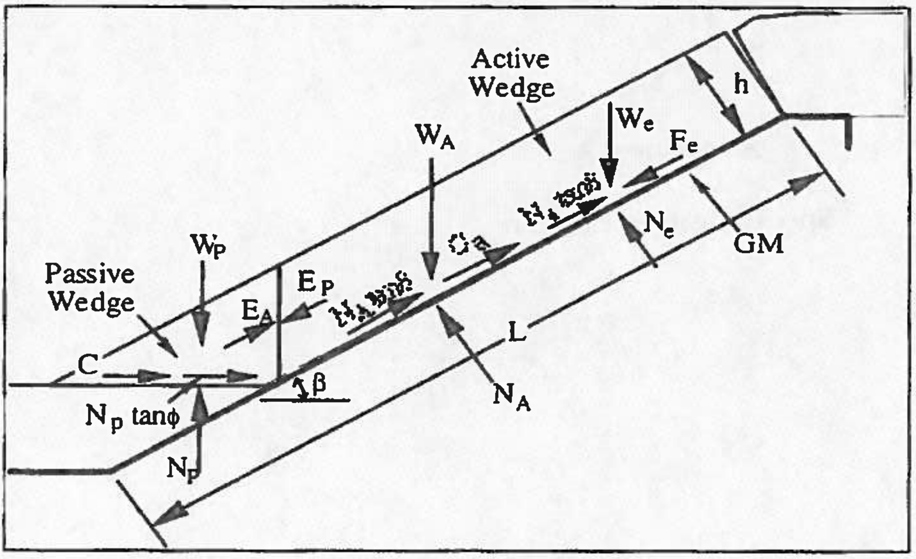
Attachment A

Spreadsheet Calculation

BEDROC LANDFILL

Placement of the 12-inch thick Protective Cover Material Layer across

across the 3:1 (H:V) Baseliner Sideslopes - Static Loading



Calculation of FS

Active Wedge:

Wa= 12567.1 lb
Na= 11922.6 lb

Passive Wedge:

Wp= 216.7 lb

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a= 5626.5
b= -9676
c= 1193.3

FS= 1.586

thickness of the prot. cover material = h = 1.00 ft
slope angle beneath the geomembrane = β = 18.43 ° *= 0.32 (rad.)*
finished prot. cover material slope angle = ω = 18.43 ° *= 0.32 (rad.)*
length of slope measured along the geomembrane = L = 100.0 ft
unit weight of the prot. cover material = γ = 130.0 lb/ft^3
friction angle of the prot. cover material = ϕ = 27.0 ° *= 0.47 (rad.)*
cohesion of the prot. cover material = c = 500.0 lb/ft^2 *C= 1581.5499 lb*
critical interface friction angle = δ = 22.60 ° *= 0.39 (rad.)*
adhesion = ca = 0.0 lb/ft^2 *Ca= 0 lb*

thickness of the prot. cover material = h = 1.00 ft *b/h= 3.0*
equipment ground pressure (= wt. of equipment/(2wb)) = q = 679.1 lb/ft^2 *We=qwl= 6192.0*
length of each equipment track = w = 9.4 ft *Ne=Wecosβ= 5874.4*
width of each equipment track = b = 3.0 ft *Fe=We(a/g)= 0.0*
influence factor* at geomembrane interface = I = 0.97
acceleration/deceleration of the bulldozer = a = 0.00 g

*Influence Factor Default Values

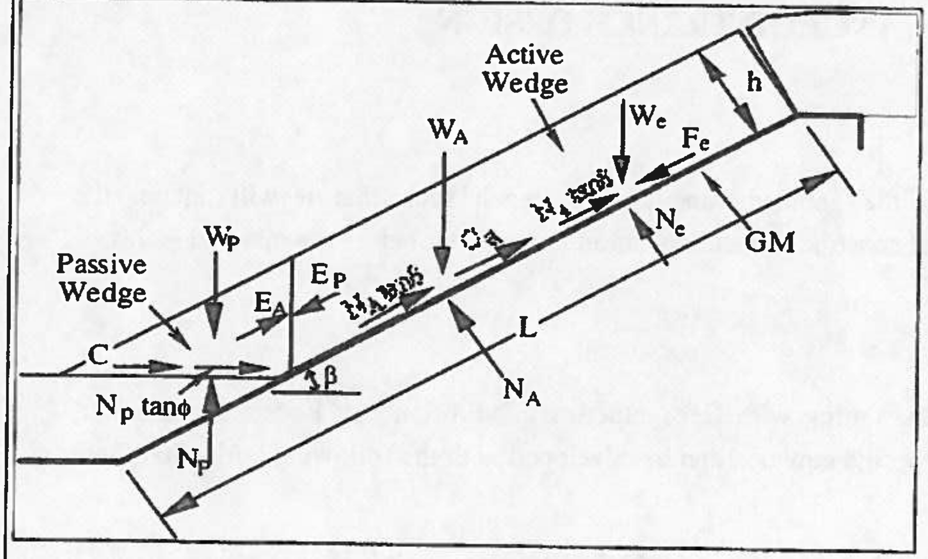
Cover Soil Thickness	Equipment Track Width		
	Very Wide	Wide	Standard
^{2}300 mm	1.00	0.97	0.94
300-1000 mm	0.97	0.92	0.70
^{3} 1000 mm	0.95	0.75	0.30

Note: numbers in boxes are input values

numbers in Italics are calculated values

BEDROC LANDFILL

Placement of the 12-inch thick Protective Cover Material Layer across the 3:1 (H:V) Baseliner Sideslopes with the incorporation of Equipment Loads - Dynamic Loading



Calculation of FS

Active Wedge:

Wa= *12567.1 lb*
Na= *11922.6 lb*

Passive Wedge:

Wp= *216.7 lb*

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a= *6742.6*
b= *-9865*
c= *1193.3*

FS= 1.330

thickness of the prot. cover material = h = 1.00 ft
slope angle beneath the geomembrane = β = 18.43° *= 0.32* *(rad.)*
finished prot. cover material slope angle = ω = 18.43° *= 0.32* *(rad.)*
length of slope measured along the geomembrane = L = 100.0 ft
unit weight of the prot. cover material = γ = 130.0 lb/ft^3
friction angle of the prot. cover material = φ = 27.0° *= 0.47* *(rad.)*
cohesion of the drain. lay./prot. cover material = c = 500.0 lb/ft^2 *C= 1581.5499 lb*
critical interface friction angle = δ = 22.60° *= 0.39* *(rad.)*
adhesion = ca = 0.0 lb/ft^2 *Ca= 0 lb*

thickness of the drain. lay./prot. cover material = h = 1.00 ft *b/h= 3.0*
equipment ground pressure (= wt. of equipment/(2wb)) = q = 679.1 lb/ft^2 *We=qwl= 6192.0*
length of each equipment track = w = 9.4 ft *Ne=Wecosβ= 5874.4*
width of each equipment track = b = 3.0 ft *Fe=We(a/g)= 1176.5*
influence factor* at geomembrane interface = I = 0.97
acceleration/deceleration of the bulldozer = a = 0.19 g

*Influence Factor Default Values

Cover Soil Thickness	Equipment Track Width		
	Very Wide	Wide	Standard
^{2}300 mm	1.00	0.97	0.94
300-1000 mm	0.97	0.92	0.70
^{3}1000 mm	0.95	0.75	0.30

Note: numbers in boxes are input values

numbers in Italics are calculated values

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Subject: Anchor Trench - Geomembrane
Sheet: 1 of 5

ANCHOR TRENCH DESIGN

OBJECTIVE:

To determine the size of the geomembrane anchor trench such that it will anchor the geomembrane during normal construction and operation but pull-out before the material yields.

METHOD:

Using Figure 5.28 from "Designing with Geosynthetics, 5th Edition" by Robert M. Koerner, which is provided below, a design equation can be developed with the following horizontal force summations:

Sec. 5.3 Liquid Containment (Pond) Liners 503

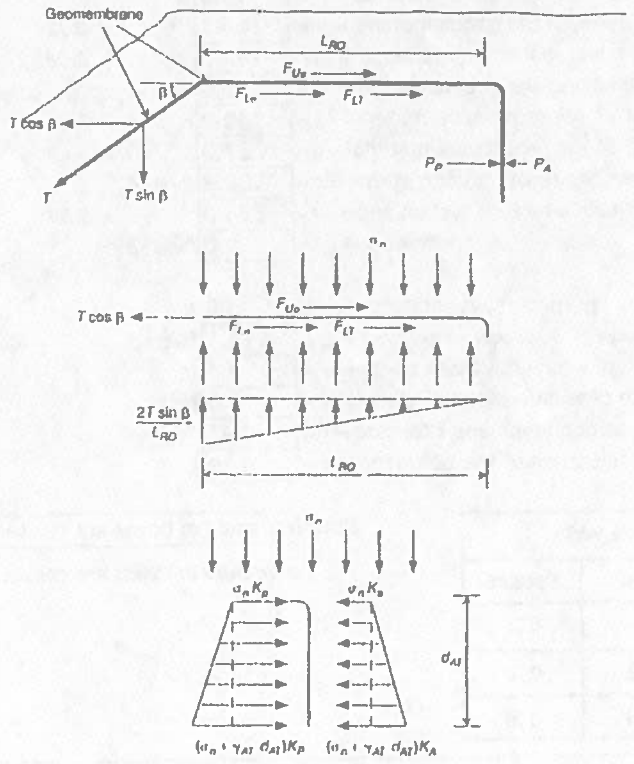

Figure 5.28 Cross section of geomembrane runout section with anchor trench and related stresses and forces involved.

$\Sigma F_x = 0$

$T_{allow} \cos \beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P$

where

T_{allow} = allowable forces in geomembrane = σ_{allow} t, where
σ_{allow} = allowable stress in geomembrane, and
t = thickness of geomembrane;
β = side slope angle;
$F_{U\sigma}$ = shear force above geomembrane due to cover soil (assume 0 due to thin cover soils and tensile cracking);
$F_{L\sigma}$ = shear force below geomembrane due to cover soil;
F_{LT} = shear force below geomembrane due to vertical component of T_{allow};
P_A = active earth pressure against the backfill side of the anchor trench; and
P_P = passive earth pressure against the in-situ side of the anchor trench.

and

$F_{U\sigma} = \sigma_n \tan \delta_U (L_{RO})$

$F_{L\sigma} = \sigma_n \tan \delta_L (L_{RO})$

$F_{LT} = 0.5\left(\frac{2T_{allow} \sin \beta}{L_{RO}}\right)(L_{RO}) \tan \delta_L$

where

σ_n = applied normal stress from cover soil;
δ = angle of shearing resistance between geomembrane and adjacent material; and
L_{RO} = length of geomembrane run-out.

Finally, P_A and P_P need to be calculated using the lateral earth pressure theory,

$P_A = (0.5\gamma_{AT} d_{AT} + \sigma_n) K_A d_{AT}$

$$P_P = (0.5\gamma_{AT}d_{AT} + \sigma_n)\, K_P d_{AT}$$

where

γ_{AT} = unit weight of soil in anchor trench;
d_{AT} = depth of the anchor trench;
σ_n = applied normal stress from cover soil;
K_A = coefficient of active earth pressure = $\tan^2(45 - \varphi/2)$;
K_P = coefficient of passive earth pressure = $\tan^2(45 + \varphi/2)$; and
φ = angle of shearing resistance of respective soil.

CALCULATION:

The above equations can be iterated to calculate the maximum allowable forces in the geomembrane, T_{calc}.

$$T_{calc} \cos\beta = F_{U\sigma} + F_{L\sigma} + F_{LT} - P_A + P_P$$

$$T_{calc} = \frac{F_{U\sigma} + F_{L\sigma} - P_A + P_P}{\cos\beta - \sin\beta\tan\delta_L}$$

For the ease of calculation the above equations were input into a spreadsheet format to produce the results to a given set of input parameters. A copy of the spreadsheet calculations displaying the results is included in Attachment A.

To ensure the geomembrane in the anchor trench will pull-out before the material yields, T_{allow} was compared to T_{calc} to calculate the following factor of safety:

$$FS = \frac{T_{allow}}{T_{calc}}$$

Using the spreadsheet calculation, the length of the geomembrane run-out and depth of the anchor trench were manipulated until a factor of safety greater to 1.0 was achieved.

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CONCLUSION:

The geomembrane anchor trench shall have a 7.25-feet run-out to provide a factor of safety of 1.01 that the geomembrane will pull-out prior to the material yielding. The geomembrane shall have a specified break strength of 90 lb/in.

REFERENCES

1. Koerner, Robert M., (2005) "Designing with Geosynthetics, 5th Edition", Pearson Education, Inc., Pearson Prentice Hall, Upper Saddle River, N.J.

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ATTACHMENT A

ANCHOR TRENCH
COMPUTER SPREADSHEET RESULT

BEDROC LANDFILL

Anchor Trench Design Calculations - Geomembrane

Sec. 5.3 Liquid Containment (Pond) Liners 503

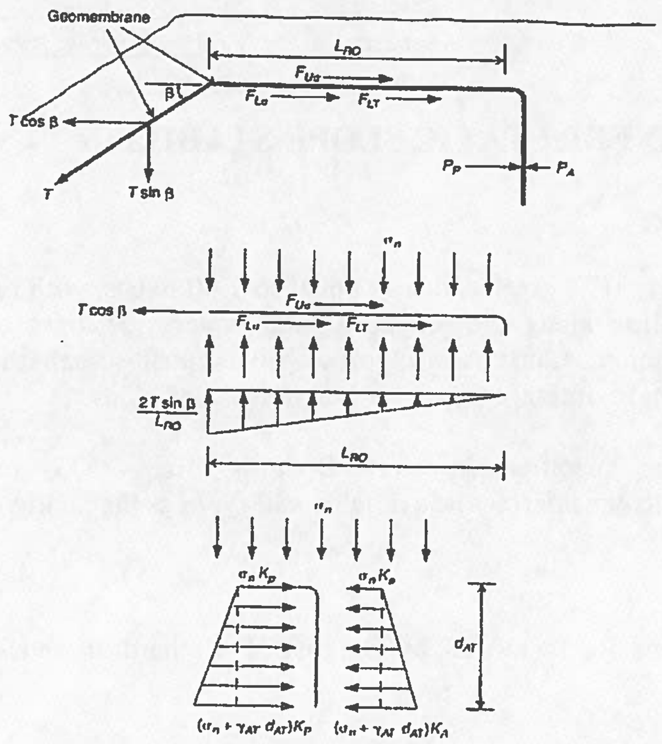

Figure 5.28 Cross section of geomembrane runout section with anchor trench and related stresses and forces involved.

Calculation of coefficients

horizontal force summation:

$F_{U\sigma}$ = *443.8*

$F_{L\sigma}$ = *423.148*

F_{LT} = *0.13* T_{allow}

lateral earth pressure:

K_A = *0.33*

K_P = *3.00*

P_A = *0.00*

P_P = *0.00*

force in geomembrane:

Tcalc = *1064.4*

F.S. = *1.01*

Slope angle = β = 18.43 ° = *0.32 (rad.)*

break strength of geomembrane from specifications = T_{allow} = 90.00 lb/in = *1080 (lb/ft)*

thickness of cover soil = 1.25 ft

unit weight of cover soil = γ_c = 110.0 lb/ft^3

applied normal stress = σ_n = 137.50 lb/ft^2

friction angle between geomembrane and adjacent material = δ_U = 24.0 ° = *0.42 (rad.)*

friction angle between geomembrane and adjacent material = δ_L = 23.0 ° = *0.40 (rad.)*

unit weight of the anchor trench soil = γ_{AT} = 110.0 lb/ft^3

friction angle of the anchor trench soil = ϕ = 30.0 ° = *0.52 (rad.)*

length of geomembrane runout = L_{RO} = 7.25 ft

depth of anchor trench = d_{AT} = 0.0 ft

Note: numbers in boxes are input values

numbers in italics are calculated values

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FINAL COVER VENEER STATIC SLOPE STABILITY

OBJECTIVE

To demonstrate that a factor of safety (FS) greater than or equal to 1.50 exists, with respect to the final cover components failing along the proposed final cover sideslopes of the landfill. Also, determine the required transmissivity of a geocomposite such that an adequate factor of safety with respect to drainage exists for long term conditions.

Additionally, demonstrate that the specified Apparent Opening Size (AOS) of the geocomposite geotextile is acceptable considering the available soil types at the facility.

REFERENCES

"Design of Lateral Drainage Systems for Landfills" by Gregory N. Richardson and Aigen Zhao, 1999.

"*Designing with Geosynthetics*" by Robert Koerner, 1994.

GRI Standard – GC8, Determination of the Allowable Flow Rate of a Drainage Geocomposite

METHODOLOGY

The analytical method used to calculate veneer slope stability FS is taken from a report entitled "Design of Lateral Drainage Systems for Landfills" by Gregory N. Richardson and Aigen Zhao, 1999. The method analyzes the ability of the drainage geocomposite to adequately transmit infiltrating rain flow, and also considers the stability of the final cover soils considering seepage forces. Exceeding the drainage capacity of the geocomposite could potentially cause the final cover soil to become saturated and possibly unstable.

The method used is a two-part method. The first part of the calculation determines the FS with respect to drainage. A factor of safety less than 1 indicates that the transmissivity of the geocomposite is inadequate and that the final cover soil is completely saturated and subject to seepage forces. For conservatism, the transmissivity of the geocomposite used in the design will be calculated assuming a factor of safety of 1.5 for drainage and also includes reduction factors based on information provided within GRI Standard – GC8, and *Designing with Geosynthetics*.

The second part of the calculation determines the FS with respect to slope failure. The most critical interface friction angle will be varied such that the FS is greater than or equal to 1.5.

The proposed 3H:1V final cover slope presented in this analysis is typical of MSW landfills. The final cover slope will be have a longest sideslope length of approximately 500 feet, but the geocomposite will be daylighted at an interval as specified in the calculation to achieve the necessary factor of safety.

An industry accepted design approach for establishing a soil retention design is to use the soil's grain size characteristics and compare them to the 95% opening size (O_{95}) of the geotextile. The term, apparent opening size (AOS) is equivalent to O_{95}.

PROPOSED FINAL COVER SYSTEM

The permitted Final Cover System is outlined below, from top to bottom:

- 24-inch soil layer comprised of local soil compacted to an unspecified permeability with the top six inches consisting of seeded top soil, native soil, or soil suitably amended to support native vegetation;
- A geonet composite;
- 40-mil linear low density polyethylene (LLDPE) geomembrane;
- A geonet composite; and,
- Local soil placed as intermediate cover during filling operations.

ADDITIONAL MATERIAL PROPERTIES

Assumed unit weight of final cover soil: γ_s **= 125 pcf**
Assumed permeability of the final cover soil = **1.0 x 10^{-3} cm/sec**

VARIABLES DEFINED

θ = Transmissivity of the geocomposite;
β = Sideslope angle;
k_{cs} = Permeability of final cover soil;
γ_{sat} = Saturated Unit weight of the final cover soil;
γ_b = Saturated Unit weight of the final cover soil – Unit Weight of water (62.4 pcf)
L = Length of sideslope measured along the Geocomposite = 100 feet;
β = Sideslope angle;
i = slope gradient;

δ = Minimum contact interface friction angle of the geosynthetics along the final cover sideslope;
Q_{in} = Flow into the geocomposite; and
Q_{out} = Flow out of the geocomposite.

CALCULATIONS

The FS for drainage is calculated by:

$$FS_d = Qout/Qin = (\theta_{req} * i) / (k_{cs} * L) *(\cos \beta)$$

As stated above, the Required Transmissivity will be calculated considering a FS = 1.5. This assumes that the geocomposite is capable of handling 1.5 times the design flow, a conservative assumption. A Factor of safety of 1 indicates a steady state condition where the amount of water infiltrating the final cover system is equal to the amount of water draining out of the geocomposite. Having a FS<1 equates to fully saturated conditions where seepage forces can build up.

Rearranging the equation yields:

$$\theta_{req} = (\cos \beta) (k_{cs} * L * FS_d) / i$$

For long term conditions, this transmissivity will be further reduced using reduction factors based on GRI Standard – GC8 *and Designing with Geosynthetics.*

$$\theta_{ult} = \theta_{req} * (RF_{IN} * RF_{CR} * RF_{CC} * RF_{BC})$$

Where :

RF_{IN} = Reduction Factor for geotextile intrusion;
RF_{CR} = Reduction Factor for creep deformation;
RF_{CC} = Reduction Factor for chemical clogging; and
RF_{BC} = Reduction Factor for biological clogging.

Since the laboratory testing will be performed using site-specific boundary conditions, the reduction factor for intrusion of the geotextile into the geonet will be ignored. As discussed in GRI Standard – GC8, chemical clogging includes precipitates from soils, and fines from turbid liquids.

The following reduction factors for chemical clogging ($RF_{CC} = 1.1$), biological clogging ($RF_{BC} = 1.2$), and creep deformation ($RF_{CR} = 1.2$) are applied below to result in the specification for final cover geocomposite transmissivity.

The following spreadsheet is utilized for the calculations:

CALCULATION OF θreq		
$\theta_{req} = (\cos\beta)(k_{cs} * L * FS_d)/i$		
θ_{req} =	Required long term transmisivity	
β =	Slope Angle	
k_{cs} =	Permeability of the final cover soil	
L =	Length of slope	
FS_d =	Factor of Safety for Drainage	
i =	Gradient = sin β	
β =	18.43	
k_{cs} =	1.00E-03 cm/sec	
L =	100 feet	3048 cm
FS_d =	1.5	
i =	0.316228	
θ_{req} =	**1.37E-03**	**m²/sec**

CALCULATION OF θult		
$\theta_{ULT} = \theta req *(RF_{IN}*RF_{CR}*RF_{CC}*RF_{BC})$		
RF_{IN} =	Reduction Factor for geotextile intrusion	
RF_{CR} =	Reduction Factor for creep deformation	
RF_{CC} =	Reduction Factor for chemical clogging	
RF_{BC} =	Reduction Factor for biological clogging	
RF_{IN} =	1	
RF_{CR} =	1.2	
RF_{CC} =	1.1	
RF_{BC} =	1.2	
θ_{ult} =	**2.17E-03**	**m²/sec**

The value of 2.17×10^{-3} m²/sec is the transmissivity of the geocomposite that will be specified in the Geocomposite Technical Specifications. A day light for the geocomposite will have to be installed every 100 feet of slope.

FS against slope failure is calculated by:

$$FS_f = (\gamma_b * \text{Tan } \delta) / (\gamma_{sat} * \text{Tan } \beta)$$

During conditions where a FS for drainage is greater than or equal to 1.0, the soil is not saturated, and therefore γ_b can be substituted for γ_{sat}. Thus, the equation for FS against slope failure is reduced to:

$$FS_f = \text{Tan } \delta / \text{Tan } \beta$$

Since the assumed FS against slope failure is 1.5, the equation is rearranged to solve for Tan δ and the resulting δ will be the minimum interface friction angle required within all of the final cover system components.

$$\text{Tan } \delta = (FS_f) * \text{Tan } (\beta)$$

Solving: $\text{Tan } \delta = (1.5) * \text{Tan } (18.43) = 0.50$

$\delta = \text{Tan}^{-1}\ 0.50 =$ *26.6 degrees*

Verification Of AOS Specification

As suggested in *Designing with Geosynthetics*, the AOS of a geotextile to be used in a soil retention or separation function can be calculated as a function of the grain size of the soil. This is given by the following equation:

$$AOS < (2 \text{ to } 3)*d_{85}$$

Where d_{85} = the particle size in mm for which 85% of the total soil is finer.

Assuming an AOS equivalent to a US sieve size of 70 (0.212 mm), the d_{85} of the cover soil must be:

$d_{85} > AOS/2$

$d_{85} > (0.212 \text{ mm} /2)$

$d_{85} > 0.106 \text{ mm}$

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CONCLUSIONS

Since exceeding the capacity of the geocomposite to drain the final cover slope could potentially cause the final cover soil to become saturated and possibly unstable, a method was utilized to determine the required transmissivity of a geocomposite which would provide a factor of safety for drainage equal to 1.5. Reduction factors were then applied to the required transmissivity to obtain an ultimate transmissivity of **2.17×10^{-3} m^2/sec** that will be required for long term performance. A geocomposite day light shall be installed every 100 feet along the slope.

Considering the factor of safety for drainage and all reduction factors, the required transmissivity results in an overall factor of safety for transmissivity equal to:

$$1.5 * 1.0 * 1.2 * 1.1 * 1.2 = \mathbf{2.4}$$

To model field conditions, the selected geocomposite shall be tested with a normal load of **300** psf, which is a conservative estimate based on the anticipated loading due to 2.0 feet of protective cover and erosion soils. Testing shall also be performed at a hydraulic gradient of **0.316** ft/ft with site specific boundary conditions.

During the second part of the analysis, a FS against slope failure of 1.5 was assumed, and the value of the minimum interface friction angle of the components proposed to be placed along the final cover sideslope was solved for. The minimum interface friction angle required for a FS of 1.5 was determined to be **26.6 degrees.**

The AOS for the geotextile component of the geocomposite will be specified as a maximum of **0.212 mm**, which corresponds US Sieve size of **70**. Therefore, the d_{85} of the cover soils must be greater than **0.106 mm.** This AOS and d_{85} will be listed in Technical Specifications for the Geocomposite.

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FINAL COVER VENEER SEISMIC SLOPE STABILITY

OBJECTIVE

The objective of this calculation is to perform a seismic slope stability analysis for the final cover system of the landfill.

METHODOLOGY

A spreadsheet taken from a report prepared by the Geosynthetic Research Institute (GRI), Drexel University, entitled "Cover Soil Stability Involving Geosynthetic Interfaces", by Te-Yang Soong and Robert M. Koerner is utilized to perform the calculation. This method analyzes the situation where a uniform layer of cover soil lies along a finite length of landfill side slope.

The seismic coefficient used within the stability analysis was obtained from the "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (site: NEHRP B-C boundary)" published by the U.S.G.S in 2008 which is included here. As suggested, the factor of safety for the worst-case slope and most critical interface must be greater than or equal to 1.0.

VARIABLES DEFINED

The shear strength envelope of the most critical interface in the final cover system was defined in the "Final Cover Veneer Slope Stability" calculation included with this Amendment.

The seismic coefficient, Cs, is defined as follows:

Cs = Seismic Coefficient, or the yield acceleration, Ky, which is expressed as a percentage of g, (acceleration due to gravity)

The seismic coefficient is multiplied by the weight of the active and passive blocks to produce a horizontal force resulting from the seismic acceleration. (F = ma)

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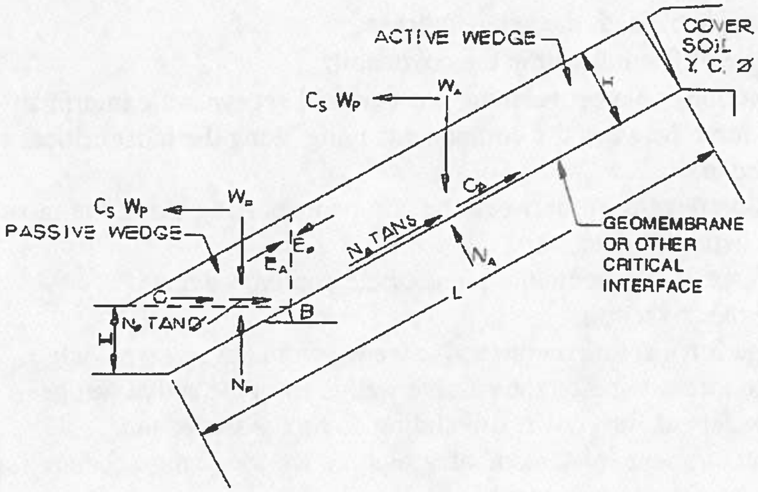

Figure 1, Side Slope Geometry & Free Body Diagram

Slope Dimensions	
Maximum Slope Length	100 feet
Slope Orientation	3H:1V or 18.43 degrees

The proposed final cover system along the landfill sideslope is outlined below, from top to bottom:

- 24-inch soil layer comprised of local soil compacted to an unspecified permeability with the top six inches consisting of seeded top soil, native soil, or soil suitably amended to support native vegetation;
- A geonet composite;
- 40-mil linear low density polyethylene (LLDPE) geomembrane;
- A geonet composite; and,
- Local soil placed as intermediate cover during filling operations.

W_A = Total weight of the active wedge;
W_P = Total weight of the passive wedge;
N_A = Effective force normal to the failure plane of the active wedge;
N_P = Effective force normal to the failure plane of the passive wedge;
γ = Unit weight of the cover soil;
h = Thickness of the cover soil;
L = Length of slope measured along the geomembrane;

β = Soil slope angle beneath the geomembrane;
ϕ = Internal angle of friction within the cover soil;
δ = Interface friction angle between the most critical geosynthetic interface;
C_a = Adhesive force between the components lying along the most critical geosynthetic interface of the active wedge;
c_a = The adhesion developed between the components lying along the most critical geosynthetic interface of the active wedge;
C = Cohesive force along the failure plane of the passive wedge;
c = cohesion of the cover soil;
E_A = Interwedge force acting on the active wedge from the passive wedge;
Ep = Interwedge force acting on the passive wedge from the active wedge;
FS = Factor of safety against cover soil sliding down the slope; and
Cs = Seismic coefficient in percent of gravity. The resulting acceleration at the crest of the landfill is based on the design bedrock acceleration.

Relevant Geosynthetic Strength Data

As determined in the "Final Cover Veneer Slope Stability" calculation, the minimum shear strength envelope required in the final cover system was determined to be $\delta = 26.6°$ with no adhesion.

Additional Material Properties

Assumed unit weight of the cap protection layer material: $\gamma_S = 125$ pcf

The final cover soils were modeled as one layer with a thickness of 2.0 feet and assigned the average values for cohesion and friction angle.

Internal angle of friction = 27°

Equations Used

The forces illustrated in Figure 1 are resolved below to produce a FS:

$$W_a = \gamma h^2 \left[\frac{L}{h} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2}\right]$$

$$N_a = W_a \cos\beta$$

$$C_a = c_a \left[L - \frac{h}{\sin\beta}\right]$$

Balancing the forces in the horizontal direction, the following formulation results:

$$E_A \cos\beta + \frac{N_A \tan\delta + C_a}{FS} \cos\beta = C_S W_A + N_A \sin\beta$$

The interwedge force acting on the active wedge is:

$$E_A = \frac{FS \cdot (C_S W_A + N_A \sin\beta) - (N_A \tan\delta + C_a)\cos\beta}{FS \cos\beta}$$

The passive wedge can be considered in a similar manner:

$$W_p = \frac{\gamma h^2}{\sin 2\beta}$$

$$N_p = W_p + E_p \sin\beta$$

$$C = \frac{c\,h}{\sin\ \beta}$$

Balancing the forces in the horizontal direction produces:

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$$E_p \cos\beta + C_S W_P = \frac{C + N_p \tan\phi}{FS}$$

The interwedge force acting on the passive wedge is:

$$E_p = \frac{C + W_p \tan\phi - C_S W_P (FS)}{\cos\beta (FS) - \sin\beta \tan\phi}$$

Setting $E_A = E_p$, the equation can be arranged in the form of the following quadratic equation:

$$a(FS)^2 + b(FS) + c = 0$$

Where the coefficients a, b and c are equal to the following expressions:

$$a = (C_S W_A + N_A \sin\beta)\cos\beta + C_S W_p \cos\beta$$

$$b = -\left[(C_S W_A + N_A \sin\beta)\sin\beta \tan\phi + (N_A \tan\delta + C_a)\cos^2\beta + \cos\beta(C + W_p \tan\phi)\right]$$

$$c = (N_A \tan\delta + C_a)\sin\beta\cos\beta\tan\phi$$

The quadratic equation is then used to calculate the FS:

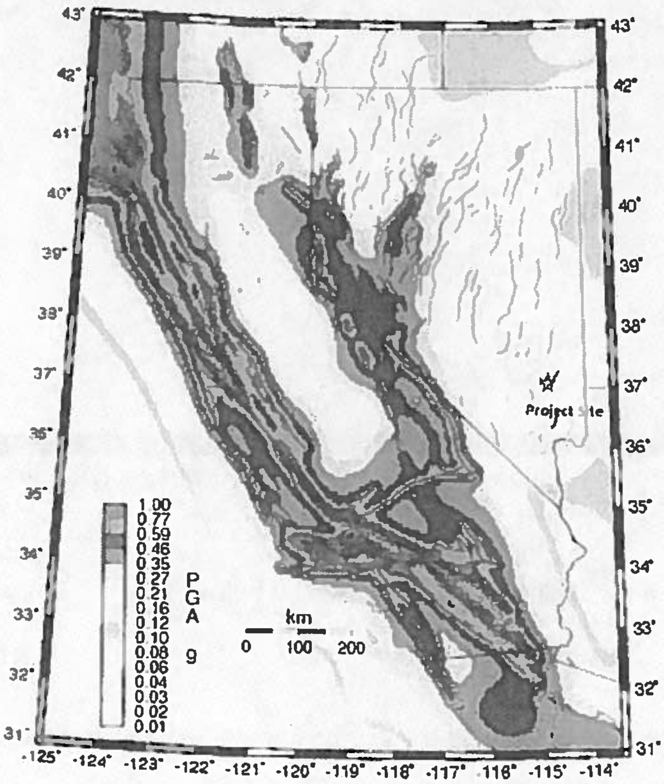
$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

For the ease of calculation the above quadratic equation was input into a spreadsheet format to produce a FS corresponding to a given set of input parameters. A copy of the spreadsheet calculations displaying the results is included in Attachment A.

Seismic Analysis

The shear wave acceleration is modeled within the stability analysis by inputting a coefficient, (Cs) that is some fraction of gravity. The peak acceleration for the site is estimated to be 0.27 g which is taken from the "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (site: NEHRP B-C boundary)" published by the U.S.G.S in 2008 shown below. Since this analysis is for the final cover system, the acceleration at the crest of the landfill will be considered.

Calif NV. PGA w/2%PE50yr. 760 m/s Rock



When plotting this value onto Singh and Sun's 1995 figure below for the relationship between maximum horizontal seismic acceleration at the base and crest of 162 feet of refuse, the maximum horizontal seismic acceleration at the crest of the landfill can be expected to be 0.37 g.

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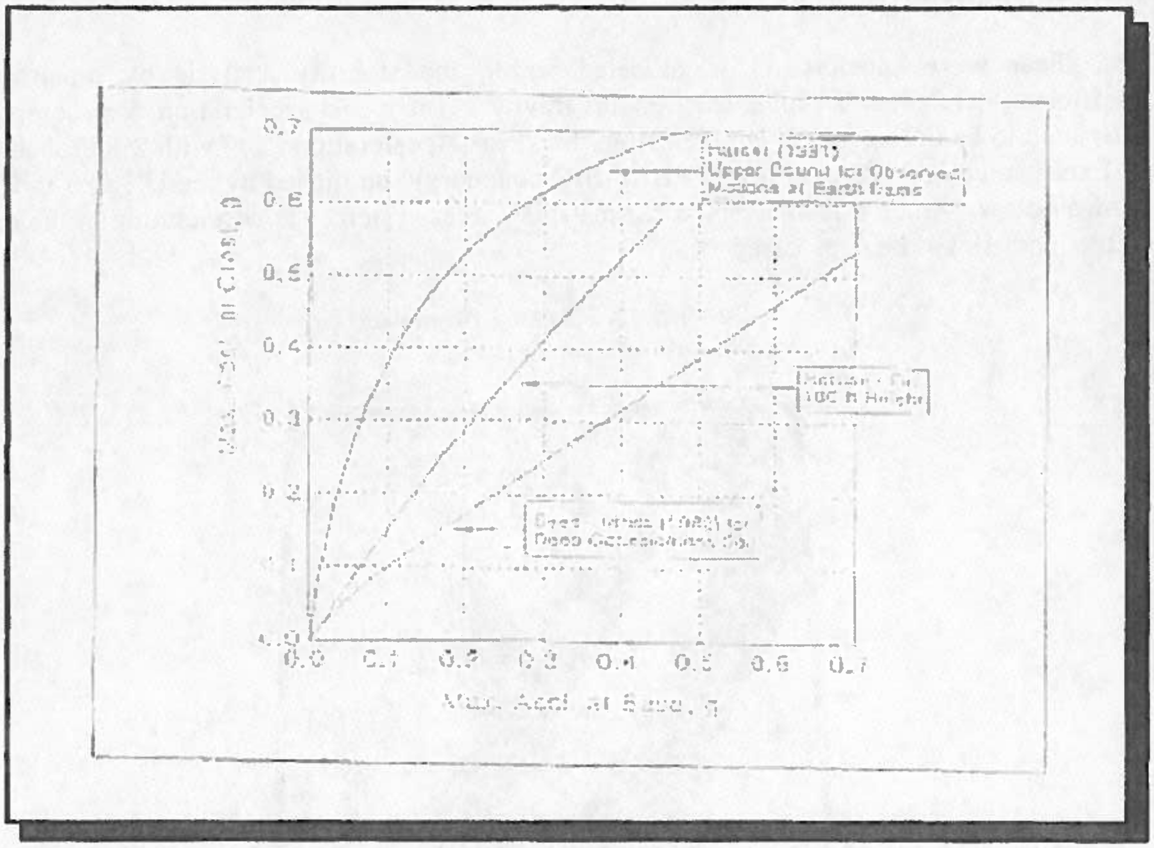

Figure 8-11 Approximate relationship between maximum accelerations at the base and crest for various ground conditions. Singh and Sun,1995, Figure 3.

The parameters used in the seismic analysis are stated below:

h = Thickness of cover soil = 2.0 ft

L = Length of slope measured along the geomembrane between benches = 100 ft

γ = Unit weight of the cover soil = 125.0 lb/ft^3

δ = Critical interface friction angle = 26.6 degrees

ca = Adhesion of cover soil = 20.0 lb/ft^2

D = Thickness of cover soil along the bottom of the slope = 2.0 ft

ϕ = Friction angle of the cover soil layer = 27 degrees

c = Cohesion of cover soil = 500.0 lb/ft^2

CALCULATIONS

The spreadsheet printout of the seismic stability analysis considering yield acceleration is included in Attachment A.

RESULTS

The results of the seismic stability analyses to determine the yield acceleration is presented below:

$$Cs = 0.37\text{ g},\quad FS = 1.04$$

Therefore, the final cover system should be stable during seismic activity with a factor of safety of 1.04.

REFERENCES

1. Soong, Te-Yang and Koerner, R.M., (1996) "Cover Soil Slope Stability Involving Geosynthetic Interfaces", Geosynthetic Research Institute, Drexel University, GRI Report #18

2. Ohio EPA, (September 14, 2002), "Geotechnical and Stability Analyses for Ohio Waste Containment Facilities".

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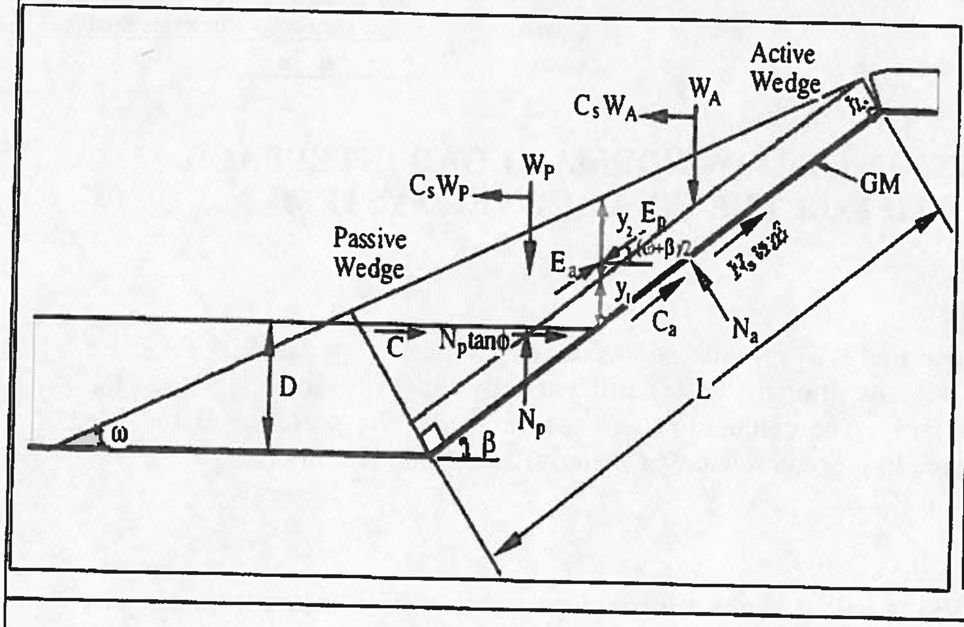
ATTACHMENT A

FINAL COVER SYSTEM
SEISMIC STABILITY ANALYSIS
COMPUTER SPREADSHEET RESULT

WESTERN ELITE LANDFILL

Uniform and/or Tapered Cover Soil with Consideration of Seismic Forces



Calculation of FS

Active Wedge:

Wa= 23335.1 lb

Na= 22138.3 lb

Ca= 1873.5 lb

Passive Wedge:

Wp= 833.5 lb

C= 3163.1 lb

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a= 15123.7

b= -17586.2240

c= 1980.5

FS= 1.04

(Note: for uniform cover soil thickness the input value of ω = β)

thickness of cover soil at top (crest) of the slope = hc = 2.00 ft

thickness of cover soil along the bottom of the site = D = 2.00 ft

soil slope angle beneath the geomembrane = β = 18.43 ° *= 0.32 (rad.)*

finished cover soil slope angle = ω = 18.43 ° *= 0.32 (rad.)*

length of slope measured along the geomembrane = L = 100.0 ft *Due to benches at ~30 vertical feet*

y2= 0.00 (ft)

y1= 2.11 (ft)

(ω+β)/2= 0.322 (rad.)

(= 18.4 °)

unit weight of the cover soil = γ = 125.0 lb/ft^3

friction angle of the cover soil = φ = 27.0 ° *= 0.47 (rad.)*

cohesion of the cover soil = c = 500.0 lb/ft^2

critical interface friction angle = δ = 26.6 ° *= 0.46 (rad.)*

adhesion between cover soil and geocomposite = ca = 20.0 lb/ft^2

seismic coefficient = Cs = 0.370 g

Note: numbers in boxes are input values

numbers in Italics are calculated values

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DETERMINATION OF LOW NORMAL LOAD INTERFACE STRENGTH FOR THE FINAL COVER SYSTEM

OBJECTIVE

Calculate the shear strength that will provide an unsaturated veneer slope stability FS ≥ 1.5 with respect to the geocomposite drainage layer / soil protective cover layer failing along the final cover 3H:1V sideslopes. The calculation will also consider the presence of moving equipment placing and spreading protective cover material across the sideslope.

METHODOLOGY

The analytical method used to calculate the veneer slope stability FS is taken from a report prepared by the Geosynthetic Research Institute (GRI), Drexel University:

1) "*Cover Soil Slope Stability Involving Geosynthetic Interfaces*", (GRI REPORT #18), by Te-Yang Soong and Robert M. Koerner, December 9, 1996 and

GRI Report #18 is used to consider the presence of equipment on top of the protective cover layer and provides a FS based on the most critical interface shear strength of final cover components. The spreadsheet calculates a FS by dividing the protective cover material along the 3H:1V sideslope into two blocks:

1) an active wedge of protective cover material along the length of the sideslope; and
2) a passive wedge of protective cover material at the toe of the sideslope.

A freebody diagram is then drawn identifying the forces on each wedge and static equilibrium equations are resolved in terms of vertical and horizontal components. Expressions are derived that quantify the magnitude of both the passive and active interwedge forces. Subsequently, the interwedge force equations are set equal to each other and are arranged in the form of a quadratic equation that can be solved to calculate a FS.

This calculation analyzes the longest length of the 3H:1V final cover sideslope between benches. Figure 1 illustrates the proposed geometry of the final cover sideslope and the freebody of the forces acting along the sideslope.

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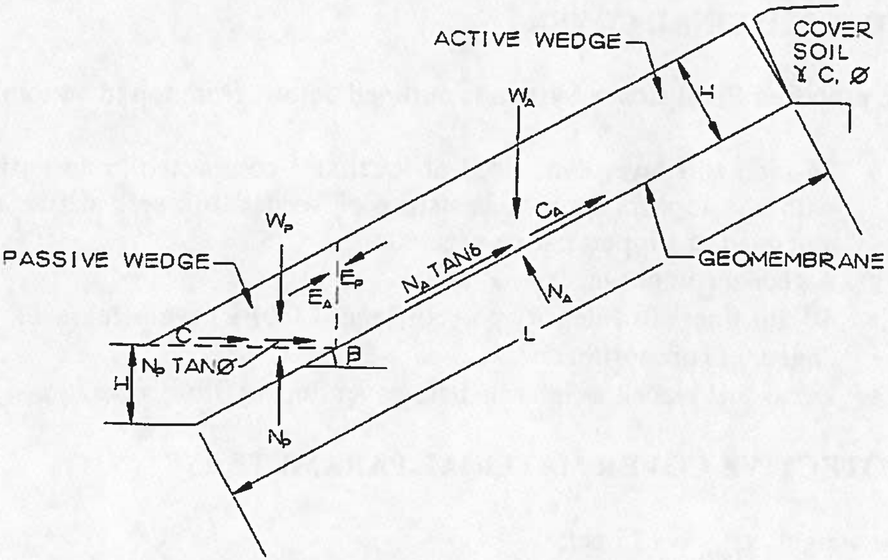

Figure 1, Slope Geometry & Free Body Diagram

Slope Dimensions	
Maximum Length of Cover Sideslope (along the length of the geomembrane)	500 feet
Cover Sideslope Orientation	3H:1V or 18.43 degrees

This veneer slope stability FS calculation is prepared proposing the following assumptions:

- The presence of moving equipment (dynamic loading) along the 3H:1V protective cover sideslope is analyzed within GRI Report #18.
- The shear strength component of adhesion developed between geosynthetic material layers is ignored.
- Tensile strength of the geosynthetic materials contributing to the veneer slope stability FS is ignored.
- The protective cover material provides a buttress at the toe of the slope, i.e. the passive soil wedge.
- For conservatism, the cohesive strength of the proposed protective cover material was ignored.
- Weights of the geosynthetic components are negligible compared to the weight of protective cover material and therefore are not considered in the calculations.
- All calculations will utilize a 1-foot unit width of sideslope.

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PROPOSED FINAL COVER

The proposed Final Cover System is outlined below, from top to bottom:

- 24-inch soil layer comprised of local soil compacted to an unspecified permeability with the top six inches consisting of seeded top soil, native soil, or soil suitably amended to support native vegetation;
- A geonet composite;
- 40-mil linear low density polyethylene (LLDPE) geomembrane;
- A geonet composite; and,
- Local soil placed as intermediate cover during filling operations.

PROTECTIVE COVER MATERIAL PARAMETERS

Unit weight: γ_{Total} = 125 pcf;

Cohesion: c = 0 psf; and
Internal angle of friction: ϕ_i = 27 degrees, a conservative value a based upon NAVFAC Design Manual 7.2, 1986, which lists the following friction angles for soil:

USCS GROUP	SOIL TYPE	FRICTION ANGLE
SM	Silty Sand	34
GM	Silty Gravel	34

REQUIRED SHEAR STRENGTH PARAMETERS

The calculation spreadsheet presented within GRI Report #18 will be used to determine the shear strength parameter (contact interface friction angle, $\delta_{\text{interface friction}}$) that corresponds to a FS ≥ 1.5 under drained conditions for all geosynthetic interfaces. The input variables of final cover sideslope length, protective cover, and LGP equipment will be held constant within the spreadsheet while the contact interface friction angle, $\delta_{\text{interface friction}}$, is varied until a FS of ≥ 1.5 is achieved. Cohesion values of 0.0 psf will be entered.

The calculated $\delta_{\text{interface friction}}$ that corresponds to the FS ≥ 1.5 represents laboratory data where a straight line is drawn from the origin through the first data point (i.e. c = 0 psf) that corresponds to the lowest normal load within the given data set. The lowest normal load models the shear strength of protective cover material under relatively light normal loads that are anticipated to be initially encountered in the field during placement of the material. With respect to the protective cover, normal loads representative of 2.0 foot of protective cover are appropriate. The proposed critical contact interface will undergo ASTM D-5321-92 Direct Shear Testing and will be required to meet the minimum calculated contact interface friction angle corresponding to the first normal load.

The resulting contact interface friction angles will be included with other minimum shear strength parameters specified within the Construction Quality Assurance (CQA) Plan and/or specifications.

VARIABLES DEFINED

W_A = Total weight of the active wedge;
W_P = Total weight of the passive wedge;
N_A = Effective force normal to the failure plane of the active wedge;
N_P = Effective force normal to the failure plane of the passive wedge;
γ = Unit weight of the leachate collection/protective cover material;
h = Thickness of the leachate collection/protective cover material;
L = Length of slope measured along the geomembrane;
β = Soil slope angle beneath the geomembrane;
ϕ = Internal angle of friction within the protective cover soil;
δ = Interface friction angle between the most critical geosynthetic to soil interface;
C_a = Adhesive force between the components lying along the most critical geosynthetic interface of the active wedge;
c_a = The adhesion developed between the components lying along the most critical geosynthetic interface of the active wedge;
C = Cohesive force along the failure plane of the passive wedge;
c = cohesion of the protective cover soil;
E_A = Interwedge force acting on the active wedge from the passive wedge;
E_P = Interwedge force acting on the passive wedge from the active wedge; and
FS = Factor of safety against protective cover soil sliding down the slope.

CALCULATIONS

It is proposed that a Low Ground Pressure (LGP) bulldozer will be used to place protective cover material across the sideslope. The pressure exerted upon the top of the geosynthetic layers by a bulldozer is modeled as illustrated in Figure 2 thus the bulldozer will not operate over the geosynthetic layers until the 24-inch thick protective cover material layer is placed.

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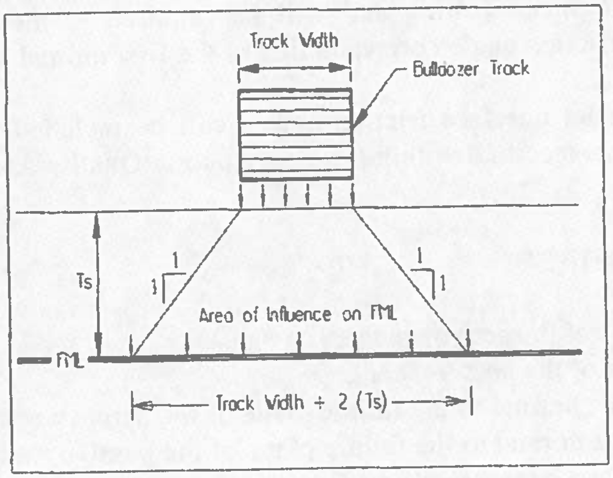

Figure 2, Stress Distribution of the LGP Bulldozer upon the Geosynthetic Layers

The following typical LGP Bulldozer equipment specifications are used within the GRI Report #18.

- 2 tracks
- Track length = 9.4 feet
- Track width = 3.0 feet
- Operating weight = 38,300 lbs
- One Track Contact area = 28.2 ft^2
- One Track Contact pressure = 19,150 lbs / 28.2 ft^2 = 679.1 psf

Subsequently, the forces illustrated in Figure 1 are resolved below to produce a veneer slope stability FS. The equations presented are taken from pages 13 and 14 of GRI Report #18.

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$$W_a = \gamma h^2 \left[\frac{L}{h} - \frac{1}{\sin \beta} - \frac{\tan \beta}{2} \right]$$

$$N_a = W_a \cos \beta$$

$$C_a = c_a \left[L - \frac{h}{\sin \beta} \right]$$

Balancing the forces in the vertical direction, the following formulation results:

$$E_A \sin \beta = W_A - N_A \cos \beta - \frac{N_A \tan \delta + C_a}{FS} \sin \beta$$

The interwedge force acting on the active wedge is:

$$E_A = \frac{FS \cdot (W_A - N_A \cos\beta) - (N_A \tan \delta + C_a) \sin\beta}{\sin \beta \, FS}$$

The passive wedge can be considered in a similar manner:

$$W_p = \frac{\gamma h^2}{\sin 2 \beta}$$

$$N_p = W_p + E_p \sin\beta$$

$$C = \frac{c\,h}{\sin \beta}$$

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Balancing the forces in the horizontal direction produces:

$$E_p \cos\beta = \frac{C + N_p \tan\phi}{FS}$$

The interwedge force acting on the passive wedge is:

$$E_p = \frac{C + W_p \tan\phi}{\cos\beta(FS) - \sin\beta\tan\phi}$$

Setting $E_A = E_p$ the equation can be arranged in the form of the quadratic equation:

$$a(FS)^2 + b(FS) + c = 0$$

Where the coefficients a, b and c are equal to the following expressions:

$$a = (W_A - N_A \cos\beta)\cos\beta$$

$$b = -[(W_A - N_A \cos\beta)\sin\beta\tan\phi + (N_A \tan\delta + C_a)\sin\beta\cos\beta + \sin\beta(C + W_p \tan\phi)]$$

$$c = (N_A \tan\delta + C_a)\sin^2\beta\tan\phi$$

The quadratic equation is then used to calculate the FS:

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

For the ease of calculations the above quadratic equation was input into a spreadsheet format to produce a FS corresponding to a given set of input parameters. A copy of the spreadsheet calculations displaying the results is included in Attachment A.

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CONCLUSIONS

Utilizing a contact interface shear strength friction angle of 26.6 degrees within GRI Report #18 resulted in a veneer slope stability FS equal to 1.51 while the equipment is static. This is the critical interface friction angle for all final cover interfaces. While the equipment is placing the protective cover, a veneer slope stability FS equal to 1.47 was calculated. Additional assumptions include:

- The presence of an equipment load along the final cover sideslope, equipment pushes material from toe towards the crest;
- The shear strength component of adhesion/cohesion between the protective cover material and nonwoven geotextile cushion does not exist;
- Geosynthetic materials are not in tension; and
- Calculations consider that the 24-inch thick soil protective cover layer is entirely in-place along the longest length of final cover sideslope approximately 500 feet.

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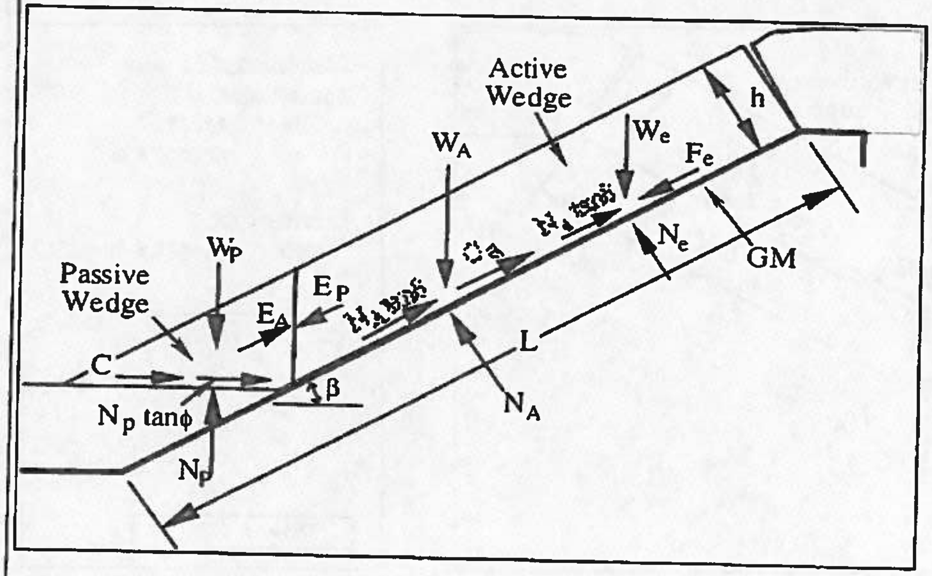
Attachment A

Spreadsheet Calculation

WESTERN ELITE LANDFILL

Placement of the 24-inch thick Soil Protection Layer across the 3:1 (H:V) Final Cover Sideslopes



Calculation of FS

Active Wedge:

Wa= 123335.1 lb
Na= 117009.4 lb

Passive Wedge:

Wp= 833.5 lb

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

a= 38830.0
b= -65368
c= 9907.5

$\boxed{FS= 1.515}$

thickness of protective cover soil = h = 2.00 ft
pro. cov. mat. slope angle beneath the geocomposite = β = 18.43 ° *= 0.32 (rad.)*
finished protective cover material slope angle = ω = 18.43 ° *= 0.32 (rad.)*
length of slope measured along the geocomposite = L = 500.0 ft
unit weight of the protective cover soil = γ = 125.0 lb/ft^3
friction angle of the protective cover soil = ϕ = 27.0 ° *= 0.47 (rad.)*
cohesion of the protective cover soil = c = 0.0 lb/ft^2 *C= 0 lb*
critical interface friction angle = δ = 26.60 ° *= 0.46 (rad.)*
adhesion = ca = 0.0 lb/ft^2 *Ca= 0 lb*

thickness of the protective cover soil = h = 2.00 ft
equipment ground pressure (= wt. of equipment/(2wb)) = q = 679.1 lb/ft^2
length of each equipment track = w = 9.4 ft
width of each equipment track = b = 3.0 ft
influence factor* at geocomposite interface = I = 0.96
acceleration/deceleration of the bulldozer = a = 0.00 g

b/h= 1.5
We=qwI= 6128.2
Ne=Wecosβ= 5813.9
Fe=We(a/g)= 0.0

*Influence Factor Default Values

Cover Soil Thickness	Equipment Track Width		
	Very Wide	Wide	Standard
^{2}300 mm	1.00	0.97	0.94
300-1000 mm	0.97	0.92	0.70
^{3}1000 mm	0.95	0.75	0.30

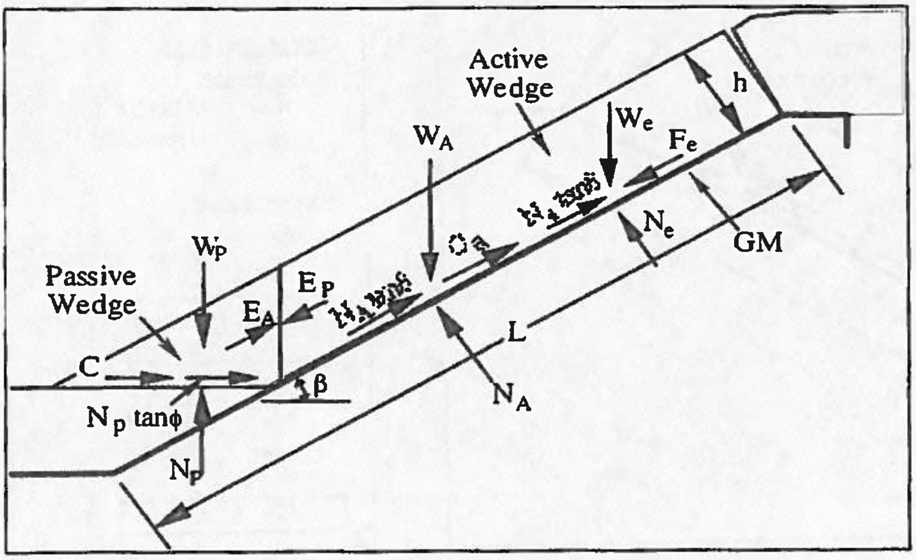
Note: numbers in boxes are input values

numbers in Italics are calculated values

WESTERN ELITE LANDFILL

Placement of the 24-inch thick Soil Protection Layer

across the 3:1 (H:V) Final Cover Sideslopes with the incorporation of Equipment Loads



Calculation of FS

Active Wedge:

Wa= 123335.1 lb
Na= 117009.4 lb

Passive Wedge:

Wp= 833.5 lb

$$\boxed{FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}}$$

a= 39934.7
b= -65556
c= 9907.5

$\boxed{FS = 1.473}$

---

thickness of protective cover soil = h = 2.00 ft
pro. cov. mat. slope angle beneath the geocomposite = β = 18.43 ° *= 0.32 (rad.)*
finished protective cover material slope angle = ω = 18.43 ° *= 0.32 (rad.)*
length of slope measured along the geocomposite = L = 500.00 ft
unit weight of the protective cover soil = γ = 125.00 lb/ft^3
friction angle of the protective cover soil = ϕ = 27.00 ° *= 0.47 (rad.)*
cohesion of the protective cover soil = c = 0.00 lb/ft^2 *C= 0 lb*
critical interface friction angle = δ = 26.60 ° *= 0.46 (rad.)*
adhesion = ca = 0.00 lb/ft^2 *Ca= 0 lb*

thickness of the protective cover soil = h = 2.00 ft *b/h= 1.5*
equipment ground pressure (= wt. of equipment/(2wb)) = q = 679.1 lb/ft^2 *We=qwI= 6128.2*
length of each equipment track = w = 9.4 ft *Ne=Wecosβ= 5813.9*
width of each equipment track = b = 3.0 ft *Fe=We(a/g)= 1164.4*
influence factor* at geocomposite interface = I = 0.96
acceleration/deceleration of the bulldozer = a = 0.19 g

*Influence Factor Default Values

Cover Soil Thickness	Equipment Track Width		
	Very Wide	Wide	Standard
²300 mm	1.00	0.97	0.94
300-1000 mm	0.97	0.92	0.70
³ 1000 mm	0.95	0.75	0.30

Note: numbers in boxes are input values

numbers in Italics are calculated values

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GEOCOMPOSITE OUTLET PIPE SIZE

OBJECTIVE

Show that the proposed 4-inch diameter piping can accommodate the anticipated flows within the proposed geocomposite drainage layer of the final cap.

METHODOLOGY

Manning's equation is used to calculate the required pipe diameter given the expected daily peak leachate flow, Q.

Manning's Equation.

$$Q = A * \frac{1.49}{n} * \left(\frac{A}{WP}\right)^{(2/3)} * \sqrt{S}$$

Solve this equation for A.

Where:

Q = Discharge (cfs); From HELP Model output data
A = Area of pipe (sq. ft); = $(\pi/4) * D^2$
D = Pipe diameter (ft)
n = Manning's roughness coefficient
WP = Wetted Perimeter (ft)
S = Minimum design slope of leachate collection pipes (ft/ft)

CALCULATIONS

Collection and Outlet Piping

The flow rate from the geocomposite drainage layer was calculated to be 1.53×10^{-7} ft/s from the HELP flow analysis peak daily flow. The collection piping will be installed at a maximum spacing of 100 feet along the slope with outlets every 1,000 linear feet and at low points. The flow rate from the geocomposite piping (collection and outlet) is expected to handle equals:

$$Q = 1.53 \times 10^{-7} \text{ ft/s} * 100 \text{ ft} * 1000 \text{ ft} = 0.015 \text{ cfs}$$

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To verify the adequacy of a 3-inch geocomposite piping to carry the total flow, Manning's Equation and the following assumptions were used.

Assumptions:

Pipe is flowing full
n (for HDPE pipe) = 0.012
S = 2% or 0.02 (minimum slope)

The table below shows the input parameters and maximum discharge for 3-inch diameter HDPE pipe.

material roughness	Slope		**Inside Diameter**	**Area**	**$R^{2/3}$**	**$AR^{2/3}$**	**Vel**	**Qd**
n	(ft/ft)	**1.49 / n**	(inches)	(sf)	(ft)		(ft/s)	(cfs)
0.012	0.02	124.17	3	0.049	0.157	0.008	2.76	0.135

At the worst case daily flowrate, the resulting velocity of flow for the pipe calculated using the flow rate as calculated with manning's equation above would be 2.76 ft/s. This velocity is suitable to aid in self cleaning.

Determine the factor of safety (F.S.) that can be achieved using a 3-in diameter pipe by:

Where $$\text{F.S.} = \frac{\text{Total Allowable Discharge of Pipe}}{\text{Potential Discharge}}$$

$$\text{F.S.} = \frac{0.135 \text{ cfs}}{0.015 \text{ cfs}} = 9$$

Conclusion

The 3-inch geocomposite piping (collection and outlet) will provide sufficient capacity for the anticipated flow rates.

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GLOBAL STATIC AND SEISMIC SLOPE STABILITY

OBJECTIVE

The objective of this calculation is to analyze the stability of the Western Elite Northern Expansion (Landfill) during the post-closure period when the waste has reached final grade. This analysis will determine an acceptable soil to geosynthetic interface / internal soil liner friction envelope that will yield deep-seated translational and rotational factors of safety exceeding 1.5 for static conditions and 1.0 for seismic conditions. These analyses provide the minimum interface shear strength values for the geosynthetic material and allows for greater flexibility for the site to choose geosynthetic materials from different manufacturers. To determine the acceptable interface strength parameters for the baseliner and sideslope liner system interfaces, the worst case cross sections were analyzed, final condition scenarios Cross Section D-D and H-H.

This analysis includes:

- Attachment A – XSTABL Slope Stability Software Static Analysis Output Data
- Attachment B – XSTABL Slope Stability Software Seismic Analysis Output Data

METHODOLOGY

Cross Section D-D – Final Grade Slopes

The final grade scenario was considered by preparing a cross-section through the proposed landfill final condition configuration that included the maximum crest height and sloping landfill basegrade.

Cross Section H-H – Final Grade Slopes

The final grade scenario was considered by preparing a cross-section through the proposed landfill final condition configuration that included the maximum crest height and sloping landfill basegrade.

CROSS-SECTION GEOMETRY

Cross Sections H-H – Post-Closure Slopes

Cross-section H-H depicts the maximum waste elevation and thickness through the landfill east to west. See the cross-sections in the Drawings for a plan view location of cross-section D-D. The maximum elevation is approximately 2634 feet with a waste thickness of 154 feet. Since global stability is being analyzed, the final cover system was modeled as one soil unit. The baseliner is generally sloping to the west at a slope greater than 2 percent.

Cross Section H--H – Post-Closure Slopes

Cross-section H-H depicts the maximum waste elevation and thickness through the landfill north to south. See the cross-sections in the Drawings for a plan view location of cross-section H-H. The maximum elevation is approximately 2634 feet with a waste thickness of 162 feet. Since global stability is being analyzed, the final cover system was modeled as one soil unit. The baseliner is generally sloping at a slope greater than 2 percent.

LANDFILL DESIGN

The liner system design on the cell bottom consists of the following (from top to bottom):

- 12-inch thick Leachate Collection Layer with permeability no less than 0.5 cm/sec;
- Protective cushion consisting of a non-woven 16-oz/sy geotextile;
- 60-mil textured HDPE Flexible Membrane Liner; and,
- Prepared subgrade, smooth and generally free of rocks larger than ¾".

The liner system design on the side slopes consists of the following (from top to bottom):

- 12-inch thick Protective Cover Layer of native soil of unspecified permeability;
- Drainage layer consisting of a 10 oz/sy geonet geocomposite;
- 60-mil textured HDPE Flexible Membrane Liner; and,
- Prepared subgrade, smooth and generally free of rocks larger than ¾".

The cap system design consists of the following (from top to bottom):

- 24-inch soil layer comprised of local soil compacted to an unspecified permeability with the top six inches consisting of seeded top soil, native soil, or soil suitably amended to support native vegetation;
- A geonet composite;
- 40-mil linear low density polyethylene (LLDPE) geomembrane;
- A geonet composite; and,
- Local soil placed as intermediate cover during filling operations.

STATIC STABILITY ANALYSIS

The software program used to calculate slope stability FS within this analysis is entitled, "XSTABL" version 5.206, compiled by Interactive Software Designs, Inc. of Moscow, Idaho. It is a version of "PC STABL 5M" written by Purdue University for the Indiana Department of Highways.

The program uses limit equilibrium techniques to determine a FS for each given input cross-section and corresponding data file. XSTABL will calculate FS for both rotational and translational failure surfaces within each cross-section in terms of both static and seismic conditions based upon slope geometry, a phreatic surface and the shear strength parameters of MSW waste, soils and the most critical contact interface within the proposed baseliner system. The software is used to analyze both static and seismic conditions.

Bishop's Simplified Method

Bishop's simplified method is a limit equilibrium technique initially used within this analysis by XSTABL to locate the most critical rotational failure surface within the cross-section.

Characteristics of Bishop's Method include:

- Dividing failure mass into a number of slices;
- Satisfies vertical force equilibrium for each slice and overall moment equilibrium about the center of the rotational failure surface;
- Specifically applicable to rotational failure surfaces;
- Considers all interslice shear forces to be horizontal (no interslice shear forces); and
- Produces a conservative FS.

Rankine Method

The Rankine method is a technique used within XSTABL to locate the most critical translational failure surface within the cross-section.

Characteristics of the Rankine Method include:

- The ability to single out a confined zone that may represent a potentially weak layer.
- Generating passive and active portions of the failure surface at angles dependent on the shear strength of the surrounding soil unit;
- Satisfies both vertical force and moment equilibrium for each slice and overall horizontal force equilibrium for the entire wedge;
- Applicable to any shape of failure surface;
- Considers all interslice shear forces to be horizontal (no interslice shear force); and
- Produces a FS that is considerably lower than methods that satisfies all conditions of equilibrium for each slice.

Spencer's Method

The Spencer's Method was utilized for analyzing the single most critical static failure surface for each of the cross sections considering seismic conditions. This method is typically more conservative than Bishop's method when evaluating single surfaces under seismic conditions. Additionally, using Spencer's method for the cross sections evaluated resulted in a thrust line location plot that fit better within the waste mass.

Half-Sine General Limit Equilibrium Method

The Half-Sine General Limit Equilibrium (GLE) Method is an extension of Spencer's procedure and was utilized to minimize negative and unreasonable forces. GLE method satisfies complete force and moment equilibrium using an assumed interslice force angle distribution. These distributions are specified as a function of the normalized x-coordinate along the failure surface. These normalized coordinates range between 0.0 at the toe and 1.0 at the crest of the failure surface. The half sine method chosen is a smooth function that increases from 0.0 at the toe to 1.0 at the mid point, before decreasing to 0.0 at the crest of the failure surface.

Geosynthetic Shear Strength Parameters

The shear strength of the baseliner within this stability analysis is represented by the most critical contact interface along the landfill floor and sideslopes defining the weakest material and plane within the landfill baseliner. The most critical peak strength interface contact of the proposed baseliner was represented in the analysis as a layer with a thickness 0.5 foot along the liner layer.

The shear strength parameters utilized in both analyses were varied for the 1.0 foot and 0.5 foot thick layers respectively to determine the minimum shear strength of the interfaces that will result in a factor of safety of at least 1.5 for static conditions and 1.0 for seismic conditions.

Existing Ground and Structural Fill Materials

The soils can generally be characterized as poorly graded silty sand and gravel with USCS symbols of GM and SM.

The friction angle used is a value a based upon NAVFAC Design Manual 7.2, 1986, which lists the following friction angles for clay:

USCS GROUP	SOIL TYPE	FRICTION ANGLE
SM	Silty Sand	34
GM	Silty Gravel	34

γ': Moist Unit weight of existing ground/structural fill layers = 120 pcf
$\gamma s'$: Saturated Unit weight of residual soils and structural fill layers = 126 pcf
c': Cohesion = 270 psf
Φ': Friction angle = 30 degrees (for conservatism)

Geosynthetic Materials

γ': Moist Unit weight of compacted clay liner layers = 90 pcf
γ_s': Saturated Unit weight of compacted clay liner layers = 95 pcf
c': Cohesion =0 psf
Φ': Friction angle = 17 degrees

Drainage Layer Shear Strength Parameters

γ': Moist Unit weight of drainage layer = 125 pcf
γ_s': Saturated Unit weight of drainage layer = 135 pcf
c': Cohesion = 0 psf
Φ': Friction angle = 30 degrees

The friction angle used is a value a based upon NAVFAC Design Manual 7.2, 1986, which lists the following friction angles for gravel:

USCS GROUP	SOIL TYPE	FRICTION ANGLE
GM	Silty Gravel	34
GP	Poorly Graded Gravel	37
GW	Well Graded Gravel	38

Waste Materials

γ': Moist Unit weight of drainage layer = 70 pcf
γ_s': Saturated Unit weight of drainage layer = 75 pcf
c': Cohesion = 0 psf
Φ': Friction angle = 35 degrees

Final Cover System Parameters

The Final Cover System parameters were calculated in the Final Cover Veneer Slope Stability analysis provided in the submittal.

Final Cover System Shear Strength Parameters

γ': Moist Unit weight of drainage layer = 120 pcf
γ_s': Saturated Unit weight of drainage layer = 125 pcf
c': Cohesion = 0 psf
Φ': Friction angle = 27 degrees

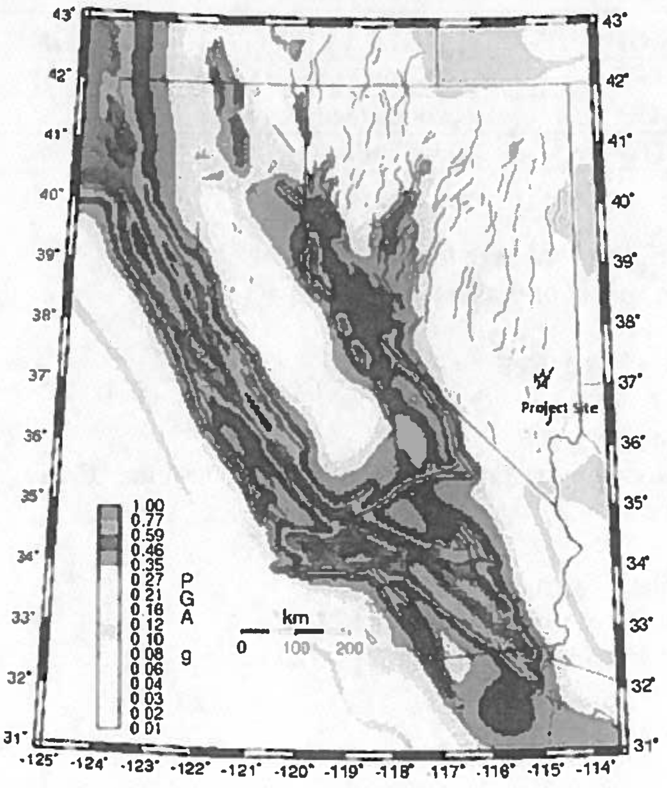
Phreatic Surfaces

One phreatic surface input within the stability analysis represents a leachate head of 1-ft along the floor of baseliner system. This reflects the maximum head upon the baseliner. A phreatic surface was input to represent the surface of the uppermost groundwater level as depicted in the base grading plan.

SEISMIC STABILITY ANALYSIS

A shear wave accelerating through the landfill will produce horizontal and vertical accelerations and stresses within the waste, baseliner system, in-situ soils and bedrock producing a slope stability FS that is less than a corresponding slope stability FS governed by static conditions. The shear wave acceleration is modeled within the stability analysis by inputting a coefficient, k_y, that is some fraction of gravity. The peak acceleration for the site is estimated to be 0.27 g which is taken from the "Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years (site: NEHRP B-C boundary)" published by the U.S.G.S 2008 shown below.

Calif NV, PGA w/2%PE50yr. 760 m/s Rock



XSTABL software was used to perform the seismic slope stability analysis on the most critical failure surface within each cross section.

XSTABL seismic slope stability output files are presented in Attachment B.

SLOPE STABILITY RESULTS

Factors of safety (FS) were calculated for the critical interim and final slope conditions. The XSTABL software package calculated FS, expressing the ratio of resisting to driving forces, for each failure surface considering static conditions. Attachment A contains the XSTABL slope stability software output data for static conditions.

The most critical static failure surface for the cross section was then evaluated under seismic conditions. Attachment B contains the XSTABL slope stability software output data for seismic conditions.

Post-Closure Slopes

Cross-sections D-D and H-H were selected for the global stability analysis to demonstrate the stability of the landfill in the final condition. The configuration selected is shown on the Drawings. Rotational analysis resulted in acceptable factors of safety.

The worst-case scenario Post-Closure condition was the rotational analysis. To demonstrate this, also included with this analysis are the translational runs through the waste mass.

CONCLUSIONS

Considering rotational and translational failure surfaces, it was the rotational surfaces that produced the lowest FS for the each case. The software assumes that the weight of the waste will become the driving force and a rotational failure surface will develop within the waste progressing until exiting the outer slope.

Calculated Factors of Safety

The Factors of Safety calculated within this stability analysis comply with industry accepted standards. All deep-seated translational and rotational analysis provided a static and seismic factor of safety greater than 1.5 and 1.0, respectfully. The results of the analyses are shown in the table below.

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Slope Stability Factor of Safety Summary

FINAL CONDITION SCENARIO

File	Failure Type	Static/Seismic	FS
WEDDBL	Translational	Static	3.987
WEDDBLZ	Translational	Seismic	1.040
WEDDCIR	Rotational	Static	2.676
WEDDCIZ	Rotational	Seismic	1.242

Figures showing each cross section are included in the Drawings.

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ATTACHMENT A
XSTABL SLOPE STABILITY SOFTWARE
STATIC ANALYSIS OUTPUT DATA

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Slope Stability Cross-Section D-D

Static Analysis

```
XSTABL File: WEDDBL    10-07-13  16:23

            ******************************************
            *                X S T A B L             *
            *                                        *
            *        Slope Stability Analysis        *
            *               using the                *
            *           Method of Slices             *
            *                                        *
            *        Copyright (C) 1992 - 2002       *
            *     Interactive Software Designs, Inc. *
            *        Moscow, ID 83843, U.S.A.        *
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            *                                        *
            *  Ver. 5.206                96 - 1932   *
            ******************************************

   Problem Description : WESTERN ELITE D-D BLOCK


   -----------------------------
   SEGMENT BOUNDARY COORDINATES
   -----------------------------

      10 SURFACE boundary segments

   Segment    x-left     y-left    x-right    y-right      Soil Unit
     No.       (ft)       (ft)       (ft)       (ft)     Below Segment

      1          .0     2496.5       72.0     2497.0           1
      2        72.0     2497.0      173.0     2530.0           2
      3       173.0     2530.0      190.0     2530.0           2
      4       190.0     2530.0      290.0     2563.5           2
      5       290.0     2563.5      308.0     2563.5           2
      6       308.0     2563.5      405.0     2597.0           2
      7       405.0     2597.0      423.0     2597.0           2
      8       423.0     2597.0      461.0     2610.7           2
      9       461.0     2610.7      935.0     2634.0           2
     10       935.0     2634.0     1100.0     2626.0           2

      25 SUBSURFACE boundary segments

   Segment    x-left     y-left    x-right    y-right      Soil Unit
     No.       (ft)       (ft)       (ft)       (ft)     Below Segment

      1        72.0     2496.5      173.0     2528.0           3
      2       173.0     2528.0      190.0     2528.0           3
      3       190.0     2528.0      290.0     2561.5           3
      4       290.0     2561.5      308.0     2561.5           3
      5       308.0     2561.5      405.0     2595.0           3
      6       405.0     2595.0      423.0     2595.0           3
      7       423.0     2595.0      461.0     2608.7           3
      8       461.0     2608.7      935.0     2632.0           3
      9       935.0     2632.0     1100.0     2624.0           3
     10       100.0     2504.5      115.0     2499.5           4
     11       115.0     2499.5      430.0     2493.5           4
     12       430.0     2493.5      625.0     2485.5           4
     13       625.0     2485.5     1100.0     2479.0           4
```

```
    14        100.0     2503.5      115.0     2498.5          5
    15        115.0     2498.5      430.0     2492.5          5
    16        430.0     2492.5      625.0     2484.5          5
    17        625.0     2484.5     1100.0     2478.0          5
    18        100.0     2503.0      115.0     2498.0          6
    19        115.0     2498.0      430.0     2492.0          6
    20        430.0     2492.0      625.0     2484.0          6
    21        625.0     2484.0     1100.0     2477.5          6
    22        100.0     2500.0      115.0     2495.0          1
    23        115.0     2495.0      430.0     2489.0          1
    24        430.0     2489.0      625.0     2481.0          1
    25        625.0     2481.0     1100.0     2474.5          1


--------------------------
ISOTROPIC Soil Parameters
--------------------------

 6 Soil unit(s) specified

Soil    Unit Weight    Cohesion  Friction    Pore Pressure       Water
Unit   Moist    Sat.  Intercept    Angle   Parameter  Constant  Surface
 No.   (pcf)   (pcf)    (psf)      (deg)       Ru       (psf)     No.

  1    120.0   126.0    270.0      30.00      .000          .0       1
  2    120.0   125.0       .0      27.00      .000          .0       0
  3     70.0    75.0       .0      35.00      .000          .0       0
  4    125.0   135.0       .0      30.00      .000          .0       2
  5     90.0    95.0       .0      17.00      .000          .0       0
  6    117.0   120.0       .0      27.00      .000          .0       0


 2 Water surface(s) have been specified

Unit weight of water =    62.40  (pcf)

Water Surface No.  1 specified by  7 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point      x-water     y-water
   No.         (ft)        (ft)

    1            .00     2445.00
    2          88.00     2440.00
    3         200.00     2435.00
    4         343.00     2430.00
    5         650.00     2425.00
    6         925.00     2420.00
    7        1160.00     2415.00


Water Surface No.  2 specified by  4 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point      x-water     y-water
```

```
                                WEDDBL
      No.          (ft)        (ft)

       1          115.00      2499.00
       2          430.00      2493.00
       3          625.00      2485.00
       4         1100.00      2478.50


  A critical failure surface searching method, using a random
  technique for generating sliding BLOCK surfaces, has been
  specified.


   1600 trial surfaces will be generated and analyzed.


    4 boxes specified for generation of central block base


  * * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

  Length of line segments for active and passive portions of
  sliding block is      26.0 ft

  Box         x-left     y-left     x-right    y-right      Width
  no.          (ft)       (ft)        (ft)       (ft)        (ft)

   1          115.0     2498.0      300.0     2494.5          .5
   2          350.0     2493.8      430.0     2492.0          .5
   3          500.0     2489.0      625.0     2484.0          .5
   4          700.0     2483.0      925.0     2480.0          .5


  Factors of safety have been calculated by the :

  * * * * *   SIMPLIFIED JANBU METHOD   * * * * *


  The 10 most critical of all the failure surfaces examined
  are displayed below - the most critical first

  Failure surface No. 1 specified by 14 coordinate points
          Point        x-surf       y-surf
           No.          (ft)         (ft)

            1          171.44      2529.49
            2          180.46      2528.31
            3          200.94      2512.30
            4          221.37      2496.22
            5          427.05      2492.15
            6          621.10      2484.21
            7          733.23      2482.81
            8          743.74      2506.59
            9          760.97      2526.06
           10          779.22      2544.58
           11          795.50      2564.85
           12          813.42      2583.69
```

```
         13          829.13     2604.41
         14          835.50     2629.11

  **   Corrected JANBU FOS =    3.987  **     (Fo factor = 1.044)

 Failure surface No. 2 specified by 13 coordinate points

        Point        x-surf      y-surf
         No.          (ft)        (ft)

          1          136.49     2518.07
          2          155.79     2504.04
          3          180.76     2496.81
          4          428.78     2492.15
          5          619.25     2484.24
          6          734.16     2482.52
          7          749.32     2503.65
          8          758.63     2527.92
          9          777.01     2546.31
         10          782.51     2571.72
         11          793.30     2595.38
         12          803.28     2619.38
         13          811.84     2627.95

  **   Corrected JANBU FOS =    4.051  **     (Fo factor = 1.043)

 Failure surface No. 3 specified by 13 coordinate points

        Point        x-surf      y-surf
         No.          (ft)        (ft)

          1          110.58     2509.61
          2          130.77     2497.89
          3          428.06     2492.10
          4          609.08     2484.71
          5          849.61     2481.01
          6          867.85     2499.54
          7          885.87     2518.28
          8          897.35     2541.61
          9          914.36     2561.27
         10          924.57     2585.19
         11          942.16     2604.33
         12          960.24     2623.01
         13          966.54     2632.47

  **   Corrected JANBU FOS =    4.068  **     (Fo factor = 1.037)

 Failure surface No. 4 specified by 14 coordinate points

        Point        x-surf      y-surf
         No.          (ft)        (ft)

          1          109.25     2509.17
          2          118.92     2506.24
          3          143.40     2497.50
          4          389.00     2492.91
          5          617.38     2484.11
          6          714.35     2482.91
          7          732.01     2501.99
          8          749.24     2521.46
```

```
             9          767.61      2539.86
            10          783.74      2560.25
            11          802.05      2578.71
            12          813.12      2602.24
            13          826.42      2624.58
            14          830.71      2628.87

  **  Corrected JANBU FOS =    4.289   **     (Fo factor = 1.040)

 Failure surface No. 5 specified by 12 coordinate points

          Point        x-surf       y-surf
           No.          (ft)         (ft)

             1          111.92      2510.04
             2          124.26      2497.88
             3          416.35      2492.52
             4          618.57      2484.42
             5          766.69      2482.32
             6          785.01      2500.77
             7          788.86      2526.48
             8          803.31      2548.10
             9          815.81      2570.90
            10          823.88      2595.61
            11          839.56      2616.35
            12          843.83      2629.52

  **  Corrected JANBU FOS =    4.312   **     (Fo factor = 1.042)

 Failure surface No. 6 specified by 12 coordinate points

          Point        x-surf       y-surf
           No.          (ft)         (ft)

             1          119.09      2512.39
             2          134.04      2497.49
             3          425.21      2492.23
             4          604.92      2484.70
             5          705.15      2483.06
             6          722.03      2502.84
             7          729.34      2527.79
             8          742.71      2550.08
             9          757.13      2571.72
            10          773.53      2591.89
            11          783.39      2615.95
            12          784.21      2626.59

  **  Corrected JANBU FOS =    4.445   **     (Fo factor = 1.043)

 Failure surface No. 7 specified by 13 coordinate points

          Point        x-surf       y-surf
           No.          (ft)         (ft)

             1          104.30      2507.55
             2          116.86      2498.16
             3          380.60      2492.96
             4          616.00      2484.59
             5          820.50      2481.51
             6          836.66      2501.88
```

```
      7        854.67     2520.63
      8        872.69     2539.37
      9        884.79     2562.39
     10        897.12     2585.28
     11        915.49     2603.67
     12        927.56     2626.70
     13        928.11     2633.66

 **  Corrected JANBU FOS =    4.470  **    (Fo factor = 1.039)

Failure surface No. 8 specified by 13 coordinate points

    Point       x-surf       y-surf
     No.         (ft)         (ft)

      1        117.39     2511.83
      2        131.47     2497.93
      3        418.58     2492.48
      4        537.33     2487.68
      5        767.96     2481.97
      6        786.30     2500.40
      7        804.00     2519.45
      8        818.81     2540.82
      9        831.89     2563.29
     10        850.19     2581.75
     11        866.37     2602.11
     12        875.67     2626.39
     13        880.31     2631.31

 **  Corrected JANBU FOS =    4.472  **    (Fo factor = 1.040)

Failure surface No. 9 specified by 13 coordinate points

    Point       x-surf       y-surf
     No.         (ft)         (ft)

      1        113.39     2510.52
      2        131.28     2497.83
      3        359.32     2493.69
      4        616.14     2484.12
      5        718.36     2483.00
      6        736.60     2501.52
      7        753.69     2521.12
      8        770.88     2540.62
      9        789.01     2559.26
     10        797.77     2583.74
     11        802.80     2609.25
     12        821.13     2627.68
     13        821.43     2628.42

 **  Corrected JANBU FOS =    4.478  **    (Fo factor = 1.041)

Failure surface No.10 specified by 13 coordinate points

    Point       x-surf       y-surf
     No.         (ft)         (ft)

      1        112.63     2510.27
      2        125.33     2497.60
      3        428.85     2492.19
```

```
                          WEDDBL
        4       566.63    2486.49
        5       757.06    2482.11
        6       767.54    2505.91
        7       785.77    2524.45
        8       804.15    2542.84
        9       822.53    2561.22
       10       837.43    2582.53
       11       848.94    2605.85
       12       861.53    2628.60
       13       863.26    2630.47
  **  Corrected JANBU FOS =   4.480  **    (Fo factor = 1.040)



 The following is a summary of the TEN most critical surfaces

 Problem Description : WESTERN ELITE D-D BLOCK

        Modified      Correction   Initial    Terminal    Available
       JANBU FOS       Factor      x-coord     x-coord     Strength
                                    (ft)        (ft)        (lb)

  1.      3.987         1.044      171.44      835.50    1.798E+06
  2.      4.051         1.043      136.49      811.84    1.745E+06
  3.      4.068         1.037      110.58      966.54    2.252E+06
  4.      4.289         1.040      109.25      830.71    2.222E+06
  5.      4.312         1.042      111.92      843.83    1.894E+06
  6.      4.445         1.043      119.09      784.21    2.031E+06
  7.      4.470         1.039      104.30      928.11    2.493E+06
  8.      4.472         1.040      117.39      880.31    2.386E+06
  9.      4.478         1.041      113.39      821.43    2.229E+06
 10.      4.480         1.040      112.63      863.26    2.309E+06

                  * * *  END OF FILE  * * *
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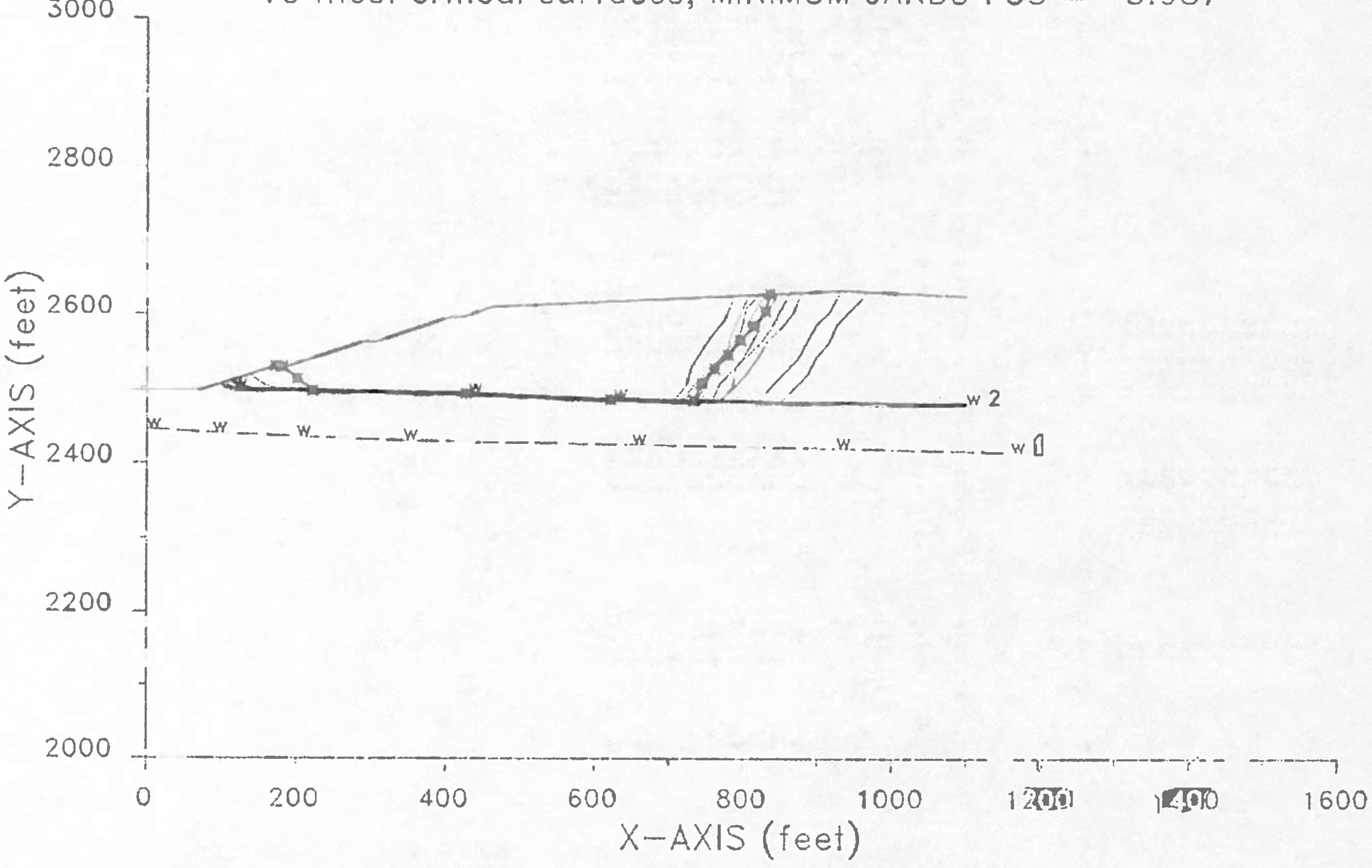
WESTERN ELITE D–D BLOCK
10 most critical surfaces, MINIMUM JANBU FOS = 3.987



```
XSTABL File: WEDDCIR   10-08-13   9:40

                   ******************************************
                   *              X S T A B L               *
                   *                                        *
                   *        Slope Stability Analysis        *
                   *              using the                 *
                   *          Method of Slices              *
                   *                                        *
                   *        Copyright (C) 1992 - 2002       *
                   *    Interactive Software Designs, Inc.  *
                   *        Moscow, ID 83843, U.S.A.        *
                   *                                        *
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                   *                                        *
                   *   Ver. 5.206              96 - 1932    *
                   ******************************************


   Problem Description : WESTERN ELITE D-D CIRCULAR


   -----------------------------
   SEGMENT BOUNDARY COORDINATES
   -----------------------------

      10 SURFACE boundary segments

   Segment    x-left     y-left    x-right    y-right      Soil Unit
     No.       (ft)       (ft)       (ft)       (ft)     Below Segment

      1          .0      2496.5       72.0     2497.0          1
      2        72.0      2497.0      173.0     2530.0          2
      3       173.0      2530.0      190.0     2530.0          2
      4       190.0      2530.0      290.0     2563.5          2
      5       290.0      2563.5      308.0     2563.5          2
      6       308.0      2563.5      405.0     2597.0          2
      7       405.0      2597.0      423.0     2597.0          2
      8       423.0      2597.0      461.0     2610.7          2
      9       461.0      2610.7      935.0     2634.0          2
     10       935.0      2634.0     1100.0     2626.0          2

      25 SUBSURFACE boundary segments

   Segment    x-left     y-left    x-right    y-right      Soil Unit
     No.       (ft)       (ft)       (ft)       (ft)     Below Segment

      1        72.0      2496.5      173.0     2528.0          3
      2       173.0      2528.0      190.0     2528.0          3
      3       190.0      2528.0      290.0     2561.5          3
      4       290.0      2561.5      308.0     2561.5          3
      5       308.0      2561.5      405.0     2595.0          3
      6       405.0      2595.0      423.0     2595.0          3
      7       423.0      2595.0      461.0     2608.7          3
      8       461.0      2608.7      935.0     2632.0          3
      9       935.0      2632.0     1100.0     2624.0          3
     10       100.0      2504.5      115.0     2499.5          4
     11       115.0      2499.5      430.0     2493.5          4
     12       430.0      2493.5      625.0     2485.5          4
     13       625.0      2485.5     1100.0     2479.0          4
```

```
                              WEDDCIR
  14      100.0    2503.5     115.0    2498.5        5
  15      115.0    2498.5     430.0    2492.5        5
  16      430.0    2492.5     625.0    2484.5        5
  17      625.0    2484.5    1100.0    2478.0        5
  18      100.0    2503.0     115.0    2498.0        6
  19      115.0    2498.0     430.0    2492.0        6
  20      430.0    2492.0     625.0    2484.0        6
  21      625.0    2484.0    1100.0    2477.5        6
  22      100.0    2500.0     115.0    2495.0        1
  23      115.0    2495.0     430.0    2489.0        1
  24      430.0    2489.0     625.0    2481.0        1
  25      625.0    2481.0    1100.0    2474.5        1

--------------------------
ISOTROPIC Soil Parameters
--------------------------

 6 Soil unit(s) specified

Soil   Unit Weight   Cohesion  Friction    Pore Pressure      Water
Unit  Moist   Sat.   Intercept   Angle  Parameter  Constant  Surface
 No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)      No.

  1   120.0   126.0    270.0     30.00     .000        .0        1
  2   120.0   125.0       .0     27.00     .000        .0        0
  3    70.0    75.0       .0     35.00     .000        .0        0
  4   125.0   135.0       .0     30.00     .000        .0        2
  5    90.0    95.0       .0     17.00     .000        .0        0
  6   117.0   120.0       .0     27.00     .000        .0        0


 2 Water surface(s) have been specified

Unit weight of water =    62.40  (pcf)

Water Surface No.  1 specified by  7 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point      x-water     y-water
   No.        (ft)        (ft)

    1           .00     2445.00
    2         88.00     2440.00
    3        200.00     2435.00
    4        343.00     2430.00
    5        650.00     2425.00
    6        925.00     2420.00
    7       1160.00     2415.00

Water Surface No.  2 specified by  4 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point      x-water     y-water
```

```
                              WEDDCIR
  No.           (ft)           (ft)

   1           115.00       2499.00
   2           430.00       2493.00
   3           625.00       2485.00
   4          1100.00       2478.50


A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.


 1600 trial surfaces will be generated and analyzed.

  40 Surfaces initiate from each of  40 points equally spaced
along the ground surface between   x =     72.0 ft
                             and   x =    173.0 ft


Each surface terminates between   x =    461.0 ft
                            and   x =    935.0 ft


Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =       .0 ft


* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

   14.0 ft line segments define each trial failure surface.


---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=   -10.0 degrees


Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED BISHOP METHOD   * * * * *


  The most critical circular failure surface
  is specified by 34 coordinate points

       Point        x-surf       y-surf
        No.          (ft)         (ft)

         1          90.13       2502.92
```

```
                                WEDDCIR
              2        103.90    2500.41
              3        117.74    2498.28
              4        131.63    2496.53
              5        145.56    2495.16
              6        159.53    2494.17
              7        173.51    2493.56
              8        187.51    2493.35
              9        201.51    2493.51
             10        215.50    2494.06
             11        229.47    2494.99
             12        243.41    2496.31
             13        257.30    2498.01
             14        271.15    2500.09
             15        284.93    2502.54
             16        298.64    2505.38
             17        312.27    2508.59
             18        325.80    2512.17
             19        339.23    2516.13
             20        352.55    2520.45
             21        365.74    2525.13
             22        378.80    2530.18
             23        391.71    2535.58
             24        404.48    2541.34
             25        417.08    2547.44
             26        429.50    2553.89
             27        441.75    2560.67
             28        453.81    2567.79
             29        465.66    2575.24
             30        477.31    2583.01
             31        488.74    2591.09
             32        499.94    2599.49
             33        510.91    2608.19
             34        517.19    2613.46

 ****  Simplified BISHOP FOS =   2.676  ****


 The following is a summary of the TEN most critical surfaces

 Problem Description : WESTERN ELITE D-D CIRCULAR

         FOS       Circle Center      Radius   Initial  Terminal  Resisting
       (BISHOP)  x-coord   y-coord             x-coord   x-coord    Moment
                   (ft)      (ft)       (ft)     (ft)      (ft)     (ft-lb)

  1.    2.676    188.47   3003.13    509.79     90.13    517.19   4.252E+08
  2.    2.715    165.59   2930.31    439.24     79.77    467.27   3.061E+08
  3.    2.728    243.45   2886.03    365.63    167.82    485.27   1.678E+08
  4.    2.738    212.29   2915.08    406.71    131.56    483.27   2.321E+08
  5.    2.753    173.11   2905.55    415.20     82.36    465.69   2.977E+08
  6.    2.758    216.39   2876.48    369.87    131.56    474.16   2.117E+08
  7.    2.762    219.72   2976.34    482.02    105.67    538.19   4.442E+08
  8.    2.771    222.94   2919.14    408.79    139.33    492.90   2.405E+08
  9.    2.788    223.47   2868.24    362.12    134.15    478.79   2.186E+08
 10.    2.800    202.37   2912.13    422.83     92.72    500.76   3.762E+08

                     * * *  END OF FILE  * * *
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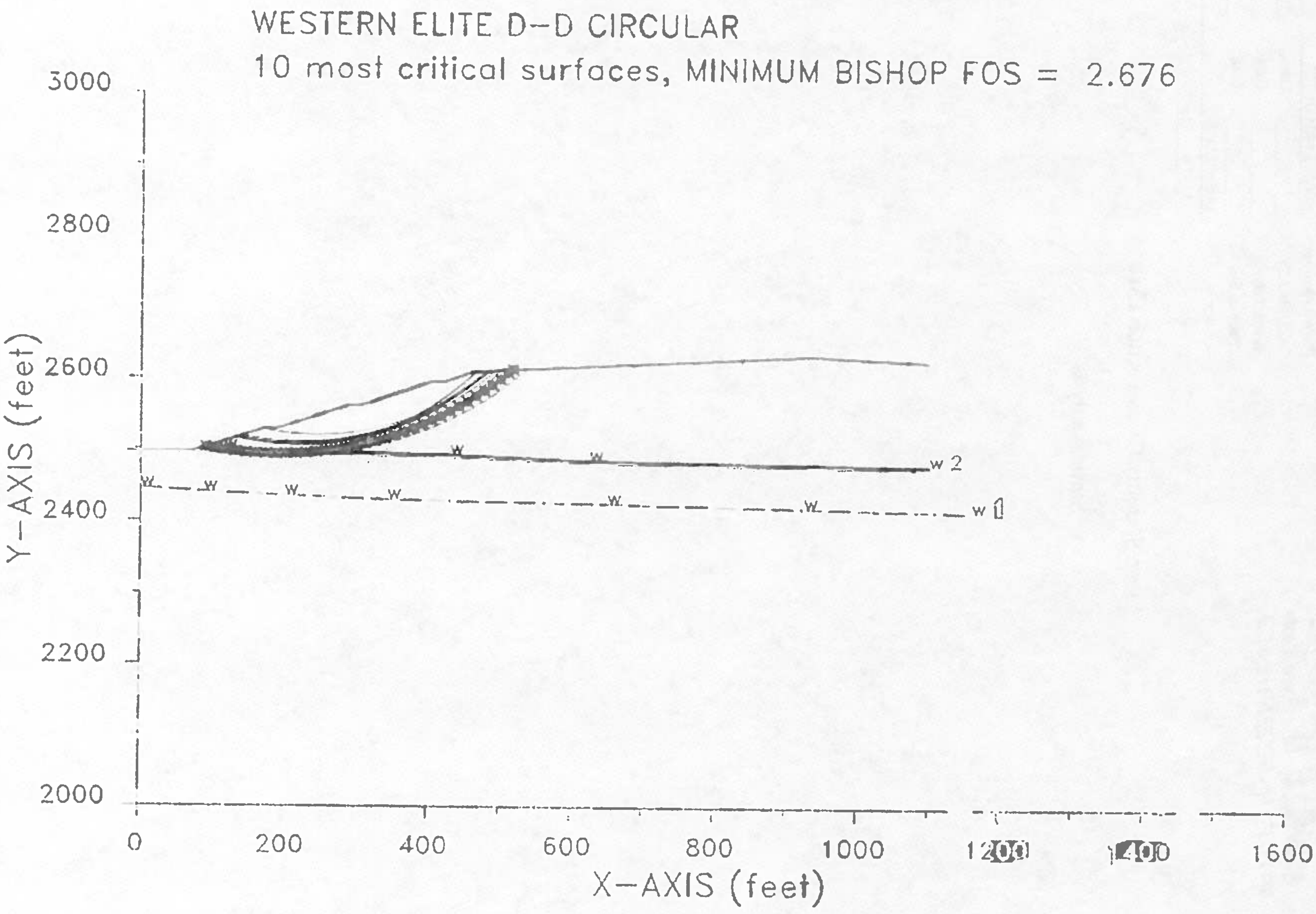
WEDDCIR 10-08-13 9:40



WESTERN ELITE D-D CIRCULAR
10 most critical surfaces, MINIMUM BISHOP FOS = 2.676

JOYCE ENGINEERING

Project: Western Elite
Project Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/8/13
Revised By: Date:
Checked By: Date:
Subject: Global Stability
Sheet: 11 of 14

Slope Stability Cross-Section H-H

Static Analysis

```
                   *******************************************
                   *              X S T A B L                *
                   *                                         *
                   *        Slope Stability Analysis         *
                   *               using the                 *
                   *            Method of Slices             *
                   *                                         *
                   *        Copyright (C) 1992 - 2002        *
                   *   Interactive Software Designs, Inc.    *
                   *        Moscow, ID 83843, U.S.A.         *
                   *                                         *
                   *          All Rights Reserved            *
                   *                                         *
                   *  Ver. 5.206               96 - 1932     *
                   *******************************************

    Problem Description : WESTERN ELITE H-H BLOCK


    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

       11 SURFACE boundary segments

    Segment    x-left    y-left    x-right    y-right     Soil Unit
      No.       (ft)      (ft)      (ft)       (ft)     Below Segment

       1          .0     2499.0      85.0     2498.0          1
       2        85.0     2498.0     142.0     2518.0          2
       3       142.0     2518.0     160.0     2518.0          2
       4       160.0     2518.0     231.0     2542.5          2
       5       231.0     2542.5     249.0     2542.5          2
       6       249.0     2542.5     333.0     2571.0          2
       7       333.0     2571.0     351.0     2571.0          2
       8       351.0     2571.0     435.0     2600.0          2
       9       435.0     2600.0     453.0     2600.0          2
      10       453.0     2600.0     555.0     2634.0          2
      11       555.0     2634.0    2100.0     2634.0          2

       46 SUBSURFACE boundary segments

    Segment    x-left    y-left    x-right    y-right     Soil Unit
      No.       (ft)      (ft)      (ft)       (ft)     Below Segment

       1        85.0     2497.5     142.0     2516.0          3
       2       142.0     2516.0     160.0     2516.0          3
       3       160.0     2516.0     231.0     2540.5          3
       4       231.0     2540.5     249.0     2540.5          3
       5       249.0     2540.5     333.0     2569.0          3
       6       333.0     2569.0     351.0     2569.0          3
       7       351.0     2569.0     435.0     2598.0          3
       8       435.0     2598.0     453.0     2598.0          3
       9       453.0     2598.0     555.0     2632.0          3
      10       555.0     2632.0    2100.0     2632.0          3
      11        95.0     2499.0     139.0     2487.5          4
      12       139.0     2487.5     200.0     2486.5          4
```

```
   13       200.0    2486.5    1120.0    2473.5         4
   14      1120.0    2473.5    1385.0    2473.5         4
   15      1385.0    2473.5    1862.0    2479.5         4
   16      1862.0    2479.5    1875.0    2483.5         4
   17      1875.0    2483.5    1885.0    2483.5         4
   18      1885.0    2483.5    1900.0    2480.0         4
   19      1900.0    2480.0    2100.0    2483.5         4
   20        95.0    2498.0     139.0    2486.5         5
   21       139.0    2486.5     200.0    2485.5         5
   22       200.0    2485.5    1120.0    2472.5         5
   23      1120.0    2472.5    1385.0    2472.5         5
   24      1385.0    2472.5    1862.0    2478.5         5
   25      1862.0    2478.5    1875.0    2482.5         5
   26      1875.0    2482.5    1885.0    2482.5         5
   27      1885.0    2482.5    1900.0    2479.0         5
   28      1900.0    2479.0    2100.0    2482.5         5
   29        95.0    2497.5     139.0    2486.0         6
   30       139.0    2486.0     200.0    2485.0         6
   31       200.0    2485.0    1120.0    2472.0         6
   32      1120.0    2472.0    1385.0    2472.0         6
   33      1385.0    2472.0    1862.0    2478.0         6
   34      1862.0    2478.0    1875.0    2482.0         6
   35      1875.0    2482.0    1885.0    2482.0         6
   36      1885.0    2482.0    1900.0    2478.5         6
   37      1900.0    2478.5    2100.0    2482.0         6
   38        95.0    2494.0     139.0    2483.0         1
   39       139.0    2483.0     200.0    2482.0         1
   40       200.0    2482.0    1120.0    2469.0         1
   41      1120.0    2469.0    1385.0    2469.0         1
   42      1385.0    2469.0    1862.0    2475.0         1
   43      1862.0    2475.0    1875.0    2479.0         1
   44      1875.0    2479.0    1885.0    2479.0         1
   45      1885.0    2479.0    1900.0    2475.5         1
   46      1900.0    2475.5    2100.0    2479.0         1


--------------------------
ISOTROPIC Soil Parameters
--------------------------

 6 Soil unit(s) specified

Soil   Unit Weight   Cohesion  Friction    Pore Pressure      Water
Unit  Moist    Sat.  Intercept   Angle  Parameter  Constant  Surface
 No.  (pcf)   (pcf)    (psf)     (deg)      Ru       (psf)     No.

  1   120.0   126.0     270.0    30.00     .000         .0      1
  2   120.0   125.0        .0    27.00     .000         .0      0
  3    70.0    75.0        .0    35.00     .000         .0      0
  4   125.0   135.0        .0    30.00     .000         .0      2
  5    90.0    95.0        .0    17.00     .000         .0      0
  6   117.0   120.0        .0    27.00     .000         .0      0


 2 Water surface(s) have been specified

Unit weight of water =     62.40  (pcf)


Water Surface No.  1 specified by  7 coordinate points

**********************************
```

```
        PHREATIC SURFACE,
**************************************

   Point         x-water       y-water
    No.           (ft)          (ft)

     1               .00       2445.00
     2             88.00       2440.00
     3            200.00       2435.00
     4            343.00       2430.00
     5            650.00       2425.00
     6            925.00       2420.00
     7           1160.00       2415.00

Water Surface No.  2 specified by  4 coordinate points

**************************************
        PHREATIC SURFACE,
**************************************

   Point         x-water       y-water
    No.           (ft)          (ft)

     1            115.00       2499.00
     2            430.00       2493.00
     3            625.00       2485.00
     4           1100.00       2478.50


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.

 1600 trial surfaces will be generated and analyzed.

  5 boxes specified for generation of central block base


* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

Length of line segments for active and passive portions of
sliding block is      28.0 ft

Box        x-left     y-left    x-right    y-right      Width
no.         (ft)       (ft)       (ft)       (ft)        (ft)

 1          95.0     2500.0      200.0     2485.0          .5
 2         300.0     2483.5      500.0     2480.5          .5
 3         600.0     2479.5      800.0     2476.0          .5
 4         900.0     2475.0     1120.0     2472.0          .5
 5        1385.0     2472.0     1600.0     2475.0          .5

*******************************************************************
**     Factor of safety calculation for surface #  1121       **
**     failed to converge within FIFTY iterations             **
**                                                            **
```

```
**    The last calculated value of the FOS was  19.9831    **
**    This will be ignored for final summary of results    **
*************************************************************

The trial failure surface in question is
defined by the following 14 coordinate points

       Point       x-surf      y-surf
        No.         (ft)        (ft)

         1        115.48     2508.69
         2        119.38     2506.29
         3        144.00     2492.95
         4        365.21     2482.59
         5        716.17     2477.33
         6        999.72     2473.40
         7       1492.25     2473.39
         8       1492.32     2501.39
         9       1503.14     2527.21
        10       1522.10     2547.82
        11       1522.97     2575.80
        12       1542.19     2596.16
        13       1545.17     2624.00
        14       1555.01     2634.00

*************************************************************
**     Factor of safety calculation for surface #  1393    **
**     failed to converge within FIFTY iterations          **
**                                                         **
**    The last calculated value of the FOS was  24.4327    **
**    This will be ignored for final summary of results    **
*************************************************************

The trial failure surface in question is
defined by the following 13 coordinate points

       Point       x-surf      y-surf
        No.         (ft)        (ft)

         1         97.73     2502.46
         2        107.82     2498.40
         3        443.34     2481.17
         4        763.56     2476.45
         5        969.14     2474.03
         6       1477.09     2473.53
         7       1477.38     2501.53
         8       1497.11     2521.40
         9       1497.16     2549.40
        10       1508.13     2575.16
        11       1512.31     2602.84
        12       1531.65     2623.10
        13       1533.01     2634.00


Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED JANBU METHOD   * * * * *


The 10 most critical of all the failure surfaces examined
```

```
are displayed below - the most critical first

Failure surface No. 1 specified by 15 coordinate points

       Point      x-surf     y-surf
        No.        (ft)       (ft)

         1        142.75    2518.00
         2        162.50    2505.63
         3        183.74    2487.40
         4        347.31    2482.79
         5        638.00    2479.02
         6       1104.08    2472.28
         7       1386.11    2472.26
         8       1405.83    2492.13
         9       1425.31    2512.25
        10       1432.01    2539.44
        11       1451.79    2559.26
        12       1467.50    2582.43
        13       1476.39    2608.98
        14       1495.04    2629.86
        15       1498.86    2634.00

 **  Corrected JANBU FOS =    7.392  **    (Fo factor = 1.029)

Failure surface No. 2 specified by 16 coordinate points

       Point      x-surf     y-surf
        No.        (ft)       (ft)

         1        130.79    2514.07
         2        139.65    2505.21
         3        166.07    2495.95
         4        192.27    2486.06
         5        359.48    2482.76
         6        601.64    2479.63
         7       1108.50    2472.40
         8       1457.71    2472.88
         9       1477.28    2492.90
        10       1493.90    2515.44
        11       1512.97    2535.94
        12       1528.14    2559.47
        13       1546.87    2580.29
        14       1566.24    2600.51
        15       1573.72    2627.49
        16       1577.34    2634.00

 **  Corrected JANBU FOS =    8.062  **    (Fo factor = 1.028)

Failure surface No. 3 specified by 15 coordinate points

       Point      x-surf     y-surf
        No.        (ft)       (ft)

         1        145.21    2518.00
         2        155.46    2507.80
         3        175.52    2488.26
         4        487.47    2480.89
         5        633.99    2479.05
         6       1051.09    2472.98
         7       1394.34    2472.12
```

```
             8        1413.71     2492.34
             9        1432.93     2512.71
            10        1443.62     2538.58
            11        1463.22     2558.58
            12        1475.59     2583.70
            13        1493.09     2605.56
            14        1512.25     2625.98
            15        1513.87     2634.00

  **   Corrected JANBU FOS =     8.128   **     (Fo factor = 1.029)

 Failure surface No. 4 specified by 14 coordinate points

          Point       x-surf        y-surf
           No.         (ft)          (ft)

             1         111.80     2507.40
             2         134.83     2491.90
             3         162.79     2490.33
             4         385.92     2482.41
             5         666.23     2478.58
             6        1099.29     2472.04
             7        1394.16     2472.16
             8        1413.16     2492.72
             9        1432.92     2512.56
            10        1443.44     2538.51
            11        1451.89     2565.21
            12        1464.05     2590.43
            13        1478.17     2614.61
            14        1488.80     2634.00

  **   Corrected JANBU FOS =     8.163   **     (Fo factor = 1.029)

 Failure surface No. 5 specified by 13 coordinate points

          Point       x-surf        y-surf
           No.         (ft)          (ft)

             1         118.52     2509.76
             2         137.08     2494.20
             3         419.35     2481.78
             4         626.52     2479.27
             5        1097.36     2472.30
             6        1409.20     2472.11
             7        1413.66     2499.75
             8        1430.05     2522.46
             9        1443.94     2546.77
            10        1455.23     2572.39
            11        1475.03     2592.19
            12        1488.64     2616.66
            13        1502.58     2634.00

  **   Corrected JANBU FOS =     8.380   **     (Fo factor = 1.029)

 Failure surface No. 6 specified by 15 coordinate points

          Point       x-surf        y-surf
           No.         (ft)          (ft)

             1         141.92     2517.97
```

```
                         WEHHBL
       2        165.57   2506.63
       3        185.44   2486.90
       4        317.95   2483.12
       5        620.49   2479.29
       6       1000.09   2473.86
       7       1392.77   2472.00
       8       1412.39   2491.97
       9       1430.50   2513.32
      10       1450.27   2533.15
      11       1457.06   2560.32
      12       1476.72   2580.25
      13       1496.46   2600.11
      14       1503.68   2627.16
      15       1509.87   2634.00

  **  Corrected JANBU FOS =   8.434  **    (Fo factor = 1.029)

 Failure surface No. 7 specified by 15 coordinate points

     Point        x-surf       y-surf
      No.          (ft)         (ft)

       1        141.84   2517.95
       2        152.88   2506.94
       3        174.11   2488.69
       4        439.24   2481.56
       5        606.87   2479.36
       6       1117.82   2471.96
       7       1410.58   2472.45
       8       1418.89   2499.19
       9       1437.41   2520.19
      10       1457.05   2540.14
      11       1469.53   2565.21
      12       1489.00   2585.33
      13       1500.61   2610.81
      14       1520.11   2630.90
      15       1522.88   2634.00

  **  Corrected JANBU FOS =   8.458  **    (Fo factor = 1.029)

 Failure surface No. 8 specified by 15 coordinate points

     Point        x-surf       y-surf
      No.          (ft)         (ft)

       1        148.54   2518.00
       2        161.84   2505.67
       3        183.14   2487.50
       4        364.41   2482.70
       5        617.77   2479.37
       6       1053.02   2472.67
       7       1391.64   2472.26
       8       1411.25   2492.25
       9       1428.54   2514.27
      10       1446.91   2535.40
      11       1451.01   2563.10
      12       1470.64   2583.07
      13       1483.14   2608.12
      14       1502.83   2628.03
      15       1504.31   2634.00
```

```
                              WEHHBL
  **  Corrected JANBU FOS =   8.463  **    (Fo factor = 1.029)

 Failure surface No. 9 specified by 14 coordinate points

           Point        x-surf       y-surf
            No.          (ft)         (ft)

             1          134.86      2515.49
             2          141.81      2509.28
             3          162.51      2490.42
             4          454.46      2481.07
             5          648.29      2478.68
             6         1106.65      2472.42
             7         1403.95      2472.26
             8         1422.36      2493.35
             9         1426.86      2520.99
            10         1443.07      2543.82
            11         1461.93      2564.51
            12         1480.25      2585.69
            13         1494.91      2609.55
            14         1505.04      2634.00

  **  Corrected JANBU FOS =   8.464  **    (Fo factor = 1.029)

 Failure surface No.10 specified by 15 coordinate points

           Point        x-surf       y-surf
            No.          (ft)         (ft)

             1          136.69      2516.14
             2          146.89      2509.01
             3          167.34      2489.88
             4          460.32      2481.12
             5          650.82      2478.76
             6         1105.77      2472.06
             7         1399.50      2472.30
             8         1418.38      2492.98
             9         1438.08      2512.87
            10         1455.36      2534.91
            11         1472.32      2557.19
            12         1491.38      2577.70
            13         1502.28      2603.49
            14         1515.70      2628.07
            15         1519.71      2634.00

  **  Corrected JANBU FOS =   8.503  **    (Fo factor = 1.029)


 **********************************************************************
 **                                                                  **
 **  Out of the   1600 surfaces generated and analyzed by XSTABL,    **
 **        2 surfaces were found to have MISLEADING FOS values.      **
 **                                                                  **
 **********************************************************************



 The following is a summary of the TEN most critical surfaces
```

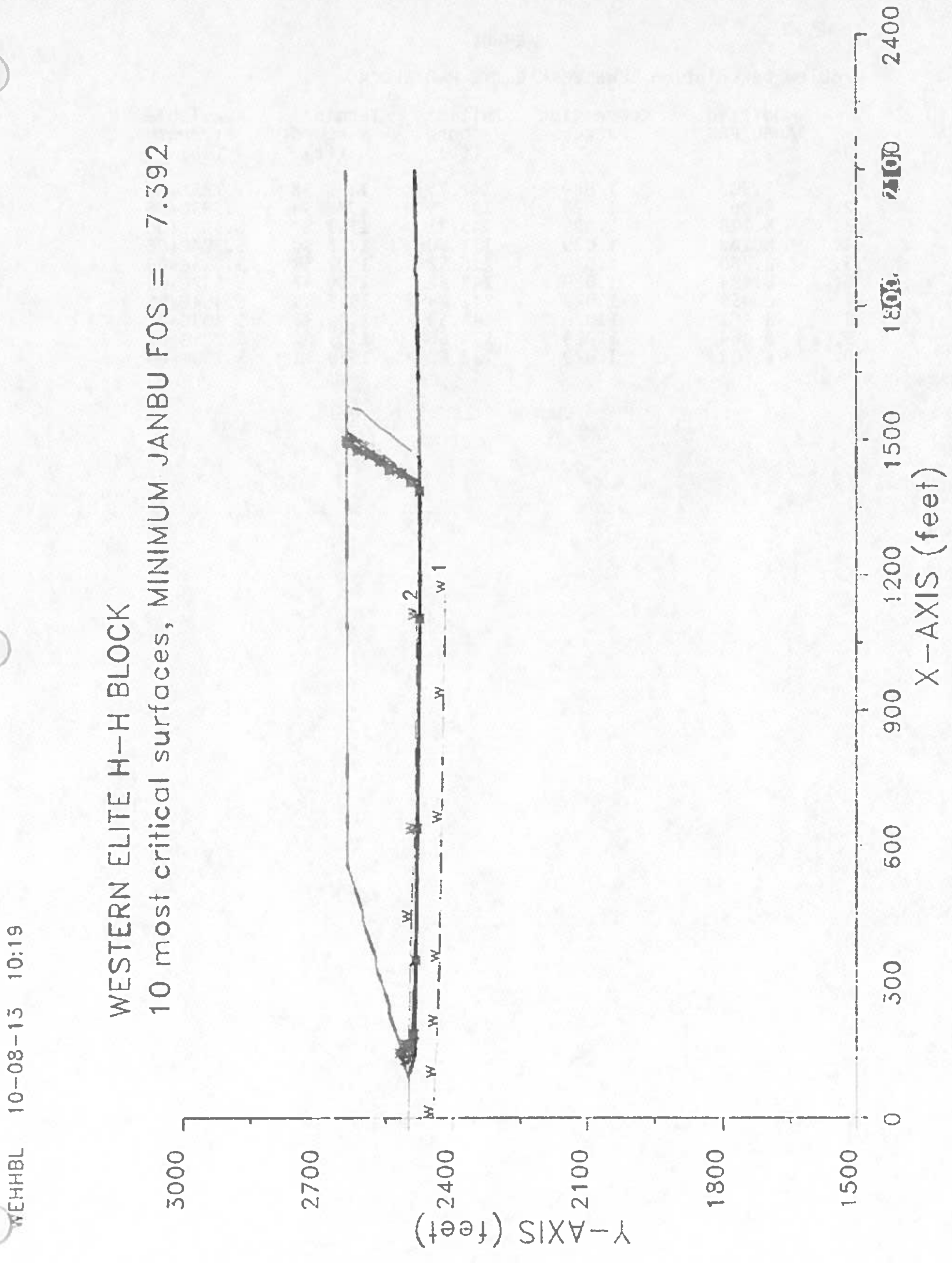
```
                                 WEHHBL

 Problem Description : WESTERN ELITE H-H BLOCK

          Modified      Correction   Initial    Terminal   Available
          JANBU FOS       Factor     x-coord    x-coord     Strength
                                      (ft)       (ft)        (lb)

   1.       7.392         1.029      142.75    1498.86    4.725E+06
   2.       8.062         1.028      130.79    1577.34    5.503E+06
   3.       8.128         1.029      145.21    1513.87    5.399E+06
   4.       8.163         1.029      111.80    1488.80    5.384E+06
   5.       8.380         1.029      118.52    1502.58    5.015E+06
   6.       8.434         1.029      141.92    1509.87    5.552E+06
   7.       8.458         1.029      141.84    1522.88    5.464E+06
   8.       8.463         1.029      148.54    1504.31    5.409E+06
   9.       8.464         1.029      134.86    1505.04    5.255E+06
  10.       8.503         1.029      136.69    1519.71    5.760E+06

                    * * *  END OF FILE  * * *
```



WEHHBL 10-08-13 10:19

WESTERN ELITE H-H BLOCK

10 most critical surfaces, MINIMUM JANBU FOS = 7.392

```
XSTABL File: WEHHCIR   10-08-13   10:30

               ******************************************
               *              X S T A B L               *
               *                                        *
               *        Slope Stability Analysis        *
               *               using the                *
               *            Method of Slices            *
               *                                        *
               *        Copyright (C) 1992 - 2002       *
               *   Interactive Software Designs, Inc.   *
               *        Moscow, ID 83843, U.S.A.        *
               *                                        *
               *          All Rights Reserved           *
               *                                        *
               *  Ver. 5.206                96 - 1932   *
               ******************************************

    Problem Description : WESTERN ELITE H-H CIRCULAR



    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

       11 SURFACE boundary segments

    Segment    x-left    y-left    x-right    y-right     Soil Unit
      No.       (ft)      (ft)       (ft)       (ft)    Below Segment

       1          .0     2499.0      85.0     2498.0          1
       2        85.0     2498.0     142.0     2518.0          2
       3       142.0     2518.0     160.0     2518.0          2
       4       160.0     2518.0     231.0     2542.5          2
       5       231.0     2542.5     249.0     2542.5          2
       6       249.0     2542.5     333.0     2571.0          2
       7       333.0     2571.0     351.0     2571.0          2
       8       351.0     2571.0     435.0     2600.0          2
       9       435.0     2600.0     453.0     2600.0          2
      10       453.0     2600.0     555.0     2634.0          2
      11       555.0     2634.0    2100.0     2634.0          2

       46 SUBSURFACE boundary segments

    Segment    x-left    y-left    x-right    y-right     Soil Unit
      No.       (ft)      (ft)       (ft)       (ft)    Below Segment

       1        85.0     2497.5     142.0     2516.0          3
       2       142.0     2516.0     160.0     2516.0          3
       3       160.0     2516.0     231.0     2540.5          3
       4       231.0     2540.5     249.0     2540.5          3
       5       249.0     2540.5     333.0     2569.0          3
       6       333.0     2569.0     351.0     2569.0          3
       7       351.0     2569.0     435.0     2598.0          3
       8       435.0     2598.0     453.0     2598.0          3
       9       453.0     2598.0     555.0     2632.0          3
      10       555.0     2632.0    2100.0     2632.0          3
      11        95.0     2499.0     139.0     2487.5          4
      12       139.0     2487.5     200.0     2486.5          4
```

```
    13        200.0    2486.5    1120.0    2473.5        4
    14       1120.0    2473.5    1385.0    2473.5        4
    15       1385.0    2473.5    1862.0    2479.5        4
    16       1862.0    2479.5    1875.0    2483.5        4
    17       1875.0    2483.5    1885.0    2483.5        4
    18       1885.0    2483.5    1900.0    2480.0        4
    19       1900.0    2480.0    2100.0    2483.5        4
    20         95.0    2498.0     139.0    2486.5        5
    21        139.0    2486.5     200.0    2485.5        5
    22        200.0    2485.5    1120.0    2472.5        5
    23       1120.0    2472.5    1385.0    2472.5        5
    24       1385.0    2472.5    1862.0    2478.5        5
    25       1862.0    2478.5    1875.0    2482.5        5
    26       1875.0    2482.5    1885.0    2482.5        5
    27       1885.0    2482.5    1900.0    2479.0        5
    28       1900.0    2479.0    2100.0    2482.5        5
    29         95.0    2497.5     139.0    2486.0        6
    30        139.0    2486.0     200.0    2485.0        6
    31        200.0    2485.0    1120.0    2472.0        6
    32       1120.0    2472.0    1385.0    2472.0        6
    33       1385.0    2472.0    1862.0    2478.0        6
    34       1862.0    2478.0    1875.0    2482.0        6
    35       1875.0    2482.0    1885.0    2482.0        6
    36       1885.0    2482.0    1900.0    2478.5        6
    37       1900.0    2478.5    2100.0    2482.0        6
    38         95.0    2494.0     139.0    2483.0        1
    39        139.0    2483.0     200.0    2482.0        1
    40        200.0    2482.0    1120.0    2469.0        1
    41       1120.0    2469.0    1385.0    2469.0        1
    42       1385.0    2469.0    1862.0    2475.0        1
    43       1862.0    2475.0    1875.0    2479.0        1
    44       1875.0    2479.0    1885.0    2479.0        1
    45       1885.0    2479.0    1900.0    2475.5        1
    46       1900.0    2475.5    2100.0    2479.0        1


 --------------------------
 ISOTROPIC Soil Parameters
 --------------------------

  6 Soil unit(s) specified

 Soil   Unit Weight    Cohesion  Friction     Pore Pressure       Water
 Unit  Moist    Sat.   Intercept   Angle   Parameter  Constant   Surface
  No.  (pcf)   (pcf)     (psf)     (deg)       Ru       (psf)      No.

   1   120.0   126.0     270.0     30.00      .000         .0       1
   2   120.0   125.0        .0     27.00      .000         .0       0
   3    70.0    75.0        .0     35.00      .000         .0       0
   4   125.0   135.0        .0     30.00      .000         .0       2
   5    90.0    95.0        .0     17.00      .000         .0       0
   6   117.0   120.0        .0     27.00      .000         .0       0


  2 Water surface(s) have been specified

 Unit weight of water =    62.40  (pcf)

 Water Surface No.  1 specified by  7 coordinate points

 **********************************
```

```
         PHREATIC SURFACE,
***********************************

  Point       x-water     y-water
   No.          (ft)        (ft)

    1            .00      2445.00
    2          88.00      2440.00
    3         200.00      2435.00
    4         343.00      2430.00
    5         650.00      2425.00
    6         925.00      2420.00
    7        1160.00      2415.00

Water Surface No.  2 specified by  4 coordinate points

***********************************
         PHREATIC SURFACE,
***********************************

  Point       x-water     y-water
   No.          (ft)        (ft)

    1         115.00      2499.00
    2         430.00      2493.00
    3         625.00      2485.00
    4        1100.00      2478.50


A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.


 1600 trial surfaces will be generated and analyzed.


  40 Surfaces initiate from each of  40 points equally spaced
along the ground surface between  x =        .0 ft
                             and  x =     231.0 ft


Each surface terminates between   x =     600.0 ft
                            and   x =     900.0 ft


Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =        .0 ft


   20.0 ft line segments define each trial failure surface.


---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
```

```
                    Upper angular limit :=   -10.0 degrees



Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED BISHOP METHOD   * * * * *


  The most critical circular failure surface
  is specified by 33 coordinate points

       Point       x-surf      y-surf
        No.         (ft)        (ft)

         1          17.77     2498.79
         2          37.44     2495.20
         3          57.21     2492.13
         4          77.05     2489.61
         5          96.95     2487.62
         6         116.90     2486.17
         7         136.87     2485.25
         8         156.87     2484.88
         9         176.87     2485.05
        10         196.86     2485.76
        11         216.82     2487.01
        12         236.74     2488.80
        13         256.60     2491.12
        14         276.40     2493.98
        15         296.11     2497.38
        16         315.72     2501.30
        17         335.22     2505.76
        18         354.59     2510.74
        19         373.81     2516.24
        20         392.89     2522.26
        21         411.79     2528.79
        22         430.51     2535.83
        23         449.03     2543.37
        24         467.35     2551.42
        25         485.43     2559.95
        26         503.29     2568.97
        27         520.89     2578.46
        28         538.22     2588.43
        29         555.29     2598.87
        30         572.06     2609.76
        31         588.53     2621.10
        32         604.70     2632.88
        33         606.14     2634.00

****  Simplified BISHOP FOS =   2.772  ****



The following is a summary of the TEN most critical surfaces

Problem Description : WESTERN ELITE H-H CIRCULAR
```

```
                                WEHHCIR
           FOS        Circle Center       Radius    Initial  Terminal   Resisting
        (BISHOP)    x-coord   y-coord               x-coord   x-coord    Moment
                      (ft)      (ft)        (ft)      (ft)      (ft)     (ft-lb)

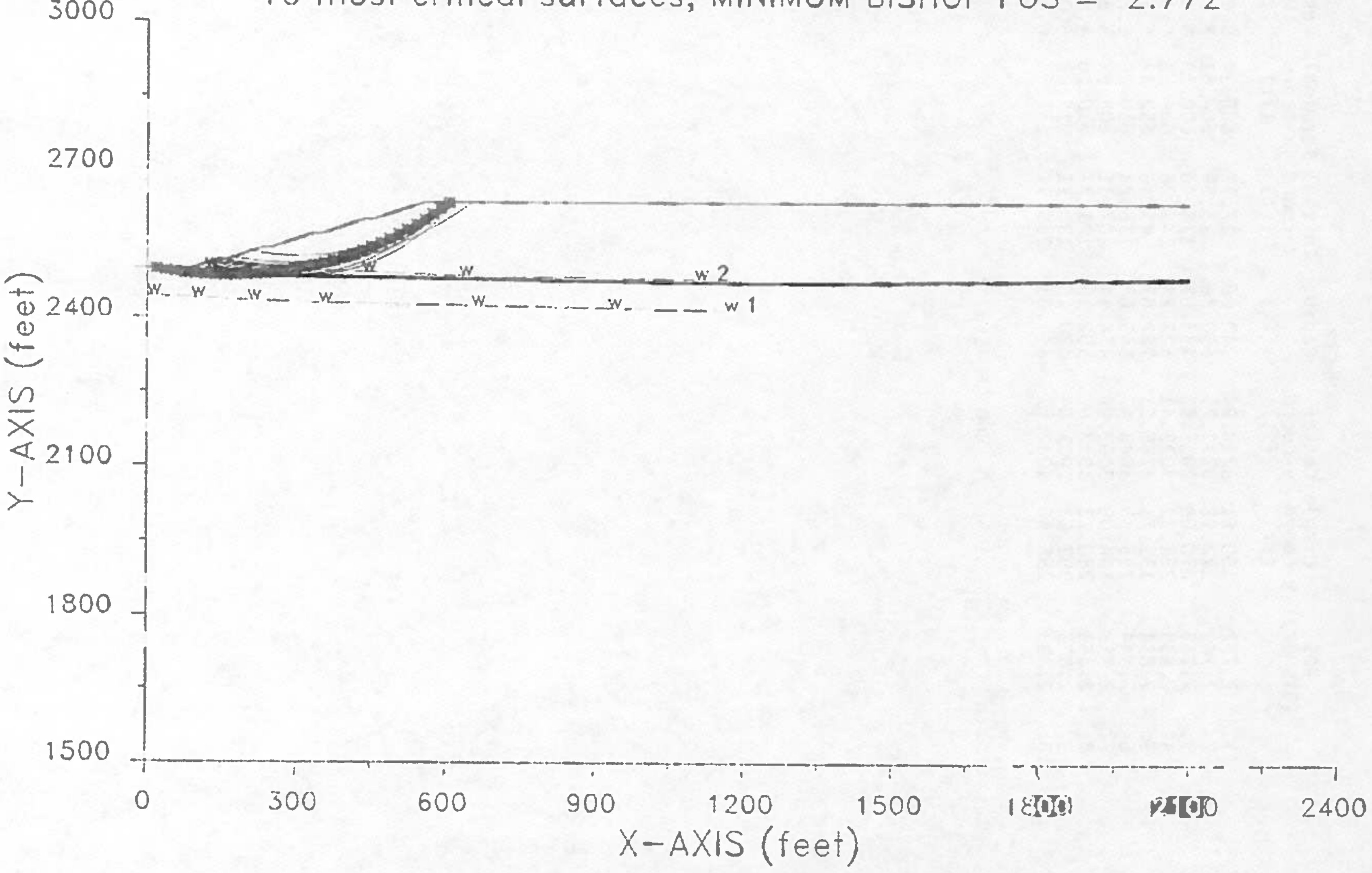
  1.     2.772      160.61   3224.94     740.06      17.77    606.14   8.934E+08
  2.     2.782      172.98   3172.75     690.36      23.69    604.61   8.779E+08
  3.     2.785      270.68   2915.82     433.67     118.46    600.19   5.800E+08
  4.     2.833      263.31   3027.41     522.28     148.08    606.73   5.306E+08
  5.     2.834      191.71   3266.63     782.67      41.46    652.42   1.150E+09
  6.     2.844      255.48   3048.47     545.68     136.23    610.29   5.797E+08
  7.     2.853      304.09   3002.97     478.54     207.31    608.62   3.650E+08
  8.     2.863      280.11   3012.62     502.38     171.77    610.16   4.861E+08
  9.     2.878      292.12   2901.64     420.16     130.31    615.83   6.080E+08
 10.     2.893      258.46   3042.61     544.03     130.31    617.65   6.417E+08

                      * * *  END OF FILE  * * *
```

WEHHCIR 10-08-13 10:30

WESTERN ELITE H-H CIRCULAR

10 most critical surfaces, MINIMUM BISHOP FOS = 2.772



JOYCE ENGINEERING

Project: Western Elite
Project Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/8/13
Revised By: Date:
Checked By: Date:
Subject: Global Stability
Sheet: 12 of 14

ATTACHMENT B
XSTABL SLOPE STABILITY SOFTWARE
SEISMIC ANALYSIS OUTPUT DATA

JOYCE
ENGINEERING

Project:	Western Elite		
Project Number:	00383.1401.01 T01		
Calculated By:	DWT	Date:	10/8/13
Revised By:		Date:	
Checked By:		Date:	
Subject:	Global Stability		
Sheet:	13 of 14		

Slope Stability Cross-Section D-D

Seismic Analysis

```
XSTABL File: WEDDBLZ   10-07-13   16:37

                 ******************************************
                 *             X S T A B L                *
                 *                                        *
                 *       Slope Stability Analysis         *
                 *             using the                  *
                 *          Method of Slices              *
                 *                                        *
                 *       Copyright (C) 1992 - 2002        *
                 *    Interactive Software Designs, Inc.  *
                 *       Moscow, ID 83843, U.S.A.         *
                 *                                        *
                 *          All Rights Reserved           *
                 *                                        *
                 *  Ver. 5.206               96 - 1932    *
                 ******************************************

     Problem Description : WESTERN ELITE D-D BLOCK SEISMIC


     ------------------------------
     SEGMENT BOUNDARY COORDINATES
     ------------------------------

        10 SURFACE boundary segments

     Segment     x-left     y-left     x-right    y-right      Soil Unit
       No.        (ft)       (ft)       (ft)       (ft)      Below Segment

        1           .0     2496.5        72.0     2497.0          1
        2         72.0     2497.0       173.0     2530.0          2
        3        173.0     2530.0       190.0     2530.0          2
        4        190.0     2530.0       290.0     2563.5          2
        5        290.0     2563.5       308.0     2563.5          2
        6        308.0     2563.5       405.0     2597.0          2
        7        405.0     2597.0       423.0     2597.0          2
        8        423.0     2597.0       461.0     2610.7          2
        9        461.0     2610.7       935.0     2634.0          2
       10        935.0     2634.0      1100.0     2626.0          2

        25 SUBSURFACE boundary segments

     Segment     x-left     y-left     x-right    y-right      Soil Unit
       No.        (ft)       (ft)       (ft)       (ft)      Below Segment

        1         72.0     2496.5       173.0     2528.0          3
        2        173.0     2528.0       190.0     2528.0          3
        3        190.0     2528.0       290.0     2561.5          3
        4        290.0     2561.5       308.0     2561.5          3
        5        308.0     2561.5       405.0     2595.0          3
        6        405.0     2595.0       423.0     2595.0          3
        7        423.0     2595.0       461.0     2608.7          3
        8        461.0     2608.7       935.0     2632.0          3
        9        935.0     2632.0      1100.0     2624.0          3
       10        100.0     2504.5       115.0     2499.5          4
       11        115.0     2499.5       430.0     2493.5          4
       12        430.0     2493.5       625.0     2485.5          4
       13        625.0     2485.5      1100.0     2479.0          4
```

```
    14        100.0    2503.5     115.0    2498.5          5
    15        115.0    2498.5     430.0    2492.5          5
    16        430.0    2492.5     625.0    2484.5          5
    17        625.0    2484.5    1100.0    2478.0          5
    18        100.0    2503.0     115.0    2498.0          6
    19        115.0    2498.0     430.0    2492.0          6
    20        430.0    2492.0     625.0    2484.0          6
    21        625.0    2484.0    1100.0    2477.5          6
    22        100.0    2500.0     115.0    2495.0          1
    23        115.0    2495.0     430.0    2489.0          1
    24        430.0    2489.0     625.0    2481.0          1
    25        625.0    2481.0    1100.0    2474.5          1


 --------------------------
 ISOTROPIC Soil Parameters
 --------------------------

  6 Soil unit(s) specified

 Soil   Unit Weight   Cohesion  Friction    Pore Pressure       Water
 Unit  Moist   Sat.  Intercept   Angle   Parameter  Constant  Surface
  No.  (pcf)  (pcf)    (psf)     (deg)       Ru       (psf)      No.

   1   120.0  126.0     270.0    30.00     .000          .0       1
   2   120.0  125.0        .0    27.00     .000          .0       0
   3    70.0   75.0        .0    35.00     .000          .0       0
   4   125.0  135.0        .0    30.00     .000          .0       2
   5    90.0   95.0        .0    17.00     .000          .0       0
   6   117.0  120.0        .0    27.00     .000          .0       0


  2 Water surface(s) have been specified

 Unit weight of water =    62.40  (pcf)

 Water Surface No.  1 specified by  7 coordinate points

 **********************************
          PHREATIC SURFACE,
 **********************************

   Point       x-water      y-water
    No.          (ft)         (ft)

     1             .00      2445.00
     2           88.00      2440.00
     3          200.00      2435.00
     4          343.00      2430.00
     5          650.00      2425.00
     6          925.00      2420.00
     7         1160.00      2415.00

 Water Surface No.  2 specified by  4 coordinate points

 **********************************
          PHREATIC SURFACE,
 **********************************

   Point       x-water      y-water
```

```
                              WEDDBLZ
       No.          (ft)        (ft)

        1          115.00     2499.00
        2          430.00     2493.00
        3          625.00     2485.00
        4         1100.00     2478.50


    A horizontal earthquake loading coefficient
    of   .270 has been assigned

    A vertical earthquake loading coefficient
    of   .000 has been assigned


    A critical failure surface searching method, using a random
    technique for generating sliding BLOCK surfaces, has been
    specified.

     1600 trial surfaces will be generated and analyzed.

      4 boxes specified for generation of central block base


    * * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

    Length of line segments for active and passive portions of
    sliding block is      26.0 ft


    Box        x-left     y-left     x-right     y-right       Width
    no.         (ft)       (ft)        (ft)        (ft)          (ft)

     1          115.0     2498.0      300.0      2494.5           .5
     2          350.0     2493.8      430.0      2492.0           .5
     3          500.0     2489.0      625.0      2484.0           .5
     4          700.0     2483.0      925.0      2480.0           .5


    Factors of safety have been calculated by the :

    * * * * *   SIMPLIFIED JANBU METHOD   * * * * *


    The 10 most critical of all the failure surfaces examined
    are displayed below - the most critical first

    Failure surface No. 1 specified by 13 coordinate points

           Point        x-surf      y-surf
            No.          (ft)        (ft)

             1          110.58     2509.61
             2          130.77     2497.89
             3          428.06     2492.10
             4          609.08     2484.71
```

```
      5          849.61      2481.01
      6          867.85      2499.54
      7          885.87      2518.28
      8          897.35      2541.61
      9          914.36      2561.27
     10          924.57      2585.19
     11          942.16      2604.33
     12          960.24      2623.01
     13          966.54      2632.47

 **  Corrected JANBU FOS =    1.040  **    (Fo factor = 1.037)

Failure surface No. 2 specified by 13 coordinate points

    Point        x-surf       y-surf
     No.          (ft)         (ft)

      1          123.64      2513.87
      2          142.35      2497.73
      3          419.77      2492.41
      4          610.08      2484.67
      5          864.01      2480.83
      6          882.24      2499.37
      7          888.40      2524.63
      8          905.99      2543.78
      9          910.98      2569.29
     10          929.06      2587.98
     11          946.12      2607.60
     12          962.08      2628.12
     13          965.72      2632.51

 **  Corrected JANBU FOS =    1.091  **    (Fo factor = 1.038)

Failure surface No. 3 specified by 13 coordinate points

    Point        x-surf       y-surf
     No.          (ft)         (ft)

      1          136.49      2518.07
      2          155.79      2504.04
      3          180.76      2496.81
      4          428.78      2492.15
      5          619.25      2484.24
      6          734.16      2482.52
      7          749.32      2503.65
      8          758.63      2527.92
      9          777.01      2546.31
     10          782.51      2571.72
     11          793.30      2595.38
     12          803.28      2619.38
     13          811.84      2627.95

 **  Corrected JANBU FOS =    1.091  **    (Fo factor = 1.043)

Failure surface No. 4 specified by 14 coordinate points

    Point        x-surf       y-surf
     No.          (ft)         (ft)

      1          126.49      2514.80
```

```
          2          130.06       2511.71
          3          151.55       2497.09
          4          426.41       2492.31
          5          624.62       2484.15
          6          897.70       2480.47
          7          916.05       2498.89
          8          931.05       2520.12
          9          949.24       2538.70
         10          965.02       2559.36
         11          977.94       2581.92
         12          988.16       2605.83
         13          999.26       2629.34
         14         1000.63       2630.82

  **  Corrected JANBU FOS =    1.102  **     (Fo factor = 1.037)

Failure surface No. 5 specified by 12 coordinate points

        Point        x-surf       y-surf
         No.          (ft)         (ft)

          1          111.92       2510.04
          2          124.26       2497.88
          3          416.35       2492.52
          4          618.57       2484.42
          5          766.69       2482.32
          6          785.01       2500.77
          7          788.86       2526.48
          8          803.31       2548.10
          9          815.81       2570.90
         10          823.88       2595.61
         11          839.56       2616.35
         12          843.83       2629.52

  **  Corrected JANBU FOS =    1.108  **     (Fo factor = 1.042)

Failure surface No. 6 specified by 14 coordinate points

        Point        x-surf       y-surf
         No.          (ft)         (ft)

          1          171.44       2529.49
          2          180.46       2528.31
          3          200.94       2512.30
          4          221.37       2496.22
          5          427.05       2492.15
          6          621.10       2484.21
          7          733.23       2482.81
          8          743.74       2506.59
          9          760.97       2526.06
         10          779.22       2544.58
         11          795.50       2564.85
         12          813.42       2583.69
         13          829.13       2604.41
         14          835.50       2629.11

  **  Corrected JANBU FOS =    1.129  **     (Fo factor = 1.044)

Failure surface No. 7 specified by 16 coordinate points
```

```
           Point          x-surf        y-surf
            No.            (ft)          (ft)

             1            167.95       2528.35
             2            168.22       2528.12
             3            193.09       2520.54
             4            216.64       2509.53
             5            238.61       2495.61
             6            422.13       2492.38
             7            621.87       2484.14
             8            874.83       2480.83
             9            890.15       2501.83
            10            907.36       2521.32
            11            917.06       2545.44
            12            931.72       2566.92
            13            949.72       2585.68
            14            967.80       2604.36
            15            978.71       2627.96
            16            979.79       2631.83

       **  Corrected JANBU FOS =    1.134   **    (Fo factor = 1.040)

      Failure surface No. 8 specified by 12 coordinate points

           Point          x-surf        y-surf
            No.            (ft)          (ft)

             1            103.62       2507.33
             2            116.57       2498.06
             3            427.77       2492.19
             4            603.88       2484.95
             5            881.71       2480.51
             6            882.56       2506.50
             7            893.49       2530.09
             8            911.74       2548.61
             9            922.76       2572.15
            10            935.07       2595.06
            11            953.46       2613.44
            12            960.61       2632.76

       **  Corrected JANBU FOS =    1.181   **    (Fo factor = 1.039)

      Failure surface No. 9 specified by 13 coordinate points

           Point          x-surf        y-surf
            No.            (ft)          (ft)

             1            134.73       2517.49
             2            142.88       2513.60
             3            163.10       2497.25
             4            414.37       2492.58
             5            606.96       2484.92
             6            767.99       2481.92
             7            780.44       2504.75
             8            792.83       2527.61
             9            796.60       2553.33
            10            809.91       2575.67
            11            824.58       2597.13
            12            840.36       2617.80
            13            841.94       2629.43
```

```
 **  Corrected JANBU FOS =   1.202  **     (Fo factor = 1.043)

Failure surface No.10 specified by 13 coordinate points

          Point       x-surf       y-surf
           No.         (ft)         (ft)

            1        114.52      2510.89
            2        129.55      2509.66
            3        152.53      2497.49
            4        409.28      2492.60
            5        612.09      2484.70
            6        750.77      2482.27
            7        767.88      2501.84
            8        783.96      2522.28
            9        791.00      2547.30
           10        793.05      2573.22
           11        811.39      2591.65
           12        829.30      2610.50
           13        846.73      2629.66

 **  Corrected JANBU FOS =   1.206  **     (Fo factor = 1.041)


The following is a summary of the TEN most critical surfaces

Problem Description : WESTERN ELITE D-D BLOCK SEISMIC

        Modified      Correction    Initial     Terminal     Available
        JANBU FOS       Factor      x-coord      x-coord      Strength
                                     (ft)         (ft)          (lb)

  1.      1.040         1.037       110.58       966.54     2.061E+06
  2.      1.091         1.038       123.64       965.72     2.066E+06
  3.      1.091         1.043       136.49       811.84     1.596E+06
  4.      1.102         1.037       126.49      1000.63     2.325E+06
  5.      1.108         1.042       111.92       843.83     1.738E+06
  6.      1.129         1.044       171.44       835.50     1.683E+06
  7.      1.134         1.040       167.95       979.79     2.180E+06
  8.      1.181         1.039       103.62       960.61     2.162E+06
  9.      1.202         1.043       134.73       841.94     1.846E+06
 10.      1.206         1.041       114.52       846.73     1.865E+06

                    * * *  END OF FILE  * * *
```

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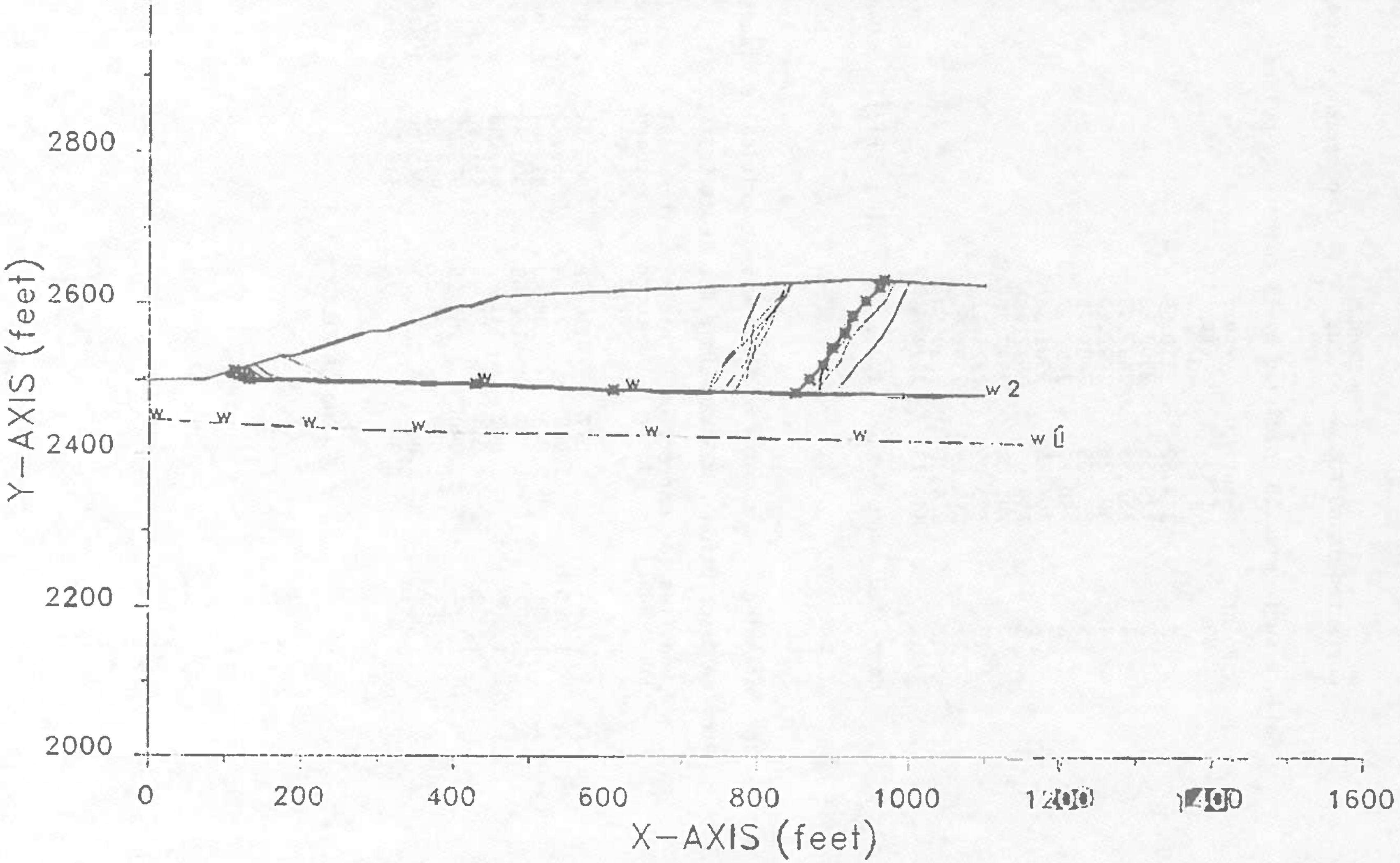
WESTERN ELITE D-D BLOCK SEISMIC
10 most critical surfaces, MINIMUM JANBU FOS = 1.040



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XSTABL File: WEDDCIZ   10-08-13   9:42

                  ******************************************
                  *              X S T A B L               *
                  *                                        *
                  *        Slope Stability Analysis        *
                  *               using the                *
                  *           Method of Slices             *
                  *                                        *
                  *        Copyright (C) 1992 - 2002       *
                  *    Interactive Software Designs, Inc.  *
                  *        Moscow, ID 83843, U.S.A.        *
                  *                                        *
                  *          All Rights Reserved           *
                  *                                        *
                  *  Ver. 5.206               96 - 1932    *
                  ******************************************


    Problem Description : WESTERN ELITE D-D CIRCULAR SEISMIC


    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

       10 SURFACE boundary segments

    Segment     x-left     y-left     x-right     y-right      Soil Unit
      No.        (ft)       (ft)        (ft)        (ft)     Below Segment

       1          .0       2496.5       72.0      2497.0          1
       2        72.0       2497.0      173.0      2530.0          2
       3       173.0       2530.0      190.0      2530.0          2
       4       190.0       2530.0      290.0      2563.5          2
       5       290.0       2563.5      308.0      2563.5          2
       6       308.0       2563.5      405.0      2597.0          2
       7       405.0       2597.0      423.0      2597.0          2
       8       423.0       2597.0      461.0      2610.7          2
       9       461.0       2610.7      935.0      2634.0          2
      10       935.0       2634.0     1100.0      2626.0          2

       25 SUBSURFACE boundary segments

    Segment     x-left     y-left     x-right     y-right      Soil Unit
      No.        (ft)       (ft)        (ft)        (ft)     Below Segment

       1        72.0       2496.5      173.0      2528.0          3
       2       173.0       2528.0      190.0      2528.0          3
       3       190.0       2528.0      290.0      2561.5          3
       4       290.0       2561.5      308.0      2561.5          3
       5       308.0       2561.5      405.0      2595.0          3
       6       405.0       2595.0      423.0      2595.0          3
       7       423.0       2595.0      461.0      2608.7          3
       8       461.0       2608.7      935.0      2632.0          3
       9       935.0       2632.0     1100.0      2624.0          3
      10       100.0       2504.5      115.0      2499.5          4
      11       115.0       2499.5      430.0      2493.5          4
      12       430.0       2493.5      625.0      2485.5          4
      13       625.0       2485.5     1100.0      2479.0          4
```

```
  14        100.0    2503.5     115.0    2498.5         5
  15        115.0    2498.5     430.0    2492.5         5
  16        430.0    2492.5     625.0    2484.5         5
  17        625.0    2484.5    1100.0    2478.0         5
  18        100.0    2503.0     115.0    2498.0         6
  19        115.0    2498.0     430.0    2492.0         6
  20        430.0    2492.0     625.0    2484.0         6
  21        625.0    2484.0    1100.0    2477.5         6
  22        100.0    2500.0     115.0    2495.0         1
  23        115.0    2495.0     430.0    2489.0         1
  24        430.0    2489.0     625.0    2481.0         1
  25        625.0    2481.0    1100.0    2474.5         1

--------------------------
ISOTROPIC Soil Parameters
--------------------------

 6 Soil unit(s) specified

Soil    Unit Weight   Cohesion  Friction    Pore Pressure     Water
Unit   Moist    Sat.  Intercept  Angle   Parameter Constant  Surface
 No.   (pcf)   (pcf)    (psf)    (deg)      Ru       (psf)     No.

  1    120.0   126.0     270.0    30.00     .000        .0       1
  2    120.0   125.0        .0    27.00     .000        .0       0
  3     70.0    75.0        .0    35.00     .000        .0       0
  4    125.0   135.0        .0    30.00     .000        .0       2
  5     90.0    95.0        .0    17.00     .000        .0       0
  6    117.0   120.0        .0    27.00     .000        .0       0


 2 Water surface(s) have been specified

Unit weight of water =    62.40  (pcf)


Water Surface No.  1 specified by  7 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point       x-water      y-water
   No.          (ft)         (ft)

   1             .00      2445.00
   2           88.00      2440.00
   3          200.00      2435.00
   4          343.00      2430.00
   5          650.00      2425.00
   6          925.00      2420.00
   7         1160.00      2415.00


Water Surface No.  2 specified by  4 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point       x-water      y-water
```

```
                           WEDDCIZ
     No.        (ft)        (ft)

      1        115.00     2499.00
      2        430.00     2493.00
      3        625.00     2485.00
      4       1100.00     2478.50


A horizontal earthquake loading coefficient
of   .270 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.


 1600 trial surfaces will be generated and analyzed.


  40 Surfaces initiate from each of  40 points equally spaced
along the ground surface between  x =     72.0 ft
                              and  x =    173.0 ft


Each surface terminates between    x =    461.0 ft
                             and   x =    935.0 ft


Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =      .0 ft


* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

   14.0 ft line segments define each trial failure surface.


---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=   -10.0 degrees



Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED BISHOP METHOD   * * * * *
```

```
 The most critical circular failure surface
 is specified by 34 coordinate points

         Point      x-surf     y-surf
          No.        (ft)       (ft)

           1         90.13    2502.92
           2        103.90    2500.41
           3        117.74    2498.28
           4        131.63    2496.53
           5        145.56    2495.16
           6        159.53    2494.17
           7        173.51    2493.56
           8        187.51    2493.35
           9        201.51    2493.51
          10        215.50    2494.06
          11        229.47    2494.99
          12        243.41    2496.31
          13        257.30    2498.01
          14        271.15    2500.09
          15        284.93    2502.54
          16        298.64    2505.38
          17        312.27    2508.59
          18        325.80    2512.17
          19        339.23    2516.13
          20        352.55    2520.45
          21        365.74    2525.13
          22        378.80    2530.18
          23        391.71    2535.58
          24        404.48    2541.34
          25        417.08    2547.44
          26        429.50    2553.89
          27        441.75    2560.67
          28        453.81    2567.79
          29        465.66    2575.24
          30        477.31    2583.01
          31        488.74    2591.09
          32        499.94    2599.49
          33        510.91    2608.19
          34        517.19    2613.46

****  Simplified BISHOP FOS =   1.242  ****



The following is a summary of the TEN most critical surfaces

Problem Description : WESTERN ELITE D-D CIRCULAR SEISMIC

       FOS      Circle Center     Radius   Initial  Terminal  Resisting
     (BISHOP)  x-coord  y-coord            x-coord   x-coord    Moment
                 (ft)     (ft)      (ft)     (ft)      (ft)     (ft-lb)

 1.     1.242   188.47  3003.13   509.79     90.13   517.19  3.960E+08
 2.     1.270   219.72  2976.34   482.02    105.67   538.19  4.148E+08
 3.     1.271   210.24  3063.52   569.25     97.90   561.61  5.282E+08
 4.     1.285   165.59  2930.31   439.24     79.77   467.27  2.866E+08
 5.     1.288   225.70  3044.03   550.70    103.08   572.33  5.475E+08
 6.     1.291   238.29  2938.14   445.45    113.44   544.61  4.110E+08
```

```
  7.   1.301    173.11  2905.55   415.20    82.36    465.69  2.792E+08
  8.   1.302    234.47  2927.02   432.18   116.03    532.70  3.718E+08
  9.   1.307    202.37  2912.13   422.83    92.72    500.76  3.526E+08
 10.   1.309    243.45  2886.03   365.63   167.82    485.27  1.573E+08

                     * * *  END OF FILE  * * *
```

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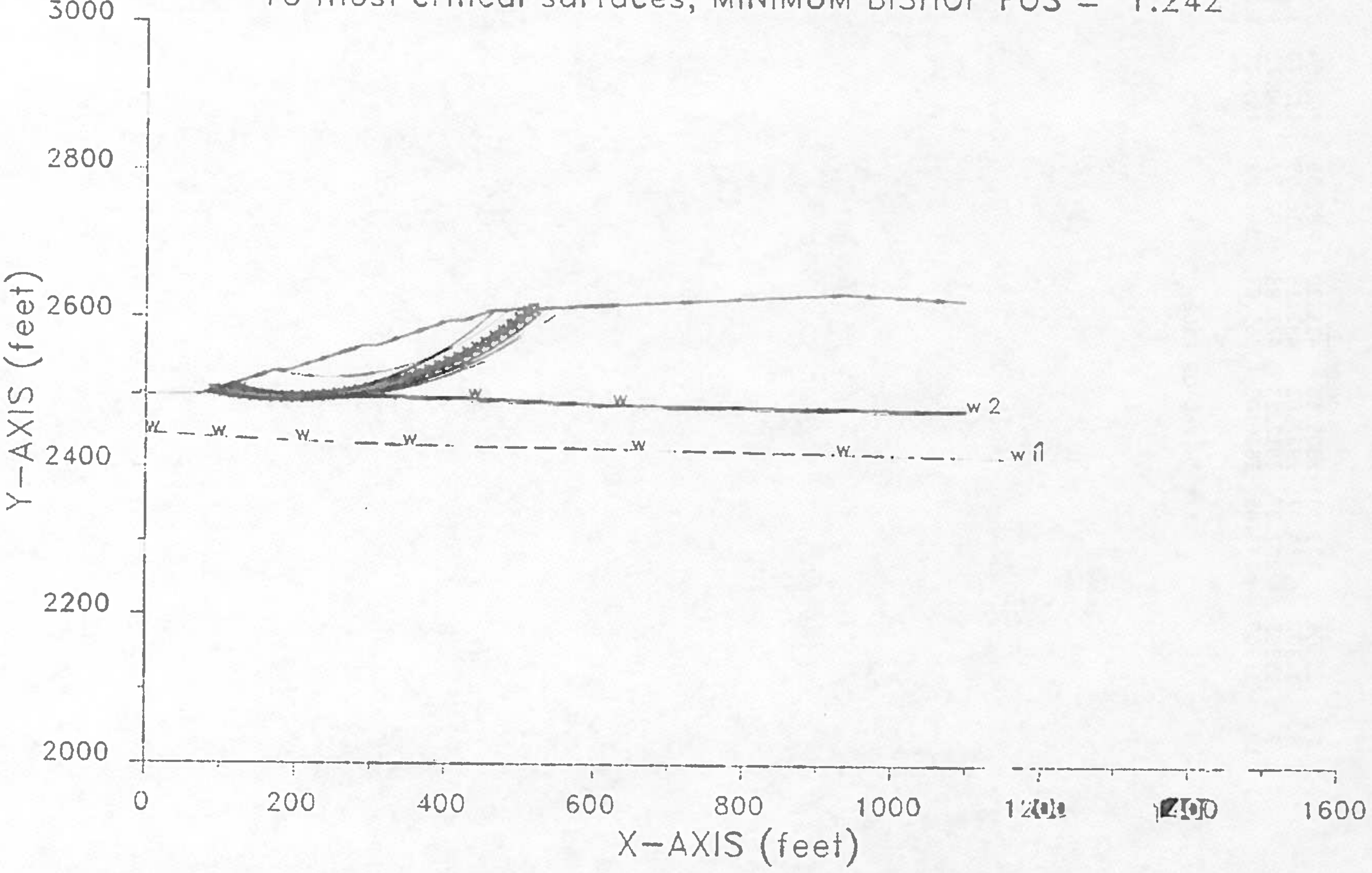
WESTERN ELITE D-D CIRCULAR SEISMIC

10 most critical surfaces, MINIMUM BISHOP FOS = 1.242



JOYCE
ENGINEERING

Project: Western Elite
Project Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/8/13
Revised By: Date:
Checked By: Date:
Subject: Global Stability
Sheet: 14 of 14

Slope Stability Cross-Section H-H

Seismic Analysis

```
              ******************************************
              *                X S T A B L             *
              *                                        *
              *        Slope Stability Analysis        *
              *               using the                *
              *           Method of Slices             *
              *                                        *
              *        Copyright (C) 1992 - 2002       *
              *   Interactive Software Designs, Inc.   *
              *        Moscow, ID 83843, U.S.A.        *
              *                                        *
              *           All Rights Reserved          *
              *                                        *
              *  Ver. 5.206                96 - 1932   *
              ******************************************


    Problem Description : WESTERN ELITE H-H BLOCK SEISMIC



    ------------------------------
    SEGMENT BOUNDARY COORDINATES
    ------------------------------

       11 SURFACE boundary segments

    Segment     x-left     y-left     x-right    y-right      Soil Unit
      No.        (ft)       (ft)        (ft)       (ft)     Below Segment

       1           .0      2499.0       85.0     2498.0            1
       2         85.0      2498.0      142.0     2518.0            2
       3        142.0      2518.0      160.0     2518.0            2
       4        160.0      2518.0      231.0     2542.5            2
       5        231.0      2542.5      249.0     2542.5            2
       6        249.0      2542.5      333.0     2571.0            2
       7        333.0      2571.0      351.0     2571.0            2
       8        351.0      2571.0      435.0     2600.0            2
       9        435.0      2600.0      453.0     2600.0            2
      10        453.0      2600.0      555.0     2634.0            2
      11        555.0      2634.0     2100.0     2634.0            2

       46 SUBSURFACE boundary segments

    Segment     x-left     y-left     x-right    y-right      Soil Unit
      No.        (ft)       (ft)        (ft)       (ft)     Below Segment

       1         85.0      2497.5      142.0     2516.0            3
       2        142.0      2516.0      160.0     2516.0            3
       3        160.0      2516.0      231.0     2540.5            3
       4        231.0      2540.5      249.0     2540.5            3
       5        249.0      2540.5      333.0     2569.0            3
       6        333.0      2569.0      351.0     2569.0            3
       7        351.0      2569.0      435.0     2598.0            3
       8        435.0      2598.0      453.0     2598.0            3
       9        453.0      2598.0      555.0     2632.0            3
      10        555.0      2632.0     2100.0     2632.0            3
      11         95.0      2499.0      139.0     2487.5            4
      12        139.0      2487.5      200.0     2486.5            4
```

```
   13        200.0    2486.5     1120.0    2473.5          4
   14       1120.0    2473.5     1385.0    2473.5          4
   15       1385.0    2473.5     1862.0    2479.5          4
   16       1862.0    2479.5     1875.0    2483.5          4
   17       1875.0    2483.5     1885.0    2483.5          4
   18       1885.0    2483.5     1900.0    2480.0          4
   19       1900.0    2480.0     2100.0    2483.5          4
   20         95.0    2498.0      139.0    2486.5          5
   21        139.0    2486.5      200.0    2485.5          5
   22        200.0    2485.5     1120.0    2472.5          5
   23       1120.0    2472.5     1385.0    2472.5          5
   24       1385.0    2472.5     1862.0    2478.5          5
   25       1862.0    2478.5     1875.0    2482.5          5
   26       1875.0    2482.5     1885.0    2482.5          5
   27       1885.0    2482.5     1900.0    2479.0          5
   28       1900.0    2479.0     2100.0    2482.5          5
   29         95.0    2497.5      139.0    2486.0          6
   30        139.0    2486.0      200.0    2485.0          6
   31        200.0    2485.0     1120.0    2472.0          6
   32       1120.0    2472.0     1385.0    2472.0          6
   33       1385.0    2472.0     1862.0    2478.0          6
   34       1862.0    2478.0     1875.0    2482.0          6
   35       1875.0    2482.0     1885.0    2482.0          6
   36       1885.0    2482.0     1900.0    2478.5          6
   37       1900.0    2478.5     2100.0    2482.0          6
   38         95.0    2494.0      139.0    2483.0          1
   39        139.0    2483.0      200.0    2482.0          1
   40        200.0    2482.0     1120.0    2469.0          1
   41       1120.0    2469.0     1385.0    2469.0          1
   42       1385.0    2469.0     1862.0    2475.0          1
   43       1862.0    2475.0     1875.0    2479.0          1
   44       1875.0    2479.0     1885.0    2479.0          1
   45       1885.0    2479.0     1900.0    2475.5          1
   46       1900.0    2475.5     2100.0    2479.0          1


-------------------------
ISOTROPIC Soil Parameters
-------------------------

 6 Soil unit(s) specified

Soil   Unit Weight    Cohesion  Friction     Pore Pressure        Water
Unit  Moist    Sat.  Intercept   Angle   Parameter  Constant    Surface
 No.  (pcf)   (pcf)    (psf)     (deg)       Ru       (psf)       No.

  1   120.0   126.0    270.0     30.00      .000         .0        1
  2   120.0   125.0       .0     27.00      .000         .0        0
  3    70.0    75.0       .0     35.00      .000         .0        0
  4   125.0   135.0       .0     30.00      .000         .0        2
  5    90.0    95.0       .0     17.00      .000         .0        0
  6   117.0   120.0       .0     27.00      .000         .0        0


 2 Water surface(s) have been specified

Unit weight of water =    62.40  (pcf)

Water Surface No.  1 specified by  7 coordinate points

***********************************
```

```
         PHREATIC SURFACE,
**********************************

  Point      x-water     y-water
   No.        (ft)        (ft)

    1           .00      2445.00
    2         88.00      2440.00
    3        200.00      2435.00
    4        343.00      2430.00
    5        650.00      2425.00
    6        925.00      2420.00
    7       1160.00      2415.00

Water Surface No.  2 specified by  4 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point      x-water     y-water
   No.        (ft)        (ft)

    1        115.00      2499.00
    2        430.00      2493.00
    3        625.00      2485.00
    4       1100.00      2478.50


A horizontal earthquake loading coefficient
of   .270 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating sliding BLOCK surfaces, has been
specified.

 1600 trial surfaces will be generated and analyzed.

  5 boxes specified for generation of central block base


* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

Length of line segments for active and passive portions of
sliding block is     28.0 ft

Box          x-left     y-left    x-right    y-right      Width
no.           (ft)       (ft)      (ft)       (ft)         (ft)

 1            95.0     2500.0     200.0     2485.0          .5
 2           300.0     2483.5     500.0     2480.5          .5
 3           600.0     2479.5     800.0     2476.0          .5
```

```
  4           900.0     2475.0     1120.0     2472.0          .5
  5          1385.0     2472.0     1600.0     2475.0          .5


Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED JANBU METHOD   * * * * *


The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 15 coordinate points

       Point      x-surf      y-surf
        No.        (ft)        (ft)

         1        142.75     2518.00
         2        162.50     2505.63
         3        183.74     2487.40
         4        347.31     2482.79
         5        638.00     2479.02
         6       1104.08     2472.28
         7       1386.11     2472.26
         8       1405.83     2492.13
         9       1425.31     2512.25
        10       1432.01     2539.44
        11       1451.79     2559.26
        12       1467.50     2582.43
        13       1476.39     2608.98
        14       1495.04     2629.86
        15       1498.86     2634.00

 **  Corrected JANBU FOS =   1.205  **    (Fo factor = 1.029)

Failure surface No. 2 specified by 16 coordinate points

       Point      x-surf      y-surf
        No.        (ft)        (ft)

         1        130.79     2514.07
         2        139.65     2505.21
         3        166.07     2495.95
         4        192.27     2486.06
         5        359.48     2482.76
         6        601.64     2479.63
         7       1108.50     2472.40
         8       1457.71     2472.88
         9       1477.28     2492.90
        10       1493.90     2515.44
        11       1512.97     2535.94
        12       1528.14     2559.47
        13       1546.87     2580.29
        14       1566.24     2600.51
        15       1573.72     2627.49
        16       1577.34     2634.00

 **  Corrected JANBU FOS =   1.294  **    (Fo factor = 1.028)
```

```
Failure surface No. 3 specified by 13 coordinate points

          Point      x-surf      y-surf
           No.        (ft)        (ft)

            1        118.52     2509.76
            2        137.08     2494.20
            3        419.35     2481.78
            4        626.52     2479.27
            5       1097.36     2472.30
            6       1409.20     2472.11
            7       1413.66     2499.75
            8       1430.05     2522.46
            9       1443.94     2546.77
           10       1455.23     2572.39
           11       1475.03     2592.19
           12       1488.64     2616.66
           13       1502.58     2634.00

 **  Corrected JANBU FOS =   1.297  **    (Fo factor = 1.029)

Failure surface No. 4 specified by 13 coordinate points

          Point      x-surf      y-surf
           No.        (ft)        (ft)

            1         95.90     2501.82
            2         98.97     2499.20
            3        338.33     2483.13
            4        681.52     2478.21
            5       1099.71     2472.30
            6       1438.27     2472.71
            7       1438.91     2500.70
            8       1456.88     2522.17
            9       1476.51     2542.14
           10       1482.11     2569.58
           11       1501.91     2589.38
           12       1510.27     2616.10
           13       1526.44     2634.00

 **  Corrected JANBU FOS =   1.317  **    (Fo factor = 1.028)

Failure surface No. 5 specified by 14 coordinate points

          Point      x-surf      y-surf
           No.        (ft)        (ft)

            1        134.86     2515.49
            2        141.81     2509.28
            3        162.51     2490.42
            4        454.46     2481.07
            5        648.29     2478.68
            6       1106.65     2472.42
            7       1403.95     2472.26
            8       1422.36     2493.35
            9       1426.86     2520.99
           10       1443.07     2543.82
           11       1461.93     2564.51
           12       1480.25     2585.69
           13       1494.91     2609.55
           14       1505.04     2634.00
```

```
 **  Corrected JANBU FOS =   1.345  **    (Fo factor = 1.029)

Failure surface No. 6 specified by 14 coordinate points

             Point        x-surf       y-surf
              No.          (ft)         (ft)

               1          111.80      2507.40
               2          134.83      2491.90
               3          162.79      2490.33
               4          385.92      2482.41
               5          666.23      2478.58
               6         1099.29      2472.04
               7         1394.16      2472.16
               8         1413.16      2492.72
               9         1432.92      2512.56
              10         1443.44      2538.51
              11         1451.89      2565.21
              12         1464.05      2590.43
              13         1478.17      2614.61
              14         1488.80      2634.00

 **  Corrected JANBU FOS =   1.357  **    (Fo factor = 1.029)

Failure surface No. 7 specified by 15 coordinate points

             Point        x-surf       y-surf
              No.          (ft)         (ft)

               1          145.21      2518.00
               2          155.46      2507.80
               3          175.52      2488.26
               4          487.47      2480.89
               5          633.99      2479.05
               6         1051.09      2472.98
               7         1394.34      2472.12
               8         1413.71      2492.34
               9         1432.93      2512.71
              10         1443.62      2538.58
              11         1463.22      2558.58
              12         1475.59      2583.70
              13         1493.09      2605.56
              14         1512.25      2625.98
              15         1513.87      2634.00

 **  Corrected JANBU FOS =   1.361  **    (Fo factor = 1.029)

Failure surface No. 8 specified by 15 coordinate points

             Point        x-surf       y-surf
              No.          (ft)         (ft)

               1          127.88      2513.05
               2          128.67      2512.62
               3          155.12      2503.42
               4          178.44      2487.94
               5          440.27      2481.48
               6          667.35      2478.47
               7         1103.06      2472.22
```

```
        8          1388.39        2472.27
        9          1396.31        2499.13
       10          1400.92        2526.75
       11          1419.39        2547.79
       12          1438.36        2568.39
       13          1446.69        2595.12
       14          1452.58        2622.49
       15          1463.53        2634.00

  **   Corrected JANBU FOS =     1.371   **      (Fo factor = 1.030)

Failure surface No. 9 specified by 15 coordinate points

       Point         x-surf        y-surf
        No.           (ft)          (ft)

         1           148.54        2518.00
         2           161.84        2505.67
         3           183.14        2487.50
         4           364.41        2482.70
         5           617.77        2479.37
         6          1053.02        2472.67
         7          1391.64        2472.26
         8          1411.25        2492.25
         9          1428.54        2514.27
        10          1446.91        2535.40
        11          1451.01        2563.10
        12          1470.64        2583.07
        13          1483.14        2608.12
        14          1502.83        2628.03
        15          1504.31        2634.00

  **   Corrected JANBU FOS =     1.379   **      (Fo factor = 1.029)

Failure surface No.10 specified by 15 coordinate points

       Point         x-surf        y-surf
        No.           (ft)          (ft)

         1           141.84        2517.95
         2           152.88        2506.94
         3           174.11        2488.69
         4           439.24        2481.56
         5           606.87        2479.36
         6          1117.82        2471.96
         7          1410.58        2472.45
         8          1418.89        2499.19
         9          1437.41        2520.19
        10          1457.05        2540.14
        11          1469.53        2565.21
        12          1489.00        2585.33
        13          1500.61        2610.81
        14          1520.11        2630.90
        15          1522.88        2634.00

  **   Corrected JANBU FOS =     1.381   **      (Fo factor = 1.029)
```

```
The following is a summary of the TEN most critical surfaces

Problem Description : WESTERN ELITE H-H BLOCK SEISMIC

          Modified       Correction    Initial     Terminal     Available
         JANBU FOS         Factor      x-coord      x-coord      Strength
                                        (ft)         (ft)         (lb)

  1.       1.205           1.029      142.75      1498.86      4.509E+06
  2.       1.294           1.028      130.79      1577.34      5.277E+06
  3.       1.297           1.029      118.52      1502.58      4.779E+06
  4.       1.317           1.028       95.90      1526.44      4.872E+06
  5.       1.345           1.029      134.86      1505.04      5.041E+06
  6.       1.357           1.029      111.80      1488.80      5.155E+06
  7.       1.361           1.029      145.21      1513.87      5.198E+06
  8.       1.371           1.030      127.88      1463.53      4.897E+06
  9.       1.379           1.029      148.54      1504.31      5.205E+06
 10.       1.381           1.029      141.84      1522.88      5.252E+06

                     * * *  END OF FILE  * * *
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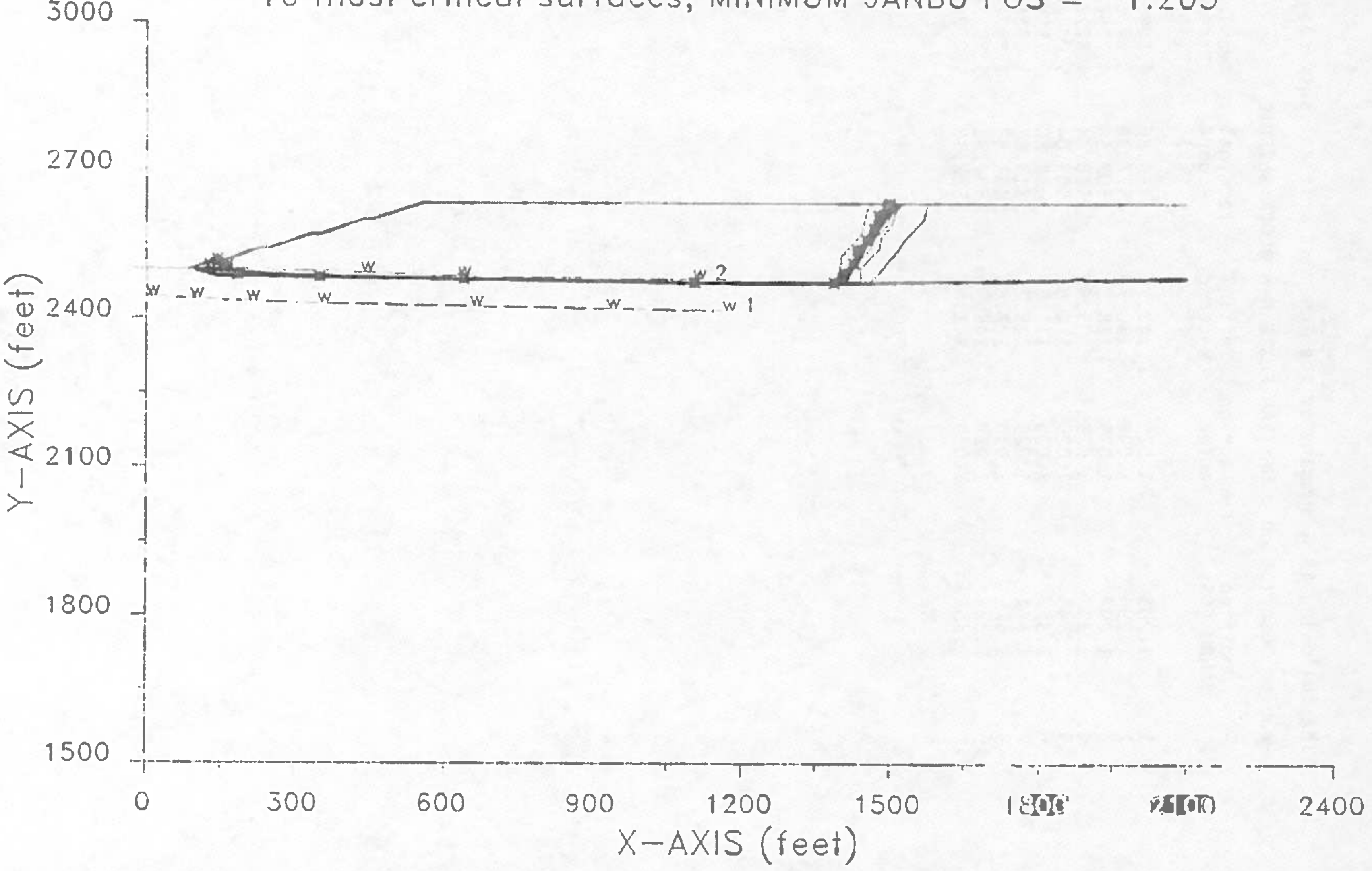
WESTERN ELITE H-H BLOCK SEISMIC
10 most critical surfaces, MINIMUM JANBU FOS = 1.205



```
XSTABL File: WEHHCIZ   10-08-13   10:33

                *******************************************
                *              X S T A B L                *
                *                                         *
                *        Slope Stability Analysis         *
                *               using the                 *
                *           Method of Slices              *
                *                                         *
                *        Copyright (C) 1992 - 2002        *
                *    Interactive Software Designs, Inc.   *
                *        Moscow, ID 83843, U.S.A.         *
                *                                         *
                *          All Rights Reserved            *
                *                                         *
                *  Ver. 5.206                96 - 1932    *
                *******************************************


    Problem Description : WESTERN ELITE H-H CIRCULAR SEISMIC


    -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------

       11 SURFACE boundary segments

    Segment    x-left     y-left     x-right    y-right      Soil Unit
      No.       (ft)       (ft)       (ft)       (ft)      Below Segment

       1          .0      2499.0       85.0     2498.0           1
       2        85.0      2498.0      142.0     2518.0           2
       3       142.0      2518.0      160.0     2518.0           2
       4       160.0      2518.0      231.0     2542.5           2
       5       231.0      2542.5      249.0     2542.5           2
       6       249.0      2542.5      333.0     2571.0           2
       7       333.0      2571.0      351.0     2571.0           2
       8       351.0      2571.0      435.0     2600.0           2
       9       435.0      2600.0      453.0     2600.0           2
      10       453.0      2600.0      555.0     2634.0           2
      11       555.0      2634.0     2100.0     2634.0           2

       46 SUBSURFACE boundary segments

    Segment    x-left     y-left     x-right    y-right      Soil Unit
      No.       (ft)       (ft)       (ft)       (ft)      Below Segment

       1        85.0      2497.5      142.0     2516.0           3
       2       142.0      2516.0      160.0     2516.0           3
       3       160.0      2516.0      231.0     2540.5           3
       4       231.0      2540.5      249.0     2540.5           3
       5       249.0      2540.5      333.0     2569.0           3
       6       333.0      2569.0      351.0     2569.0           3
       7       351.0      2569.0      435.0     2598.0           3
       8       435.0      2598.0      453.0     2598.0           3
       9       453.0      2598.0      555.0     2632.0           3
      10       555.0      2632.0     2100.0     2632.0           3
      11        95.0      2499.0      139.0     2487.5           4
      12       139.0      2487.5      200.0     2486.5           4
```

```
      13        200.0     2486.5    1120.0    2473.5         4
      14       1120.0     2473.5    1385.0    2473.5         4
      15       1385.0     2473.5    1862.0    2479.5         4
      16       1862.0     2479.5    1875.0    2483.5         4
      17       1875.0     2483.5    1885.0    2483.5         4
      18       1885.0     2483.5    1900.0    2480.0         4
      19       1900.0     2480.0    2100.0    2483.5         4
      20         95.0     2498.0     139.0    2486.5         5
      21        139.0     2486.5     200.0    2485.5         5
      22        200.0     2485.5    1120.0    2472.5         5
      23       1120.0     2472.5    1385.0    2472.5         5
      24       1385.0     2472.5    1862.0    2478.5         5
      25       1862.0     2478.5    1875.0    2482.5         5
      26       1875.0     2482.5    1885.0    2482.5         5
      27       1885.0     2482.5    1900.0    2479.0         5
      28       1900.0     2479.0    2100.0    2482.5         5
      29         95.0     2497.5     139.0    2486.0         6
      30        139.0     2486.0     200.0    2485.0         6
      31        200.0     2485.0    1120.0    2472.0         6
      32       1120.0     2472.0    1385.0    2472.0         6
      33       1385.0     2472.0    1862.0    2478.0         6
      34       1862.0     2478.0    1875.0    2482.0         6
      35       1875.0     2482.0    1885.0    2482.0         6
      36       1885.0     2482.0    1900.0    2478.5         6
      37       1900.0     2478.5    2100.0    2482.0         6
      38         95.0     2494.0     139.0    2483.0         1
      39        139.0     2483.0     200.0    2482.0         1
      40        200.0     2482.0    1120.0    2469.0         1
      41       1120.0     2469.0    1385.0    2469.0         1
      42       1385.0     2469.0    1862.0    2475.0         1
      43       1862.0     2475.0    1875.0    2479.0         1
      44       1875.0     2479.0    1885.0    2479.0         1
      45       1885.0     2479.0    1900.0    2475.5         1
      46       1900.0     2475.5    2100.0    2479.0         1


  --------------------------
  ISOTROPIC Soil Parameters
  --------------------------

   6 Soil unit(s) specified

  Soil    Unit Weight    Cohesion   Friction    Pore Pressure      Water
  Unit   Moist    Sat.   Intercept    Angle   Parameter Constant  Surface
   No.   (pcf)   (pcf)     (psf)      (deg)       Ru      (psf)     No.

   1     120.0   126.0     270.0      30.00      .000         .0      1
   2     120.0   125.0        .0      27.00      .000         .0      0
   3      70.0    75.0        .0      35.00      .000         .0      0
   4     125.0   135.0        .0      30.00      .000         .0      2
   5      90.0    95.0        .0      17.00      .000         .0      0
   6     117.0   120.0        .0      27.00      .000         .0      0


   2 Water surface(s) have been specified

  Unit weight of water =    62.40  (pcf)

  Water Surface No.  1 specified by  7 coordinate points

  **********************************
```

```
                         WEHHCIZ
         PHREATIC SURFACE,
**********************************

  Point       x-water     y-water
   No.         (ft)        (ft)

    1            .00     2445.00
    2          88.00     2440.00
    3         200.00     2435.00
    4         343.00     2430.00
    5         650.00     2425.00
    6         925.00     2420.00
    7        1160.00     2415.00

Water Surface No.  2 specified by  4 coordinate points

**********************************
         PHREATIC SURFACE,
**********************************

  Point       x-water     y-water
   No.         (ft)        (ft)

    1         115.00     2499.00
    2         430.00     2493.00
    3         625.00     2485.00
    4        1100.00     2478.50


A horizontal earthquake loading coefficient
of   .270 has been assigned

A vertical earthquake loading coefficient
of   .000 has been assigned


A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.


 1600 trial surfaces will be generated and analyzed.


  40 Surfaces initiate from each of  40 points equally spaced
along the ground surface between   x =       .0 ft
                               and  x =    231.0 ft


Each surface terminates between    x =    600.0 ft
                              and   x =    900.0 ft


Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =       .0 ft


   20.0 ft line segments define each trial failure surface.
```

```
----------------------
ANGULAR RESTRICTIONS
----------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=   -10.0 degrees



Factors of safety have been calculated by the :

* * * * *   SIMPLIFIED BISHOP METHOD   * * * * *


  The most critical circular failure surface
  is specified by 33 coordinate points

       Point      x-surf      y-surf
        No.        (ft)        (ft)

         1         17.77     2498.79
         2         37.44     2495.20
         3         57.21     2492.13
         4         77.05     2489.61
         5         96.95     2487.62
         6        116.90     2486.17
         7        136.87     2485.25
         8        156.87     2484.88
         9        176.87     2485.05
        10        196.86     2485.76
        11        216.82     2487.01
        12        236.74     2488.80
        13        256.60     2491.12
        14        276.40     2493.98
        15        296.11     2497.38
        16        315.72     2501.30
        17        335.22     2505.76
        18        354.59     2510.74
        19        373.81     2516.24
        20        392.89     2522.26
        21        411.79     2528.79
        22        430.51     2535.83
        23        449.03     2543.37
        24        467.35     2551.42
        25        485.43     2559.95
        26        503.29     2568.97
        27        520.89     2578.46
        28        538.22     2588.43
        29        555.29     2598.87
        30        572.06     2609.76
        31        588.53     2621.10
        32        604.70     2632.88
        33        606.14     2634.00

****  Simplified BISHOP FOS =   1.282  ****
```

```
The following is a summary of the TEN most critical surfaces

Problem Description : WESTERN ELITE H-H CIRCULAR SEISMIC

         FOS       Circle Center       Radius   Initial  Terminal  Resisting
       (BISHOP)  x-coord   y-coord              x-coord   x-coord    Moment
                  (ft)      (ft)        (ft)     (ft)      (ft)     (ft-lb)

  1.     1.282   160.61   3224.94     740.06     17.77    606.14   8.357E+08
  2.     1.284   172.98   3172.75     690.36     23.69    604.61   8.218E+08
  3.     1.285   191.71   3266.63     782.67     41.46    652.42   1.076E+09
  4.     1.294   218.68   3290.04     807.64     59.23    689.62   1.279E+09
  5.     1.315   270.68   2915.82     433.67    118.46    600.19   5.438E+08
  6.     1.326   237.93   3158.38     679.61     77.00    670.13   1.113E+09
  7.     1.326   275.21   3088.50     606.80    106.62    677.04   9.759E+08
  8.     1.329   265.07   3079.21     598.71    100.69    665.25   9.504E+08
  9.     1.333   244.90   3307.44     826.57     77.00    724.11   1.499E+09
 10.     1.336   259.38   3295.67     814.38     88.85    734.16   1.507E+09

                         * * *  END OF FILE  * * *
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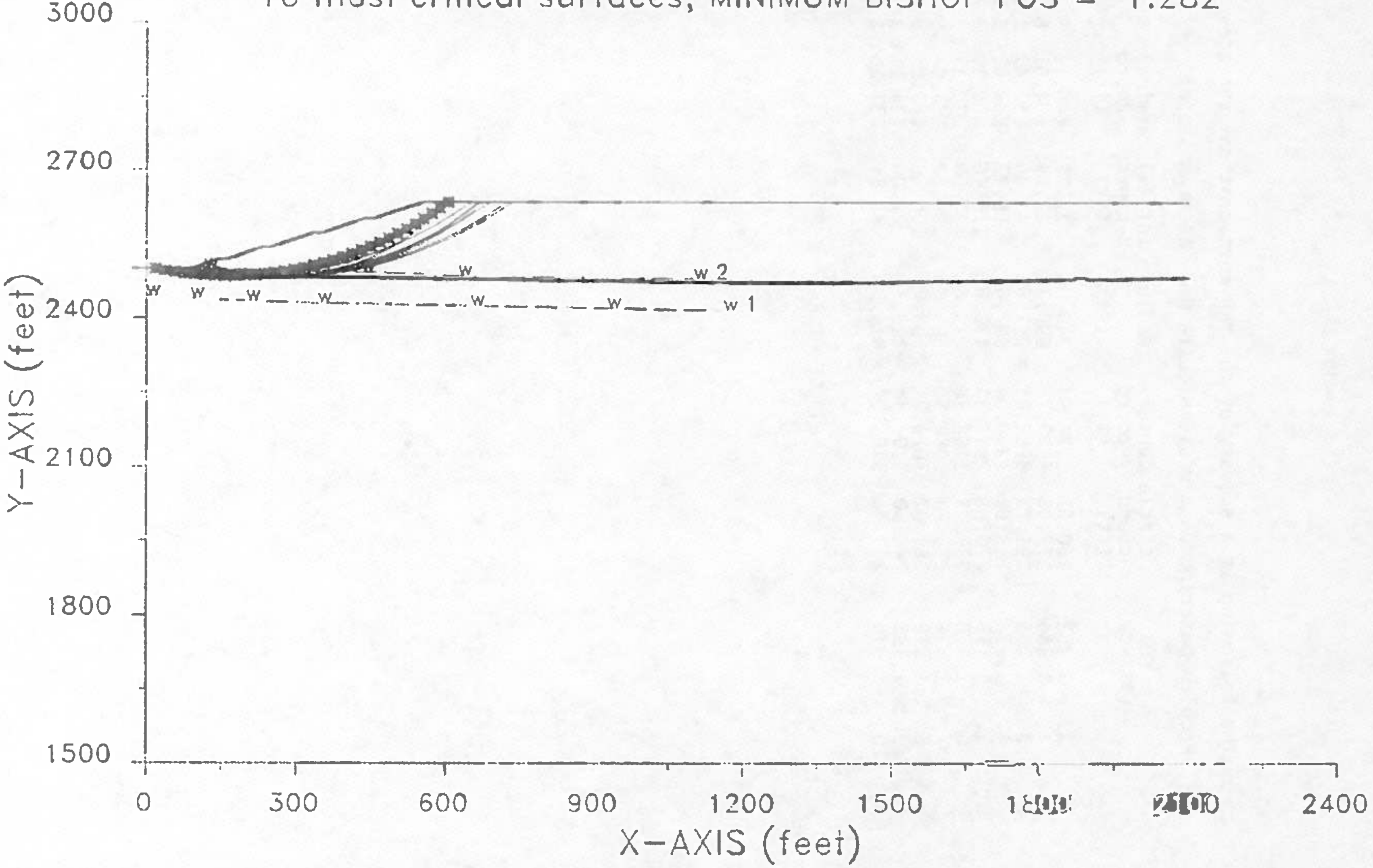
WESTERN ELITE H-H CIRCULAR SEISMIC
10 most critical surfaces, MINIMUM BISHOP FOS = 1.282



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Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/24/13
Revised By: Date:
Checked By: Date:
Subject: Seismic Deformation Stability
Sheet: 1 of 7

SEISMIC SLOPE STABILITY ANALYSIS

OBJECTIVE:

To evaluate the static and seismic slope stability for proposed permanent base liner.

METHOD:

The simplified procedure of Bray et al. (1998) is used to estimate the permanent seismic deformation for the median and 84th percentile. The peak ground acceleration used is 0.27 g. A PGA of 0.27 g corresponds to bedrock. For thick soil conditions, it is common to reduce the PGA by 10% to account for attenuation. This reduction was ignored.

CALCULATIONS:

The following figures were used to provide the inputs for the calculations as described in Bray et al (1998). These inputs and outputs are shown in the attached spreadsheets (Attachment A). The distance from the nearest epicenter is approximately 18 km. The Magnitude earthquake, M_w, is assumed to be 7.0 from historical information. Waste fill height is approximately 50 m high.

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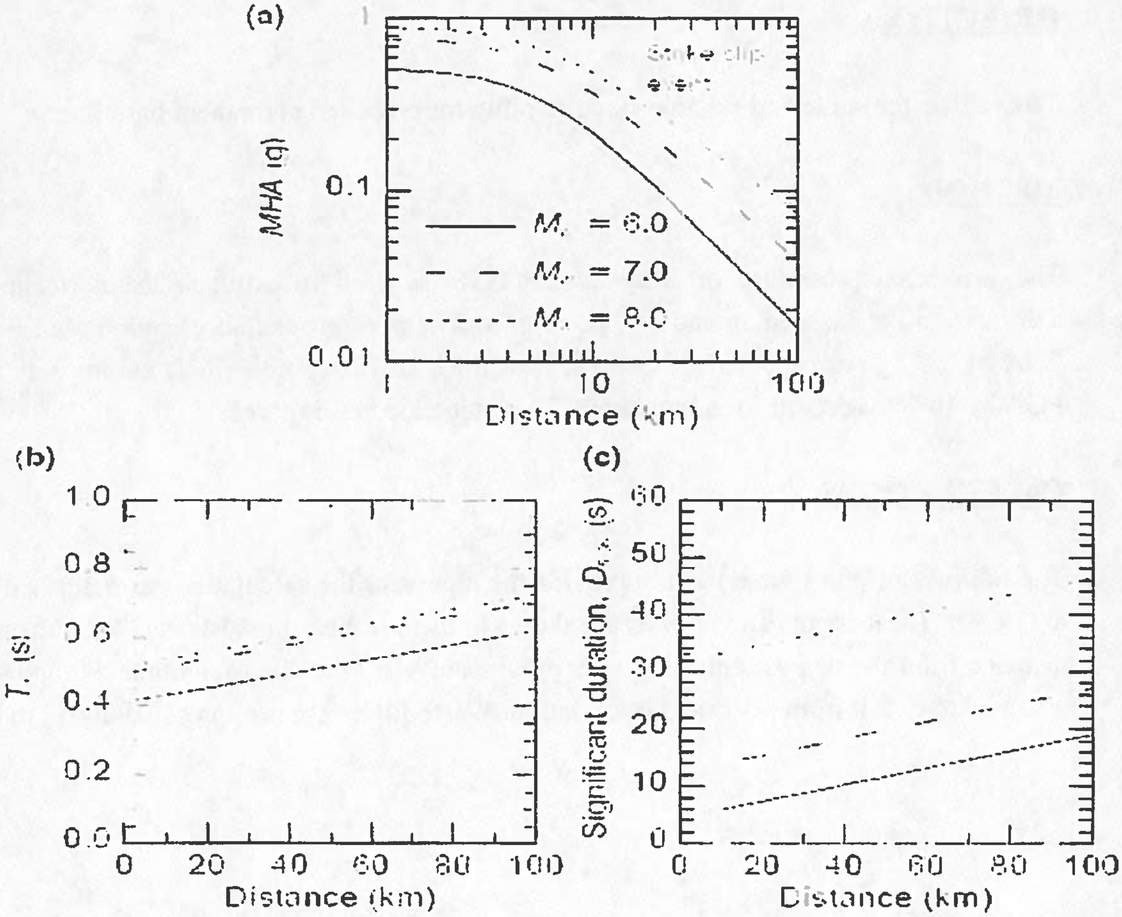

Figure 2. Simplified characterization of earthquake rock motions: (a) intensity, *MHA* for strike-slip faults (for reverse faults, use 1.3 × *MHA* for $M_w \geq 6.4$ and 1.64 × *MHA* for $M_w = 6.0$, with linear interpolation for $6.0 < M_w < 6.4$) (Abrahamson and Silva 1997); (b) frequency content, T_m (Rathje et al. 1998); (c) duration, D_{5-95} (Abrahamson and Silva 1996).

From Fig. 2, MHA = 0.25 g, T_m = 0.53 s, and D_{5-95} = 15 s.

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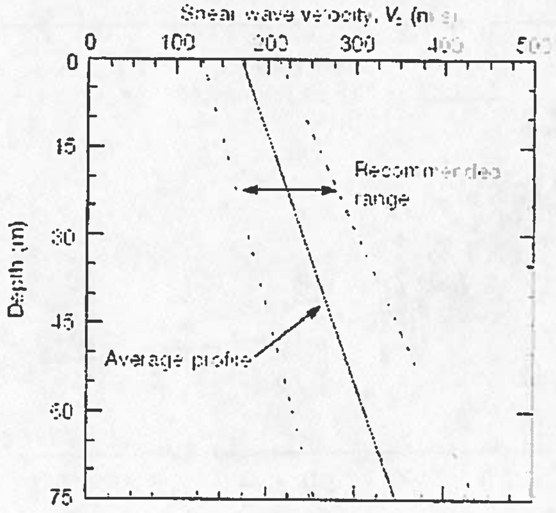

Figure 3. Shear wave velocity profiles for municipal solid-waste (after Kavazanjian et al. 1996).

From Fig. 3, the average shear wave velocity in the waste profile is 280 m/s. $T_s = 4H/V_s =$ 4 * (50 m) / 280 m/s = 0.7 s and $T_s/T_m = 1.32$.

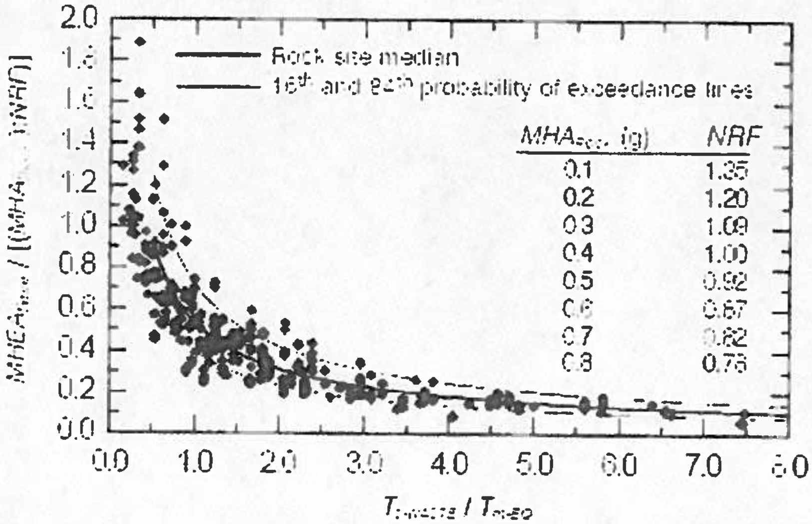

Figure 6. Normalized maximum horizontal equivalent acceleration for base sliding versus normalized fundamental period of waste fill (adapted from Bray and Rathje 1998)

From Fig. 6, $MHEA_{base}$ / [($MHEA_{rock}$)(NRF)] = 0.35 to 0.55, NRF = 1.145. Thus, $MHEA_{base}$ = 0.10 to 0.16 g.

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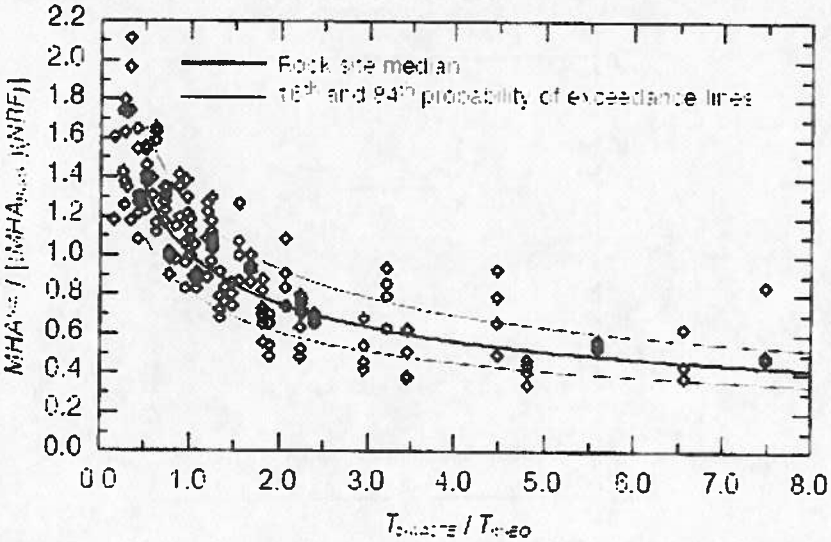

Figure 8. Normalized maximum horizontal acceleration at the top versus the normalized fundamental period of the waste fill (from Bray and Rathje 1998).

From Fig. 8, $MHEA_{top}$ / [$(MHEA_{rock})$(NRF)] = 0.70 to 1.10, NRF = 1.145. Thus, $MHEA_{top}$ = 0.20 to 0.31 g.

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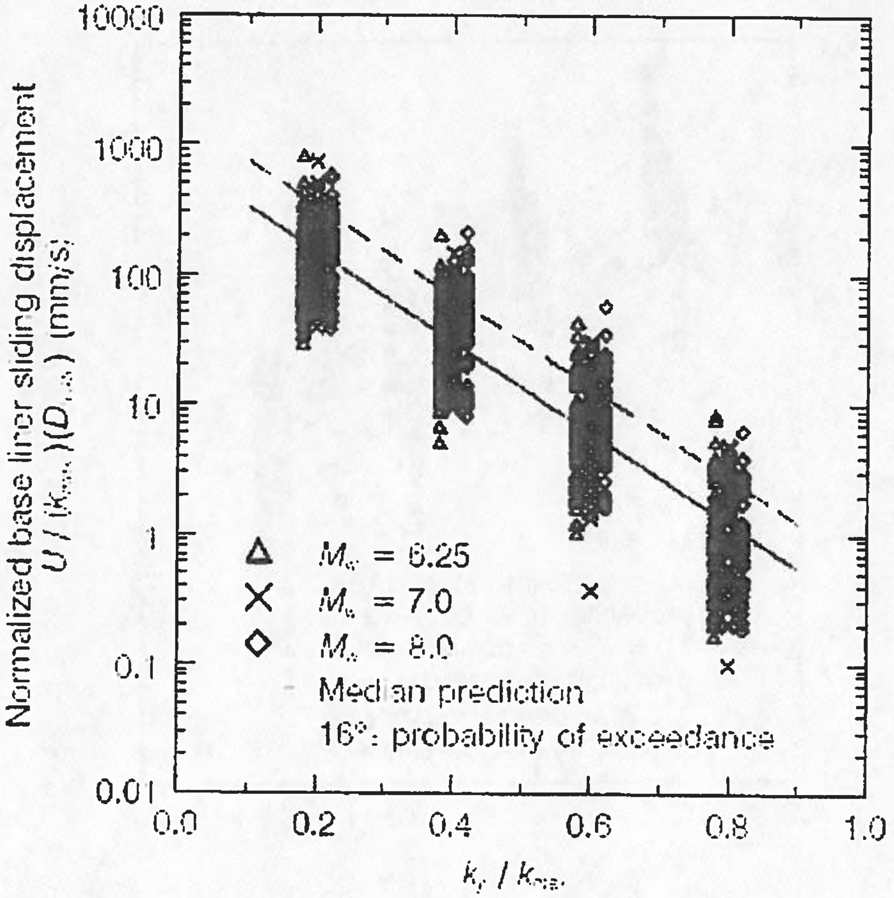

Figure 11. Normalized base liner sliding displacements (from Bray and Rathje 1998).

k_y = 0.095 g (from seismic stability with 0 cohesion for conservatism), k_{max} = $MHEA_{base}$ = 0.10 to 0.16 g. k_y/k_{max} = 0.95 to 0.59, From Fig. 11, U / (k_{max})($D_{5\text{-}95}$) ~ 8, U = 0.3 mm to 12 mm = 0.01 to 0.47 inches.

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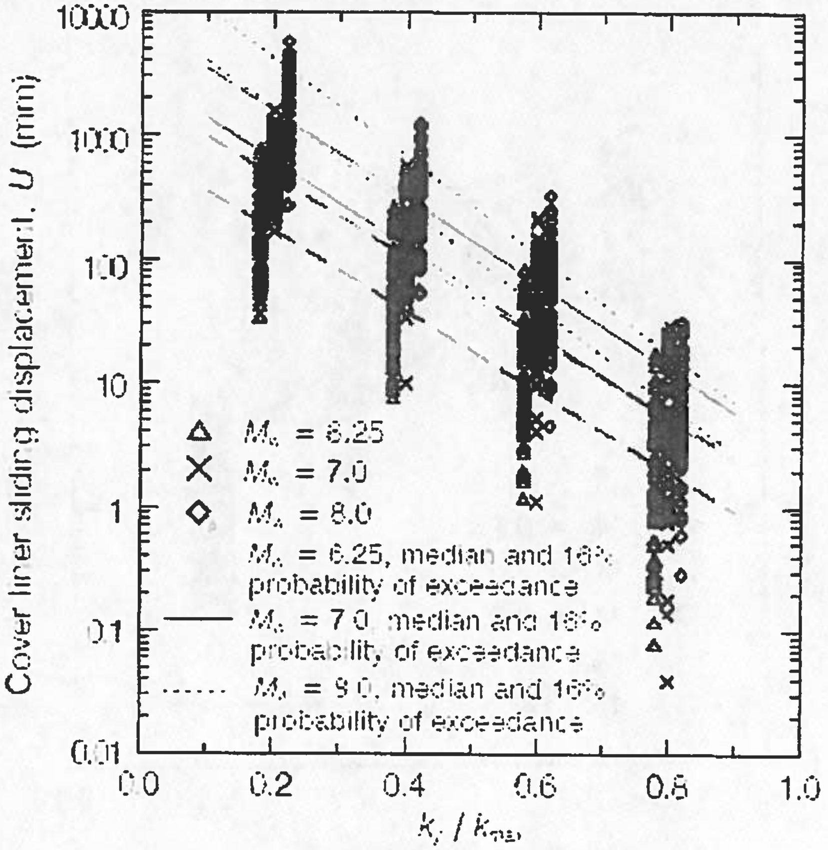

Figure 12. Cover liner sliding displacements.

k_y = 0.24 g (from seismic stability with 0 cohesion for conservatism), k_{max} = $MHEA_{base}$ = 0.20 to 0.31 g. k_y/k_{max} = 1.2 to 0.77, From Fig. 12, U = 0.1 mm to 15 mm = 0.59 inches

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CONCLUSION:

Using the simplified procedure of Bray et al. (1998), a permanent seismic deformation of less than 1 inch was computed for the design earthquake event for both the cover and liner system. Displacements of less than 6 to 12 inches are generally considered acceptable for liner/cover systems and are not expected to adversely impact the landfill's containment or control system.

REFERENCES

1. Bray, J.D., E.M. Rathje, A.J. Augello and S. M. Perry, (1998) "Simplified Seismic Design Procedure for Geosynthetic-Lined, Solid Waste Landfills. 5th Edition", Pearson Education, Inc., Pearson Prentice Hall, Upper Saddle River, N.J.

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Project: Bedroc Landfill & WMF
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Subject: Settlement
Sheet: 1 of 6

SETTLEMENT

OBJECTIVE

To estimate the bottom liner and final cover settlement for the expansion at the Bedroc Landfill.

ASSUMPTIONS

The following assumptions were made for the calculations:

- The groundwater is at or just below the bottom of the existing waste.
- The densities of materials were assumed as follows:
  - New waste – 70 pcf
- The maximum depth of influence used in the settlement calculations was assume to be 150 ft.
- Loading pressure is assumed to be equal to vertical effective stress increase in the base. No consideration for vertical stress distribution was assumed. This is conservative; the vertical stress increase will be less than the loading pressure in reality.

METHODOLOGY

A one-dimensional consolidation/compression theory is used to estimate the expected primary and secondary settlement of the waste at critical locations within the proposed landfill. A typical section for the landfill area is shown in the attached Figure 1. Settlement induced strains for base liner and the final cover were calculated and then used to evaluate the long term performance of the proposed landfill.

CALCULATIONS FOR BASE LINER SETTLEMENTS

Placement of the new waste will induce primary and secondary consolidation in the residual soils. Both primary and secondary settlements will be estimated at different critical locations along the proposed liner system. Differential settlements of the liner will be calculated to estimate the maximum induced strain in the liner. The calculated settlement induced liner strain will then be compared to the allowable strain of the liner components to assess their long term performance.

Foundation Settlement Analysis

One-dimensional elastic deformation analysis was used to estimate the primary settlement of the foundation due to vertical expansion using the SPT data found in the boring logs of the boundary probes and monitoring wells.

1. The constrained stiffness moduli of the foundation soils were calculated for the subsurface layers as,

$$E_{oed} = \frac{1-\upsilon}{(1-2\upsilon)(1+\upsilon)}E$$

where E_{oed} = constrained stiffness modulus (1D), E = deformation modulus (3D), and υ = Poisson's ratio. E was estimated from SPT N values using the average of two methods corresponding to clayey soils and sandy soils, respectively,

For clayey soils:

Method 1 : $E = 2(1+\upsilon)(0.05)(120N^{0.77})p_a$ (Wroth, et al. 1979)

Method 2 : $E = 19.3N^{0.63}p_a$ (Ohya, et al. 1982)

For sandy soils:

Method 1 : $E = 5Np_a$ (Callanan and Kulhawy, et al. 1979)

Method 2 : $E = 9.08N^{0.66}p_a$ (Ohya, et al. 1982)

where p_a = atmospheric pressure (14.7 psi). $\upsilon = 0.333$ was used in the calculations

2. Using the equation in Step 1, the foundation primary settlement was calculated as follows:

$$\delta_p = \frac{\Delta\sigma}{E_{oed}}Z$$

where $\Delta\sigma$ = the change in stress imposed by the vertical expansion (at that particular Phase), and Z = the thickness of that particular foundation layer.

3. The secondary settlement of the foundation was calculated based on SPT data as below:

$$\delta_s = 0.02\frac{1.4}{\overline{N}_{60}} Z_1 \log\left(\frac{t}{1day}\right)$$

where δ_s = settlement due to secondary consolidation;
$\overline{N}_{60}$ = arithmetic mean of the SPT-N values measured within the thickness Z_1;
Z_1 = Zone of influence. In this case, use the layer thickness of the foundation layer
t = design life of the structure, in days from the end of construction, t = 30 years = 10,950 days were used.

CALCULATIONS FOR FINAL COVER SETTLEMENT

The final cover settlement is difficult to estimate, as it is difficult to estimate when the primary settlement is complete. However, the differential settlements in the final cover are mainly a maintenance issue and are not as important as that of the base liner. In this case, it was assumed that the final cover settlement includes the settlement induced due to the top 20 ft of waste placement, in addition to the secondary settlement in the existing waste, new waste, and foundation soil. The cover is assumed to be placed at year 10, and the secondary settlements evaluated through year 30.

New Waste Settlement Analysis

Settlement of new waste was determined as shown below.

1. Primary settlement of new waste was calculated using:

$$\delta_p = H * C_c' * \log\left(\frac{\sigma'_o + \Delta\sigma}{\sigma'_0}\right)$$

where H = initial thickness of waste layer of existing landfill
C_c'= modified primary compression index (typically 0.17-0.36), assumed average Cc' = 0.265
σ'_0 = previously applied pressure in the waste layer
$\Delta\sigma$ = total overburden pressure applied at the mid-level of waste layer

2. Long term secondary settlement was calculated using:

$$\delta_s = H * C_\alpha'_{min} * \log\left(\frac{t_2}{t_1}\right) + H * C_\alpha'_{max} * \log\left(\frac{t_4}{t_3}\right)$$

where H = initial thickness of waste layer before settlement

$C_\alpha'_{min}$ = modified secondary compression index immediately following primary compression between time t_1 to t_2. A value for $C_\alpha'_{min} = 0.019$ was assumed and this settlement occurs between 1 day (t_1) to 1 month (t_2)

$C_\alpha'_{max}$ = modified secondary compression index immediately following the initial secondary compression between time t_3 to t_4. A value for $C_\alpha'_{max} = 0.125$ was assumed and this settlement occurs between 10 years (t_3) to 50 years (t_4)

CALCULATIONS FOR BASE LINER SETTLEMENTS

The settlement calculation results and differential settlement evaluation are summarized in the attached tables.

1. Liner strains were evaluated as below:

$$\varepsilon_1 = \frac{[LinerFinalLength]-[LinerInitialLength]}{LinerInitialLength}$$

Maximum Allowable Tensile Strain $\varepsilon_l < 0.12$ (12%)

The calculated liner strains for the bottom liner and final cover of the proposed expansion areas are within the tolerable range of strains for the liner materials proposed to be used for the landfill.

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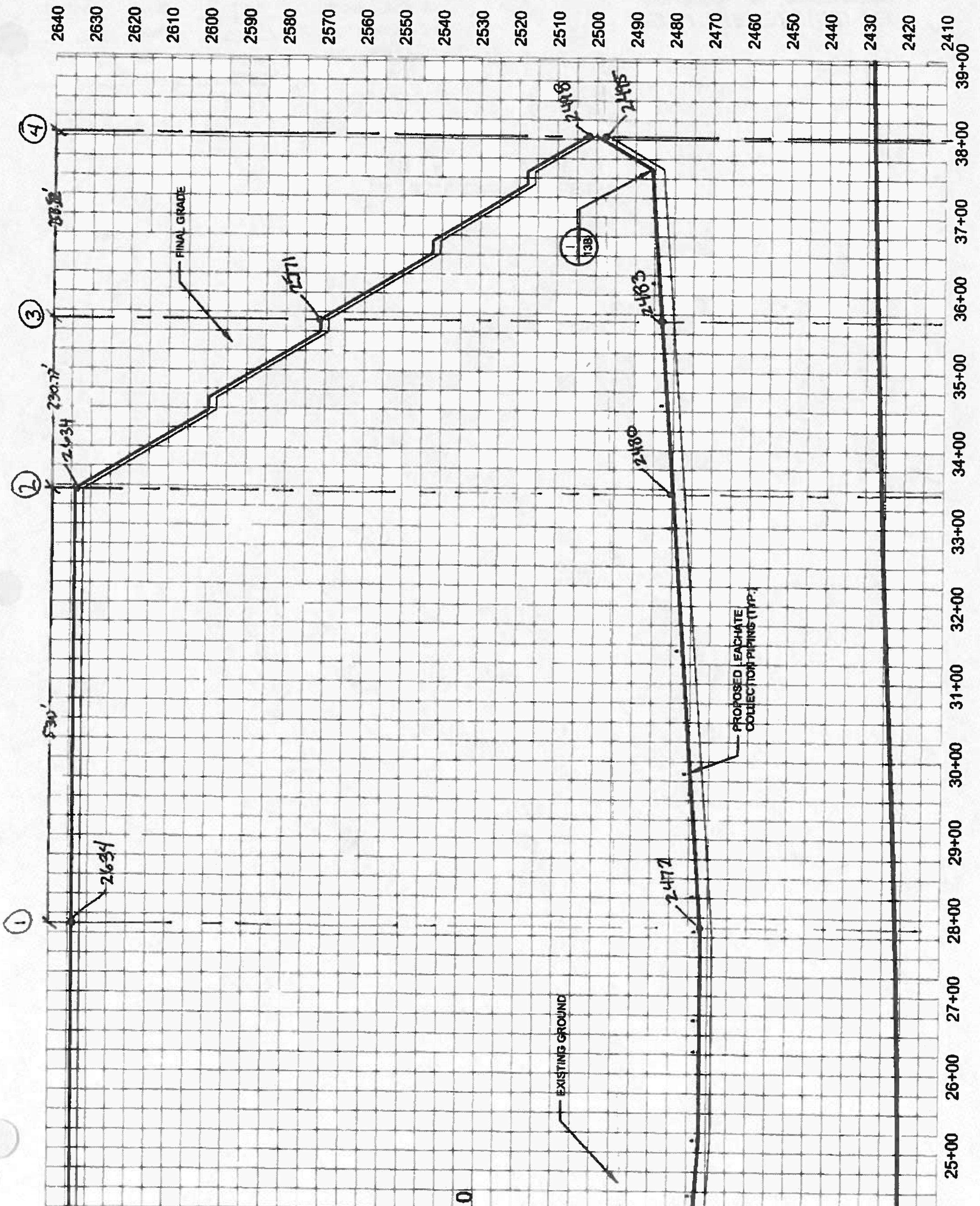
ATTACHMENT A

FIGURE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2630
2620
2610
2600
2590
2580
2570
2560
2550
2540
2530
2520
2510
2500
2490
2480
2470
2460
2450
2440
2430
2420
2410
00
25+00
26+00
27+00
28+00
29+00
30+00
31+00
32+00
33+00
34+00
35+00
36+00
37+00
38+00
39+00
①
②
③
④
530'
230.77'
337.8'
2634
2634
2571
2496
2495
2483
2480
2472
FINAL GRADE
EXISTING GROUND
PROPOSED LEACHATE COLLECTION PIPING (TYP.)
1
13B

JOYCE ENGINEERING

Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/23/13
Revised By: Date:
Checked By: Date:
Subject: Settlement
Sheet: 6 of 6

ATTACHMENT B
SETTLEMENT TABLES

JOYCE
ENGINEERING

Job: Bedroc Landfill & WMF
Job Number: 383.1401.01 Task 01
Calculated By: DWT Date: 10/23/2013
Revised By: Date:
Checked By: Date:
Subject: Settlement
Sheet: 1 of 2

Table 1 Summary of Liner Settlement Analysis - Due to Expansion

Location	Layer	Top Elevation (ft)	Bottom Elevation (ft)	Layer Thickness (ft)	σ'_o (psf)	$\Delta\sigma$ (psf)	$\delta_{primary}$ (ft)	$\delta_{secondary}$ (ft)	δ_{total} (ft)	δ_{total} (ft)	$\delta_{difference}$ (ft)
1	New Waste	2634	2472	162						6.71	
	Foundation	2472	2322	150	20,715	11,340	6.55	0.16	6.71		0.32
2	New Waste	2634	2480	154						6.39	
	Foundation	2480	2330	150	28,625	10,780	6.23	0.16	6.39		2.67
3	New Waste	2571	2483	88						3.72	
	Foundation	2483	2333	150	15,535	6,160	3.56	0.16	3.72		3.44
4	Ex Waste	2498	2495	3						0.28	
	Foundation	2495	2345	150	9,585	210	0.12	0.16	0.28		

Table 2 Evaluation of Differential Settlement of the Liner - Due to Expansion

Location	Initial Elevation (ft)	$\delta_{difference}$ (ft)	Initial Length (ft)	Final Length (ft)	ϵ (%)	Check
1	2634	0.32	530.00	530.00	0.00%	OK
2	2634	2.67	230.77	230.05	-0.31%	OK
3	2571	3.44	258.52	257.57	-0.37%	OK
4	2498					

JOYCE ENGINEERING

Job: Bedroc Landfill & WMF
Job Number: 383.1401.01 Task 01
Calculated By: DWT Date: 10/23/2013
Revised By: Date:
Checked By: Date:
Subject: Settlement
Sheet: 2 of 2

Table 3 Summary of Cover Settlement Analysis - Due to Expansion

Location	Layer	Top Elevation (ft)	Bottom Elevation (ft)	Layer Thickness (ft)	σ'_o (psf)	$\Delta\sigma$ (psf)	$\delta_{primary}$ (ft)	$\delta_{secondary}$ (ft)	δ_{total} (ft)	δ_{total} (ft)	$\delta_{difference}$ (ft)
1	Ex. New Waste	2634	2472	162	5,670			12.62	12.62	22.18	
	Foundation	2472	2322	150	15,115	1,400	1.53	8.02	9.55		0.60
2	Ex. New Waste	2634	2480	154	5,390			12.00	12.00	21.58	
	Foundation	2480	2330	150	14,890	1,400	1.55	8.02	9.58		4.86
3	Ex. New Waste	2571	2483	88	3,080			6.86	6.86	16.71	
	Foundation	2483	2333	150	12,525	1,400	1.83	8.02	9.85		6.09
4	Ex. New Waste	2498	2495	3	105			0.23	0.23	10.62	
	Foundation	2495	2345	150	9,550	1,400	2.36	8.02	10.39		

Table 4 Evaluation of Differential Settlement of the Cover Liner

Location	Initial Elevation (ft)	$\delta_{difference}$ (ft)	Initial Length (ft)	Final Length (ft)	ϵ (%)	Check
1	2634	0.60	530.00	530.00	0.00%	OK
2	2634	4.86	230.77	229.49	-0.55%	OK
3	2571	6.09	258.52	256.87	-0.64%	OK
4	2498					

JOYCE
ENGINEERING

Job: Bedroc Landfill & WMF
Job Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/9/2013
Checked By: Date:
Subject: Puncture Resistance - wheel load
Sheet: 1 of 3

Determine maximum diameter drainage material by comparing allowable pressure to pressure exerted by wheel load.

Given:

Use a 16 oz./sy geotextile for a geotextile cushion above the FML.
Use maximum size equipment will be working on stone will be a dump truck with maximum tire pressure of 65 psi.
Assume worst case, truck riding on layer of drainage material with no dissipation of energy from depth of stone accounted for.
Assume drainage material is angular and relatively small.

Find:

Find the factor of safety of a given drainage stone size to puncturing under wheel load pressures.

$$F_{reqd} = p' x d_a^2 x S_1 x S_2 x S_3$$

d_a	=	maximum diameter of the puncturing force to be resisted	=	0.75 inches
p'	=	tire pressure (100%)	=	65.00 psi
S_1	=	protrusion factor of the puncturing object	=	2.00
S_2	=	scale factor to adjust to the ASTM D4833 puncture test value	=	0.42
S_3	=	shape factor to adjust to the ASTM D4833 flat puncture probe to actual object shape	=	0.60
F_{reqd}	=	required vertical puncturing force to be resisted	=	18.43 lbs
F_{allow}	=	min. ave. roll value for puncture resistance of 16oz/sy geotextile	=	240.00 lbs

Factor of Safety $= F_{allow}/F_{reqd}$ = ***13.02***

To be conservative, assume no protective geotextile is placed over the FML:

F_{reqd}	=	required vertical puncturing force to be resisted	=	18.43 lbs
F_{allow}	=	min. ave. roll value for puncture resistance of textured HDPE liner	=	90.00 lbs

Factor of Safety $= F_{allow}/F_{reqd}$ = ***4.88***

Use a drainage material with a maximum diameter of 0.75 inches or less when using 16 oz/sy geotextile.

Reference:

Koerner, R.M. (2005).Designing with Geosynthetics. 5th Edition. Pearson Education, Inc., Pearson Prentice Hall, Upper Saddle River, NJ. (Eq. 2.30)

Determine maximum diameter stone by comparing allowable pressure to pressure exerted.

Given:

Use a 16 oz./sy geotextile for a geotextile cushion above the FML.
Use maximum height of waste of 162 feet and unit weight of landfill of 75 pcf.

Find:

Find the factor of safety of a given drainage stone size to puncturing under waste load pressures.

$$Pallow = (1/(MF_S \times MF_{PD} \times MF_A \times FS_{CR} \times FS_{CBD})) \times (50 + 0.00045 \times (M/H^2))$$

MF_S	=	mod. factor for protusion shape (angular for worst case)	=	0.75
MF_{PD}	=	mod. factor for packing density (largest stone 3/4")	=	0.50
MF_A	=	mod. factor for soil arching	=	0.25
RF_{CR}	=	reduction factor for long term creep (worst case)	=	2.0
RF_{CBD}	=	reduction factor for long term chemical/biological degradation	=	1.3
M	=	mass per unit area of geotextile	=	16 oz/yd^2 542.5 g/m^2
H	=	height of protrusion (maximum diameter stone)	=	0.75 inches
			=	0.019 m

$$Pallow = 2965.0 \text{ kPa}$$

$$Preqd = Hw * \rho w$$

Hw	=	maximum height of waste	=	162 feet 49.3776 meters
ρw	=	unit weight of landfil	=	75 pcf 11.8 kN/m^3

$$Preqd = 582.0 \text{ kPa}$$

Factor of Safety = Pallow/Preqd = 5.1

Use a drainage material with a maximum diameter of 0.75 inches or less when using 16 oz/sy geotextile.

Reference:

Koerner, R.M. (2005).Designing with Geosynthetics, 5th Edition. Pearson Education, Inc., Pearson Prentice Hall, Upper Saddle River, NJ. (Eq. 5.33)

JOYCE
ENGINEERING

Job: Bedroc Landfill & WMF
Job Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/9/2013
Checked By: Date:
Subject: Burst Resistance
Sheet: 3 of 3

Determine the factor of safety of the geotextile to provide burst resistance.

Given:

Use a 16 oz./sy geotextile for a geotextile cushion above the FML.
Use maximum size equipment will be working on drainage material will be a dump truck with maximum tire pressure of 65 psi.
Assume worst case, truck riding on layer of drainage material with no dissipation of energy from depth of stone accounted for.

Find:

Find the required geotextile strength.

$$FS = \frac{T_{allow}}{T_{reqd}} = \frac{(p_{test} d_{test})}{(\prod RF)\, p'\, d_v}$$

p_{test}	=	burst pressure of the geotextile at failure (its strength)	=	750	psi
d_{test}	=	diameter of the burst test devise (= 30 mm)	=	1.18	inches
nRF	=	cumulative reduction factors	=	4.95	
p'	=	stress on the geotextile (slightly more than the tire inflation pressure)	=	65.00	psi
d_a	=	maximum drainage material diameter	=	0.75	inches
d_v	=	maximum void diameter of the drainage material = 0.33d_a	=	0.25	inches

Factor of Safety = T_{allow}/T_{reqd} = ***11.12***

Reference:

Koerner, R.M. (2005).Designing with Geosynthetics, 5th Edition. Pearson Education, Inc., Pearson Prentice Hall, Upper Saddle River, NJ. (Eq. 2.27)

Appendix III

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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:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:       C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:     C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP307\WE10'W.D10
OUTPUT DATA FILE:            C:\HELP307\WE10'W.OUT


TIME:  16:17       DATE:  10/17/2013


******************************************************************************

     TITLE:  WESTERN ELITE - OPEN CELL WITH 10' WASTE

******************************************************************************


     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   9
           THICKNESS                     =       6.00  INCHES
           POROSITY                      =     0.5010 VOL/VOL
           FIELD CAPACITY                =     0.2840 VOL/VOL
           WILTING POINT                 =     0.1350 VOL/VOL
           INITIAL SOIL WATER CONTENT    =     0.2531 VOL/VOL
           EFFECTIVE SAT. HYD. COND.     =  0.190000006000E-03 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   9
      THICKNESS                  =     12.00   INCHES
      POROSITY                   =      0.5010 VOL/VOL
      FIELD CAPACITY             =      0.2840 VOL/VOL
      WILTING POINT              =      0.1350 VOL/VOL
      INITIAL SOIL WATER CONTENT =      0.2442 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC


              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
           AND A SLOPE LENGTH OF  263. FEET.

    SCS RUNOFF CURVE NUMBER            =     87.40
    FRACTION OF AREA ALLOWING RUNOFF   =      0.0     PERCENT
    AREA PROJECTED ON HORIZONTAL PLANE =      1.000   ACRES
    EVAPORATIVE ZONE DEPTH             =     18.0     INCHES
    INITIAL WATER IN EVAPORATIVE ZONE  =      2.085   INCHES
    UPPER LIMIT OF EVAPORATIVE STORAGE =      5.022   INCHES
    LOWER LIMIT OF EVAPORATIVE STORAGE =      1.038   INCHES
    INITIAL SNOW WATER                 =      0.000   INCHES
    INITIAL WATER IN LAYER MATERIALS   =     28.818   INCHES
    TOTAL INITIAL WATER                =     28.818   INCHES
    TOTAL SUBSURFACE INFLOW            =      0.00    INCHES/YEAR


               EVAPOTRANSPIRATION AND WEATHER DATA
               -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           LAS VEGAS            NEVADA

      STATION LATITUDE                         =  37.00 DEGREES
      MAXIMUM LEAF AREA INDEX                  =   0.00
      START OF GROWING SEASON (JULIAN DATE)    =    62
      END OF GROWING SEASON (JULIAN DATE)      =   321
      EVAPORATIVE ZONE DEPTH                   =  18.0  INCHES
      AVERAGE ANNUAL WIND SPEED                =   9.10 MPH
      AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  39.00 %
      AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  21.00 %
      AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  24.00 %
      AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  36.00 %


  NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    LAS VEGAS           NEVADA

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
```

```
                              WE10'W
                        0.0954    0.1755    0.2554    0.1365    0.2428    0.1636
  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
     TOTALS             0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                        0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

     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  6
  ------------------------------------
     TOTALS             0.0013    0.0010    0.0009    0.0008    0.0007    0.0006
                        0.0006    0.0007    0.0008    0.0007    0.0008    0.0009

     STD. DEVIATIONS    0.0052    0.0039    0.0035    0.0029    0.0027    0.0018
                        0.0015    0.0014    0.0020    0.0016    0.0017    0.0023

-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
     AVERAGES           0.0095    0.0094    0.0068    0.0060    0.0044    0.0041
                        0.0050    0.0106    0.0186    0.0074    0.0153    0.0099

     STD. DEVIATIONS    0.0205    0.0195    0.0135    0.0145    0.0093    0.0095
                        0.0143    0.0263    0.0395    0.0204    0.0376    0.0245
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                     INCHES            CU. FEET        PERCENT
                                -------------------  -------------   ---------
 PRECIPITATION                     4.36    (   1.362)     15833.0      100.00

 RUNOFF                            0.000   (  0.0000)         0.00       0.000

 EVAPOTRANSPIRATION                3.659   (  1.2402)     13281.88      83.887

 LATERAL DRAINAGE COLLECTED        0.70011 (  0.58542)     2541.390    16.05125
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH       0.00002 (  0.00001)        0.062     0.00039
   LAYER  5

 AVERAGE HEAD ON TOP               0.009 (    0.007)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH       0.00963 (  0.02710)       34.956     0.22078
   LAYER  6

 CHANGE IN WATER STORAGE          -0.007   (  0.6578)       -25.26      -0.160
*******************************************************************************
```

```
                            WE1O'W
              5         15.3720          0.4270

              6          1.9695          0.1641

          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                **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:       C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:     C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP307\WE20'W.D10
OUTPUT DATA FILE:            C:\HELP307\WE20'W.OUT


TIME:  16:19       DATE:  10/17/2013


******************************************************************************

     TITLE:  WESTERN ELITE - OPEN CELL WITH 20' WASTE

******************************************************************************


     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   9
          THICKNESS                    =       6.00  INCHES
          POROSITY                     =     0.5010 VOL/VOL
          FIELD CAPACITY               =     0.2840 VOL/VOL
          WILTING POINT                =     0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT   =     0.2531 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.190000006000E-03 CM/SEC


                                 LAYER  2
                                 --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
                           WE20'W

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   9
      THICKNESS                      =     12.00    INCHES
      POROSITY                       =      0.5010 VOL/VOL
      FIELD CAPACITY                 =      0.2840 VOL/VOL
      WILTING POINT                  =      0.1350 VOL/VOL
      INITIAL SOIL WATER CONTENT     =      0.2442 VOL/VOL
      EFFECTIVE SAT. HYD. COND.      =  0.190000006000E-03 CM/SEC


                GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
            POOR STAND OF GRASS, A SURFACE SLOPE OF  2.%
            AND A SLOPE LENGTH OF  263. FEET.

   SCS RUNOFF CURVE NUMBER               =      87.40
   FRACTION OF AREA ALLOWING RUNOFF      =       0.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE    =       1.000  ACRES
   EVAPORATIVE ZONE DEPTH                =      18.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE     =       2.085  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE    =       5.022  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE    =       1.038  INCHES
   INITIAL SNOW WATER                    =       0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS      =      37.578  INCHES
   TOTAL INITIAL WATER                   =      37.578  INCHES
   TOTAL SUBSURFACE INFLOW               =       0.00   INCHES/YEAR


                 EVAPOTRANSPIRATION AND WEATHER DATA
                 -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
            LAS VEGAS            NEVADA

        STATION LATITUDE                          =  37.00 DEGREES
        MAXIMUM LEAF AREA INDEX                   =   0.00
        START OF GROWING SEASON (JULIAN DATE)     =     62
        END OF GROWING SEASON (JULIAN DATE)       =    321
        EVAPORATIVE ZONE DEPTH                    =  18.0   INCHES
        AVERAGE ANNUAL WIND SPEED                 =   9.10 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  39.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  21.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  24.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  36.00 %


   NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
            COEFFICIENTS FOR    LAS VEGAS            NEVADA

              NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

 JAN/JUL      FEB/AUG      MAR/SEP      APR/OCT      MAY/NOV      JUN/DEC
 -------      -------      -------      -------      -------      -------
```

```
                         WE20'W
                 0.0945   0.1738   0.2571   0.1398   0.2425   0.1650

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  -----------------------------------
    TOTALS       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    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  6
  -----------------------------------
    TOTALS       0.0013   0.0010   0.0009   0.0008   0.0007   0.0006
                 0.0006   0.0007   0.0008   0.0007   0.0008   0.0009

    STD. DEVIATIONS
                 0.0052   0.0039   0.0035   0.0029   0.0027   0.0018
                 0.0015   0.0014   0.0020   0.0016   0.0017   0.0023

-----------------------------------------------------------------------------
          AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-----------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES     0.0095   0.0093   0.0069   0.0061   0.0044   0.0041
                 0.0050   0.0106   0.0187   0.0075   0.0152   0.0100

    STD. DEVIATIONS
                 0.0207   0.0194   0.0137   0.0146   0.0093   0.0095
                 0.0141   0.0260   0.0398   0.0209   0.0375   0.0247
*****************************************************************************


*****************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-----------------------------------------------------------------------------
                                     INCHES           CU. FEET     PERCENT
                               -------------------  ------------  ---------
 PRECIPITATION                   4.36    (  1.362)     15833.0     100.00

 RUNOFF                          0.000   ( 0.0000)         0.00      0.000

 EVAPOTRANSPIRATION              3.659   ( 1.2402)     13281.88     83.887

 LATERAL DRAINAGE COLLECTED      0.70011 ( 0.58565)     2541.390   16.05125
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00002 ( 0.00001)        0.062    0.00039
   LAYER  5

 AVERAGE HEAD ON TOP             0.009 (   0.007)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH     0.00963 ( 0.02710)       34.958    0.22079
   LAYER  6

 CHANGE IN WATER STORAGE        -0.007   ( 0.6584)       -25.26     -0.160
*****************************************************************************
```

```
                                  WE20'W
              5           15.3720          0.4270

              6            1.9694          0.1641

          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              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:        C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:      C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:    C:\HELP307\WE40'W.D10
OUTPUT DATA FILE:             C:\HELP307\WE40'W.OUT


TIME: 16:59       DATE: 10/17/2013


******************************************************************************

     TITLE:  WESTERN ELITE - OPEN CELL WITH 40' WASTE

******************************************************************************


     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  9
          THICKNESS                  =         6.00   INCHES
          POROSITY                   =       0.5010 VOL/VOL
          FIELD CAPACITY             =       0.2840 VOL/VOL
          WILTING POINT              =       0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =       0.2531 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =    0.190000006000E-03 CM/SEC


                                   LAYER  2
                                   --------

                        TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
                   TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   9
          THICKNESS                  =     12.00   INCHES
          POROSITY                   =      0.5010 VOL/VOL
          FIELD CAPACITY             =      0.2840 VOL/VOL
          WILTING POINT              =      0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.2448 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC


                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                 ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
           AND A SLOPE LENGTH OF  200. FEET.

        SCS RUNOFF CURVE NUMBER            =    88.40
        FRACTION OF AREA ALLOWING RUNOFF   =   100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =     1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =    18.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =     2.085  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =     5.022  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =     1.038  INCHES
        INITIAL SNOW WATER                 =     0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =    55.105  INCHES
        TOTAL INITIAL WATER                =    55.105  INCHES
        TOTAL SUBSURFACE INFLOW            =     0.00   INCHES/YEAR


                  EVAPOTRANSPIRATION AND WEATHER DATA
                  -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           LAS VEGAS           NEVADA

          STATION LATITUDE                         =  37.00 DEGREES
          MAXIMUM LEAF AREA INDEX                  =   0.00
          START OF GROWING SEASON (JULIAN DATE)    =    62
          END OF GROWING SEASON (JULIAN DATE)      =   321
          EVAPORATIVE ZONE DEPTH                   =  18.0  INCHES
          AVERAGE ANNUAL WIND SPEED                =   9.10 MPH
          AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  39.00 %
          AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  21.00 %
          AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  24.00 %
          AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  36.00 %


  NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    LAS VEGAS           NEVADA

             NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

    JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
    -------     -------     -------     -------     -------     -------
```

```
                          WE40'W
             0.0903    0.1357    0.1753    0.1099    0.2048    0.1608

 PERCOLATION/LEAKAGE THROUGH LAYER  5
 ------------------------------------
   TOTALS    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
             0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

   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  6
 ------------------------------------
   TOTALS             0.0013    0.0010    0.0009    0.0007    0.0007    0.0006
                      0.0006    0.0007    0.0008    0.0007    0.0008    0.0010

   STD. DEVIATIONS    0.0054    0.0040    0.0036    0.0030    0.0027    0.0018
                      0.0015    0.0014    0.0021    0.0017    0.0017    0.0023

-------------------------------------------------------------------------------
              AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

 DAILY AVERAGE HEAD ON TOP OF LAYER  4
 -------------------------------------
   AVERAGES           0.0117    0.0105    0.0073    0.0040    0.0027    0.0023
                      0.0043    0.0078    0.0119    0.0060    0.0142    0.0099

   STD. DEVIATIONS    0.0237    0.0198    0.0156    0.0095    0.0059    0.0057
                      0.0135    0.0203    0.0271    0.0165    0.0317    0.0241
*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                 INCHES             CU. FEET        PERCENT
                          -------------------    -------------    ---------
 PRECIPITATION              4.36    (   1.362)      15833.0        100.00

 RUNOFF                     0.050   (  0.1020)        182.49         1.153

 EVAPOTRANSPIRATION         3.707   (  1.2554)      13457.75        84.998

 LATERAL DRAINAGE COLLECTED 0.60620 (  0.47845)      2200.521      13.89834
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH 0.00002 ( 0.00001)         0.055       0.00035
   LAYER  5

 AVERAGE HEAD ON TOP        0.008 (    0.006)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH 0.00975 ( 0.02765)        35.402       0.22360
   LAYER  6

 CHANGE IN WATER STORAGE   -0.012   (  0.6766)        -43.20        -0.273
*******************************************************************************
```

```
                                    WE40'W
                  5            15.3720          0.4270

                  6             1.9643          0.1637

            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                 **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:       C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:     C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP307\WE60'W.D10
OUTPUT DATA FILE:            C:\HELP307\WE60'W.OUT


TIME:  17: 1       DATE:  10/17/2013


******************************************************************************

     TITLE:  WESTERN ELITE - OPEN CELL WITH 60' WASTE

******************************************************************************


     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   9
          THICKNESS                  =       6.00   INCHES
          POROSITY                   =       0.5010 VOL/VOL
          FIELD CAPACITY             =       0.2840 VOL/VOL
          WILTING POINT              =       0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =       0.2531 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =   0.190000006000E-03 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   9
    THICKNESS                  =      12.00    INCHES
    POROSITY                   =       0.5010 VOL/VOL
    FIELD CAPACITY             =       0.2840 VOL/VOL
    WILTING POINT              =       0.1350 VOL/VOL
    INITIAL SOIL WATER CONTENT =       0.2442 VOL/VOL
    EFFECTIVE SAT. HYD. COND.  =   0.190000006000E-03 CM/SEC


           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
           ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
           AND A SLOPE LENGTH OF  300. FEET.

  SCS RUNOFF CURVE NUMBER             =      88.20
  FRACTION OF AREA ALLOWING RUNOFF    =     100.0    PERCENT
  AREA PROJECTED ON HORIZONTAL PLANE  =       1.000  ACRES
  EVAPORATIVE ZONE DEPTH              =      18.0    INCHES
  INITIAL WATER IN EVAPORATIVE ZONE   =       2.085  INCHES
  UPPER LIMIT OF EVAPORATIVE STORAGE  =       5.022  INCHES
  LOWER LIMIT OF EVAPORATIVE STORAGE  =       1.038  INCHES
  INITIAL SNOW WATER                  =       0.000  INCHES
  INITIAL WATER IN LAYER MATERIALS    =      72.618  INCHES
  TOTAL INITIAL WATER                 =      72.618  INCHES
  TOTAL SUBSURFACE INFLOW             =       0.00   INCHES/YEAR


             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           LAS VEGAS            NEVADA

       STATION LATITUDE                           =  37.00 DEGREES
       MAXIMUM LEAF AREA INDEX                    =   0.00
       START OF GROWING SEASON (JULIAN DATE)      =     62
       END OF GROWING SEASON (JULIAN DATE)        =    321
       EVAPORATIVE ZONE DEPTH                     =  18.0  INCHES
       AVERAGE ANNUAL WIND SPEED                  =   9.10 MPH
       AVERAGE 1ST QUARTER RELATIVE HUMIDITY      =  39.00 %
       AVERAGE 2ND QUARTER RELATIVE HUMIDITY      =  21.00 %
       AVERAGE 3RD QUARTER RELATIVE HUMIDITY      =  24.00 %
       AVERAGE 4TH QUARTER RELATIVE HUMIDITY      =  36.00 %


  NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    LAS VEGAS           NEVADA

           NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
```

```
                                  WE60'W
                       0.0823   0.1360   0.1902   0.1139   0.2097   0.1762

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS             0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                       0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    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  6
  ------------------------------------
    TOTALS             0.0013   0.0010   0.0009   0.0007   0.0007   0.0006
                       0.0005   0.0007   0.0008   0.0007   0.0008   0.0009

    STD. DEVIATIONS    0.0052   0.0039   0.0035   0.0029   0.0027   0.0018
                       0.0014   0.0014   0.0020   0.0016   0.0017   0.0023

-------------------------------------------------------------------------------
             AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------

  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES           0.0106   0.0106   0.0064   0.0052   0.0029   0.0030
                       0.0035   0.0083   0.0136   0.0072   0.0134   0.0106

    STD. DEVIATIONS    0.0226   0.0221   0.0139   0.0141   0.0065   0.0089
                       0.0123   0.0204   0.0294   0.0170   0.0324   0.0264
*******************************************************************************


*******************************************************************************

    AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                     INCHES             CU. FEET     PERCENT
                                -------------------  -------------  ---------
 PRECIPITATION                    4.36    (   1.362)     15833.0     100.00

 RUNOFF                           0.048   (  0.1002)       173.69     1.097

 EVAPOTRANSPIRATION               3.693   (  1.3649)     13406.46     84.674

 LATERAL DRAINAGE COLLECTED       0.62276 (  0.51499)     2260.606   14.27783
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH      0.00002 (  0.00001)        0.057    0.00036
   LAYER  5

 AVERAGE HEAD ON TOP              0.008 (    0.007)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH      0.00968 (  0.02722)       35.150    0.22201
   LAYER  6

 CHANGE IN WATER STORAGE         -0.012   (  0.6667)       -42.94     -0.271
*******************************************************************************
```

```
                                        WE60'W
                       5           15.3720         0.4270

                       6            1.9640         0.1637

                  SNOW WATER        0.000

********************************************************************************
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```

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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:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:        C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:      C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:    C:\HELP307\WE100'W.D10
OUTPUT DATA FILE:             C:\HELP307\WE100'W.OUT


TIME:  17: 4      DATE:  10/17/2013


******************************************************************************

    TITLE:  WESTERN ELITE - OPEN CELL WITH 100' WASTE

******************************************************************************


    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   9
         THICKNESS                  =     6.00    INCHES
         POROSITY                   =     0.5010 VOL/VOL
         FIELD CAPACITY             =     0.2840 VOL/VOL
         WILTING POINT              =     0.1350 VOL/VOL
         INITIAL SOIL WATER CONTENT =     0.2531 VOL/VOL
         EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC


                                  LAYER  2
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
              TYPE 1 - VERTICAL PERCOLATION LAYER
                  MATERIAL TEXTURE NUMBER   9
     THICKNESS                   =     12.00    INCHES
     POROSITY                    =      0.5010 VOL/VOL
     FIELD CAPACITY              =      0.2840 VOL/VOL
     WILTING POINT               =      0.1350 VOL/VOL
     INITIAL SOIL WATER CONTENT  =      0.2442 VOL/VOL
     EFFECTIVE SAT. HYD. COND.   =   0.190000006000E-03 CM/SEC


              GENERAL DESIGN AND EVAPORATIVE ZONE DATA
              ----------------------------------------

  NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
           SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
           POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
           AND A SLOPE LENGTH OF  500. FEET.

   SCS RUNOFF CURVE NUMBER             =    87.90
   FRACTION OF AREA ALLOWING RUNOFF    =   100.0    PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE  =     1.000  ACRES
   EVAPORATIVE ZONE DEPTH              =    18.0    INCHES
   INITIAL WATER IN EVAPORATIVE ZONE   =     2.085  INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE  =     5.022  INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE  =     1.038  INCHES
   INITIAL SNOW WATER                  =     0.000  INCHES
   INITIAL WATER IN LAYER MATERIALS    =   107.658  INCHES
   TOTAL INITIAL WATER                 =   107.658  INCHES
   TOTAL SUBSURFACE INFLOW             =     0.00   INCHES/YEAR


              EVAPOTRANSPIRATION AND WEATHER DATA
              -----------------------------------

  NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
           LAS VEGAS           NEVADA

        STATION LATITUDE                          =  37.00 DEGREES
        MAXIMUM LEAF AREA INDEX                   =   0.00
        START OF GROWING SEASON (JULIAN DATE)     =    62
        END OF GROWING SEASON (JULIAN DATE)       =   321
        EVAPORATIVE ZONE DEPTH                    =  18.0  INCHES
        AVERAGE ANNUAL WIND SPEED                 =   9.10 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  39.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  21.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  24.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  36.00 %


  NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
           COEFFICIENTS FOR    LAS VEGAS          NEVADA

           NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL    FEB/AUG    MAR/SEP    APR/OCT    MAY/NOV    JUN/DEC
-------    -------    -------    -------    -------    -------
```

```
                            WE100'W
                       0.0811    0.1425    0.1897    0.1116    0.2014    0.1631

 PERCOLATION/LEAKAGE THROUGH LAYER  5
 ------------------------------------
   TOTALS              0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
                       0.0000    0.0000    0.0000    0.0000    0.0000    0.0000

   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  6
 ------------------------------------
   TOTALS              0.0013    0.0010    0.0009    0.0008    0.0007    0.0006
                       0.0005    0.0007    0.0008    0.0007    0.0008    0.0009

   STD. DEVIATIONS     0.0052    0.0039    0.0035    0.0029    0.0027    0.0018
                       0.0015    0.0014    0.0020    0.0016    0.0017    0.0023

-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


 DAILY AVERAGE HEAD ON TOP OF LAYER  4
 -------------------------------------
   AVERAGES            0.0101    0.0101    0.0079    0.0059    0.0040    0.0040
                       0.0035    0.0083    0.0136    0.0068    0.0132    0.0094

   STD. DEVIATIONS     0.0220    0.0192    0.0159    0.0138    0.0086    0.0096
                       0.0121    0.0213    0.0293    0.0167    0.0312    0.0244
*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                   INCHES           CU. FEET        PERCENT
                              -------------------  ------------   ---------
 PRECIPITATION                 4.36     (   1.362)    15833.0       100.00

 RUNOFF                        0.044    (  0.0921)      158.61        1.002

 EVAPOTRANSPIRATION            3.682    (  1.3221)    13366.83       84.424

 LATERAL DRAINAGE COLLECTED    0.63301 (  0.51605)     2297.841     14.51301
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH   0.00002 (  0.00001)        0.058       0.00036
   LAYER  5

 AVERAGE HEAD ON TOP           0.008 (     0.007)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH   0.00968 (  0.02714)       35.134       0.22191
   LAYER  6

 CHANGE IN WATER STORAGE      -0.007    (  0.6326)      -25.45       -0.161
*******************************************************************************
```

```
                                WE100'W
                 5           15.3720          0.4270

                 6            1.9645          0.1637

             SNOW WATER       0.000

********************************************************************************
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```

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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:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:       C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:     C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:   C:\HELP307\WEINT.D10
OUTPUT DATA FILE:            C:\HELP307\WEINT.OUT


TIME:  17: 6      DATE:  10/17/2013


******************************************************************************

    TITLE:  WESTERN ELITE - INTERMEDIATE COVER WITH 100' WASTE

******************************************************************************


    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  9
          THICKNESS                  =     12.00  INCHES
          POROSITY                   =     0.5010 VOL/VOL
          FIELD CAPACITY             =     0.2840 VOL/VOL
          WILTING POINT              =     0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.2636 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.190000006000E-03 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
```

```
                        WEINT

              TYPE 1 - VERTICAL PERCOLATION LAYER
                 MATERIAL TEXTURE NUMBER   9
      THICKNESS                  =      12.00   INCHES
      POROSITY                   =       0.5010 VOL/VOL
      FIELD CAPACITY             =       0.2840 VOL/VOL
      WILTING POINT              =       0.1350 VOL/VOL
      INITIAL SOIL WATER CONTENT =       0.2445 VOL/VOL
      EFFECTIVE SAT. HYD. COND.  =   0.190000006000E-03 CM/SEC



             GENERAL DESIGN AND EVAPORATIVE ZONE DATA
             ----------------------------------------

   NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
            SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
            POOR STAND OF GRASS, A SURFACE SLOPE OF 33.%
            AND A SLOPE LENGTH OF  500. FEET.

   SCS RUNOFF CURVE NUMBER              =    87.90
   FRACTION OF AREA ALLOWING RUNOFF     =   100.0     PERCENT
   AREA PROJECTED ON HORIZONTAL PLANE   =     1.000   ACRES
   EVAPORATIVE ZONE DEPTH               =    18.0     INCHES
   INITIAL WATER IN EVAPORATIVE ZONE    =     3.289   INCHES
   UPPER LIMIT OF EVAPORATIVE STORAGE   =     7.020   INCHES
   LOWER LIMIT OF EVAPORATIVE STORAGE   =     1.734   INCHES
   INITIAL SNOW WATER                   =     0.000   INCHES
   INITIAL WATER IN LAYER MATERIALS     =   109.297   INCHES
   TOTAL INITIAL WATER                  =   109.297   INCHES
   TOTAL SUBSURFACE INFLOW              =     0.00    INCHES/YEAR



             EVAPOTRANSPIRATION AND WEATHER DATA
             -----------------------------------

   NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
            LAS VEGAS               NEVADA

        STATION LATITUDE                             =  37.00 DEGREES
        MAXIMUM LEAF AREA INDEX                      =   0.00
        START OF GROWING SEASON (JULIAN DATE)        =     62
        END OF GROWING SEASON (JULIAN DATE)          =    321
        EVAPORATIVE ZONE DEPTH                       =  18.0  INCHES
        AVERAGE ANNUAL WIND SPEED                    =   9.10 MPH
        AVERAGE 1ST QUARTER RELATIVE HUMIDITY        =  39.00 %
        AVERAGE 2ND QUARTER RELATIVE HUMIDITY        =  21.00 %
        AVERAGE 3RD QUARTER RELATIVE HUMIDITY        =  24.00 %
        AVERAGE 4TH QUARTER RELATIVE HUMIDITY        =  36.00 %


   NOTE:  PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
            COEFFICIENTS FOR     LAS VEGAS              NEVADA

            NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

  JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
  -------     -------     -------     -------     -------     -------
```

```
                         WEINT
                   0.0246   0.0456   0.0960   0.0560   0.1120   0.1643

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                     0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    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  6
  ------------------------------------
    TOTALS           0.0010   0.0009   0.0011   0.0010   0.0009   0.0008
                     0.0007   0.0007   0.0006   0.0006   0.0006   0.0007

    STD. DEVIATIONS  0.0031   0.0023   0.0034   0.0037   0.0034   0.0029
                     0.0026   0.0023   0.0020   0.0018   0.0014   0.0019

-------------------------------------------------------------------------------
           AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES         0.0041   0.0054   0.0040   0.0022   0.0014   0.0015
                     0.0015   0.0020   0.0051   0.0035   0.0055   0.0071

    STD. DEVIATIONS  0.0108   0.0149   0.0108   0.0070   0.0038   0.0049
                     0.0037   0.0068   0.0149   0.0084   0.0173   0.0246
*******************************************************************************


*******************************************************************************

      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                   INCHES             CU. FEET      PERCENT
                             -------------------   ------------   ---------
 PRECIPITATION                4.36     (   1.362)     15833.0     100.00

 RUNOFF                       0.048    (  0.0976)       172.83      1.092

 EVAPOTRANSPIRATION           4.029    (  1.5259)     14624.52     92.368

 LATERAL DRAINAGE COLLECTED   0.28322 (  0.35387)     1028.107     6.49345
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH  0.00001 (  0.00001)        0.030     0.00019
   LAYER  5

 AVERAGE HEAD ON TOP          0.004 (    0.005)
   OF LAYER  4

 PERCOLATION/LEAKAGE THROUGH  0.00958 (  0.02985)       34.785     0.21970
   LAYER  6

 CHANGE IN WATER STORAGE     -0.008    (  0.8176)       -27.28     -0.172
*******************************************************************************
```

```
                            WEINT
              5          15.3720            0.4270

              6           1.9769            0.1647

         SNOW WATER       0.000

****************************************************************************
****************************************************************************
```

```
♀
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**                                                                          **
**              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:\HELP307\WEPRE.D4
TEMPERATURE DATA FILE:        C:\HELP307\WETEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP307\WESOL.D13
EVAPOTRANSPIRATION DATA:      C:\HELP307\WEEVAP.D11
SOIL AND DESIGN DATA FILE:    C:\HELP307\WEFIN.D10
OUTPUT DATA FILE:             C:\HELP307\WEFIN.OUT


TIME:  17: 8     DATE:  10/17/2013


******************************************************************************

     TITLE:  WESTERN ELITE - FINAL COVER WITH 100' WASTE

******************************************************************************


     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   9
          THICKNESS                    =    24.00    INCHES
          POROSITY                     =     0.5010 VOL/VOL
          FIELD CAPACITY               =     0.2840 VOL/VOL
          WILTING POINT                =     0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT   =     0.2370 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.190000006000E-03 CM/SEC


                                  LAYER  2
                                  --------

                        TYPE 2 - LATERAL DRAINAGE LAYER
```

```
                TYPE 1 - VERTICAL PERCOLATION LAYER
                    MATERIAL TEXTURE NUMBER 19
        THICKNESS                     =    1200.00    INCHES
        POROSITY                      =      0.1680 VOL/VOL
        FIELD CAPACITY                =      0.0730 VOL/VOL
        WILTING POINT                 =      0.0190 VOL/VOL
        INITIAL SOIL WATER CONTENT    =      0.0730 VOL/VOL
        EFFECTIVE SAT. HYD. COND.     =  0.100000005000E-02 CM/SEC


                              LAYER  7
                              --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER  0
        THICKNESS                     =     12.00     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.     =  0.500000000000      CM/SEC
        SLOPE                         =      2.00     PERCENT
        DRAINAGE LENGTH               =    263.0      FEET


                              LAYER  8
                              --------

                 TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER  35
        THICKNESS                     =      0.06     INCHES
        POROSITY                      =      0.0000 VOL/VOL
        FIELD CAPACITY                =      0.0000 VOL/VOL
        WILTING POINT                 =      0.0000 VOL/VOL
        INITIAL SOIL WATER CONTENT    =      0.0000 VOL/VOL
        EFFECTIVE SAT. HYD. COND.     =  0.199999996000E-12 CM/SEC
        FML PINHOLE DENSITY           =      4.00     HOLES/ACRE
        FML INSTALLATION DEFECTS      =      4.00     HOLES/ACRE
        FML PLACEMENT QUALITY         =  3 - GOOD


                              LAYER  9
                              --------

                   TYPE 3 - BARRIER SOIL LINER
                    MATERIAL TEXTURE NUMBER  16
        THICKNESS                     =     36.00     INCHES
        POROSITY                      =      0.4270 VOL/VOL
        FIELD CAPACITY                =      0.4180 VOL/VOL
        WILTING POINT                 =      0.3670 VOL/VOL
        INITIAL SOIL WATER CONTENT    =      0.4270 VOL/VOL
        EFFECTIVE SAT. HYD. COND.     =  0.100000001000E-06 CM/SEC
```

```
                                        WEFIN
      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       0.50        0.46        0.41        0.22        0.20        0.09
       0.45        0.54        0.32        0.25        0.43        0.32


         NOTE:  TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR     LAS VEGAS               NEVADA

             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

      JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
      -------     -------     -------     -------     -------     -------
       44.60       50.10       55.30       63.50       73.30       83.60
       90.30       88.00       80.10       67.60       53.60       45.40


         NOTE:  SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
                  COEFFICIENTS FOR     LAS VEGAS               NEVADA
                    AND STATION LATITUDE  =  36.08 DEGREES



*******************************************************************************

      AVERAGE MONTHLY VALUES IN INCHES FOR YEARS     1 THROUGH  100
-------------------------------------------------------------------------------

                           JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                           -------  -------  -------  -------  -------  -------
 PRECIPITATION
 -------------
   TOTALS                   0.44     0.50     0.34     0.26     0.18     0.09
                            0.42     0.60     0.38     0.29     0.49     0.37

   STD. DEVIATIONS          0.43     0.48     0.40     0.27     0.26     0.15
                            0.52     0.53     0.57     0.32     0.52     0.45
 RUNOFF
 ------
   TOTALS                  0.001    0.002    0.000    0.000    0.000    0.000
                           0.004    0.014    0.017    0.000    0.011    0.001

   STD. DEVIATIONS         0.006    0.011    0.002    0.002    0.000    0.000
                           0.021    0.057    0.071    0.003    0.047    0.011
 EVAPOTRANSPIRATION
 ------------------
   TOTALS                  0.462    0.441    0.403    0.301    0.261    0.224
                           0.311    0.381    0.378    0.329    0.328    0.410

   STD. DEVIATIONS         0.447    0.397    0.344    0.217    0.176    0.138
                           0.330    0.380    0.495    0.340    0.320    0.424
 LATERAL DRAINAGE COLLECTED FROM LAYER  2
 ----------------------------------------
   TOTALS                 0.0059   0.0036   0.0066   0.0029   0.0026   0.0035
                          0.0039   0.0045   0.0083   0.0081   0.0036   0.0210
```

```
      AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH  100
-------------------------------------------------------------------------------
                                         INCHES            CU. FEET     PERCENT
                                   -------------------  -------------  ---------
 PRECIPITATION                       4.36    (   1.362)    15833.0     100.00

 RUNOFF                              0.052   (  0.1070)     187.79      1.186

 EVAPOTRANSPIRATION                  4.226   (  1.5372)    15341.99     96.899

 LATERAL DRAINAGE COLLECTED          0.07444 (  0.14773)     270.205    1.70659
   FROM LAYER  2

 PERCOLATION/LEAKAGE THROUGH         0.01167 (  0.01434)      42.361    0.26755
   LAYER  3

 AVERAGE HEAD ON TOP                 0.000 (    0.000)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED          0.01161 (  0.01347)      42.131    0.26610
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH         0.00000 (  0.00000)       0.010    0.00007
   LAYER  9

 AVERAGE HEAD ON TOP                 0.000 (    0.000)
   OF LAYER  8

 PERCOLATION/LEAKAGE THROUGH         0.00897 (  0.01876)      32.547    0.20557
   LAYER 10

 CHANGE IN WATER STORAGE            -0.011   (  0.8989)      -41.69     -0.263
*******************************************************************************

♀
*******************************************************************************

            PEAK DAILY VALUES FOR YEARS    1 THROUGH  100
  ------------------------------------------------------------------------
                                                   (INCHES)      (CU. FT.)
                                                  ----------   -------------
    PRECIPITATION                                    1.94          7042.200

    RUNOFF                                           0.410         1487.1509

    DRAINAGE COLLECTED FROM LAYER  2                 0.15876        576.28540

    PERCOLATION/LEAKAGE THROUGH LAYER  3             0.004383        15.91147

    AVERAGE HEAD ON TOP OF LAYER  3                  0.001

    MAXIMUM HEAD ON TOP OF LAYER  3                  0.002

    LOCATION OF MAXIMUM HEAD IN LAYER  2
           (DISTANCE FROM DRAIN)                     0.0 FEET

    DRAINAGE COLLECTED FROM LAYER  7                 0.00301         10.93673

    PERCOLATION/LEAKAGE THROUGH LAYER  9             0.000000         0.00031
```

Appendix IV

JOYCE
ENGINEERING

Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T01
Calculated By: LBB Date: 10/21/13
Revised By: LBB Date: 5/19/14
Checked By: Date:
Subject: HELP Analysis
Sheet: 1 of 6

LEACHATE GENERATION AND MAXIMUM HEAD ON THE LINER

OBJECTIVE

Determine the leachate generation over the life of the Bedroc Landfill and Waste Management Facility. Also, it will be determined that the maximum leachate head does not exceed 12 inches over the liner excluding sumps.

METHODOLOGY

The Hydrologic Evaluation of Landfill Performance (HELP) Model Version 3.07 was used to simulate leachate generation. The model utilizes climatologic, soil and design data, and performs a solution technique that accounts for the effects of surface layer storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage to calculate a leachate generation volume. This model is applicable for open, partially closed and fully closed landfills.

PARAMETERS

Climatological Data:

The HELP Model utilizes historical precipitation data and generates synthetic temperature and solar radiation data for various cities in the United States. The nearest pre-defined climatic data location to the Bedroc Landfill and Waste Management Facility is Las Vegas, Nevada. This data was used to evaluate leachate generation over a period of 100 years.

Soil and Design Data:

The liner system consists of 36" of 10^{-7} cm/sec soil with a 60-mil geomembrane with 12" of drainage material on top. Profiles were examined at 10', 20' 40', 60' and 100' of waste, intermediate cover, and final closure to determine leachate generation. Profiles 1 – 5 are the conditions representing active filling conditions in which 10-feet to 100-feet of waste has been placed within the cell. Profile 6 presents a pre-closure condition in which a height of waste of 100-feet exists with intermediate cover prior to the final cover system is installed. Profile 7 presents to final closure condition after the final cover system is installed.

The following tables summarize the landfill profiles for each condition from the top down and present the following data: HELP Model default material texture number, component thickness, and component permeability. The default material texture number classifies each component within the given profile with specific default values for the proposed soil and liner components. Each material has default values for total porosity, field capacity, wilting point, and saturated hydraulic conductivity.

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ENGINEERING

Project: Bedroc Landfill & WMF
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Subject: HELP Analysis
Sheet: 2 of 6

Profile 1-5 Active Waste Filling Condition

	Layer	HELP Texture No.	Thickness	Permeability (cm/sec)
Layer 1	Daily Cover	9	6 inches	1.9E-04
Layer 2	Waste	19	10 ft - 100 ft	1.00E-03
Layer 3	Leachate Drainage Layer	0	12 inches	0.5
Layer 4	FML	35	.06 inches	2.0E-13
Layer 5	Compacted Soil Liner	16	36 inches	1.00E-07
Layer 6	Prepared Subgrade	9	12 inches	1.9E-04

Profile 6 Intermediate Cover Condition

	Layer	HELP Texture No.	Thickness	Permeability (cm/sec)
Layer 1	Intermediate Cover	9	12 inches	1.9E-04
Layer 2	Waste	19	100 ft	1.00E-03
Layer 3	Leachate Drainage Layer	0	12 inches	0.5
Layer 4	FML	35	.06 inches	2.0E-13
Layer 5	Compacted Soil Liner	16	36 inches	1.00E-07
Layer 6	Prepared Subgrade	9	12 inches	1.9E-04

Profile 7 Final Closure Condition FML Cap

	Layer	HELP Texture No.	Thickness	Permeability (cm/sec)
Layer 1	Protective Layer	9	24 inches	1.9E-04
Layer 2	GC	20	0.2 inches	10
Layer 3	FML	35	0.06 inches	2.0E-13
Layer 4	GC	20	0.2 inches	10
Layer 5	Intermediate Cover	8	12 inches	3.70E-04
Layer 6	Waste	18	60 feet	1.00E-03
Layer 7	Leachate Drainage Layer	0	18 inches	0.1
Layer 8	FML	35	.06 inches	2.0E-13
Layer 9	Compacted Soil Liner	16	24 inches	1.00E-07
Layer 10	Prepared Subgrade	9	12 inches	1.9E-04

Project:	Bedroc Landfill & WMF		
Project Number:	00383.1401.01 T01		
Calculated By:	LBB	Date:	10/21/13
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Checked By:		Date:	
Subject:	HELP Analysis		
Sheet:	3 of 6		

ASSUMPTIONS:

1. The geotextiles were omitted from HELP Model runs as their relative thickness and high permeability will not affect leachate generation results.
2. The leachate drainage layer shall have a minimum thickness of 12 inches with a minimum permeability of 0.5 cm/sec.
3. A 263-foot long floor drainage length has been assumed for all scenarios.
4. Profiles have assumed evaporative zone depths of 18 inches, poor stand of grass, and a leaf area index of 0.
5. The final cover system geocomposite drainage layer in Profile 8 is modeled with a 33% slope and 100-foot slope drainage length.
6. The compacted soil liner within the liner system has a maximum permeability of 1 x 10^{-7} cm/sec.
7. The compacted soil barrier layer within the cap system conforms to NAC 444.6891 that require the permeability of the cap be less than or equal to the permeability of the bottom liner.
8. The liner and cap FMLs were each modeled with an average of 8 pinholes per acre, four resulting from the manufacturing process and four created during installation defects.

CALCULATIONS

Analyses were performed incorporating the design parameters described above. All of the calculated leachate generation estimates were performed for a landfill area of 1-acre. The calculated leachate generation estimates will be used in other calculations to design components within the leachate management system. The highest average monthly flow rate for the 100-year simulation period is used to estimate leachate generation and sizing of the leachate storage pond . Analyses were performed assuming waste depths of 10-feet through 100-feet above the cell floor during active operating conditions. A closure scenario using a final waste height of 100-foot is also calculated.

The following tables summarize the results of the analyses with a slope of 2 percent.

JOYCE ENGINEERING

Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T01
Calculated By: LBB Date: 10/21/13
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Profile	Waste Depth (ft)	Slope (%)	Max. Flow Length Between Pipes (ft)	Max. Daily Head (in)	Peak Average Monthly Flow (in/month)	Daily Flow Rate (gal/acre/day)
1	10	2	263	2.504	0.1205	108
2	20	2	263	2.061	0.1206	108
3	40	2	263	1.637	0.0917	82
4	60	2	263	1.599	0.0876	78
5	100	2	263	1.544	0.0878	78
7	INT	2	263	1.423	0.0475	42
8	FINAL	2	263	0.028	0.0015	1

Peak average monthly flow is converted to a daily flow rate (gal/acre/day) by the following method:

$$\frac{0.1205\text{ in}}{\text{mon}} * \frac{12\text{ mon}}{\text{yr}} * \frac{1\text{ yr}}{365\text{ days}} * \frac{43{,}560\text{ ft}^2}{\text{acre}} * \frac{1\text{ ft}}{12\text{ inch}} * \frac{7.481\text{ gal}}{\text{ft}^3} = \mathbf{108\text{ gal/acre/day}}$$

TOTAL LANDFILL FLOW ESTIMATION

Over the life of the facility, the maximum daily leachate flow is estimated to be approximately 3,500 gallons/day. This occurs during waste placement activities in Cell 15. The maximum daily leachate flow was determined by evaluating various depths of waste as the landfill is developed and filled. Calculations were based on the daily flow during the peak average month during the 100-year simulation period. Leachate production estimates are included in Appendix I.

LEACHATE STORAGE POND

The capacity of the leachate storage pond needed to provide storage for 7 days of the maximum daily leachate flow is approximately 25,000 gallons.

The capacity of the proposed leachate storage pond is approximately 140,000 gallons with 1-foot of freeboard.

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ENGINEERING

Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T01
Calculated By: LBB Date: 10/21/13
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Checked By: Date:
Subject: HELP Analysis
Sheet: 5 of 6

CONCLUSIONS

The maximum head on the liner does not exceed 12-inches as required by NAC 444.681. The minimum permeability of the leachate collection layer is 0.5 cm/sec. The maximum flow length between pipes is 263 feet for the cell floor areas with 2 percent slope.

Project:	Bedroc Landfill & WMF		
Project Number:	00383.1401.01 T01		
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Revised By:	LBB	Date:	5/19/14
Checked By:		Date:	
Subject:	HELP Analysis		
Sheet:	6 of 6		

Attachment 1

Leachate Production and Collection Calculations

Leachate Production Summary Table

		2	3	4		5				
AVERAGE DEPTH OF WASTE:	**10' (acres)**	**20' (acres)**	**40' (acres)**	**60' (acres)**	**100' (acres)**	**Int. Cover (acres)**	**Final Cover (acres)**	**Total Area (acres)**	**Daily Flow in Peak Avg Month (gal/day)**	**7 Day Storage (gals)**
Phase I - Cell 1 (10.79 ac)										
10 ft waste	10.79	0.00	0.00	0.00	0.00	0.00	0.00	10.79	1,165.32	8,157
20ft waste	0.00	10.79	0.00	0.00	0.00	0.00	0.00	10.79	1,165.32	8,157
40 ft waste	0.00	0.00	10.79	0.00	0.00	0.00	0.00	10.79	884.78	6,193
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase II - Cell 2 (9.53 ac)										0
10 ft waste	9.53	0.00	10.79	0.00	0.00	0.00	0.00	20.32	1,914.02	13,398
20ft waste	0.00	9.53	10.79	0.00	0.00	0.00	0.00	20.32	1,914.02	13,398
40 ft waste	0.00	0.00	20.32	0.00	0.00	0.00	0.00	20.32	1,666.24	11,664
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase III - Cell 3 (7.31 ac)										0
10 ft waste	7.31	0.00	20.32	0.00	0.00	0.00	0.00	27.63	2,455.72	17,190
20ft waste	0.00	7.31	20.32	0.00	0.00	0.00	0.00	27.63	2,455.72	17,190
40 ft waste	0.00	0.00	25.75	0.00	0.00	0.00	1.88	27.63	2,113.38	14,794
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase IV - Cell 4 (6.84 ac)										0
10 ft waste	6.84	0.00	25.75	0.00	0.00	0.00	1.88	34.47	2,852.10	19,965
20ft waste	0.00	6.84	25.75	0.00	0.00	0.00	1.88	34.47	2,852.10	19,965
40 ft waste	0.00	0.00	32.57	0.00	0.00	0.00	1.88	34.45	2,672.62	18,708
60 ft waste	0.00	0.00	0.00	26.78	0.00	0.00	7.69	34.47	2,096.53	14,676
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase V - Cell 5 (6.50 ac)										0
10 ft waste	6.50	0.00	0.00	26.78	0.00	0.00	7.69	40.97	2,798.53	19,590
20ft waste	0.00	6.50	0.00	24.91	0.00	0.00	9.56	40.97	2,654.54	18,582
40 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Leachate Production Summary Table

		2	3	4		5				
AVERAGE DEPTH OF WASTE:	**10' (acres)**	**20' (acres)**	**40' (acres)**	**60' (acres)**	**100' (acres)**	**Int. Cover (acres)**	**Final Cover (acres)**	**Total Area (acres)**	**Daily Flow in Peak Avg Month (gal/day)**	**7 Day Storage (gals)**
Phase VI - Cell 6 (6.15 ac)										0
10 ft waste	6.15	6.50	0.00	24.91	0.00	0.00	9.56	47.12	3,318.74	23,231
20ft waste	0.00	12.65	0.00	9.13	0.00	0.00	25.34	47.12	2,103.68	14,726
40 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase VII - Cell 7 (6.15 ac)										0
10 ft waste	6.15	12.65	0.00	9.13	0.00	0.00	25.34	53.27	2,767.88	19,375
20ft waste	0.00	18.80	0.00	9.13	0.00	0.00	25.34	53.27	2,767.88	19,375
40 ft waste	0.00	0.00	18.80	9.13	0.00	0.00	25.34	53.27	2,279.08	15,954
60 ft waste	0.00	0.00	0.00	25.46	0.00	0.00	27.81	53.27	2,013.69	14,096
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase VIII - Cell 8 (7.2 ac)										0
10 ft waste	7.20	0.00	0.00	25.46	0.00	0.00	27.81	60.47	2,791.29	19,539
20ft waste	0.00	7.20	0.00	25.46	0.00	0.00	27.81	60.47	2,791.29	19,539
40 ft waste	0.00	0.00	7.20	22.50	0.00	0.00	30.77	60.47	2,376.17	16,633
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase IX - Cell 9 (6.15 ac)										0
10 ft waste	6.15	0.00	7.20	22.50	0.00	0.00	30.77	66.62	3,040.37	21,283
20ft waste	0.00	6.15	7.20	22.50	0.00	0.00	30.77	66.62	3,040.37	21,283
40 ft waste	0.00	0.00	13.35	9.54	0.00	0.00	43.73	66.62	1,882.55	13,178
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase X - Cell 10 (6.15 ac)										0
10 ft waste	6.15	0.00	13.35	9.54	0.00	0.00	43.73	72.77	2,546.75	17,827
20ft waste	0.00	6.15	13.35	9.54	0.00	0.00	43.73	72.77	2,546.75	17,827
40 ft waste	0.00	0.00	19.50	9.54	0.00	0.00	43.73	72.77	2,386.85	16,708
60 ft waste	0.00	0.00	0.00	26.22	0.00	0.00	46.55	72.77	2,091.71	14,642
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Leachate Production Summary Table

		2	3	4		5				
AVERAGE DEPTH OF WASTE:	**10' (acres)**	**20' (acres)**	**40' (acres)**	**60' (acres)**	**100' (acres)**	**Int. Cover (acres)**	**Final Cover (acres)**	**Total Area (acres)**	**Daily Flow in Peak Avg Month (gal/day)**	**7 Day Storage (gals)**
Phase XI - Cell 11 (5.41 ac)										0
10 ft waste	5.41	0.00	0.00	26.22	0.00	0.00	46.55	78.18	2,675.99	18,732
20ft waste	0.00	5.41	0.00	26.22	0.00	0.00	46.55	78.18	2,675.99	18,732
40 ft waste	0.00	0.00	5.41	21.84	0.00	0.00	50.93	78.18	2,198.07	15,386
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase XII - Cell 12 (6.82 ac)										0
10 ft waste	6.82	0.00	5.41	21.84	0.00	0.00	50.93	85.00	2,934.63	20,542
20ft waste	0.00	6.82	5.41	21.84	0.00	0.00	50.93	85.00	2,934.63	20,542
40 ft waste	0.00	0.00	12.23	10.14	0.00	0.00	62.63	85.00	1,856.41	12,995
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase XIII - Cell 13 (7.88 ac)										0
10 ft waste	7.88	0.00	12.23	10.14	0.00	0.00	62.63	92.88	2,707.45	18,952
20ft waste	0.00	7.88	12.23	10.14	0.00	0.00	62.63	92.88	2,707.45	18,952
40 ft waste	0.00	0.00	20.11	10.14	0.00	0.00	62.63	92.88	2,502.57	17,518
60 ft waste	0.00	0.00	0.00	28.29	0.00	0.00	64.59	92.88	2,271.21	15,898
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase XIV - Cell 14 (7.31 ac)										0
10 ft waste	7.31	0.00	0.00	28.29	0.00	0.00	64.59	100.19	3,060.69	21,425
20ft waste	0.00	7.31	0.00	28.29	0.00	0.00	64.59	100.19	3,060.69	21,425
40 ft waste	0.00	0.00	7.31	25.01	0.00	0.00	67.87	100.19	2,618.07	18,326
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Phase XV - Cell 15 (8.22 ac)										0
10 ft waste	8.22	0.00	7.31	25.01	0.00	0.00	67.87	108.41	3,505.83	24,541
20ft waste	0.00	8.22	7.31	25.01	0.00	0.00	67.87	108.41	3,505.83	24,541
40 ft waste	0.00	0.00	15.53	10.99	0.00	0.00	81.89	108.41	2,212.57	15,488
60 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

Leachate Production Summary Table

		2	3	4		5				
AVERAGE DEPTH OF WASTE:	**10' (acres)**	**20' (acres)**	**40' (acres)**	**60' (acres)**	**100' (acres)**	**Int. Cover (acres)**	**Final Cover (acres)**	**Total Aren (acres)**	**Daily Flow in Peak Avg Month (gal/day)**	**7 Day Storage (gals)**
Phase XVI - Cell 16 (6.78 ac)										0
10 ft waste	6.78	0.00	15.53	10.99	0.00	0.00	81.89	115.19	2,944.81	20,614
20ft waste	0.00	6.78	15.53	10.99	0.00	0.00	81.89	115.19	2,944.81	20,614
40 ft waste	0.00	0.00	22.31	10.99	0.00	0.00	81.89	115.19	2,768.53	19,380
60 ft waste	0.00	0.00	0.00	21.01	0.00	0.00	94.18	115.19	1,732.96	12,131
100 ft waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Intermediate Cover	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Final Cover	0.00	0.00	0.00	0.00	0.00	0.00	115.19	115.19	115.19	806
*Daily Flow in Peak Avg Month (gal/acre/day)	108.0	108.0	82.0	78.0	78.0	42.0	1.0			

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Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T 01
Calculated By: LBB Date: 10/21/13
Revised By: LBB Date: 5/19/14
Checked By: Date:
Subject: Leachate Pipe Size
Sheet: 1 of 2

LEACHATE COLLECTION PIPE SIZE

OBJECTIVE

Show that the proposed 6-inch diameter leachate collection piping can accommodate the anticipated leachate flows within the proposed landfill design.

METHODOLOGY

Manning's equation is used to calculate the required leachate collection pipe diameter given the expected daily peak leachate flow, Q.

Manning's Equation.

$$Q = A * \frac{1.49}{n} * (\frac{A}{WP})^{(2/3)} * \sqrt{S}$$

Solve this equation for A.

Where:

Q = Discharge (cfs); From HELP Model output data
A = Area of pipe (sq. ft); = $(\pi/4) * D^2$
D = Pipe diameter (ft)
n = Manning's roughness coefficient
WP = Wetted Perimeter (ft)
S = Minimum design slope of leachate collection pipes (ft/ft)

CALCULATIONS

Leachate Piping

The HELP model estimated a worst case daily leachate flow rate from the largest contributing area when waste is in place: Cells 13-17 (60 feet); Cell 18 (10 feet), 2,852 gal/day (381 cf/day) Assuming a factor of safety of 10 to account for obstruction, manufacturing flaws, and installation, the largest flowrate a leachate pipe can be expected to handle equals:

$$10 * 381\text{cf} * \frac{1\text{ day}}{86400\text{ sec}} = 0.044 \text{ cfs}$$

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Subject: Leachate Pipe Size
Sheet: 2 of 2

To verify the adequacy of a 6-inch leachate pipe to carry the total flow, Manning's Equation and the following assumptions were used.

Assumptions:

Pipe is flowing full
n (for HDPE pipe) = 0.012
S = 1.3% or 0.013 (minimum)

The table below shows the input parameters and maximum discharge for 6-inch diameter HDPE pipe.

material							
roughness	Slope		Inside Diameter	Area	$R^{2/3}$	$AR^{2/3}$	Qd
n	(ft/ft)	**1.49 / n**	(inches)	(sf)	(ft)		(cfs)
0.012	0.013	124.17	6	0.196	0.25	0.049	0.69

Determine the factor of safety (F.S.) that can be achieved using a 6-in diameter pipe by:

Where $$\text{F.S.} = \frac{\text{Total Allowable Discharge of Pipe}}{\text{Potential Discharge}}$$

$$\text{F.S.} = \frac{0.69\ \text{cfs}}{0.044\ \text{cfs}} = 15$$

Conclusion

6-inch leachate pipe will provide sufficient capacity for the leachate flowrates predicted by the HELP model at the landfill.

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Project:	Bedroc Landfill & WMF		
Project Number:	00383.1401.01 T 01		
Calculated By:	LBB	Date:	10/23/13
Revised By:		Date:	
Checked By:		Date:	
Subject:	Leachate Pipe Perforation Sizing		
Sheet:	1 of 2		

LEACHATE PIPE PERFORATION

OBJECTIVE

Determine the leachate pipe perforation diameter and perforation spacing along the collection pipes to accommodate the anticipated generated leachate volume.

METHODOLOGY

1. Estimate the maximum leachate flow length into the leachate collection pipe.
2. Estimate the maximum leachate production rate by using the HELP Model.
3. Calculate the minimum required hole spacing based on a maximum entrance velocity of 0.1 ft/sec (Driscol, "Groundwater and Wells").
4. Compare the D_{85} of the drainage media to the hole diameter.

$$\frac{D_{85}\text{ of drainage media}}{\text{hole diameter}} \geq 1.2$$

*Based on USEPA publication, "Lining of Waste Containment and Other Impoundment Facilities"

CALCULATIONS

The HELP model considers a maximum leachate drainage flow path of 263 ft on a 2% slope along the cell floor before entering the collection pipe. This corresponds to a maximum collection area, per linear foot of pipe, of 263 ft^2 (263 foot length by 1 foot width). HELP then uses the maximum drainage flow path to calculate a worst-case scenario peak daily leachate flow rate, Q, of 108 gal/acre/day (14.4 cf/acre/day).

The maximum leachate flow (Q) is:

$$Q = \frac{14.4\text{ cf}}{\text{acre day}} * \frac{1\text{ day}}{86400\text{ sec}} * \frac{1\text{ acre}}{43560\text{ sq. ft.}} * \frac{263\text{ sq. ft.}}{1} = 1.01 * 10^{-6}\text{ cfs}$$

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Project: Bedroc Landfill & WMF
Project Number: 00383.1401.01 T 01
Calculated By: LBB Date: 10/23/13
Revised By: Date:
Checked By: Date:
Subject: Leachate Pipe Perforation Sizing
Sheet: 2 of 2

The required open area of the leachate collection pipe is determined by:

$$A = \frac{\text{Q in cfs}}{\text{entrance velocity}} = \frac{1.01 * 10^{-6}}{0.1} = 1.01 * 10^{-5}\,\text{ft}^2$$

The minimum number of holes per linear foot is determined by:

$$\text{\# Holes} = \frac{\text{Required Open Area}}{\text{Area of Holes}}$$

The spreadsheet below shows the required number of holes per linear foot for various hole diameters and various types of drainage media.

	Perforation Diameter (in)	Perforation Area (ft^2)	Maximum Flow (cfs)	Entrance Velocity (fps)	Required Open Pipe Area (ft^2)	d85 of Stone (in)	d85/Perf. Diameter	Required Number of Perforations (per ft)
AASHTO #3 STONE	0.25	3.41E-04	1.01E-06	0.1	1.01E-05	1.83	7.32	0.03
	0.375	7.67E-04	1.01E-06	0.1	1.01E-05	1.83	4.88	0.01
	0.5	1.36E-03	1.01E-06	0.1	1.01E-05	1.83	3.66	0.01
AASHTO #57 STONE	0.25	3.41E-04	1.01E-06	0.1	1.01E-05	0.83	3.32	0.03
	0.375	7.67E-04	1.01E-06	0.1	1.01E-05	0.83	2.21	0.01
	0.5	1.36E-03	1.01E-06	0.1	1.01E-05	0.83	1.66	0.01
AASHTO #8 STONE	0.25	3.41E-04	1.01E-06	0.1	1.01E-05	0.35	1.40	0.03
	0.375	7.67E-04	1.01E-06	0.1	1.01E-05	0.35	0.93	0.01
	0.5	1.36E-03	1.01E-06	0.1	1.01E-05	0.35	0.70	0.01

CONCLUSIONS

Any combination of stone size and perforation diameter that yields a D_{85}/hole diameter value greater than or equal to 1.2 may be used. A perforation hole diameter of 3/8-inch is proposed, spaced at a minimum interval of 8-holes per linear foot using 4 rows of holes, oriented at 90 degrees from one another along the full length of each installed 6-inch diameter leachate pipe. This is a conservative design that considers the possibility of potential hole clogging from biological growth and blockage from the drainage stone.

$$FS = \frac{\text{Actual Number of Perforations}}{\text{Required Number of Perforations}} = \frac{8}{0.01} = 800$$

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Job: Bedroc Landfill & WMF
Job Number: 00383.1401.01 T01
Calculated By: DWT Date: 10/9/2013
Checked By: Date:
Subject: Bearing Strength of Aggregate
Sheet: 1 of 1

Determine the factor of safety for aggregate from crushing.

Given:

The fracture strength for stone is generally above 2,000 psi.
Use a maximum height of waste of 162 feet and unit weight of landfill of 75 pcf.
Use a height of cover of 2.0 feet and unit weight of cover of 125 pcf

Find:

Find the factor of safety.

$$P_{allow} = \textit{Fracture strength of aggregate}$$

$$P_{allow} = 2{,}000 \text{ psi}$$

$$P_{reqd} = H_w * r_w + H_c * r_c$$

H_w = maximum height of waste = 162 feet
r_w = unit weight of landfill = 75 pcf
H_c = height of cover = 2 feet
r_c = unit weight of cover = 125 pcf

$$P_{reqd} = 12{,}400 \text{ psf}$$

$$86.1 \text{ psi}$$

$$\textit{Factor of Safety} = P_{allow}/P_{reqd} = \underline{23.2}$$

The drainage stone will provide more than enough support to the expected loads with out fracturing.

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Job: Bedroc Landfill & WMF
Job Number: 383.1401.01 T01
Calculated By: LBB Date: 10/23/2013
Checked By: Date:
Subject: Pipe Strength
Sheet: 1 of 2

Given:

Using 6" diameter HDPE SDR 15.5, the maximum load will be from the pipe carrying leachate.

Find:

Find the maximum anticipated static load on this pipe and calculate actual compressive stress.

$$P_t = r \times D$$

Fill Items	Unit Weights, r (pcf)	Depth of Fill, D (ft)	Load, rD (psf)
Assume 1.5' Drainage Layer	135	1.5	203
Assumed Maximum Waste Height	75	162	12,150
Assume 4.0' Closure Cap Soil	125	2	250
Totals	***112***	***165.5***	***12,603***

Find the pipe resistance to wall crushing.

$$S_A = ((SDR\text{-}1)/2) \times P_t$$

P_t = maximum vertical stress = 87.5 psi
SDR = standard dimension ratio (O.D./wall thickness) = 15.5
S_A = actual compressive stress = 634.5 psi
S_{allow} = compressive yield strength of material = 1,500 psi

Factor of Safety against crushing = S_{allow} / S_A = $\underline{2.4}$

Find the pipe resistance to wall buckling.

$$P_{cb} = 0.8 \times sqrt(E' \times P_c)$$

E = modulus of elasticity from Chart 25 (using 50 yrs life and S_A) = 16,500 psi
P_c = critical-collapse differential pressure ($P_c = 2.32 \times E / SDR^3$) = 10.3 psi
g_s = vertical soil strain from Chart 26 (using 90% compaction and P_t as calculated) = 2 %
E' = soil modulus ($E' = P_t/g_s$) = 4,375.9 psi
P_{cb} = critical buckling pressure at top of pipe = 169.7 psi

Factor of Safety against buckling = P_{cb} / P_t = $\underline{1.9}$

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Job: Bedroc Landfill & WMF
Job Number: 383.1401.01 T01
Calculated By: LBB Date: 10/23/13
Checked By: Date:
Subject: Pipe Strength
Sheet: 2 of 2

Find the pipe resistance to pipe deflection.

$$\% \text{ deflection} = (X \times 100\%)/OD$$
$$X = (K \times D \times W)/(0.149 \times PS) + (0.61 \times E')$$

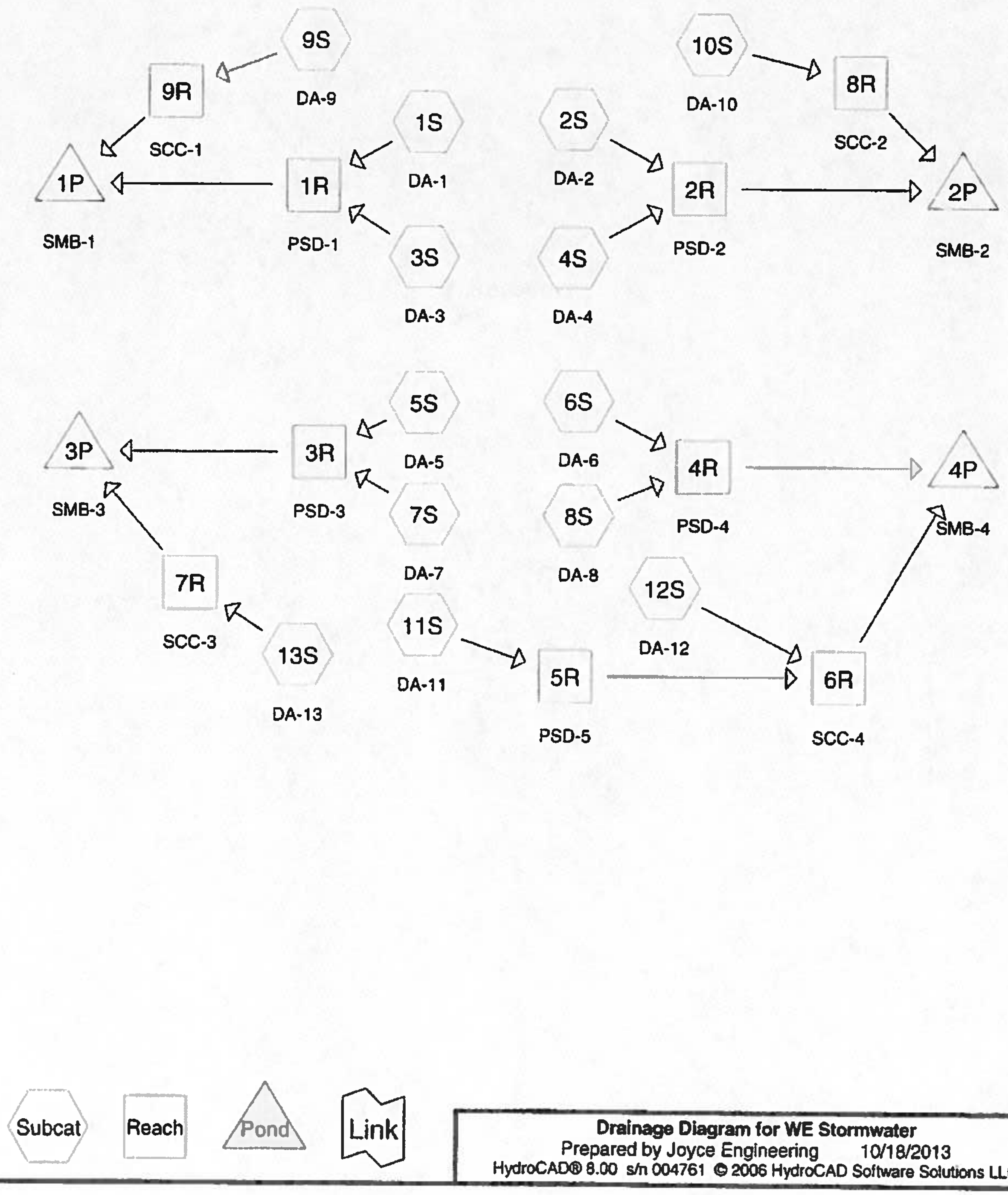
K	=	bedding factor	=	0.1	
D	=	deflection lag factor	=	1.5	
DC	=	depth of fill	=	162	feet
OD	=	outside diameter	=	6.625	inches
r	=	average soil density	=	76.1	lb/ft^3
W	=	weight per lineal inch (W =(DC x OD x (r/144)	=	567.5	lb/inch
E	=	flexural modulus of pipe	=	100,000	psi
E'	=	soils modulus (calculated previously)	=	4,376	psi
t	=	thickness of pipe	=	0.427	inch
I	=	moment of inertia of pipe $(t^3/12)$	=	6.488E-03	
R	=	mean radii of the pipe ((OD-t)/2)	=	3.099	inches
PS	=	pipe stiffness $((E \times I)/(0.149 \times R^3))$	=	146.302	psi
X	=	calculated deflection	=	0.019	inch
$\%_{allow}$	=	allowable pipe deflection	=	3.00	%
		% deflection	=	**0.29**	**%**

Factor of Safety for deflection $= \%_{allow} / \%_{deflection} =$ ***10.3***

References:

"Plexco Piping Systems Technical Information," Chevron Corporation, 11/91
"Driscopipe Systems Design Manual," Phillips 66 Corporation, 1988

Appendix V



Drainage Diagram for WE Stormwater
Prepared by Joyce Engineering 10/18/2013
HydroCAD® 8.00 s/n 004761 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
134.500	68	Desert shrub range, Good, HSG B (1S,2S,3S,4S,5S,6S,7S,8S,9S,10S,11S,
134.500		

Time span=5.00-32.00 hrs, dt=0.05 hrs, 541 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: DA-1 Runoff Area=12.800 ac Runoff Depth=0.21"
Flow Length=989' Tc=14.3 min CN=68 Runoff=1.99 cfs 0.229 af

Subcatchment 2S: DA-2 Runoff Area=12.300 ac Runoff Depth=0.21"
Flow Length=979' Tc=14.3 min CN=68 Runoff=1.91 cfs 0.220 af

Subcatchment 3S: DA-3 Runoff Area=17.300 ac Runoff Depth=0.21"
Flow Length=1,529' Tc=16.2 min CN=68 Runoff=2.47 cfs 0.310 af

Subcatchment 4S: DA-4 Runoff Area=16.600 ac Runoff Depth=0.21"
Flow Length=1,488' Tc=15.9 min CN=68 Runoff=2.39 cfs 0.297 af

Subcatchment 5S: DA-5 Runoff Area=17.200 ac Runoff Depth=0.21"
Flow Length=1,521' Tc=16.2 min CN=68 Runoff=2.45 cfs 0.308 af

Subcatchment 6S: DA-6 Runoff Area=16.500 ac Runoff Depth=0.21"
Flow Length=1,497' Tc=16.0 min CN=68 Runoff=2.37 cfs 0.295 af

Subcatchment 7S: DA-7 Runoff Area=12.700 ac Runoff Depth=0.21"
Flow Length=874' Tc=13.9 min CN=68 Runoff=2.01 cfs 0.227 af

Subcatchment 8S: DA-8 Runoff Area=11.700 ac Runoff Depth=0.21"
Flow Length=1,000' Tc=14.1 min CN=68 Runoff=1.84 cfs 0.210 af

Subcatchment 9S: DA-9 Runoff Area=0.800 ac Runoff Depth=0.21"
Flow Length=771' Slope=0.0026 '/' Tc=71.3 min CN=68 Runoff=0.04 cfs 0.014 af

Subcatchment 10S: DA-10 Runoff Area=6.400 ac Runoff Depth=0.21"
Flow Length=2,462' Slope=0.0040 '/' Tc=145.4 min CN=68 Runoff=0.23 cfs 0.115 af

Subcatchment 11S: DA-11 Runoff Area=1.400 ac Runoff Depth=0.21"
Flow Length=498' Slope=0.0720 '/' Tc=9.5 min CN=68 Runoff=0.28 cfs 0.025 af

Subcatchment 12S: DA-12 Runoff Area=5.600 ac Runoff Depth>0.21"
Flow Length=2,455' Slope=0.0016 '/' Tc=229.4 min CN=68 Runoff=0.16 cfs 0.100 af

```
Subcatchment 13S: DA-13                               Runoff Area=3.200 ac   Runoff Depth=0.21"
           Flow Length=1,435'  Slope=0.0110 '/'  Tc=56.9 min  CN=68  Runoff=0.20 cfs  0.057 af

Reach 1R: PSD-1                      Avg. Depth=0.34'  Max Vel=14.70 fps   Inflow=4.39 cfs  0.539 af
      D=18.0"  n=0.020  L=198.0'  S=0.3333 '/'  Capacity=39.42 cfs  Outflow=4.37 cfs  0.539 af

Reach 2R: PSD-2                      Avg. Depth=0.33'  Max Vel=14.56 fps   Inflow=4.25 cfs  0.518 af
      D=18.0"  n=0.020  L=228.0'  S=0.3333 '/'  Capacity=39.42 cfs  Outflow=4.23 cfs  0.518 af

Reach 3R: PSD-3                      Avg. Depth=0.34'  Max Vel=14.68 fps   Inflow=4.38 cfs  0.535 af
      D=18.0"  n=0.020  L=216.0'  S=0.3333 '/'  Capacity=39.42 cfs  Outflow=4.36 cfs  0.535 af

Reach 4R: PSD-4                      Avg. Depth=0.33'  Max Vel=14.45 fps   Inflow=4.14 cfs  0.505 af
      D=18.0"  n=0.020  L=246.0'  S=0.3333 '/'  Capacity=39.42 cfs  Outflow=4.12 cfs  0.505 af

Reach 5R: PSD-5                       Avg. Depth=0.09'  Max Vel=6.12 fps   Inflow=0.28 cfs  0.025 af
       D=18.0"  n=0.020  L=42.0'  S=0.2857 '/'  Capacity=36.50 cfs  Outflow=0.28 cfs  0.025 af

Reach 6R: SCC-4                       Avg. Depth=0.34'  Max Vel=0.57 fps   Inflow=0.28 cfs  0.125 af
                n=0.025  L=1,890.0'  S=0.0011 '/'  Capacity=18.37 cfs  Outflow=0.17 cfs  0.124 af

Reach 7R: SCC-3                       Avg. Depth=0.28'  Max Vel=0.80 fps   Inflow=0.20 cfs  0.057 af
                n=0.025  L=1,435.0'  S=0.0028 '/'  Capacity=29.82 cfs  Outflow=0.16 cfs  0.057 af

Reach 8R: SCC-2                       Avg. Depth=0.29'  Max Vel=0.99 fps   Inflow=0.23 cfs  0.115 af
                n=0.025  L=2,460.0'  S=0.0041 '/'  Capacity=36.01 cfs  Outflow=0.21 cfs  0.114 af

Reach 9R: SCC-1                       Avg. Depth=0.17'  Max Vel=0.55 fps   Inflow=0.04 cfs  0.014 af
                 n=0.025  L=772.0'  S=0.0026 '/'  Capacity=28.75 cfs  Outflow=0.04 cfs  0.014 af

Pond 1P: SMB-1                        Peak Elev=4.20'  Storage=24,105 cf   Inflow=4.37 cfs  0.553 af
                                                                         Outflow=0.00 cfs  0.000 af

Pond 2P: SMB-2                        Peak Elev=4.58'  Storage=27,524 cf   Inflow=4.23 cfs  0.632 af
                                                                         Outflow=0.00 cfs  0.000 af

Pond 3P: SMB-3                        Peak Elev=4.39'  Storage=25,820 cf   Inflow=4.36 cfs  0.593 af
                                                                         Outflow=0.00 cfs  0.000 af

Pond 4P: SMB-4                        Peak Elev=4.56'  Storage=27,401 cf   Inflow=4.12 cfs  0.629 af
                                                                         Outflow=0.00 cfs  0.000 af
```

Total Runoff Area = 134.500 ac Runoff Volume = 2.409 af Average Runoff Depth = 0.21"
100.00% Pervious Area = 134.500 ac 0.00% Impervious Area = 0.000 ac

Subcatchment 1S: DA-1

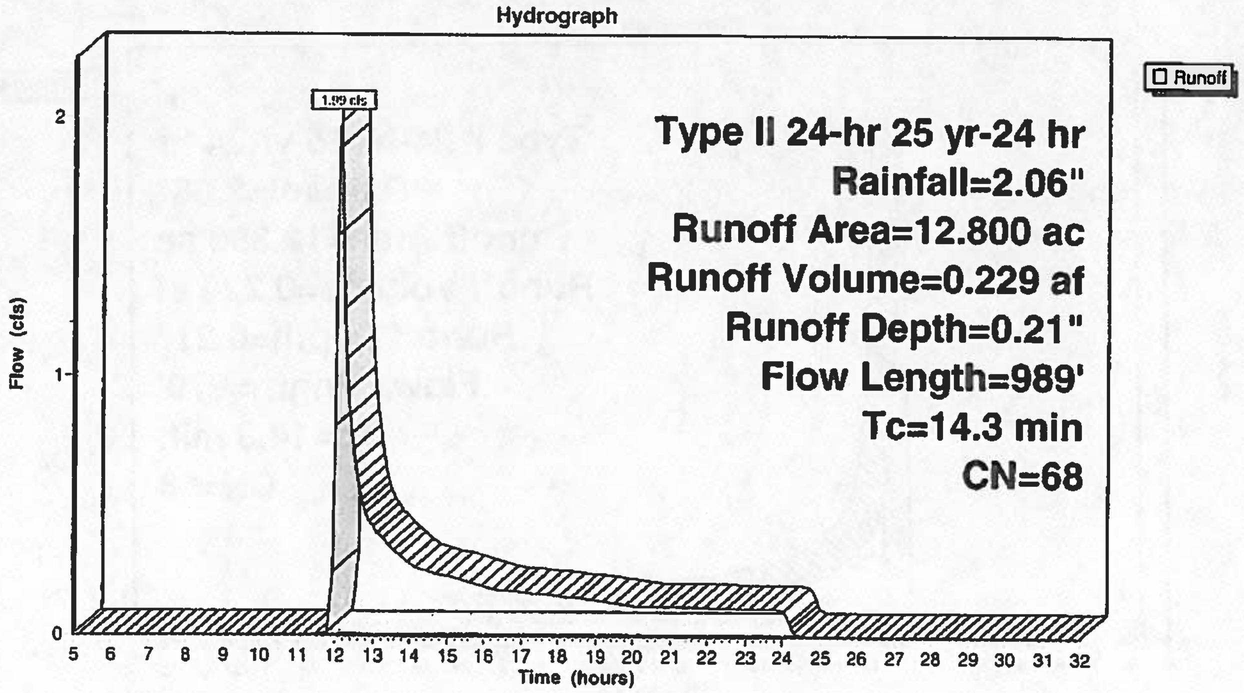
Runoff = 1.99 cfs @ 12.12 hrs, Volume= 0.229 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
12.800	68	Desert shrub range, Good, HSG B
12.800		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.5	319	0.1180	3.44		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.2	370	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 & 8.0 '/' Top.W=11.
14.3	989	Total			

Subcatchment 1S: DA-1



Subcatchment 2S: DA-2

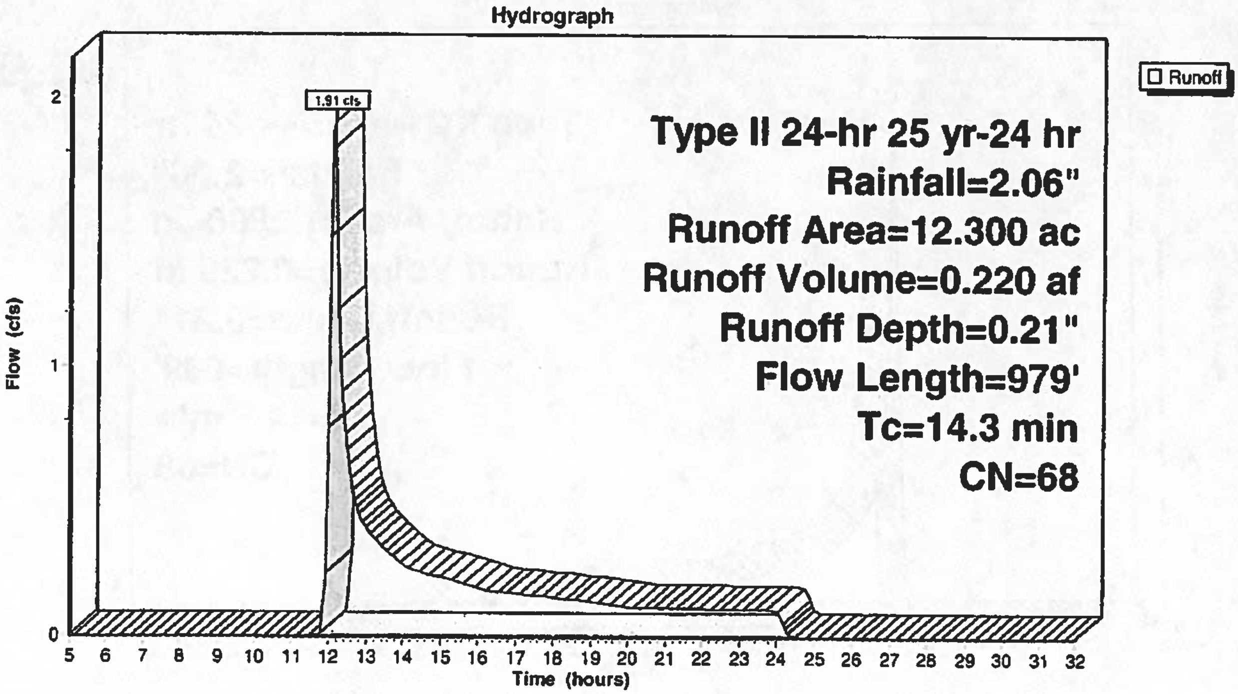
Runoff = 1.91 cfs @ 12.12 hrs, Volume= 0.220 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
12.300	68	Desert shrub range, Good, HSG B
12.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.4	286	0.1220	3.49		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.3	393	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 8.0 & 3.0 '/' Top.W=
14.3	979	Total			

Subcatchment 2S: DA-2



Subcatchment 3S: DA-3

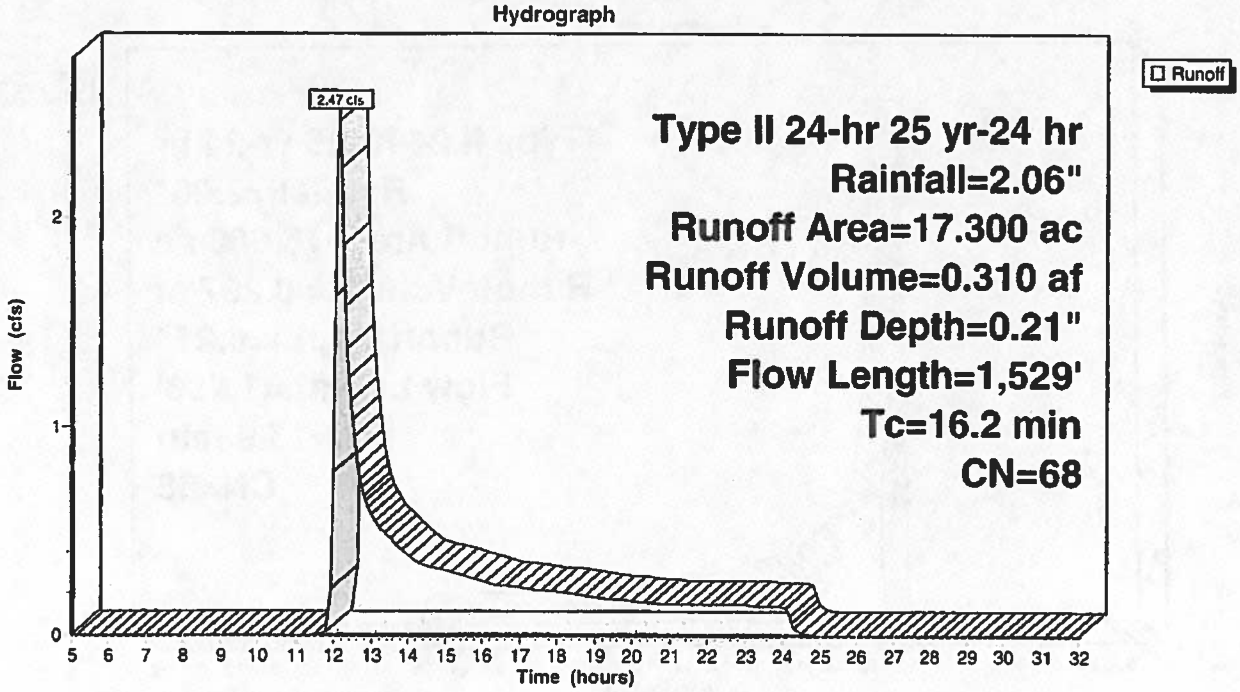
Runoff = 2.47 cfs @ 12.15 hrs, Volume= 0.310 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
17.300	68	Desert shrub range, Good, HSG B
17.300		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.5	270	0.0940	3.07		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
3.1	959	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 8.0 & 3.0 '/' Top.W=11.
16.2	1,529	Total			

Subcatchment 3S: DA-3



Subcatchment 4S: DA-4

Runoff = 2.39 cfs @ 12.14 hrs, Volume= 0.297 af, Depth= 0.21"

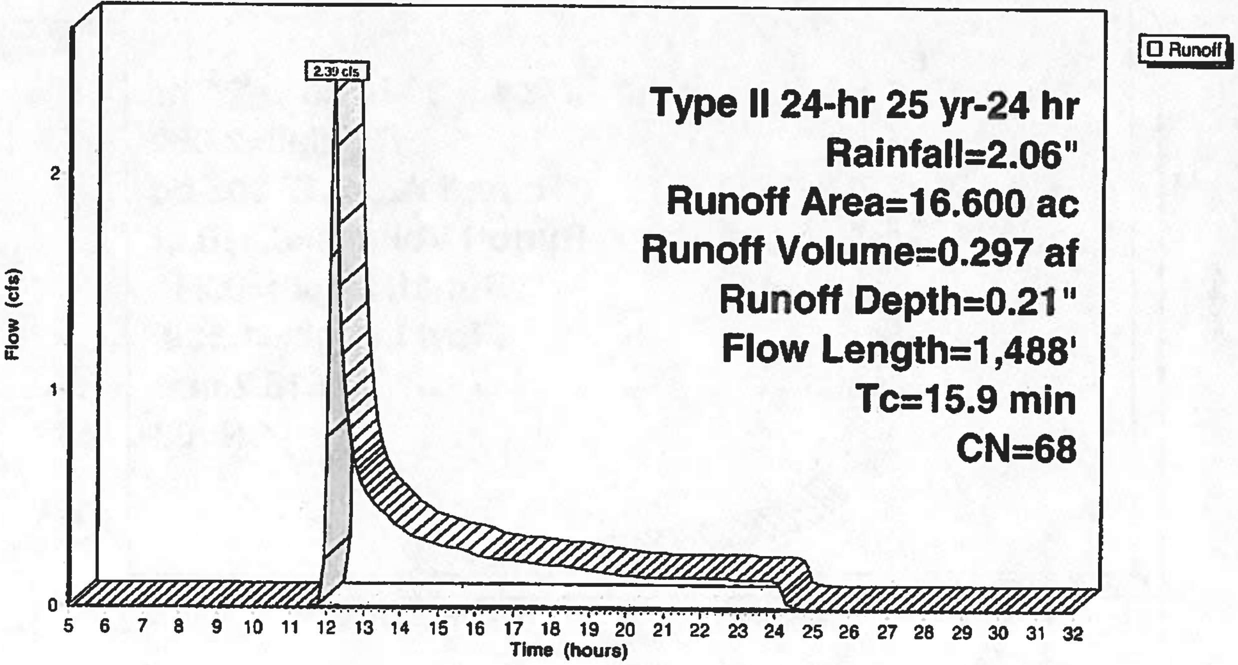
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
16.600	68	Desert shrub range, Good, HSG B
16.600		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.3	238	0.0970	3.11		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
3.0	950	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 & 8.0 '/' Top.W=
15.9	1,488	Total			

Subcatchment 4S: DA-4

Hydrograph



Subcatchment 5S: DA-5

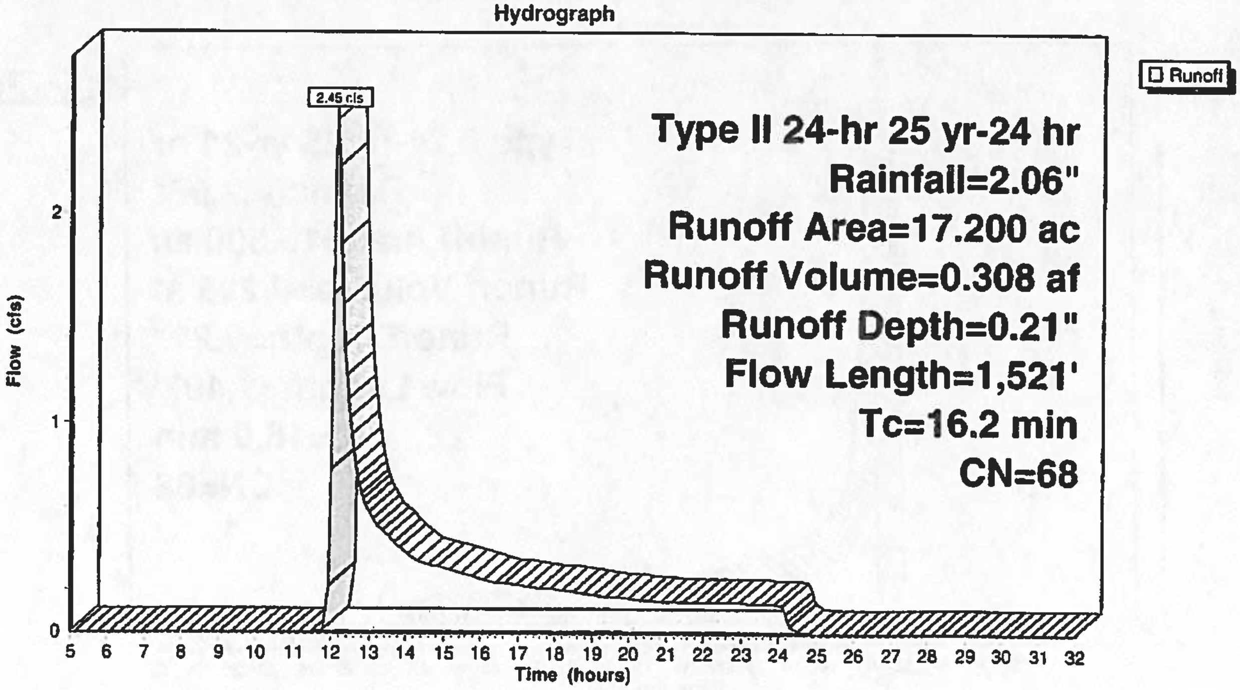
Runoff = 2.45 cfs @ 12.15 hrs, Volume= 0.308 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
17.200	68	Desert shrub range, Good, HSG B
17.200		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.5	261	0.0880	2.97		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
3.1	960	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 & 8.0 '/' Top.W=11.
16.2	1,521	Total			

Subcatchment 5S: DA-5



Subcatchment 6S: DA-6

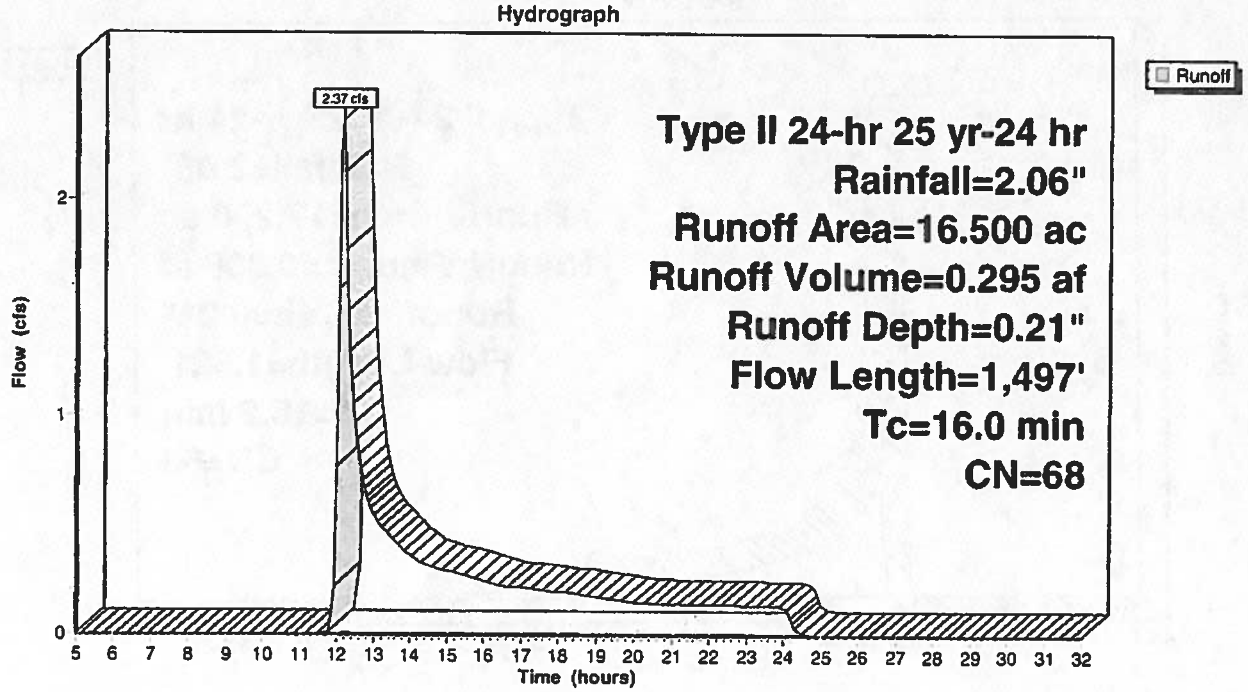
Runoff = 2.37 cfs @ 12.14 hrs, Volume= 0.295 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
16.500	68	Desert shrub range, Good, HSG B
16.500		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.3	232	0.0910	3.02		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
3.1	965	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 8.0 & 3.0 '/' Top.W=
16.0	1,497	Total			

Subcatchment 6S: DA-6



Subcatchment 7S: DA-7

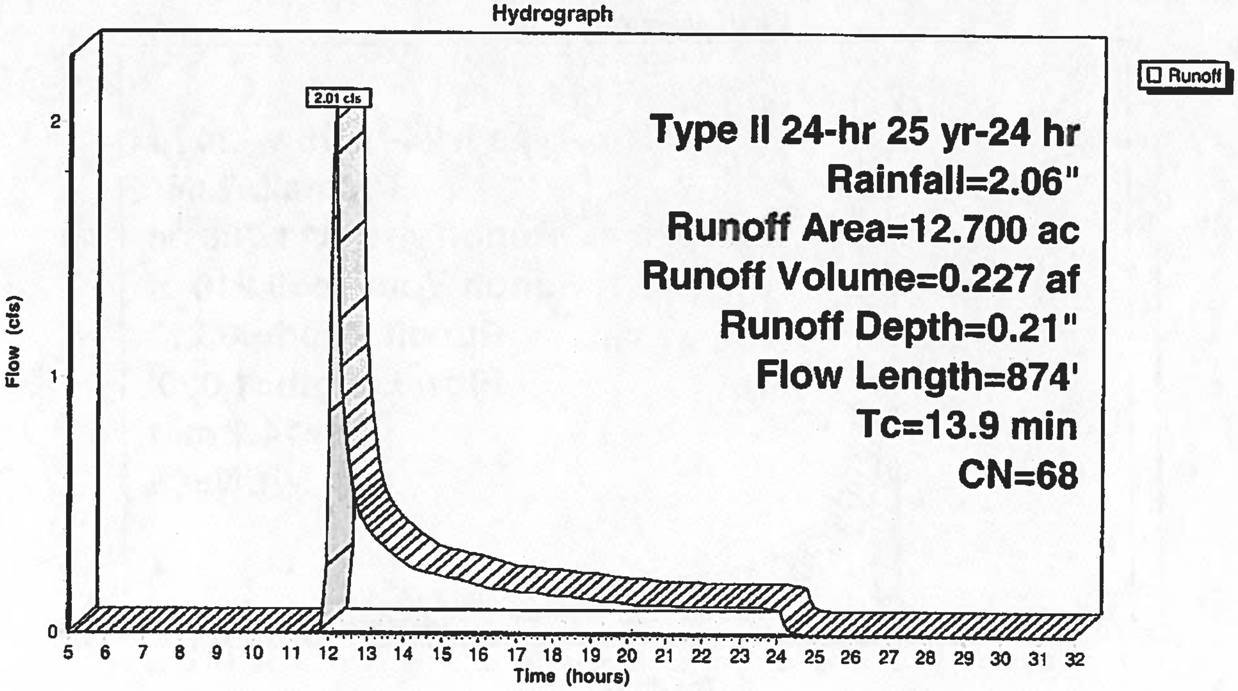
Runoff = 2.01 cfs @ 12.11 hrs, Volume= 0.227 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
12.700	68	Desert shrub range, Good, HSG B
12.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
1.4	294	0.1290	3.59		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
0.9	280	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 8.0 & 3.0 '/' Top.W=11.
13.9	874	Total			

Subcatchment 7S: DA-7



Subcatchment 8S: DA-8

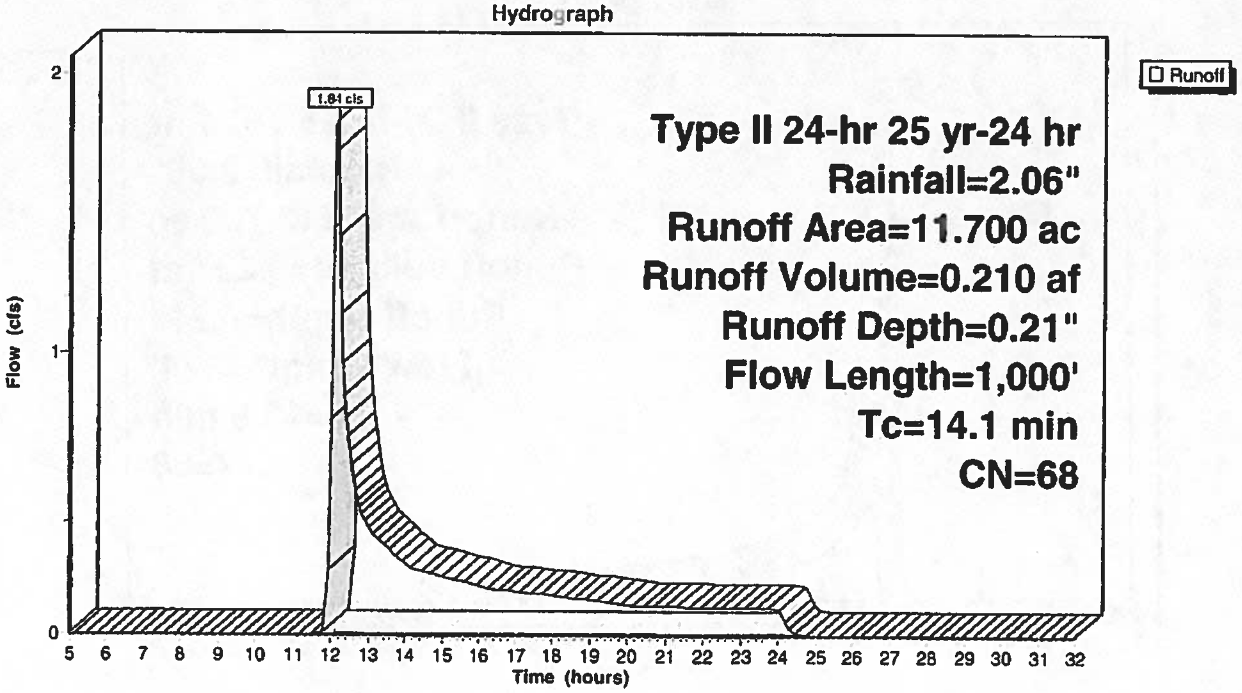
Runoff = 1.84 cfs @ 12.12 hrs, Volume= 0.210 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
11.700	68	Desert shrub range, Good, HSG B
11.700		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
11.6	300	0.0500	0.43		**Sheet Flow,** Fallow n= 0.050 P2= 1.10"
0.9	208	0.1490	3.86		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
1.6	492	0.0200	5.22	28.74	**Trap/Vee/Rect Channel Flow,** Bot.W=0.00' D=1.00' Z= 3.0 & 8.0 '/' Top.W=
14.1	1,000	Total			

Subcatchment 8S: DA-8



Subcatchment 9S: DA-9

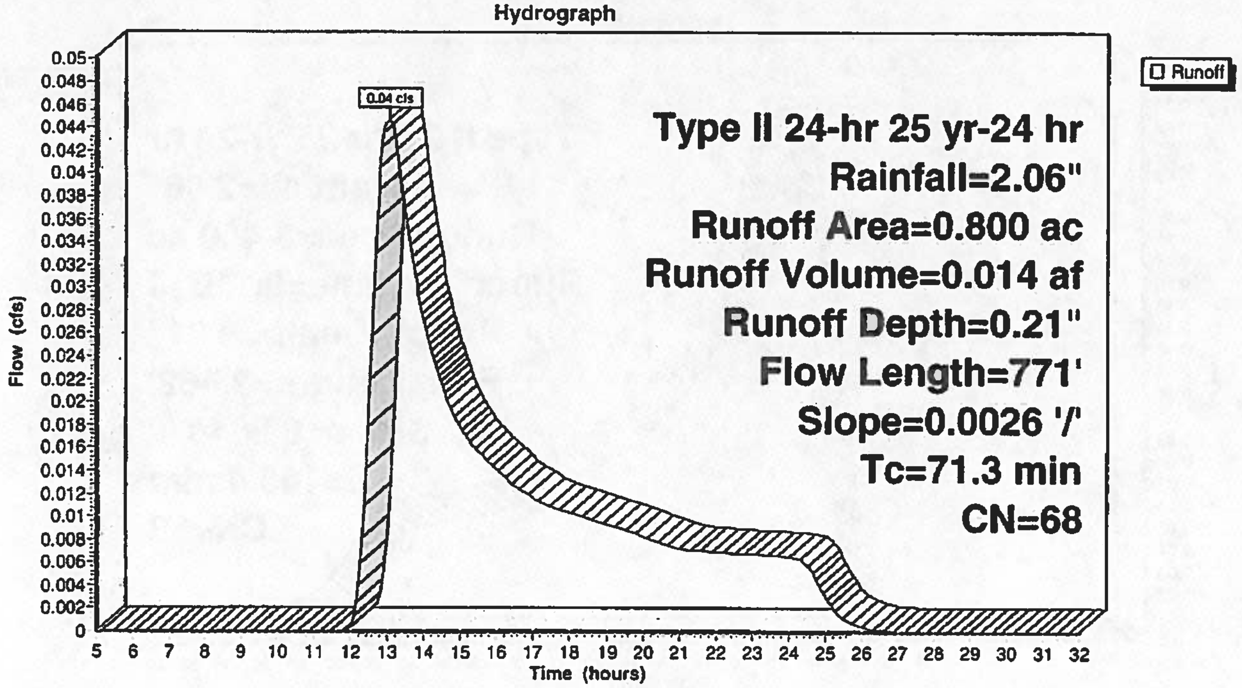
Runoff = 0.04 cfs @ 13.04 hrs, Volume= 0.014 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
0.800	68	Desert shrub range, Good, HSG B
0.800		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
71.3	771	0.0026	0.18		**Lag/CN Method,**

Subcatchment 9S: DA-9



Subcatchment 10S: DA-10

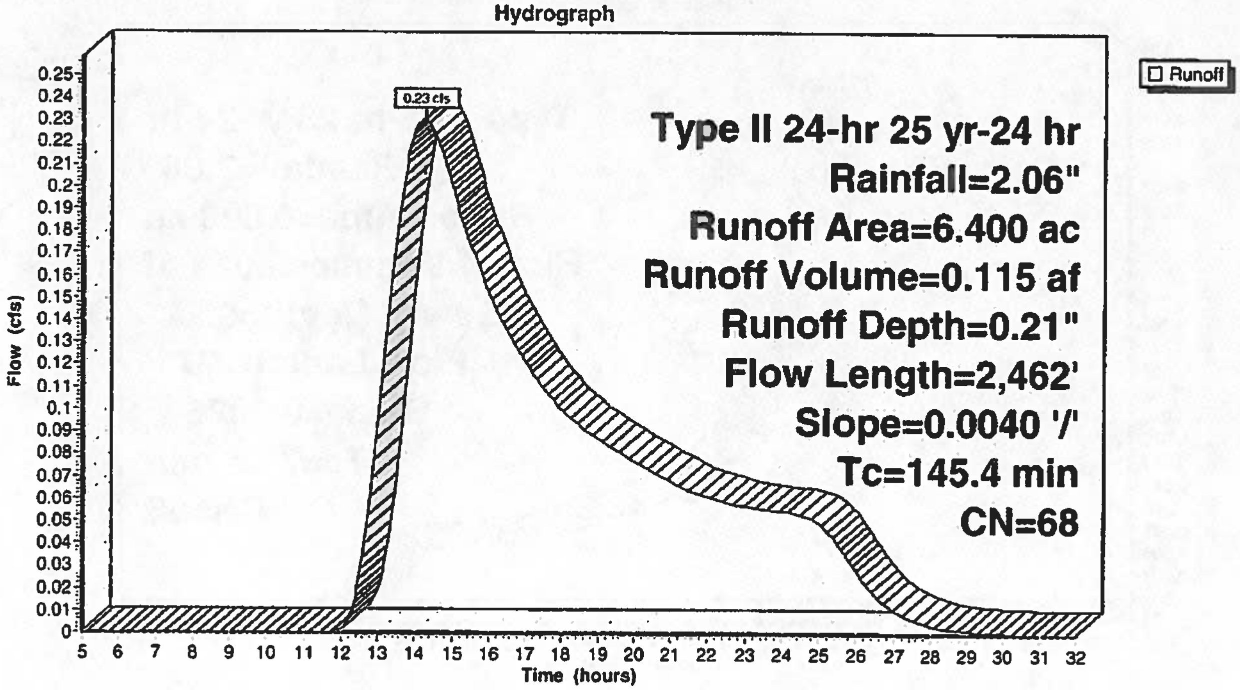
Runoff = 0.23 cfs @ 14.22 hrs, Volume= 0.115 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
6.400	68	Desert shrub range, Good, HSG B
6.400		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
145.4	2,462	0.0040	0.28		**Lag/CN Method,**

Subcatchment 10S: DA-10



Subcatchment 11S: DA-11

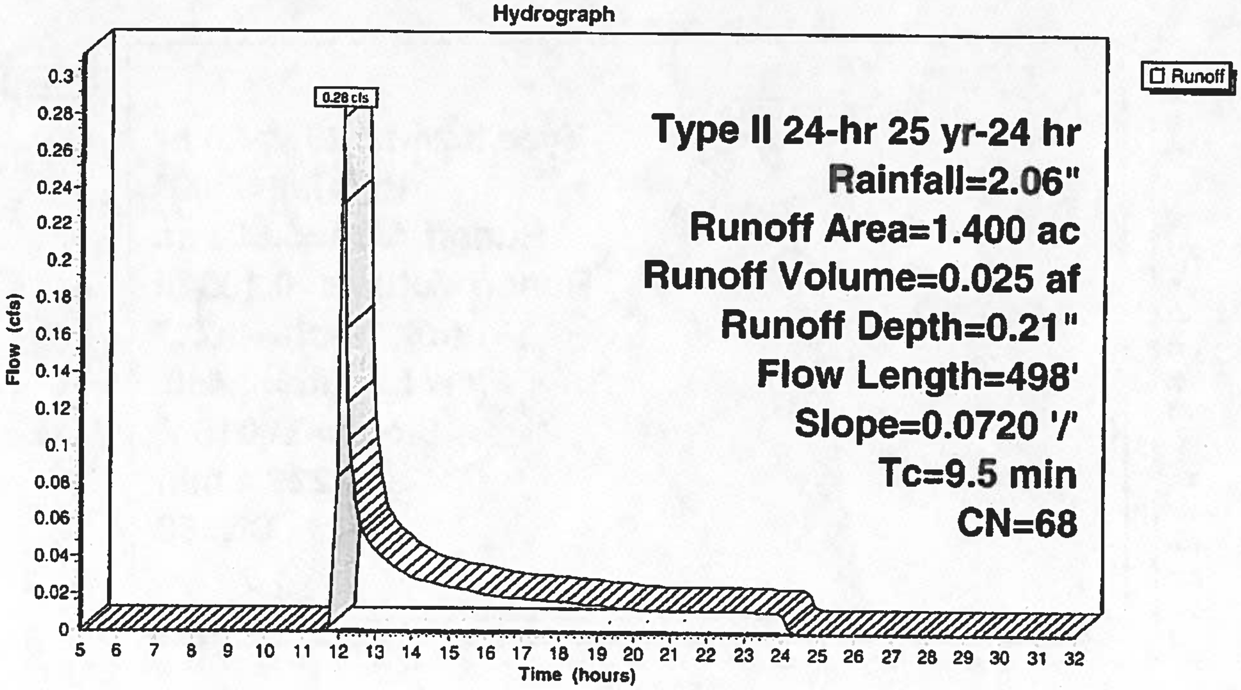
Runoff = 0.28 cfs @ 12.05 hrs, Volume= 0.025 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
1.400	68	Desert shrub range, Good, HSG B
1.400		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.5	498	0.0720	0.87		**Lag/CN Method,**

Subcatchment 11S: DA-11



Subcatchment 12S: DA-12

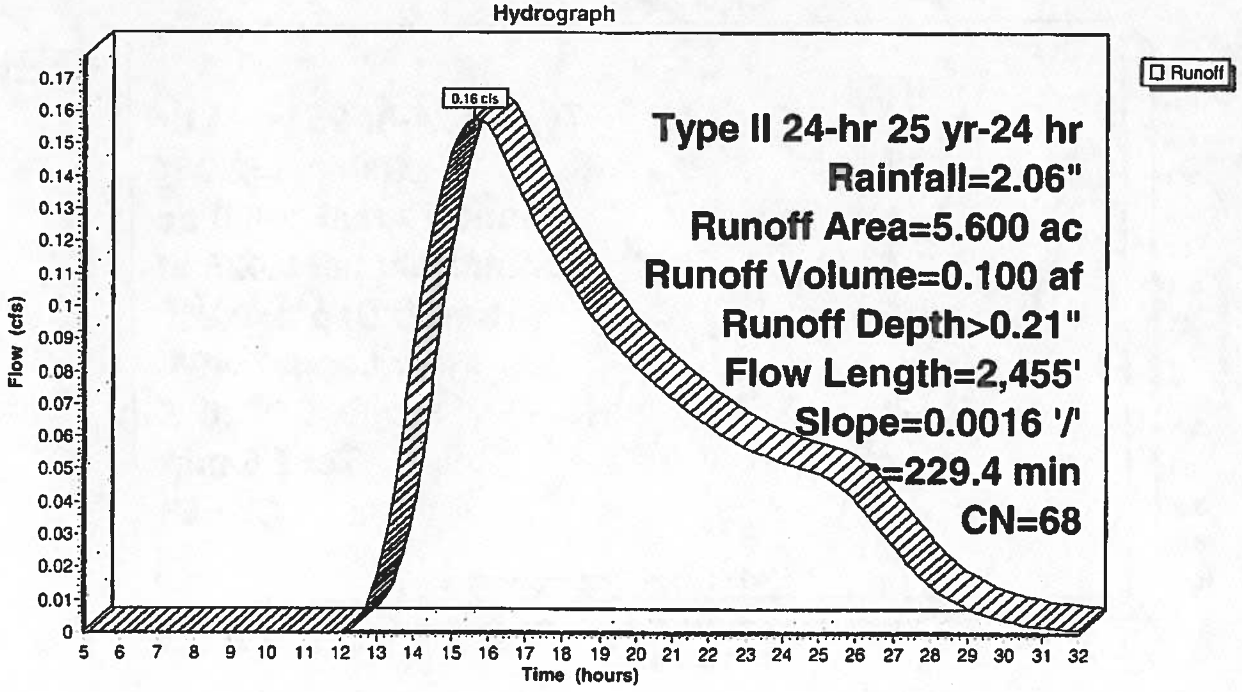
Runoff = 0.16 cfs @ 15.59 hrs, Volume= 0.100 af, Depth> 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
5.600	68	Desert shrub range, Good, HSG B
5.600		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
229.4	2,455	0.0016	0.18		**Lag/CN Method,**

Subcatchment 12S: DA-12



Subcatchment 13S: DA-13

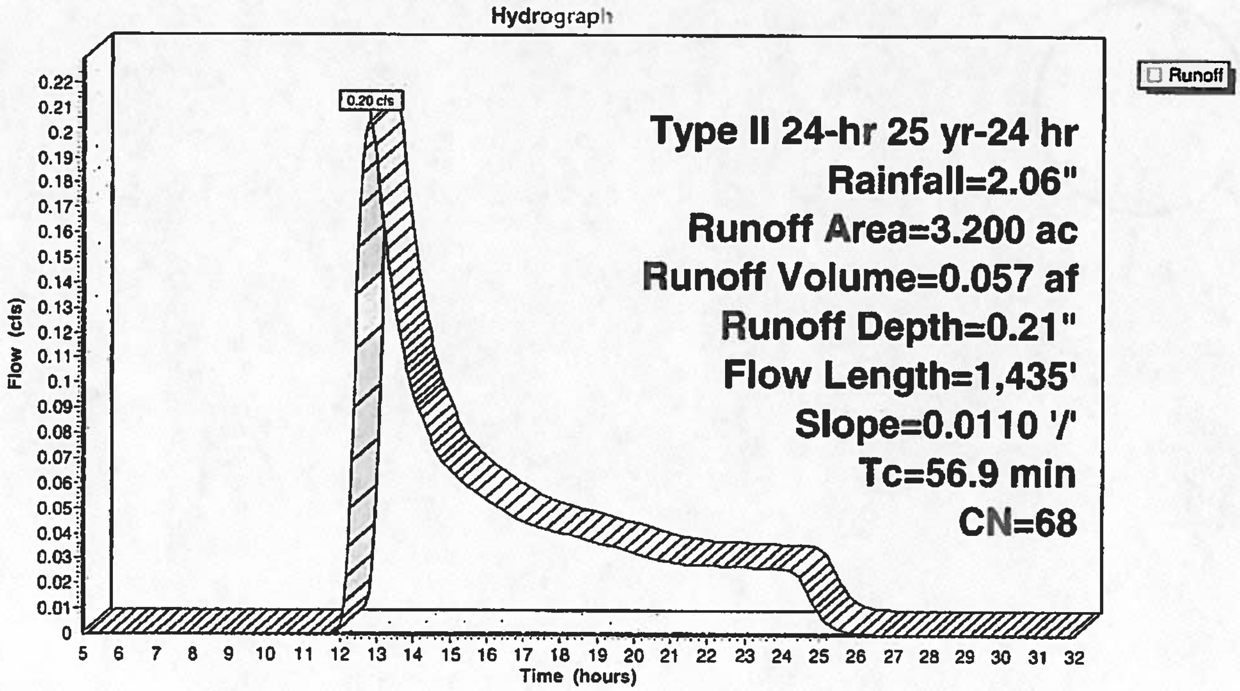
Runoff = 0.20 cfs @ 12.80 hrs, Volume= 0.057 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Type II 24-hr 25 yr-24 hr Rainfall=2.06"

Area (ac)	CN	Description
3.200	68	Desert shrub range, Good, HSG B
3.200		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
56.9	1,435	0.0110	0.42		**Lag/CN Method,**

Subcatchment 13S: DA-13



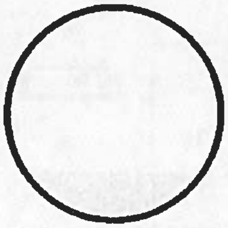
Reach 1R: PSD-1

Inflow Area = 30.100 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 4.39 cfs @ 12.13 hrs, Volume= 0.539 af
Outflow = 4.37 cfs @ 12.14 hrs, Volume= 0.539 af, Atten= 0%, Lag= 0.5 min

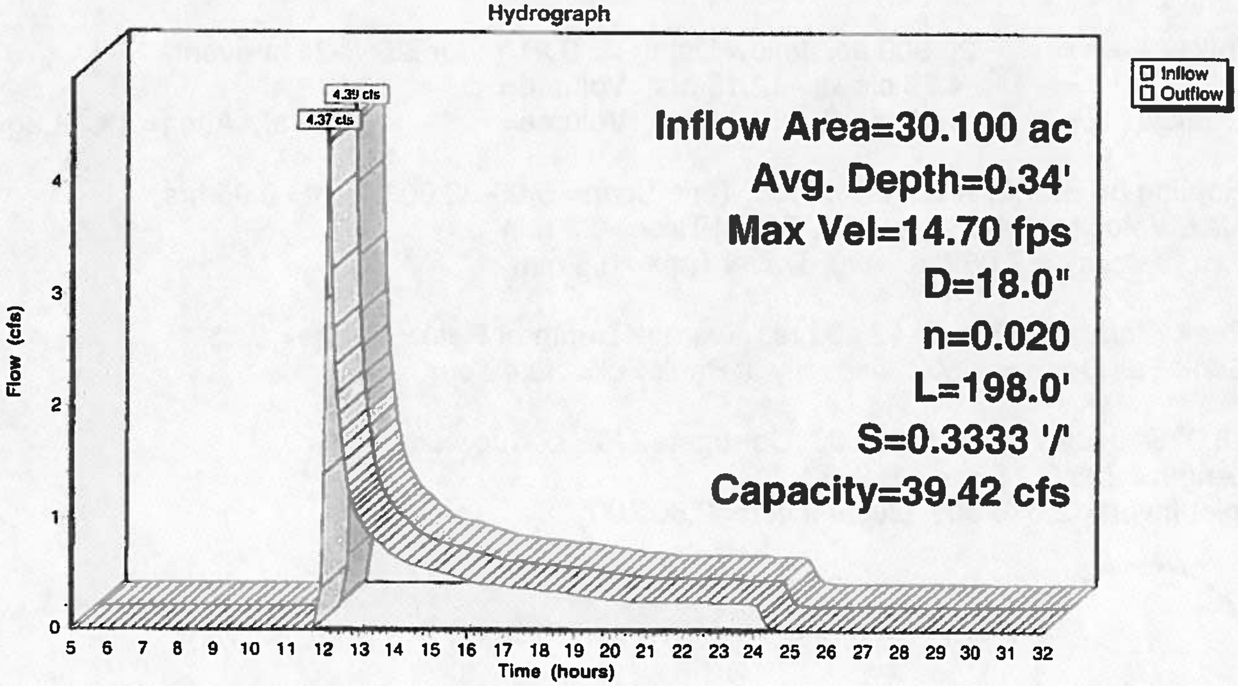
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.70 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 7.14 fps, Avg. Travel Time= 0.5 min

Peak Storage= 59 cf @ 12.14 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 39.42 cfs

18.0" Diameter Pipe, n= 0.020 Corrugated PE, corrugated interior
Length= 198.0' Slope= 0.3333 '/'
Inlet Invert= 2,574.00', Outlet Invert= 2,508.00'



Reach 1R: PSD-1



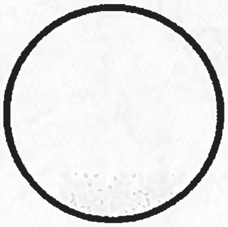
Reach 2R: PSD-2

Inflow Area = 28.900 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 4.25 cfs @ 12.13 hrs, Volume= 0.518 af
Outflow = 4.23 cfs @ 12.14 hrs, Volume= 0.518 af, Atten= 1%, Lag= 0.6 min

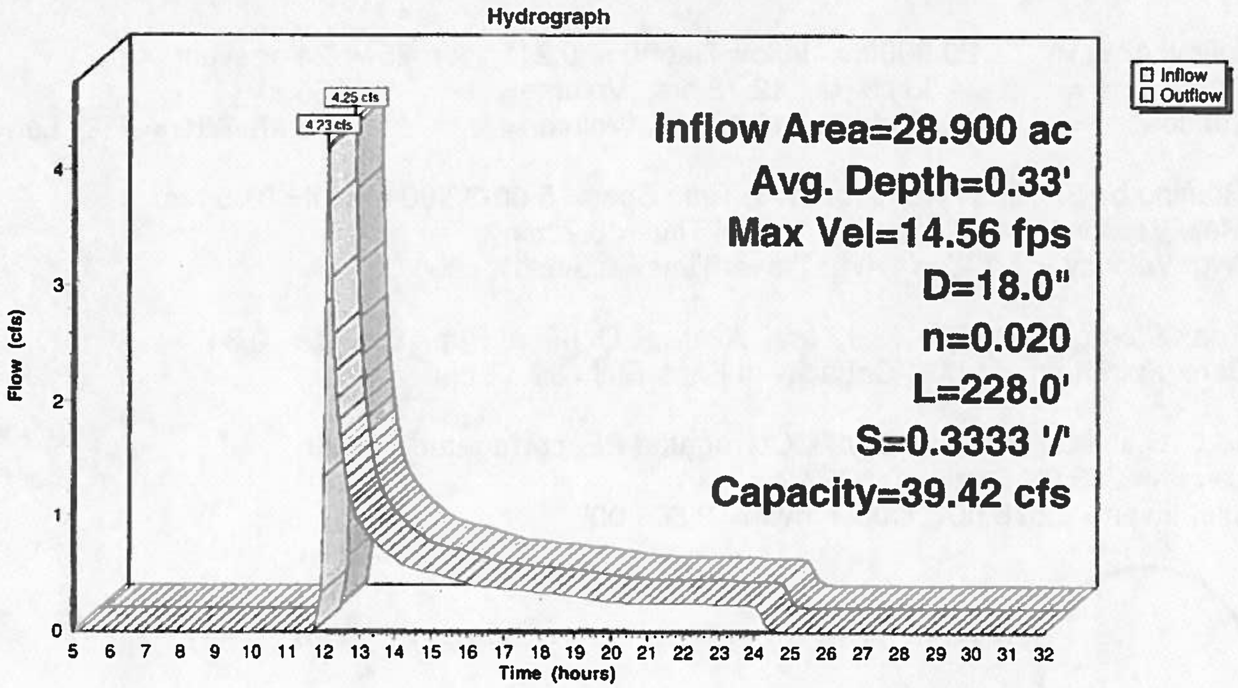
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.56 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 7.06 fps, Avg. Travel Time= 0.5 min

Peak Storage= 67 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 39.42 cfs

18.0" Diameter Pipe, n= 0.020 Corrugated PE, corrugated interior
Length= 228.0' Slope= 0.3333 '/'
Inlet Invert= 2,576.00', Outlet Invert= 2,500.00'



Reach 2R: PSD-2



Reach 3R: PSD-3

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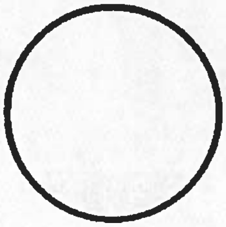
Inflow Area =      29.900 ac,  Inflow Depth =  0.21"   for  25 yr-24 hr event
Inflow      =       4.38 cfs @   12.13 hrs,  Volume=           0.535 af
Outflow     =       4.36 cfs @   12.14 hrs,  Volume=           0.535 af,  Atten= 1%,  Lag= 0.6 min

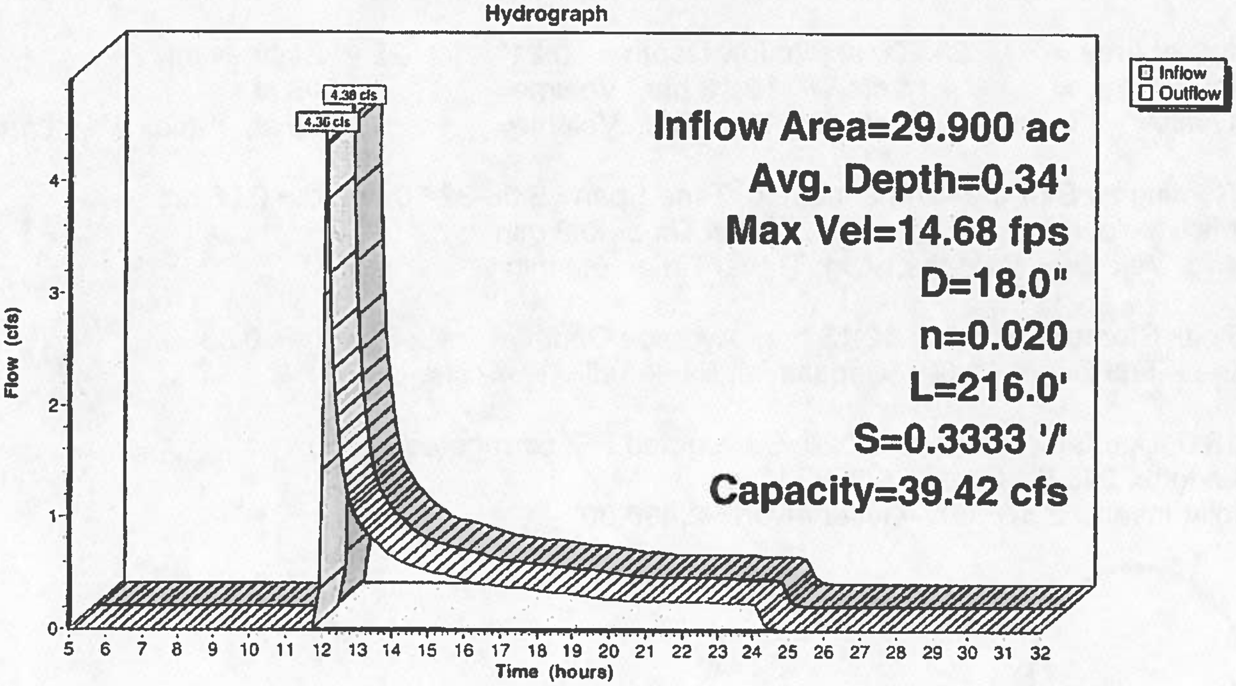
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.68 fps,  Min. Travel Time= 0.2 min
Avg. Velocity = 7.13 fps,  Avg. Travel Time= 0.5 min

Peak Storage= 64 cf @ 12.13 hrs,  Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.50',  Capacity at Bank-Full= 39.42 cfs

18.0" Diameter Pipe,  n= 0.020  Corrugated PE, corrugated interior
Length= 216.0'   Slope= 0.3333 '/'
Inlet Invert= 2,576.00',  Outlet Invert= 2,504.00'
```



Reach 3R: PSD-3



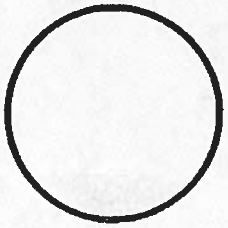
Reach 4R: PSD-4

Inflow Area = 28.200 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 4.14 cfs @ 12.13 hrs, Volume= 0.505 af
Outflow = 4.12 cfs @ 12.14 hrs, Volume= 0.505 af, Atten= 1%, Lag= 0.7 min

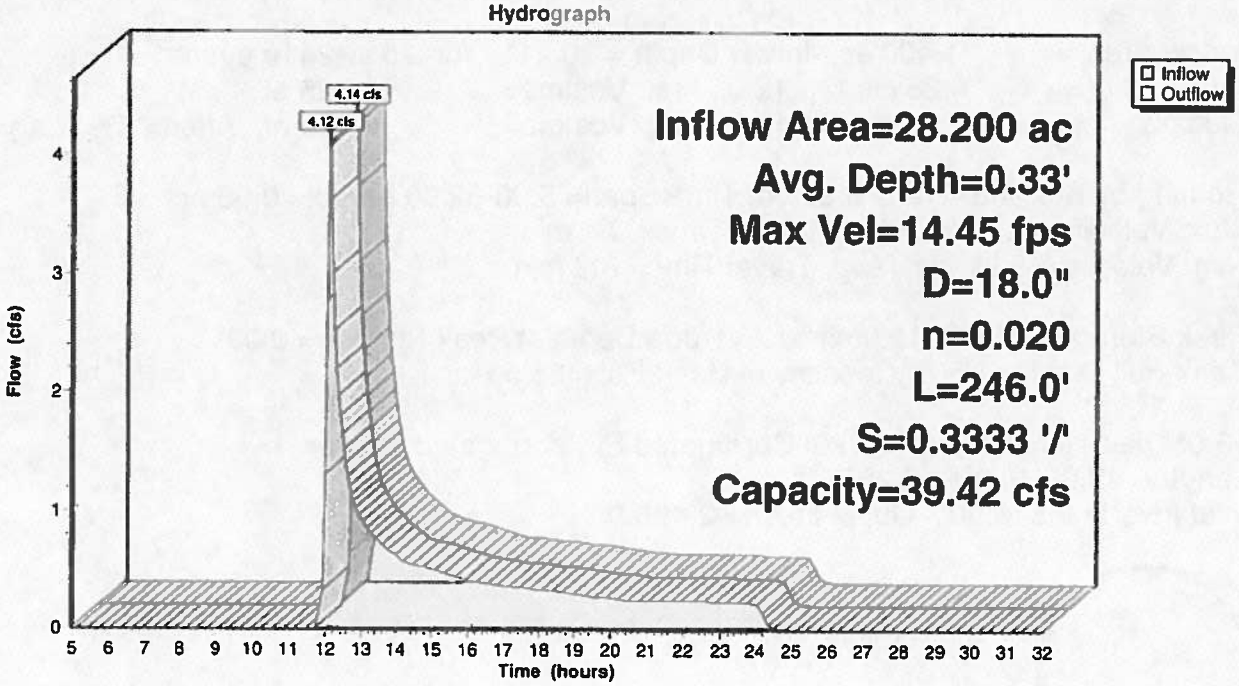
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 14.45 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 7.01 fps, Avg. Travel Time= 0.6 min

Peak Storage= 70 cf @ 12.13 hrs, Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 39.42 cfs

18.0" Diameter Pipe, n= 0.020 Corrugated PE, corrugated interior
Length= 246.0' Slope= 0.3333 '/'
Inlet Invert= 2,578.00', Outlet Invert= 2,496.00'



Reach 4R: PSD-4



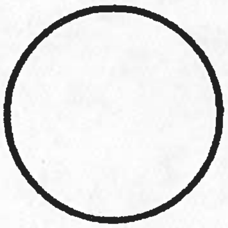
Reach 5R: PSD-5

```
Inflow Area =        1.400 ac,  Inflow Depth =  0.21"   for  25 yr-24 hr event
Inflow      =       0.28 cfs @   12.05 hrs,  Volume=          0.025 af
Outflow     =       0.28 cfs @   12.06 hrs,  Volume=          0.025 af,  Atten= 1%,  Lag= 0.2 min
```

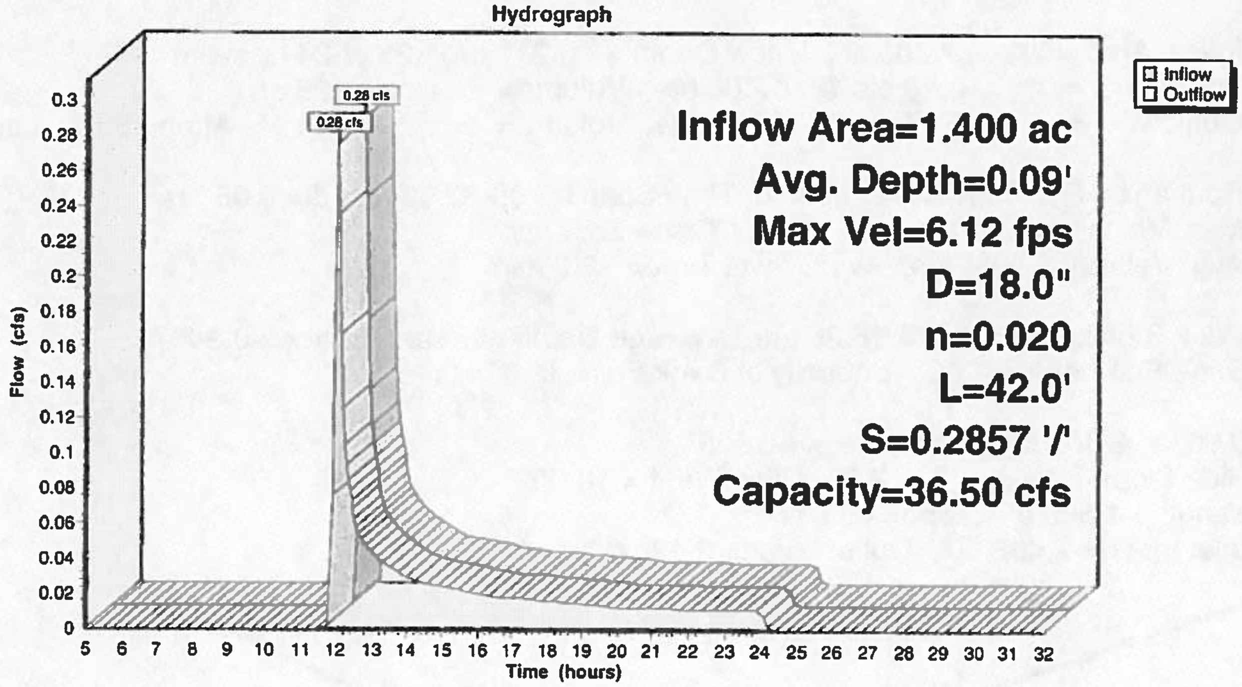
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.12 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.81 fps, Avg. Travel Time= 0.2 min

Peak Storage= 2 cf @ 12.06 hrs, Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.50', Capacity at Bank-Full= 36.50 cfs

18.0" Diameter Pipe, n= 0.020 Corrugated PE, corrugated interior
Length= 42.0' Slope= 0.2857 '/'
Inlet Invert= 2,510.00', Outlet Invert= 2,498.00'



Reach 5R: PSD-5



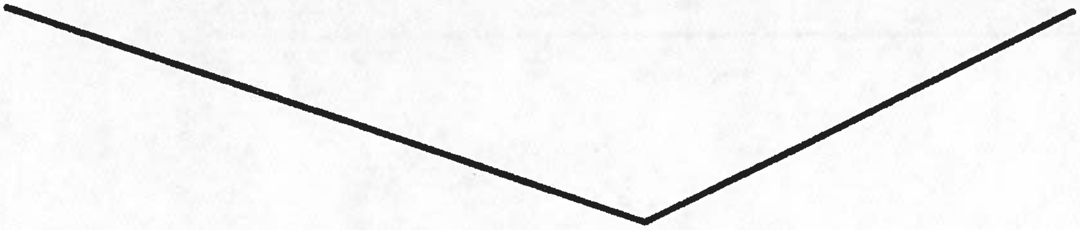
Reach 6R: SCC-4

Inflow Area = 7.000 ac, Inflow Depth > 0.21" for 25 yr-24 hr event
Inflow = 0.28 cfs @ 12.06 hrs, Volume= 0.125 af
Outflow = 0.17 cfs @ 17.18 hrs, Volume= 0.124 af, Atten= 39%, Lag= 307.5 m

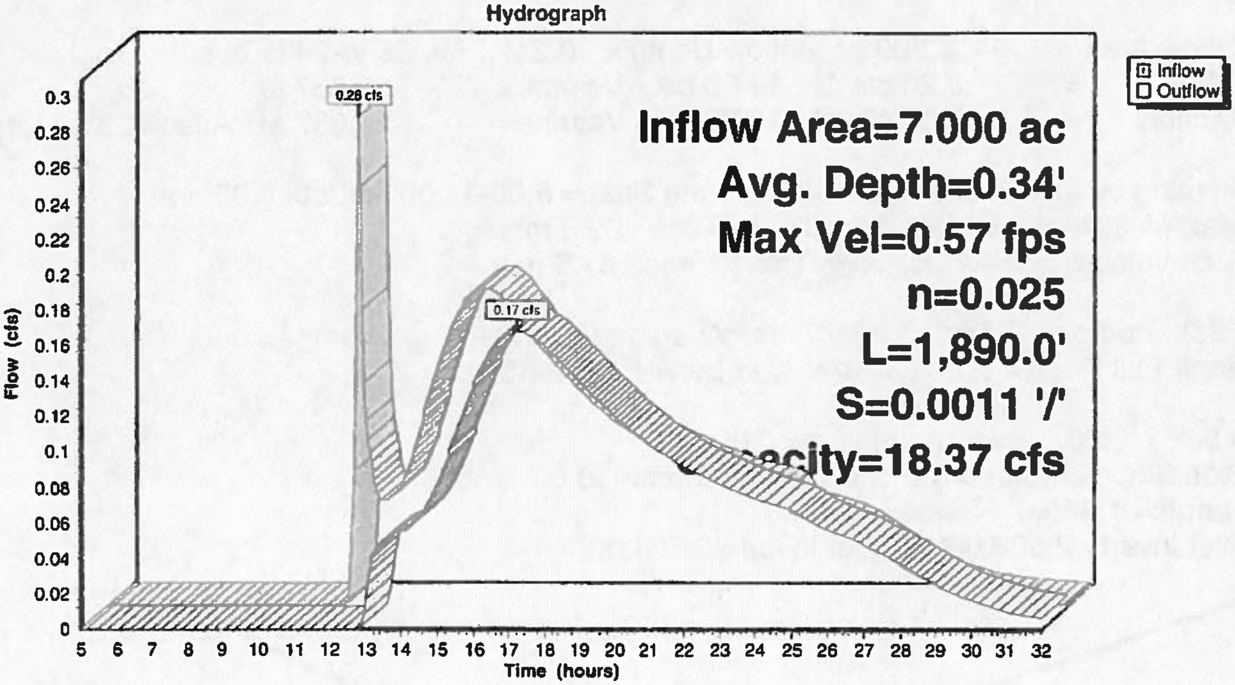
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.57 fps, Min. Travel Time= 55.4 min
Avg. Velocity = 0.44 fps, Avg. Travel Time= 72.0 min

Peak Storage= 560 cf @ 16.26 hrs, Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 18.37 cfs

0.00' x 2.00' deep channel, n= 0.025
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 1,890.0' Slope= 0.0011 '/'
Inlet Invert= 2,498.00', Outlet Invert= 2,496.00'



Reach 6R: SCC-4



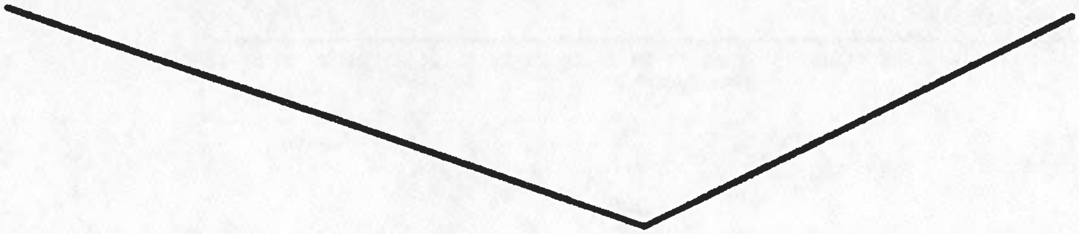
Reach 7R: SCC-3

Inflow Area = 3.200 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 0.20 cfs @ 12.80 hrs, Volume= 0.057 af
Outflow = 0.16 cfs @ 13.72 hrs, Volume= 0.057 af, Atten= 23%, Lag= 55.1 mi

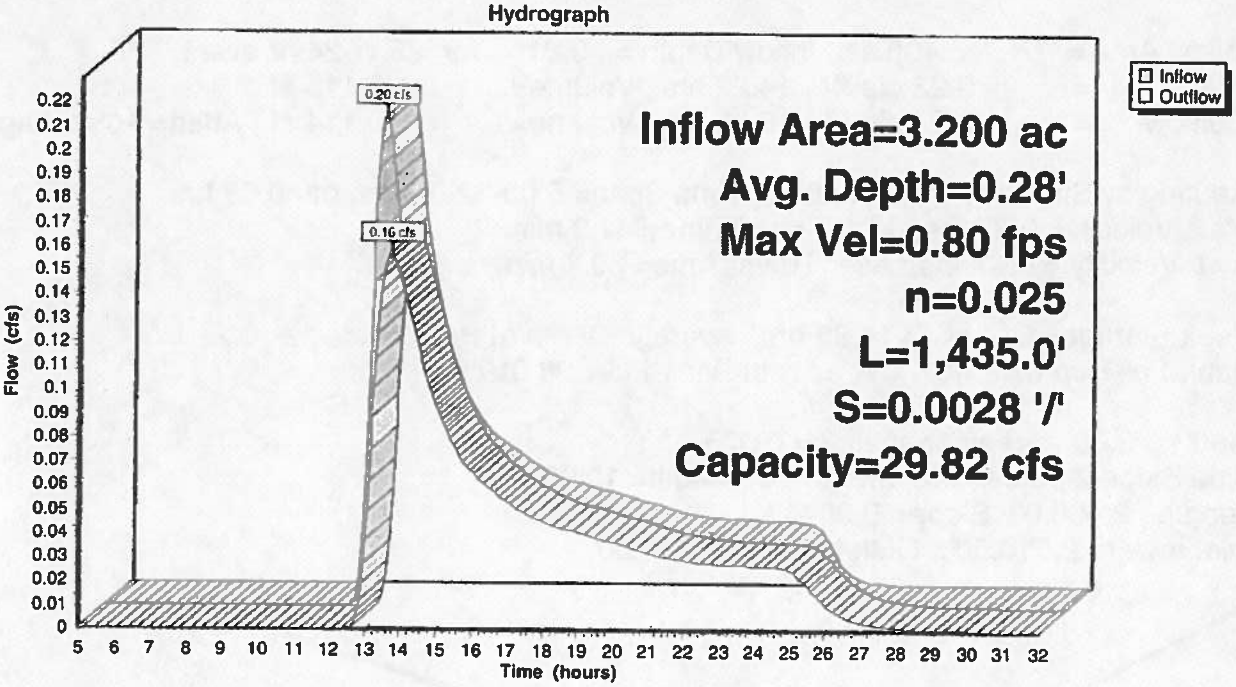
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.80 fps, Min. Travel Time= 29.8 min
Avg. Velocity = 0.46 fps, Avg. Travel Time= 51.5 min

Peak Storage= 280 cf @ 13.22 hrs, Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 29.82 cfs

0.00' x 2.00' deep channel, n= 0.025
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 1,435.0' Slope= 0.0028 '/'
Inlet Invert= 2,508.00', Outlet Invert= 2,504.00'



Reach 7R: SCC-3



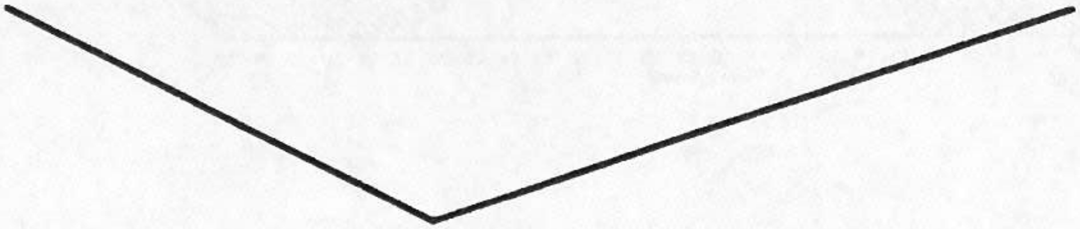
Reach 8R: SCC-2

Inflow Area = 6.400 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 0.23 cfs @ 14.22 hrs, Volume= 0.115 af
Outflow = 0.21 cfs @ 15.52 hrs, Volume= 0.114 af, Atten= 10%, Lag= 77.8 mi

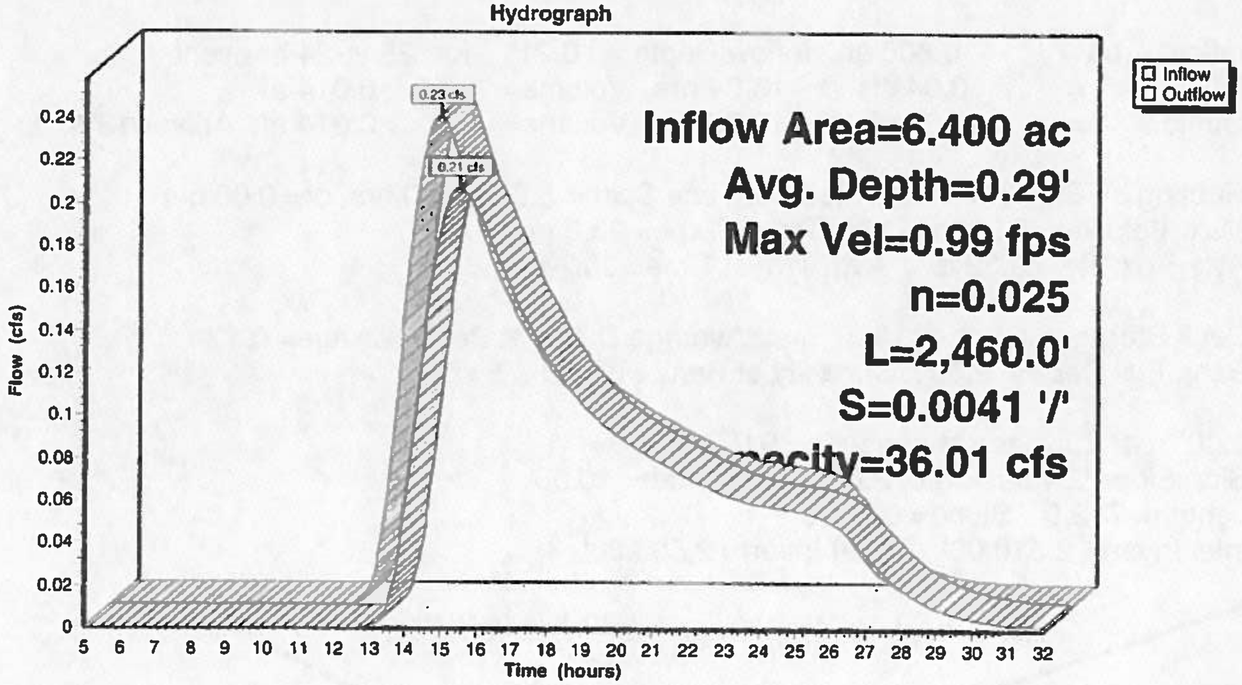
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.99 fps, Min. Travel Time= 41.3 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 60.7 min

Peak Storage= 514 cf @ 14.83 hrs, Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 36.01 cfs

0.00' x 2.00' deep channel, n= 0.025
Side Slope Z-value= 2.0 3.0 '/' Top Width= 10.00'
Length= 2,460.0' Slope= 0.0041 '/'
Inlet Invert= 2,510.00', Outlet Invert= 2,500.00'



Reach 8R: SCC-2



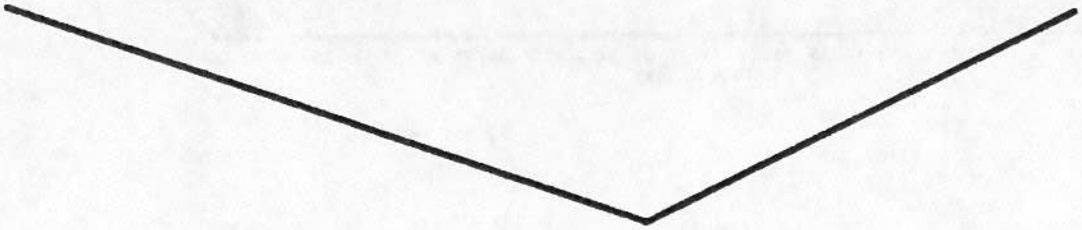
Reach 9R: SCC-1

Inflow Area = 0.800 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 0.04 cfs @ 13.04 hrs, Volume= 0.014 af
Outflow = 0.04 cfs @ 13.75 hrs, Volume= 0.014 af, Atten= 13%, Lag= 42.9 mi

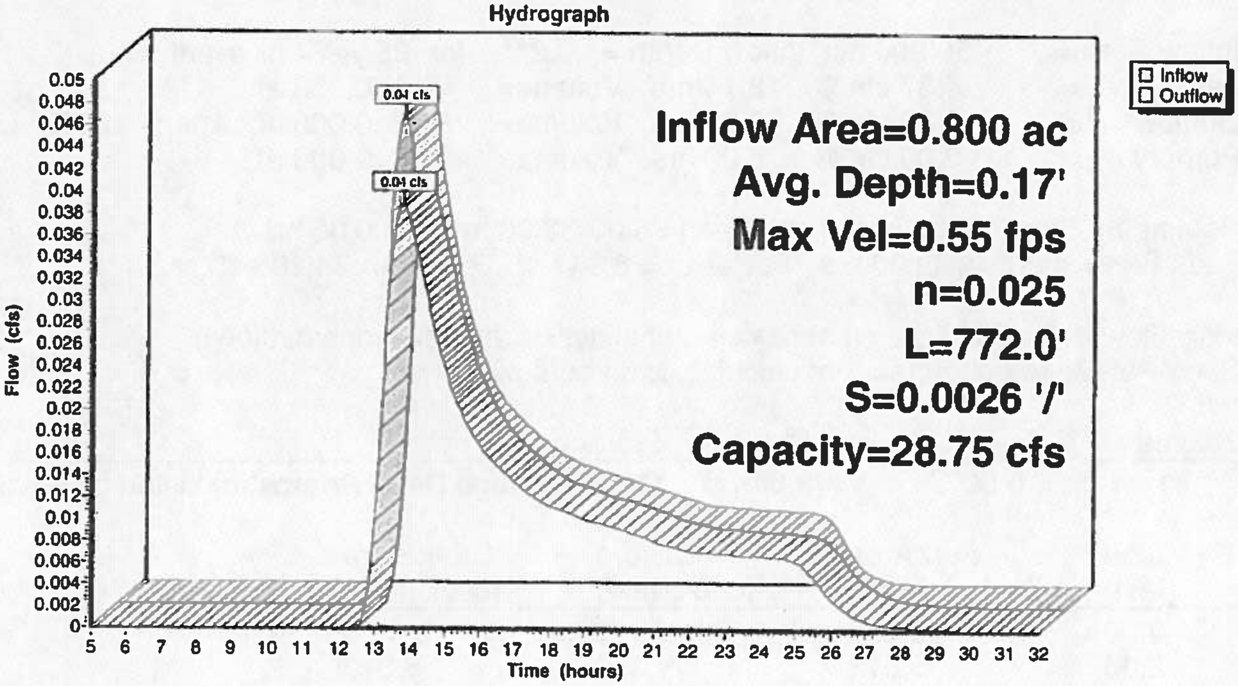
Routing by Stor-Ind+Trans method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.55 fps, Min. Travel Time= 23.3 min
Avg. Velocity = 0.32 fps, Avg. Travel Time= 39.7 min

Peak Storage= 54 cf @ 13.37 hrs, Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 2.00', Capacity at Bank-Full= 28.75 cfs

0.00' x 2.00' deep channel, n= 0.025
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 772.0' Slope= 0.0026 '/'
Inlet Invert= 2,510.00', Outlet Invert= 2,508.00'



Reach 9R: SCC-1



Pond 1P: SMB-1

Inflow Area = 30.900 ac, Inflow Depth = 0.21" for 25 yr-24 hr event
Inflow = 4.37 cfs @ 12.14 hrs, Volume= 0.553 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 mi
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Peak Elev= 4.20' @ 32.00 hrs Surf.Area= 8,847 sf Storage= 24,105 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

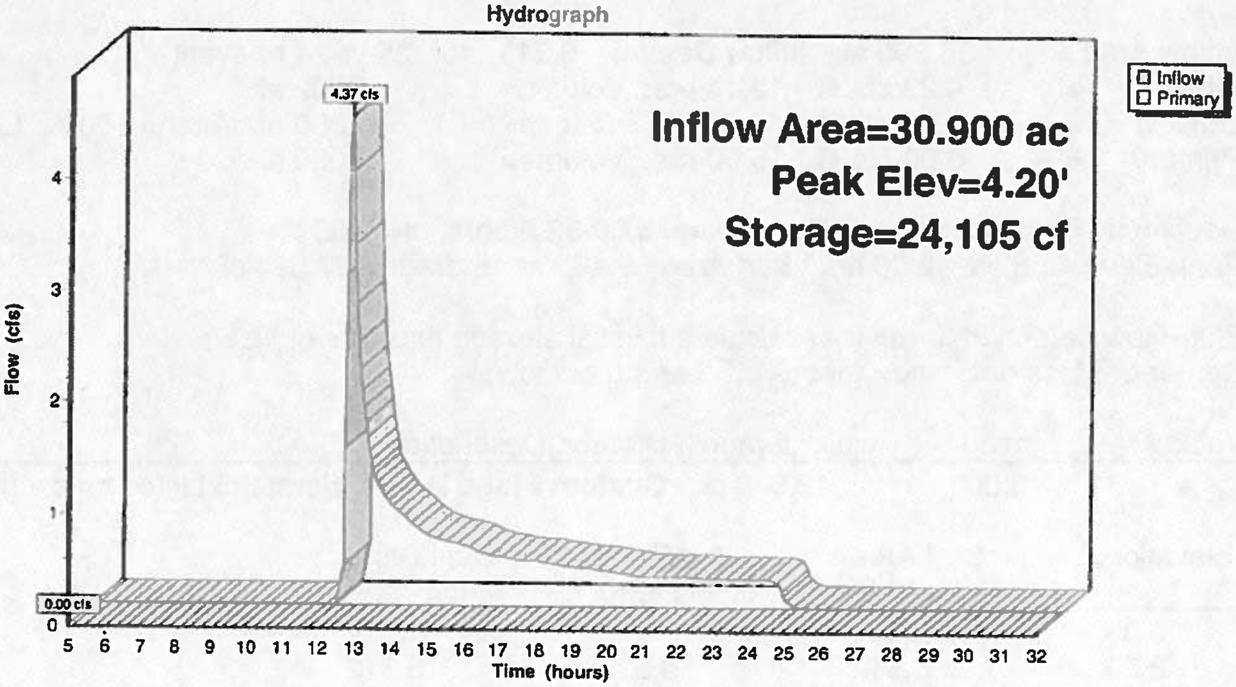
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,648 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,800	0	0
2.00	5,512	8,312	8,312
4.00	8,512	14,024	22,336
6.00	11,800	20,312	42,648

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**15.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=0.00' (Free Discharge)
↑—**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: SMB-1


Hydrograph
☐ Inflow
☐ Primary
Inflow Area=30.900 ac
Peak Elev=4.20'
Storage=24,105 cf
4.37 cfs
0.00 cfs
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Time (hours)

Pond 2P: SMB-2

Inflow Area = 35.300 ac, Inflow Depth > 0.21" for 25 yr-24 hr event
Inflow = 4.23 cfs @ 12.14 hrs, Volume= 0.632 af
Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 mi
Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Peak Elev= 4.58' @ 32.00 hrs Surf.Area= 9,461 sf Storage= 27,524 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

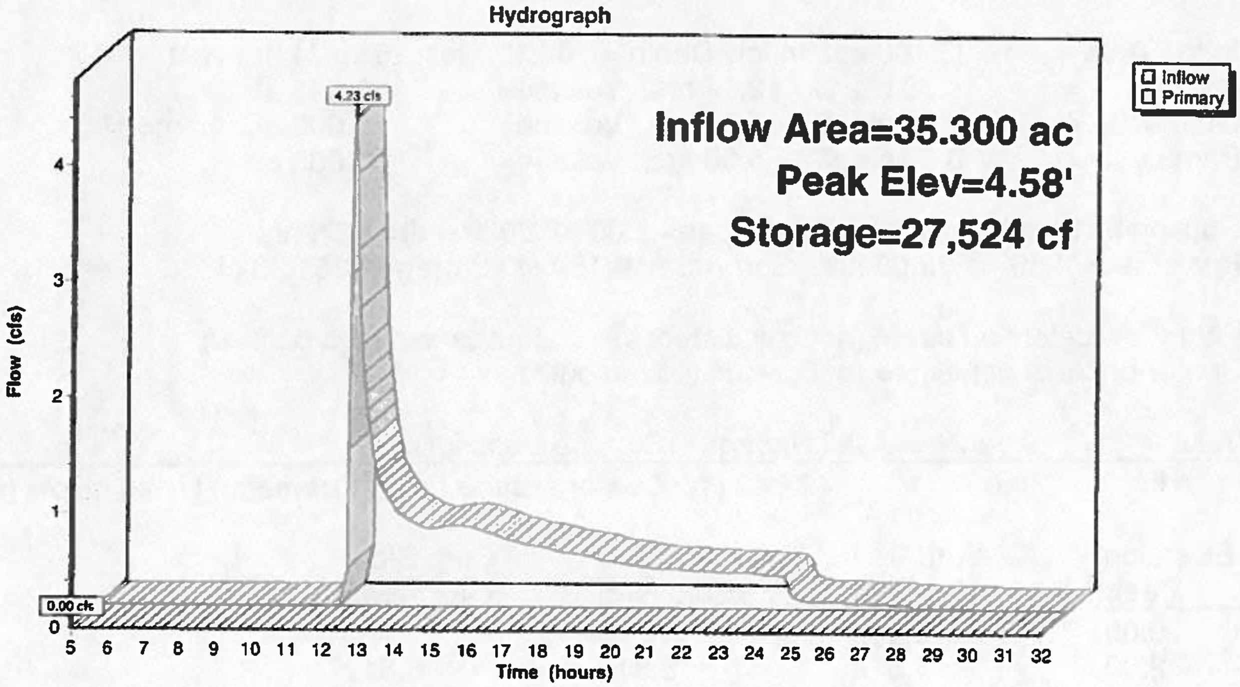
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,648 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,800	0	0
2.00	5,512	8,312	8,312
4.00	8,512	14,024	22,336
6.00	11,800	20,312	42,648

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**15.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=0.00' (Free Discharge)
↑—**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2P: SMB-2


Hydrograph
☐ Inflow
☐ Primary
4.23 cfs
0.00 cfs
Inflow Area=35.300 ac
Peak Elev=4.58'
Storage=27,524 cf
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
Time (hours)

Pond 3P: SMB-3

```
Inflow Area =       33.100 ac,  Inflow Depth =  0.21"    for  25 yr-24 hr event
Inflow      =        4.36 cfs @   12.14 hrs,  Volume=          0.593 af
Outflow     =        0.00 cfs @    5.00 hrs,  Volume=          0.000 af,  Atten= 100%,  Lag= 0.0 mi
Primary     =        0.00 cfs @    5.00 hrs,  Volume=          0.000 af

Routing by Stor-Ind method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Peak Elev= 4.39' @ 32.00 hrs   Surf.Area= 9,160 sf   Storage= 25,820 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)

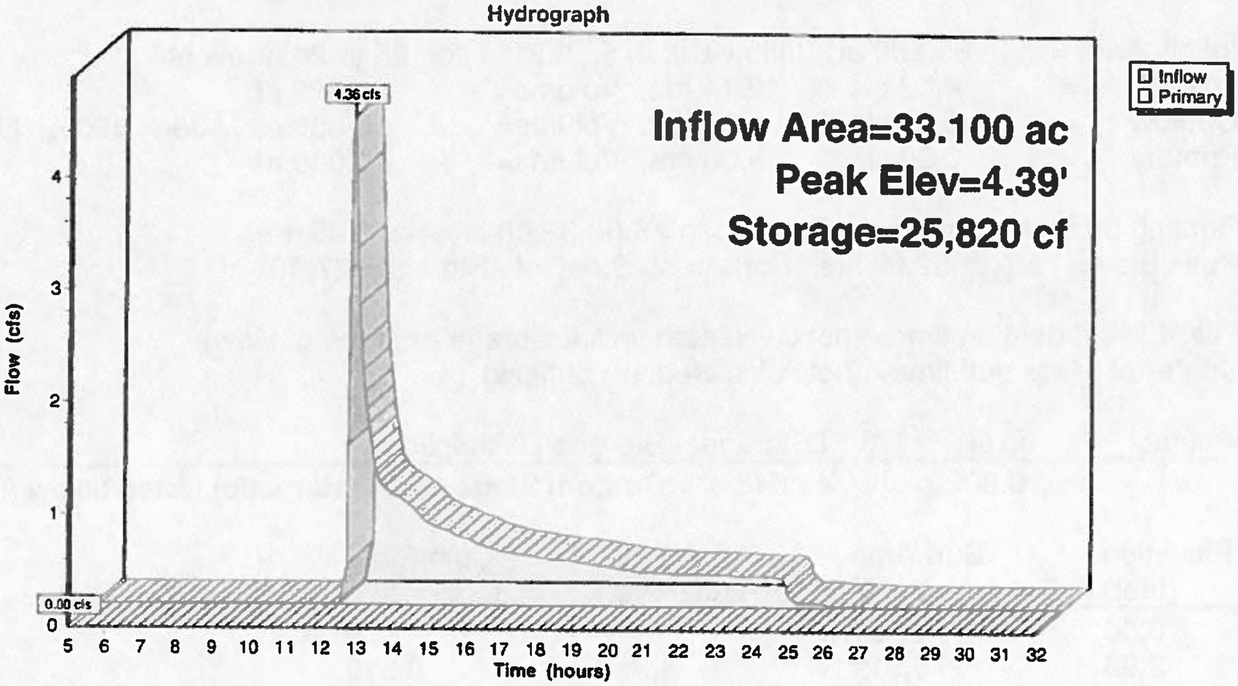
Volume      Invert     Avail.Storage   Storage Description
  #1         0.00'        42,648 cf    Custom Stage Data (Prismatic) Listed below (Recalc)

 Elevation          Surf.Area          Inc.Store         Cum.Store
   (feet)             (sq-ft)        (cubic-feet)      (cubic-feet)
    0.00              2,800                 0                 0
    2.00              5,512             8,312             8,312
    4.00              8,512            14,024            22,336
    6.00             11,800            20,312            42,648

Device   Routing            Invert   Outlet Devices
  #1     Primary             5.00'   15.0' long Sharp-Crested Rectangular Weir
                                     2 End Contraction(s)

Primary OutFlow  Max=0.00 cfs @ 5.00 hrs  HW=0.00'   (Free Discharge)
└─1=Sharp-Crested Rectangular Weir  ( Controls 0.00 cfs)
```

Pond 3P: SMB-3


Hydrograph
Inflow
Primary
4.36 cfs
0.00 cfs
Inflow Area=33.100 ac
Peak Elev=4.39'
Storage=25,820 cf
Flow (cfs)
0
1
2
3
4
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Time (hours)

Pond 4P: SMB-4

```
Inflow Area =      35.200 ac,  Inflow Depth >  0.21"   for 25 yr-24 hr event
Inflow      =       4.12 cfs @  12.14 hrs,  Volume=         0.629 af
Outflow     =       0.00 cfs @   5.00 hrs,  Volume=         0.000 af,  Atten= 100%,  Lag= 0.0 mi
Primary     =       0.00 cfs @   5.00 hrs,  Volume=         0.000 af

Routing by Stor-Ind method, Time Span= 5.00-32.00 hrs, dt= 0.05 hrs
Peak Elev= 4.56' @ 32.00 hrs   Surf.Area= 9,440 sf   Storage= 27,401 cf

Plug-Flow detention time= (not calculated: initial storage excedes outflow)
Center-of-Mass det. time= (not calculated: no outflow)
```

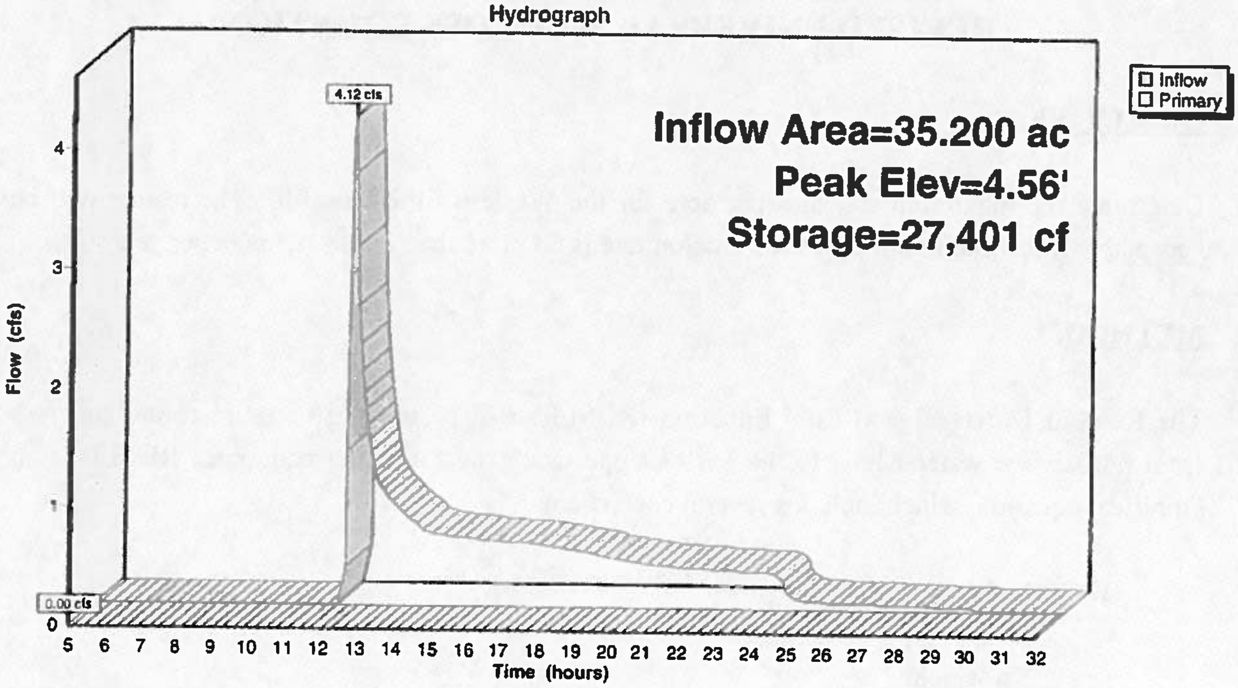
Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	42,648 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	2,800	0	0
2.00	5,512	8,312	8,312
4.00	8,512	14,024	22,336
6.00	11,800	20,312	42,648

Device	Routing	Invert	Outlet Devices
#1	Primary	5.00'	**15.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=0.00' (Free Discharge)
↑**1=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: SMB-4


Hydrograph
☐ Inflow
☐ Primary
Inflow Area=35.200 ac
Peak Elev=4.56'
Storage=27,401 cf
4.12 cfs
0.00 cfs
Flow (cfs)
0
1
2
3
4
Time (hours)
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

JOYCE ENGINEERING

Project: Western Elite Landfill
Project Number: 00383.1401.1.01 Task 01
Calculated By: DWT Date: 10/9/13
Revised By: Date:
Checked By: Date:
Subject: RUSLE
Sheet: 1 of 7

REVISED UNIVERSAL SOIL LOSS EQUATION

OBJECTIVE:

Determine the maximum soil loss per acre for the Western Elite Landfill. The results will be acceptable if the maximum projected erosion rate is no more than 2 tons per acre per year.

METHOD:

The Revised Universal Soil Loss Equation (RUSLE) will be utilized to estimate the soil loss from the surface water bench to the toe of slope using the following equation. RUSLE is an empirical equation, which includes several coefficients.

$$E = R * K * T * C * P$$

in which:
E = Computed Soil Loss in tons/acre/year
R = Rainfall Energy Factor (Erosivity Index)
K = Soil Erodibility Factor
T = Topographic Factor
C = Crop Management Factor
P = Conservation Practice Factor

CALCULATION:

The worse case scenario for maximum soil loss will be analyzed for the proposed final cover configuration for an approximately 33-foot height between the surface water diversion berms over a 3H:1V slope with a slope length of 100 feet. The references provided the following information:

Rainfall Energy Factor, R:
From Figure 1 of this document, R equals 10.

Soil Erodibility Factor, K:

From Table 3-2A of Reference 2, K equals 0.24 for the site. It is assumed that the cover soil will be sandy loam based on the USDA classification.

Topographic Factor, LS:

LS was found by using slope length (L) and slope gradient (S). The maximum slope length (L) between surface water control structures will be 100 feet which relates to the maximum distance between berms. For the 3H to 1V slopes, the slope gradient (S) is 33%. The LS value was interpreted from Table 4-3 of Reference 1. LS equals 5.63 for the site.

Crop Management Factor, C:

Using Table 10 of Reference 1, and assuming 60 percent ground cover with no appreciable canopy, the value of C is determined to be 0.090 for the site.

Conservation Practice Factor, P:

The conservation practice factor (P) is a function of the support practice and the land slope. Since there is no support practice, P equals 1.0, the highest and most conservative value. See Page 6 for additional information.

SOIL LOSS EQUATION with VEGETATED SLOPES:

$$E = 10 * 0.24 * 5.63 * 0.09 * 1$$

$$E = 1.22 \text{ tons/acre/year}$$

Project: Western Elite Landfill
Project Number: 00383.1401.1.01 Task 01
Calculated By: DWT Date: 10/9/13
Revised By: Date:
Checked By: Date:
Subject: RUSLE
Sheet: 3 of 7

CONCLUSION:

The maximum erosion rate for the Western Elite Landfill final cover was calculated to be approximately 1.21 tons/acre/year with vegetated slopes. This is an acceptable value, which is less than the maximum value of 2.0 tons/acre/year.

REFERENCES

1. Predicting Rainfall Erosion Losses, Agricultural Handbook 537, United States Department of Agriculture.
2. Predicting Soil Erosion by Water: A guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agricultural Handbook 703, United States Department of Agriculture.
3. Water Management and Sediment Control for Urbanizing Areas, Soil Conservation Service – USDA.
4. Advanced Design Methods for Selecting Sediment and Erosion BMPs, International Erosion Control Association – 1996.

K Values for Topsoil
(Taken from Reference 2, Table 3-2A)

Texture of Surface Layer	Estimated K Value
Clay, clay loam, loam, silty clay	0.32
Fine sandy loam, loamy very fine sand, sandy loam	0.24
Loamy fine sand, loamy sand	0.17
Sand	0.15
Silt loam, silty clay loam, very fine sand loam	0.37

LS Topographic Factor Values
(Excerpt Taken From Reference 1, Table 4-3)

Table 4-3: Values for topographic factor, LS, for high ratio of rill to interrill erosion. Such as for freshly prepared construction and other highly disturbed soil conditions with little or no cover (not applicable to thawing soil).

PERCENT SLOPE	SLOPE LENGTH (FEET)											
	<3	6	9	12	15	25	50	75	100	150	200	250
10	0.35	0.37	0.38	0.39	0.40	0.57	0.91	1.20	1.46	1.92	2.34	2.72
12	0.36	0.41	0.45	0.47	0.49	0.71	1.15	1.54	1.88	2.51	3.07	3.60
14	0.38	0.45	0.51	0.55	0.58	0.85	1.40	1.87	2.31	3.09	3.81	4.48
16	0.39	0.49	0.56	0.62	0.67	0.98	1.64	2.21	2.73	3.68	4.56	5.37
20	0.41	0.56	0.67	0.76	0.84	1.24	2.10	2.86	3.57	4.85	6.04	7.16
25	0.45	0.64	0.80	0.93	1.04	1.56	2.67	3.67	4.59	6.30	7.88	9.38
30	0.48	0.72	0.91	1.08	1.24	1.86	3.22	4.44	5.58	7.70	9.67	11.55
40	0.53	0.85	1.13	1.37	1.59	2.41	4.24	5.89	7.44	10.35	13.07	15.67
50	0.58	0.97	1.31	1.62	1.91	2.91	5.16	7.20	9.13	12.75	16.16	19.42

"C" for permanent pasture, range and idle land [1]
(Taken from Reference 1, Table 10)

Vegetal Canopy			Cover That Contacts the Surface					
Type and Height Of Raised Canopy [2]	Canopy Cover [3]	Type [4]	0	20	40	60	80	95-100
Column No.:	2	3	4	5	6	7	8	9
No appreciable Canopy		G	.45	.20	.10	.042	.013	.003
		W	.45	.24	.15	.090	.043	.011
Canopy of tall Weeds or short Brush (0.5 m fall ht.)	25	G	.36	.17	.09	.038	.012	.003
		W	.36	.20	.13	.082	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.075	.039	.011
	75	G	.17	.10	.06	.031	.011	.003
		W	.17	.12	.09	.067	.038	.011
Appreciable brush Or bushes (2 m fall ht.)	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.085	.042	.011
	50	G	.34	.16	.085	.038	.012	.003
		W	.34	.19	.13	.081	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.077	.041	.011
Trees but no Appreciable low Brush (4 m Fall ht.)	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.087	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.085	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.083	.041	.011

---

1 The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

2 Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33-ft.

3 Portion of total-area surface that would be hidden from view by canopy in a vertical projection, (a bird's-eye view).

4 G: Cover at surface is grass, grass like plants, decaying compacted duff, or litter at least 2 inches deep.
W: Cover at surface is mostly broadleaf herbaceous plant (as weeds with little lateral-root network near the surface) or undecayed residues or both

JOYCE
ENGINEERING

Project: Western Elite Landfill
Project Number: 00383.1401.1.01 Task 01
Calculated By: DWT Date: 10/9/13
Revised By: Date:
Checked By: Date:
Subject: RUSLE
Sheet: 6 of 7

"P" Value Table

$$P = P_c\, P_s$$

$$\text{or } P = P_t \text{ (if terraces are present)}$$

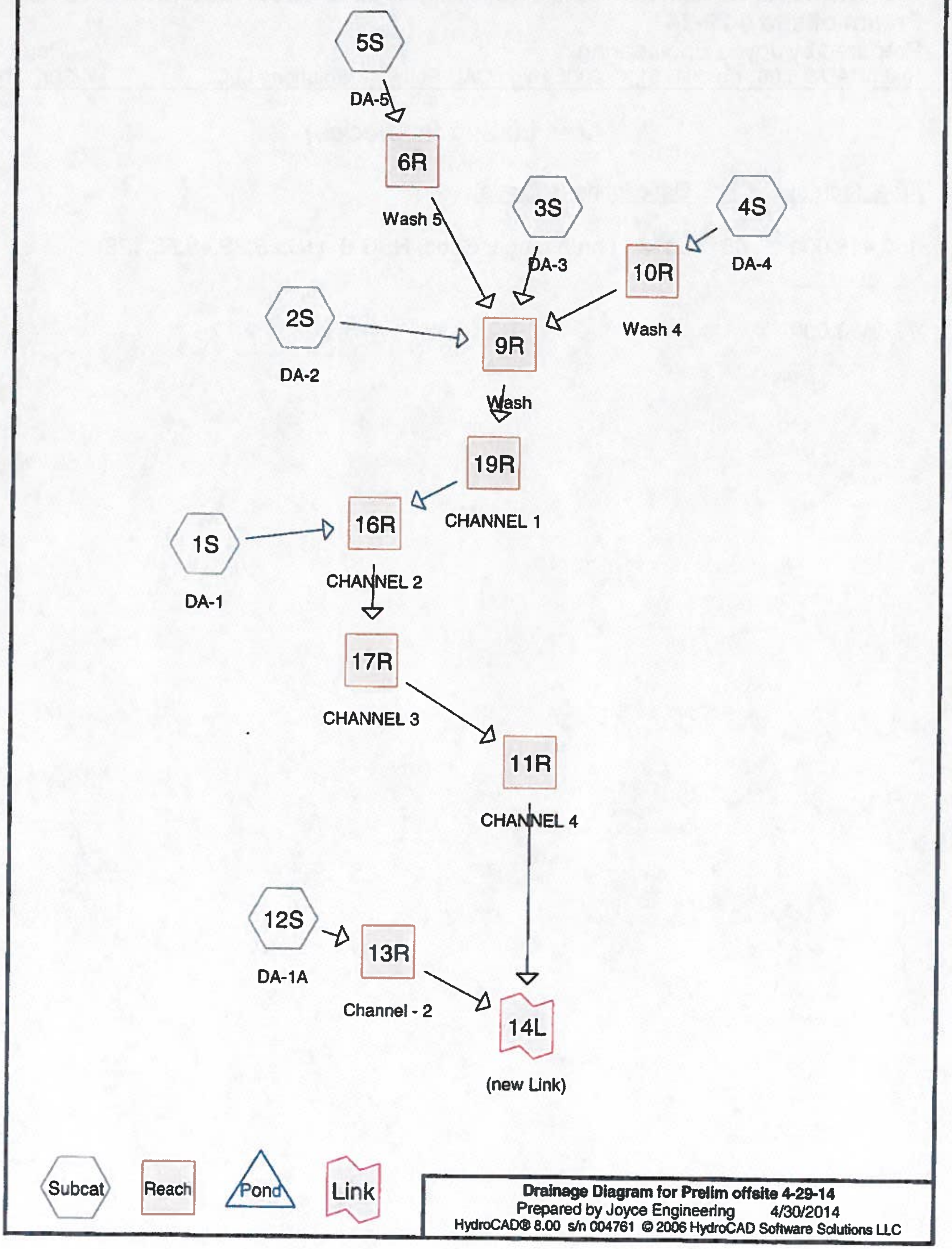
Where: P_c = contouring factor
P_s = strip cropping factor (see Table 14 in USLE Handbook)
P_t = terraces factor

	Conservation Practice Factors, P			
Slope, %	Contouring factor, P_c (Max. slope length, m)	Strip cropping factor, P_s (Max width, m)	Graded terraces with grass waterway outlets, P_t	Parallel tile outlet terraces, P_t
1-2	0.6 (120)	0.6	0.12	0.05
3-5	0.5 (90)	0.5	0.10	0.05
6-8	0.5 (60)	0.05	0.10	0.05
9-12	0.6 (35)	0.6	0.12	0.05
13-16	0.7 (25)	0.7	0.14	0.05
17-20	0.8 (18)	0.8	0.16	0.06
21-25	0.9 (15)	0.9	0.16	0.06

Source: USLE Handbook, Tables 13, 14, and 15.

Project: Western Elite Landfill
Project Number: 00383.1401.1.01 Task 01
Calculated By: DWT Date: 10/9/13
Revised By: Date:
Checked By: Date:
Subject: RUSLE
Sheet: 7 of 7

FIGURE 1 – ISOERODENT MAP OF THE WESTERN US (TAKEN FROM REFERENCE 4)



Drainage Diagram for Prelim offsite 4-29-14
Prepared by Joyce Engineering 4/30/2014
HydroCAD® 8.00 s/n 004761 © 2006 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcats)
117,418.000	68	Desert shrub range, Good, HSG B (1S,2S,3S,4S,5S,12S)
117,418.000		

```
                    Time span=5.00-60.00 hrs, dt=0.05 hrs, 1101 points
                        Runoff by SCS TR-20 method, UH=SCS
          Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment 1S: DA-1                        Runoff Area=17,132.000 ac   Runoff Depth=0.44"
  Flow Length=60,208'   Slope=0.0450 '/'   Tc=559.5 min   CN=68   Runoff=614.77 cfs  623.717 af

Subcatchment 2S: DA-2                        Runoff Area=26,071.000 ac   Runoff Depth>0.44"
  Flow Length=70,237'   Slope=0.0276 '/'   Tc=808.1 min   CN=68   Runoff=732.27 cfs  948.683 af

Subcatchment 3S: DA-3                        Runoff Area=24,308.000 ac   Runoff Depth=0.44"
  Flow Length=65,304'   Slope=0.0470 '/'   Tc=584.2 min   CN=68   Runoff=867.97 cfs  884.970 af

Subcatchment 4S: DA-4                        Runoff Area=22,611.000 ac   Runoff Depth>0.44"
  Flow Length=96,205'   Slope=0.0360 '/'   Tc=910.1 min   CN=68   Runoff=582.46 cfs  821.484 af

Subcatchment 5S: DA-5                        Runoff Area=20,320.000 ac   Runoff Depth=0.44"
  Flow Length=46,575'   Slope=0.0556 '/'   Tc=409.9 min   CN=68   Runoff=915.40 cfs  739.781 af

Subcatchment 12S: DA-1A                       Runoff Area=6,976.000 ac   Runoff Depth=0.44"
  Flow Length=41,850'   Slope=0.1030 '/'   Tc=276.4 min   CN=68   Runoff=404.20 cfs  253.972 af

Reach 6R: Wash 5            Avg. Depth=6.53'   Max Vel=5.85 fps   Inflow=915.40 cfs  739.781 af
      n=0.040   L=46,540.0'   S=0.0043 '/'   Capacity=375.37 cfs   Outflow=784.96 cfs  736.992 af

Reach 9R: Wash          Avg. Depth=6.80'   Max Vel=7.28 fps   Inflow=2,791.88 cfs  3,391.068 af
  n=0.040   L=23,429.0'   S=0.0047 '/'   Capacity=1,273.00 cfs   Outflow=2,754.22 cfs  3,380.833 af

Reach 10R: Wash 4           Avg. Depth=7.14'   Max Vel=3.93 fps   Inflow=582.46 cfs  821.484 af
       n=0.040   L=5,371.0'   S=0.0019 '/'   Capacity=247.08 cfs   Outflow=581.47 cfs  820.423 af

Reach 11R: CHANNEL Avg. Depth=3.92'   Max Vel=6.69 fps   Inflow=3,218.04 cfs  4,001.768 af
   n=0.025   L=2,250.0'   S=0.0023 '/'   Capacity=3,332.14 cfs   Outflow=3,217.77 cfs  4,000.258 af

Reach 13R: Channel - 2     Avg. Depth=4.67'   Max Vel=4.44 fps   Inflow=404.20 cfs  253.972 af
       n=0.025   L=8,000.0'   S=0.0014 '/'   Capacity=298.65 cfs   Outflow=397.49 cfs  253.958 af

Reach 16R: CHANNEL Avg. Depth=3.94'   Max Vel=5.53 fps   Inflow=3,218.31 cfs  4,003.369 af
   n=0.025   L=1,650.0'   S=0.0015 '/'   Capacity=3,305.80 cfs   Outflow=3,218.09 cfs  4,002.084 af
```

```
Reach 17R: CHANNEL Avg. Depth=3.95'   Max Vel=5.51 fps   Inflow=3,218.09 cfs  4,002.084 af
   n=0.025   L=400.0'   S=0.0015 '/'  Capacity=3,289.22 cfs  Outflow=3,218.04 cfs  4,001.768 af

Reach 19R: CHANNEL Avg. Depth=3.91'   Max Vel=6.24 fps   Inflow=2,754.22 cfs  3,380.833 af
  n=0.025   L=1,900.0'   S=0.0020 '/'  Capacity=2,862.97 cfs  Outflow=2,754.05 cfs  3,379.652 af

Link 14L: (new Link)                                     Inflow=3,348.23 cfs  4,254.216 af
                                                        Primary=3,348.23 cfs  4,254.216 af
```

tal Runoff Area = 117,418.000 ac   Runoff Volume = 4,272.607 af   Average Runoff Depth = 0.44"
100.00% Pervious Area = 117,418.000 ac   0.00% Impervious Area = 0.000 ac

Subcatchment 1S: DA-1

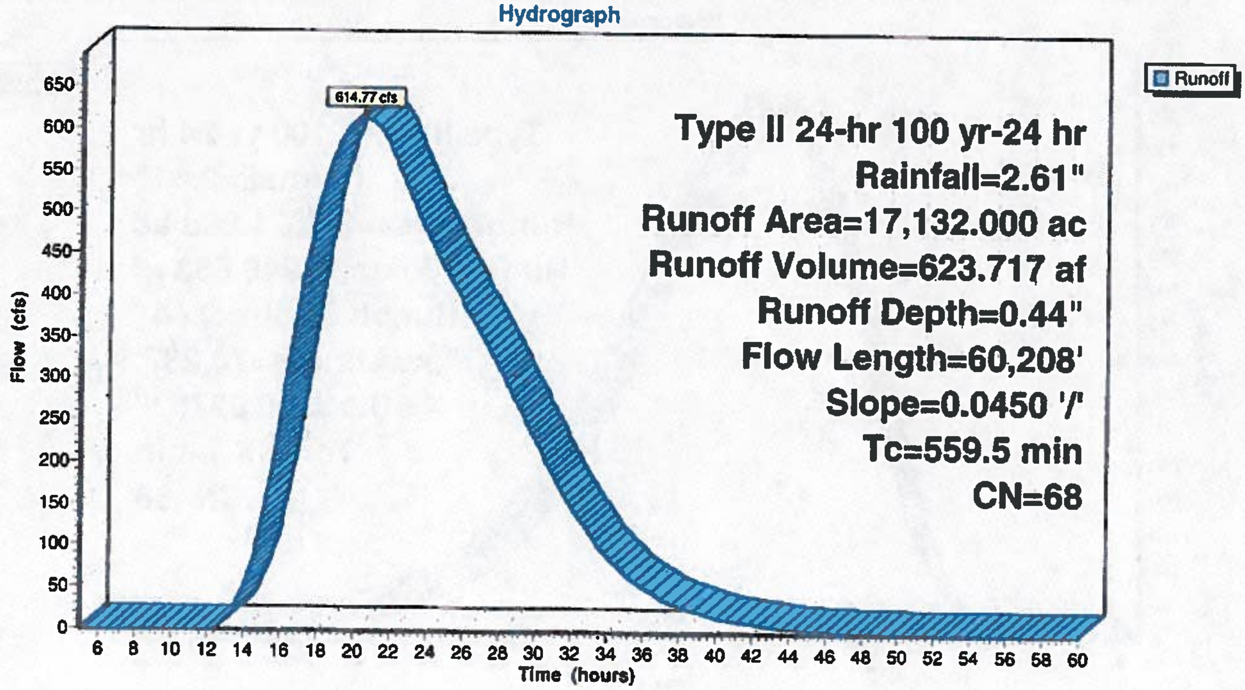
Runoff = 614.77 cfs @ 20.51 hrs, Volume= 623.717 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr-24 hr Rainfall=2.61"

Area (ac)	CN	Description
17,132.000	68	Desert shrub range, Good, HSG B
17,132.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
559.5	60,208	0.0450	1.79		**Lag/CN Method,**

Subcatchment 1S: DA-1



Subcatchment 2S: DA-2

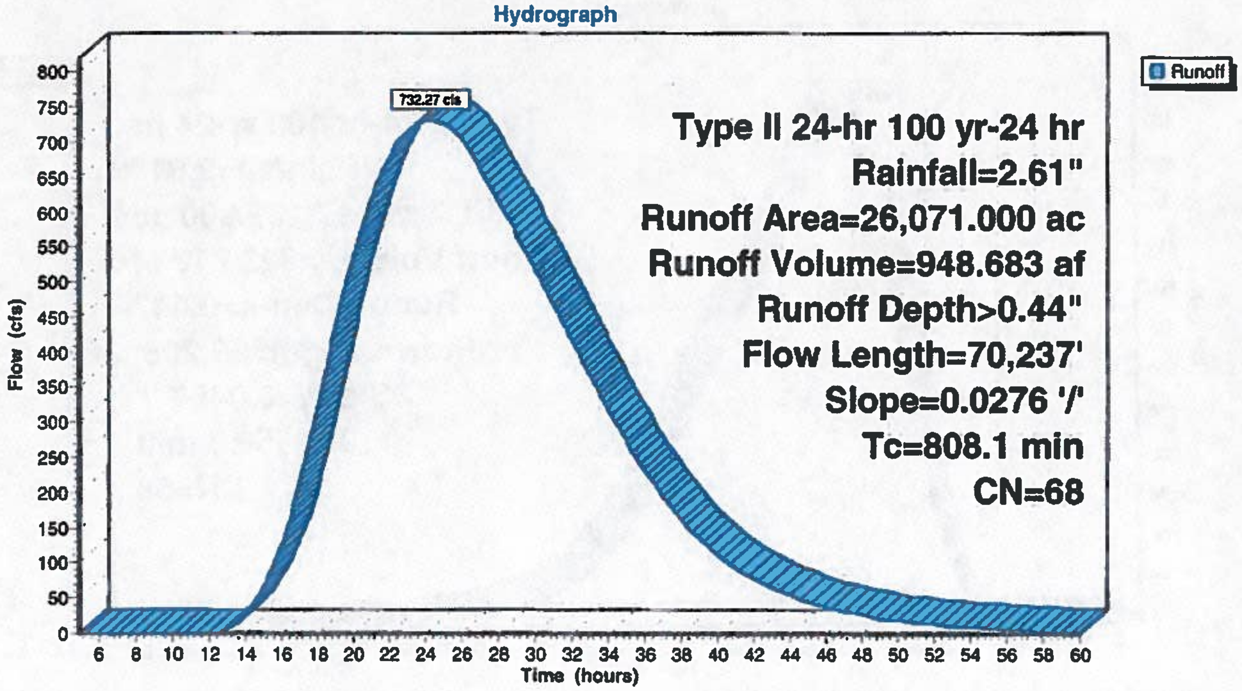
Runoff = 732.27 cfs @ 24.25 hrs, Volume= 948.683 af, Depth> 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr-24 hr Rainfall=2.61"

Area (ac)	CN	Description
26,071.000	68	Desert shrub range, Good, HSG B
26,071.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
808.1	70,237	0.0276	1.45		**Lag/CN Method,**

Subcatchment 2S: DA-2



Subcatchment 3S: DA-3

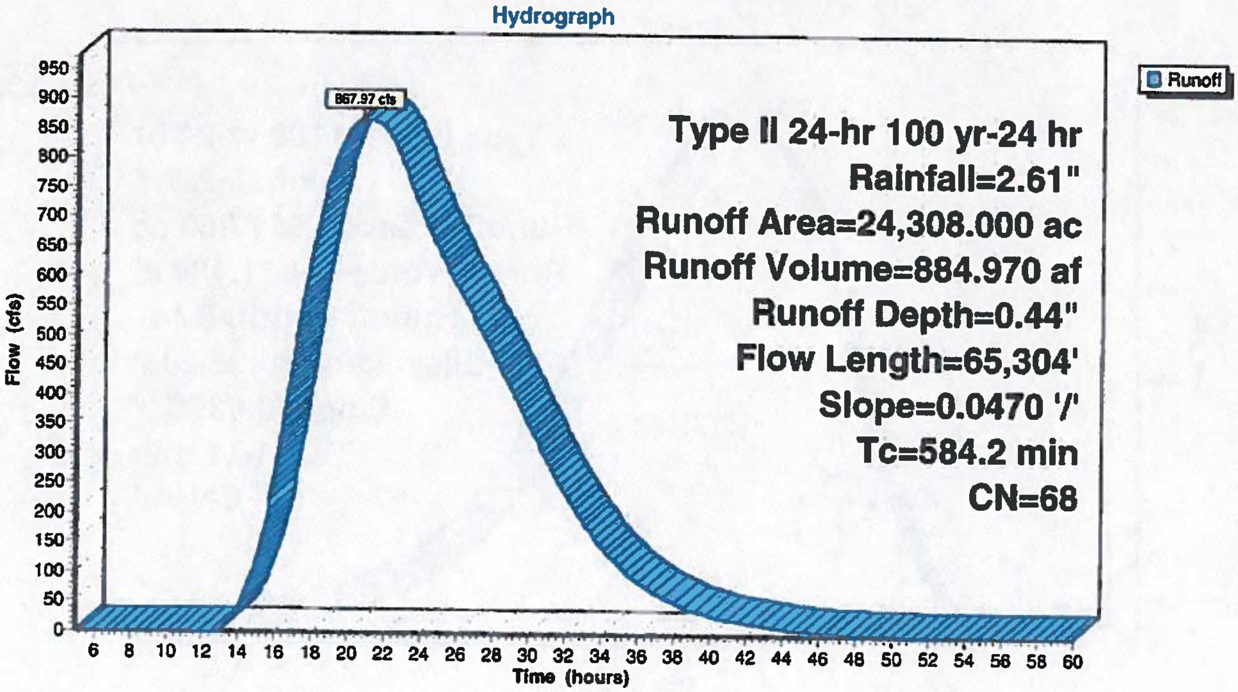
Runoff = 867.97 cfs @ 20.82 hrs, Volume= 884.970 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr-24 hr Rainfall=2.61"

Area (ac)	CN	Description
24,308.000	68	Desert shrub range, Good, HSG B
24,308.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
584.2	65,304	0.0470	1.86		**Lag/CN Method,**

Subcatchment 3S: DA-3



Subcatchment 4S: DA-4

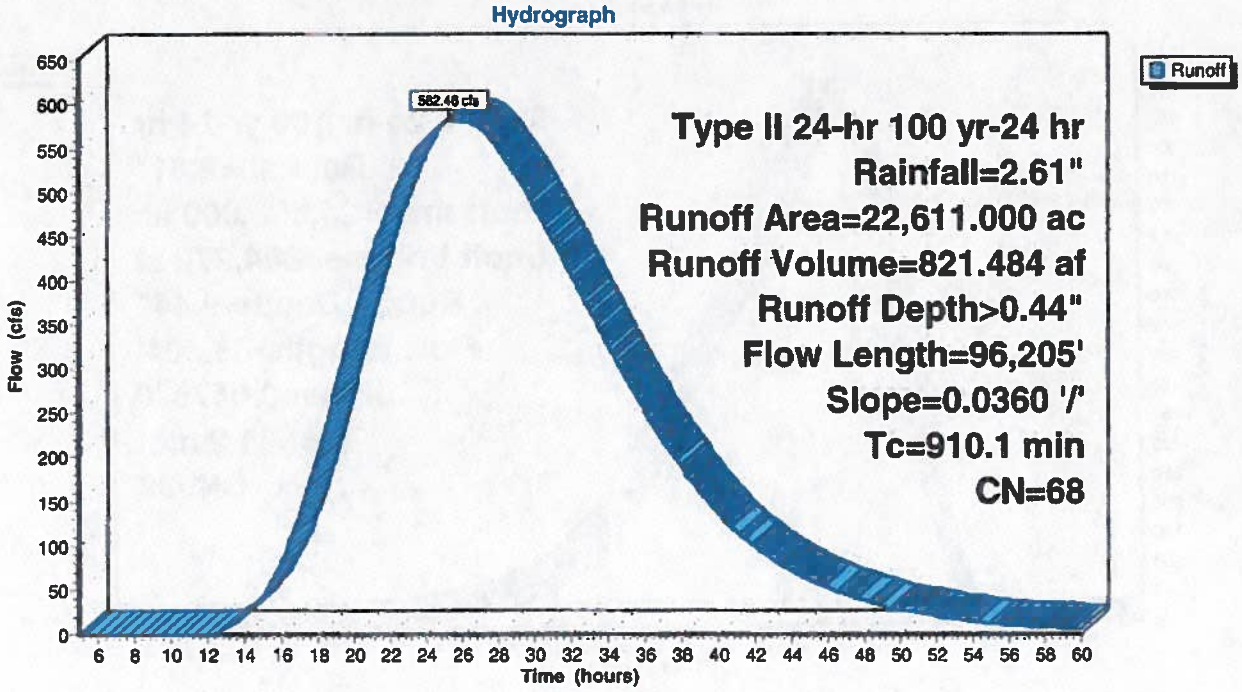
Runoff = 582.46 cfs @ 25.32 hrs, Volume= 821.484 af, Depth> 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr-24 hr Rainfall=2.61"

Area (ac)	CN	Description
22,611.000	68	Desert shrub range, Good, HSG B
22,611.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
910.1	96,205	0.0360	1.76		**Lag/CN Method,**

Subcatchment 4S: DA-4



Subcatchment 5S: DA-5

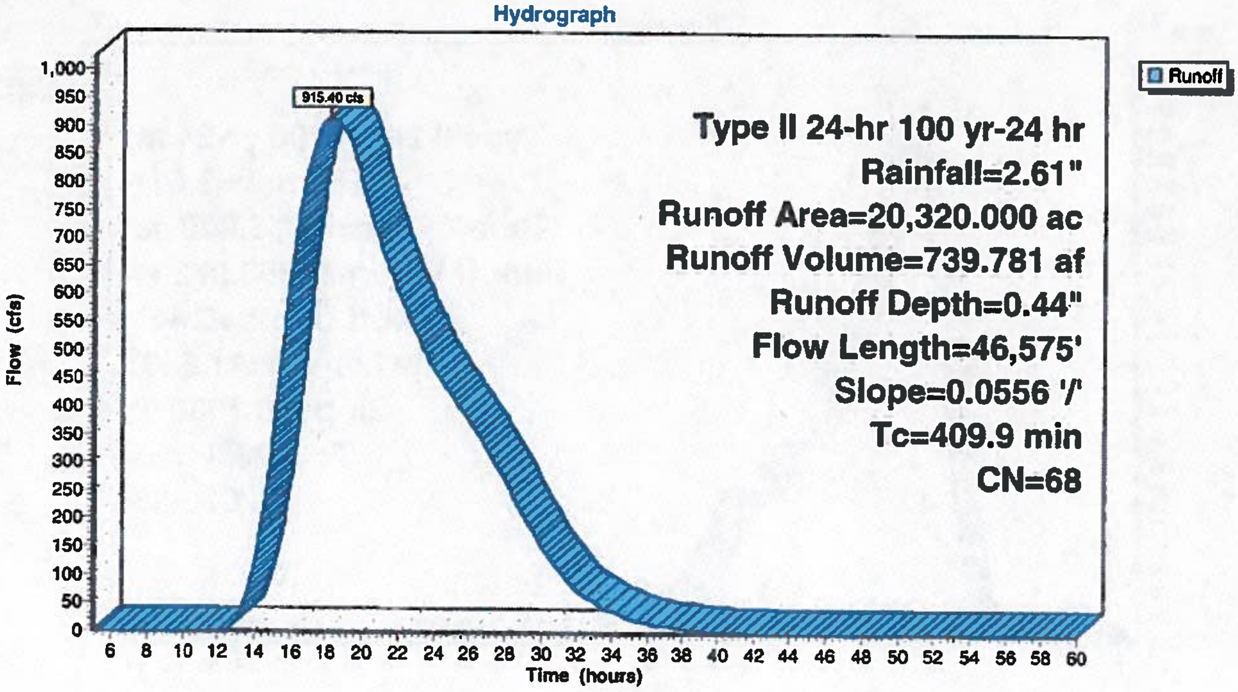
Runoff = 915.40 cfs @ 18.21 hrs, Volume= 739.781 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr-24 hr Rainfall=2.61"

Area (ac)	CN	Description
20,320.000	68	Desert shrub range, Good, HSG B
20,320.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
409.9	46,575	0.0556	1.89		**Lag/CN Method,**

Subcatchment 5S: DA-5



Subcatchment 12S: DA-1A

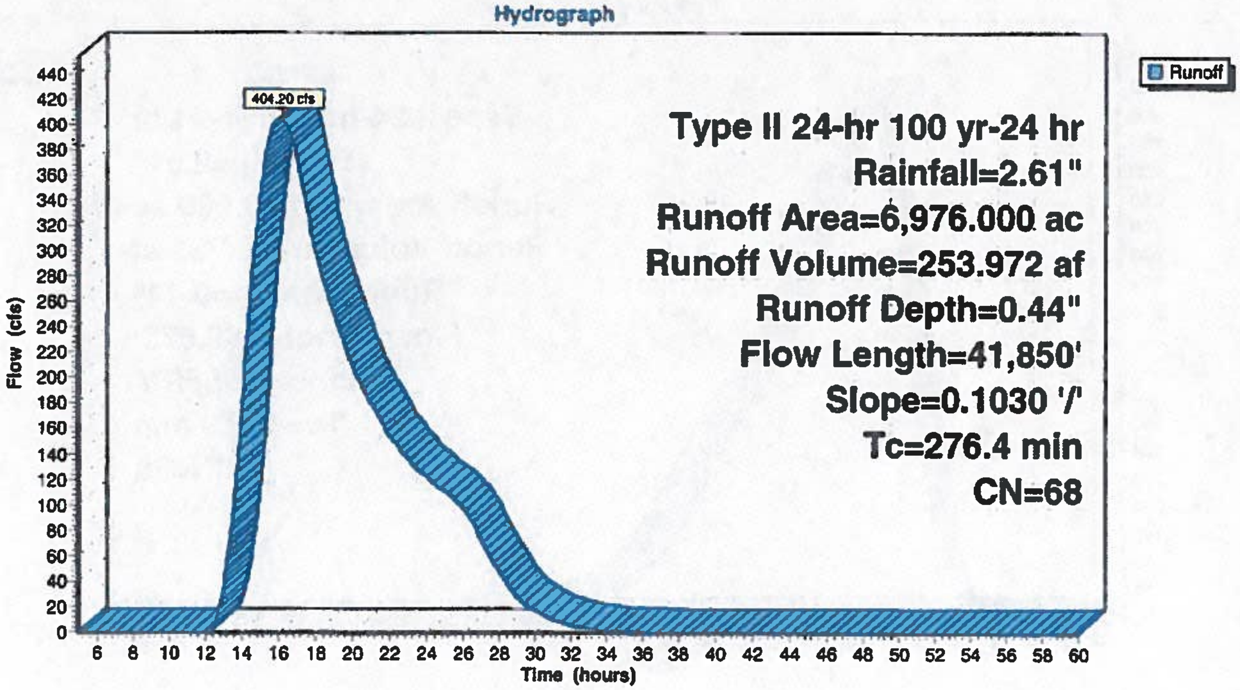
Runoff = 404.20 cfs @ 16.25 hrs, Volume= 253.972 af, Depth= 0.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 yr-24 hr Rainfall=2.61"

Area (ac)	CN	Description
6,976.000	68	Desert shrub range, Good, HSG B
6,976.000		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
276.4	41,850	0.1030	2.52		**Lag/CN Method,**

Subcatchment 12S: DA-1A



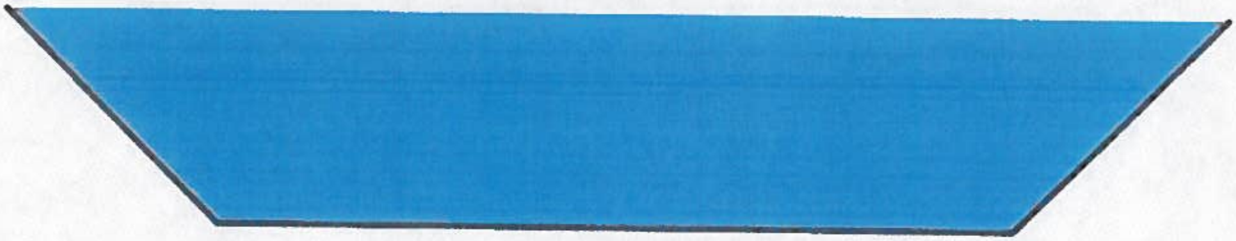
Reach 6R: Wash 5

Inflow Area = 20,320.000 ac, Inflow Depth = 0.44" for 100 yr-24 hr event
Inflow = 915.40 cfs @ 18.21 hrs, Volume= 739.781 af
Outflow = 784.96 cfs @ 22.30 hrs, Volume= 736.992 af, Atten= 14%, Lag= 245.0 r

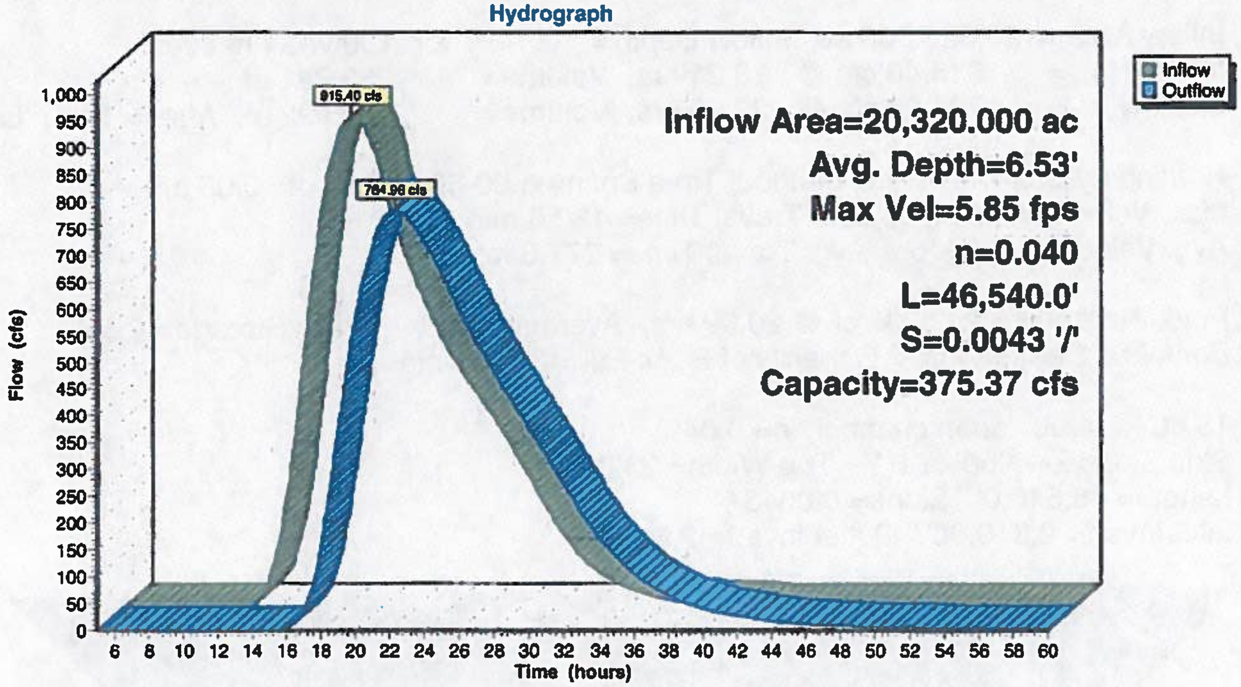
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.85 fps, Min. Travel Time= 132.5 min
Avg. Velocity = 2.79 fps, Avg. Travel Time= 277.6 min

Peak Storage= 6,242,337 cf @ 20.09 hrs, Average Depth at Peak Storage= 6.53'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 375.37 cfs

15.00' x 4.00' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 23.00'
Length= 46,540.0' Slope= 0.0043 '/'
Inlet Invert= 2,810.00', Outlet Invert= 2,610.00'



Reach 6R: Wash 5



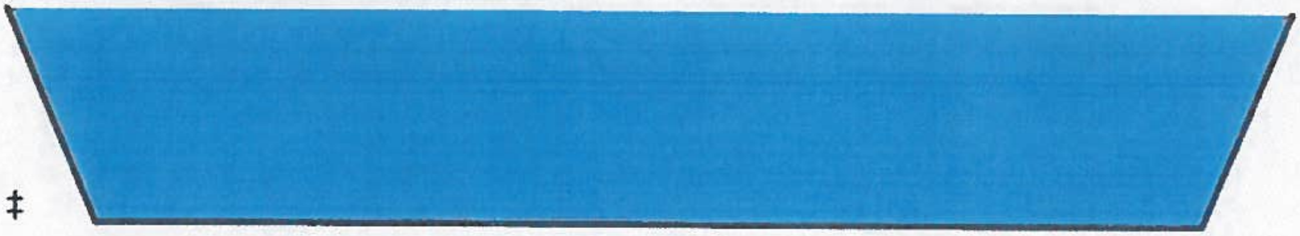
Reach 9R: Wash

```
Inflow Area = 93,310.000 ac,  Inflow Depth >  0.44"   for  100 yr-24 hr event
Inflow       =   2,791.88 cfs @   22.68 hrs,  Volume=       3,391.068 af
Outflow      =   2,754.22 cfs @   24.34 hrs,  Volume=       3,380.833 af,  Atten= 1%,  Lag= 99.3 min

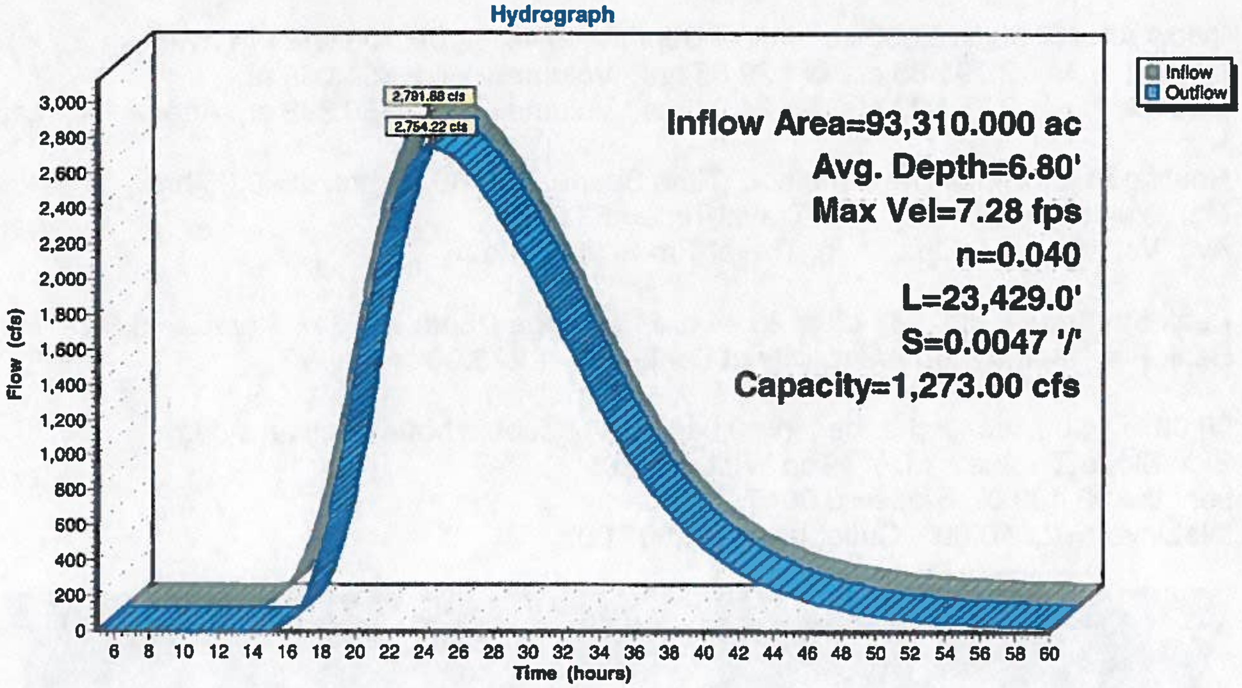
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.28 fps,  Min. Travel Time= 53.6 min
Avg. Velocity = 4.05 fps,  Avg. Travel Time= 96.4 min

Peak Storage= 8,864,681 cf @ 23.44 hrs,  Average Depth at Peak Storage= 6.80'
Bank-Full Depth= 4.00',  Capacity at Bank-Full= 1,273.00 cfs

50.00'  x  4.00'  deep channel,  n= 0.040  Earth, cobble bottom, clean sides
Side Slope Z-value= 1.0 '/'   Top Width= 58.00'
Length= 23,429.0'   Slope= 0.0047 '/'
Inlet Invert= 2,610.00',  Outlet Invert= 2,500.00'
```



Reach 9R: Wash



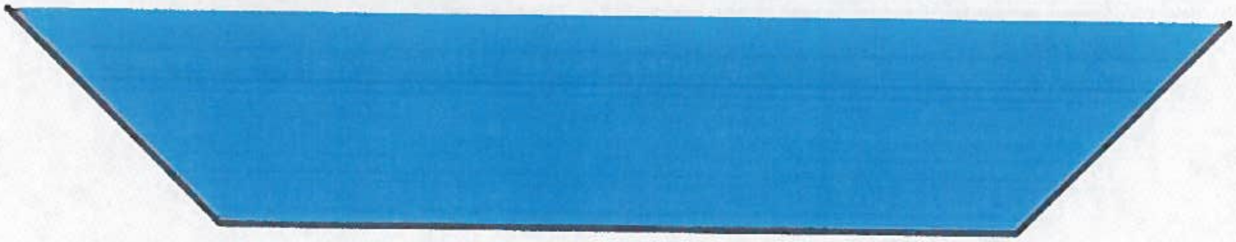
Reach 10R: Wash 4

```
Inflow Area = 22,611.000 ac,  Inflow Depth >  0.44"   for 100 yr-24 hr event
Inflow      =      582.46 cfs @  25.32 hrs,  Volume=      821.484 af
Outflow     =      581.47 cfs @  26.51 hrs,  Volume=      820.423 af,  Atten= 0%,  Lag= 71.6 min
```

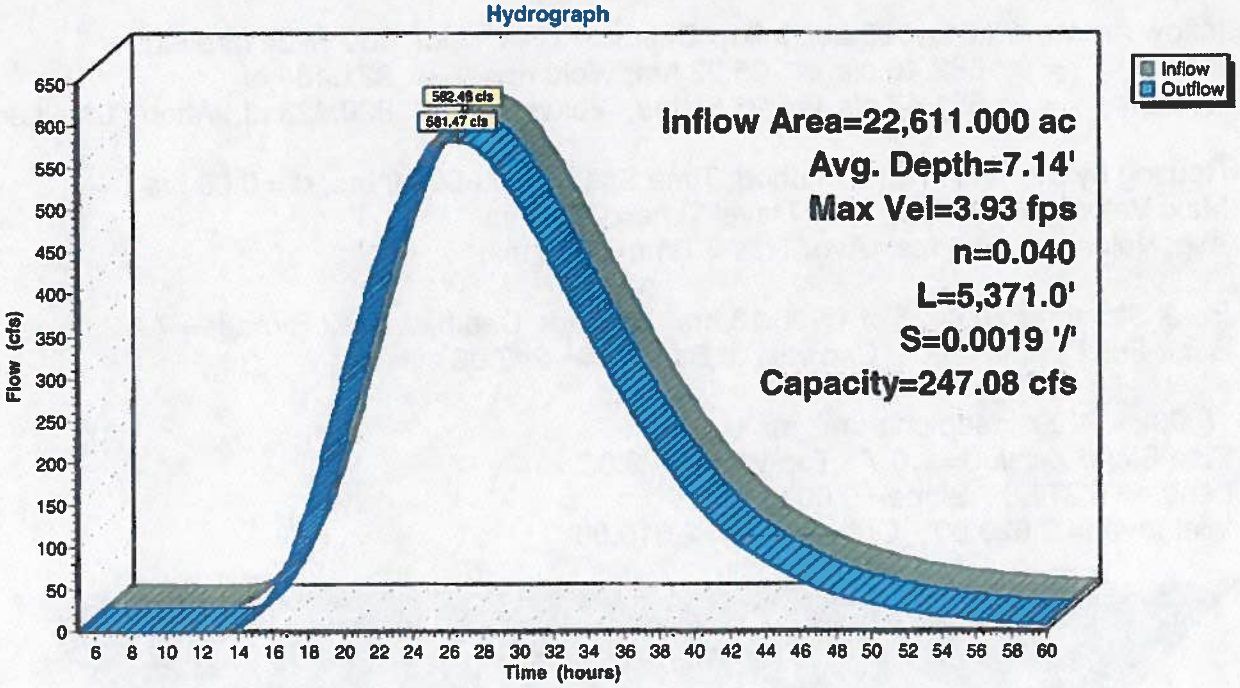
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.93 fps, Min. Travel Time= 22.8 min
Avg. Velocity = 2.54 fps, Avg. Travel Time= 35.3 min

Peak Storage= 795,425 cf @ 26.13 hrs, Average Depth at Peak Storage= 7.14'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 247.08 cfs

15.00' x 4.00' deep channel, n= 0.040
Side Slope Z-value= 1.0 '/' Top Width= 23.00'
Length= 5,371.0' Slope= 0.0019 '/'
Inlet Invert= 2,620.00', Outlet Invert= 2,610.00'



Reach 10R: Wash 4



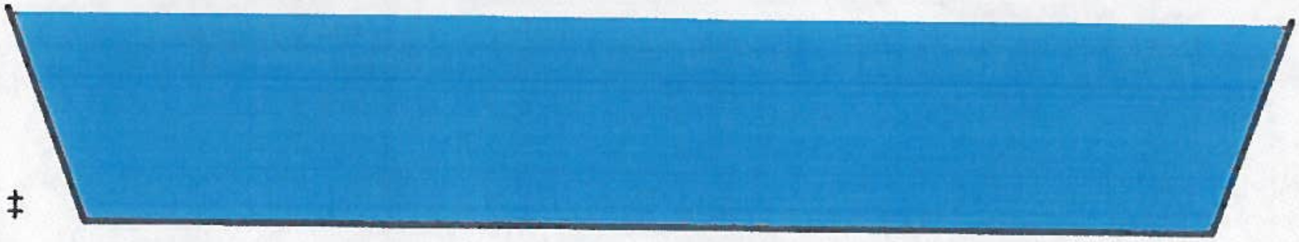
Reach 11R: CHANNEL 4

Inflow Area =110,442.000 ac, Inflow Depth > 0.43" for 100 yr-24 hr event
Inflow = 3,218.04 cfs @ 24.24 hrs, Volume= 4,001.768 af
Outflow = 3,217.77 cfs @ 24.40 hrs, Volume= 4,000.258 af, Atten= 0%, Lag= 9.3 min

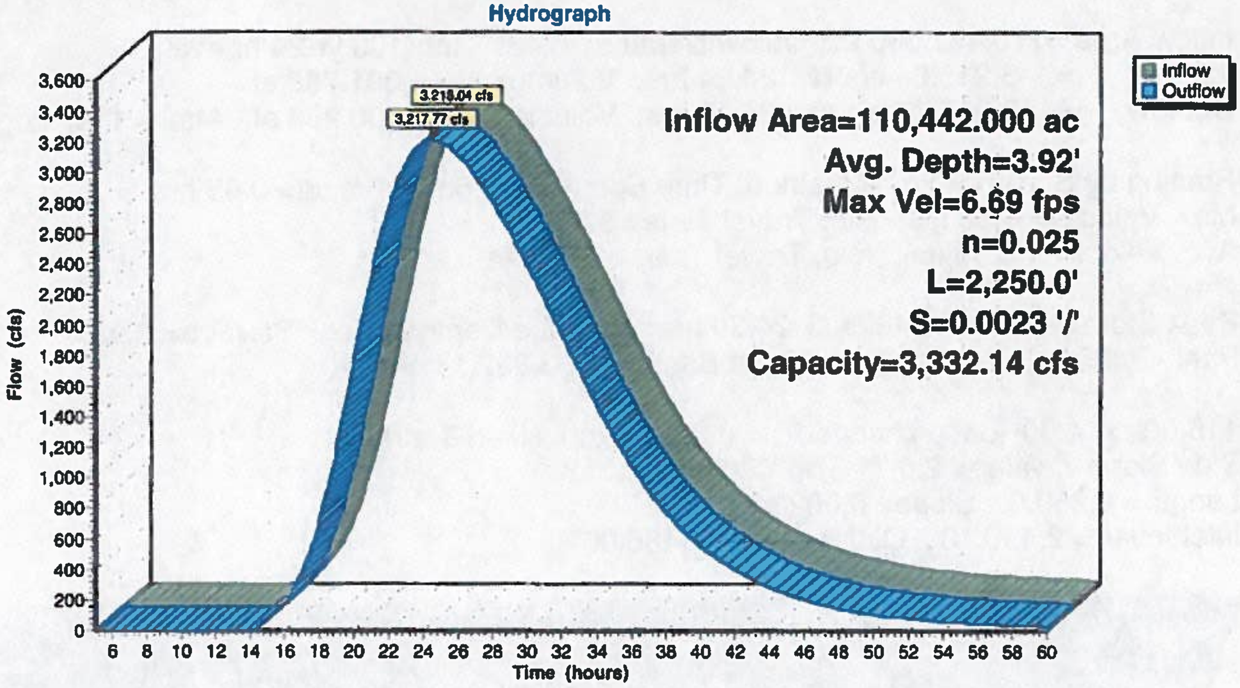
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.69 fps, Min. Travel Time= 5.6 min
Avg. Velocity = 3.55 fps, Avg. Travel Time= 10.6 min

Peak Storage= 1,082,849 cf @ 24.30 hrs, Average Depth at Peak Storage= 3.92'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 3,332.14 cfs

115.00' x 4.00' deep channel, n= 0.025 Earth, clean & straight
Side Slope Z-value= 2.0 '/' Top Width= 131.00'
Length= 2,250.0' Slope= 0.0023 '/'
Inlet Invert= 2,490.10', Outlet Invert= 2,485.00'



Reach 11R: CHANNEL 4



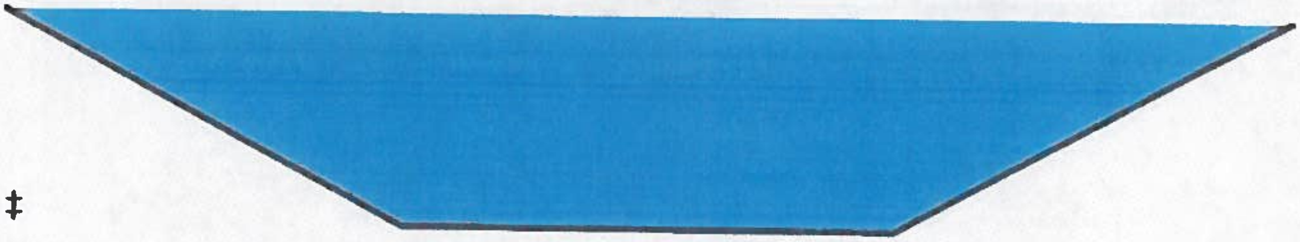
Reach 13R: Channel - 2

```
Inflow Area =   6,976.000 ac,  Inflow Depth =  0.44"   for  100 yr-24 hr event
Inflow      =     404.20 cfs @  16.25 hrs,  Volume=        253.972 af
Outflow     =     397.49 cfs @  17.04 hrs,  Volume=        253.958 af,  Atten= 2%,  Lag= 47.5 min
```

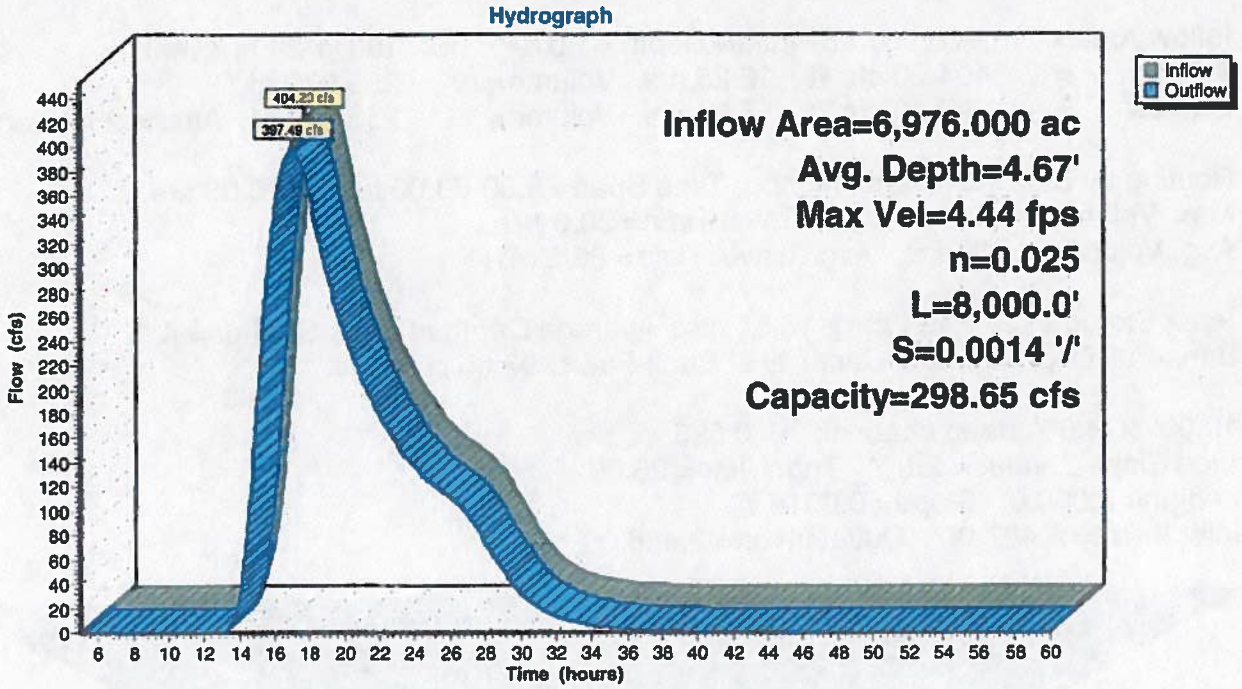
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.44 fps, Min. Travel Time= 30.0 min
Avg. Velocity = 1.55 fps, Avg. Travel Time= 86.2 min

Peak Storage= 715,424 cf @ 16.54 hrs, Average Depth at Peak Storage= 4.67'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 298.65 cfs

10.00' x 4.00' deep channel, n= 0.025
Side Slope Z-value= 2.0 '/' Top Width= 26.00'
Length= 8,000.0' Slope= 0.0014 '/'
Inlet Invert= 2,497.00', Outlet Invert= 2,486.00'



Reach 13R: Channel - 2



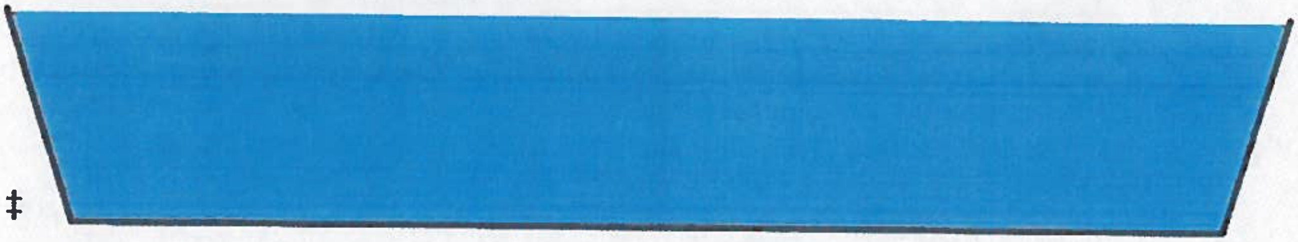
Reach 16R: CHANNEL 2

Inflow Area =110,442.000 ac, Inflow Depth > 0.43" for 100 yr-24 hr event
Inflow = 3,218.31 cfs @ 24.07 hrs, Volume= 4,003.369 af
Outflow = 3,218.09 cfs @ 24.21 hrs, Volume= 4,002.084 af, Atten= 0%, Lag= 8.2 min

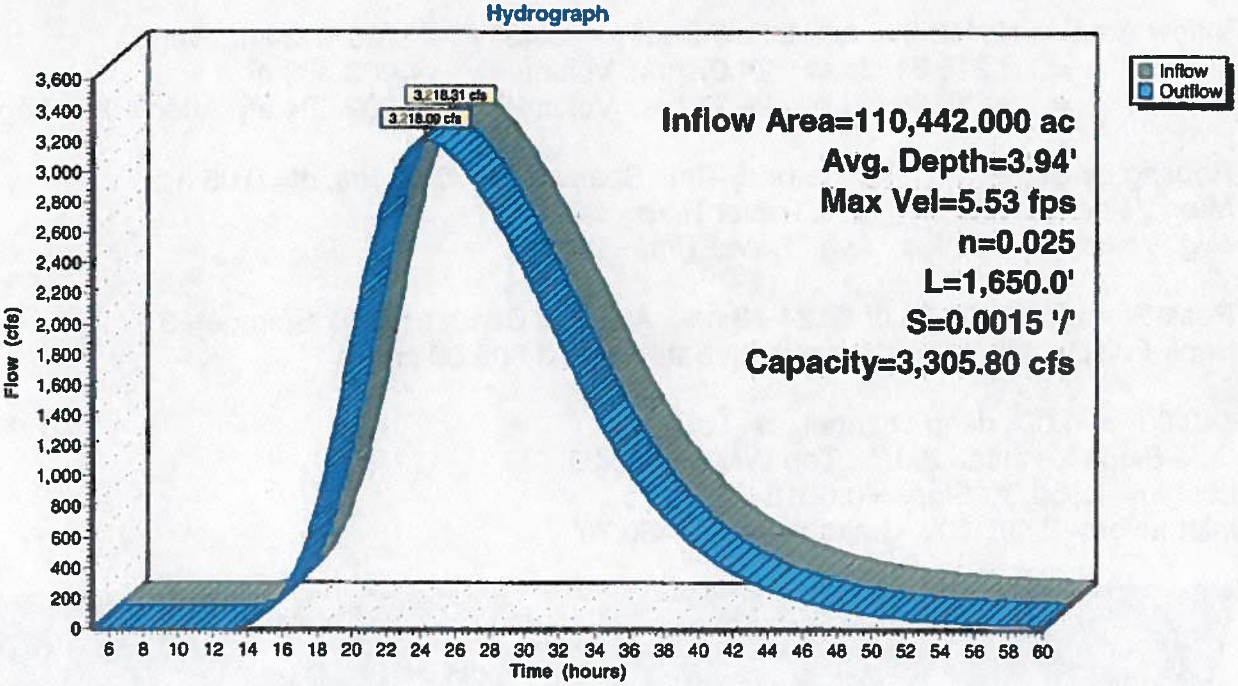
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.53 fps, Min. Travel Time= 5.0 min
Avg. Velocity = 2.92 fps, Avg. Travel Time= 9.4 min

Peak Storage= 960,475 cf @ 24.13 hrs, Average Depth at Peak Storage= 3.94'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 3,305.80 cfs

140.00' x 4.00' deep channel, n= 0.025
Side Slope Z-value= 2.0 '/' Top Width= 156.00'
Length= 1,650.0' Slope= 0.0015 '/'
Inlet Invert= 2,493.20', Outlet Invert= 2,490.70'



Reach 16R: CHANNEL 2



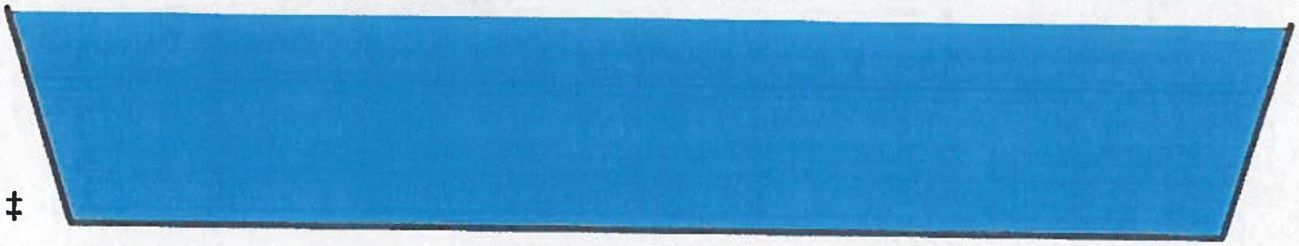
Reach 17R: CHANNEL 3

Inflow Area =110,442.000 ac, Inflow Depth > 0.43" for 100 yr-24 hr event
Inflow = 3,218.09 cfs @ 24.21 hrs, Volume= 4,002.084 af
Outflow = 3,218.04 cfs @ 24.24 hrs, Volume= 4,001.768 af, Atten= 0%, Lag= 2.0 min

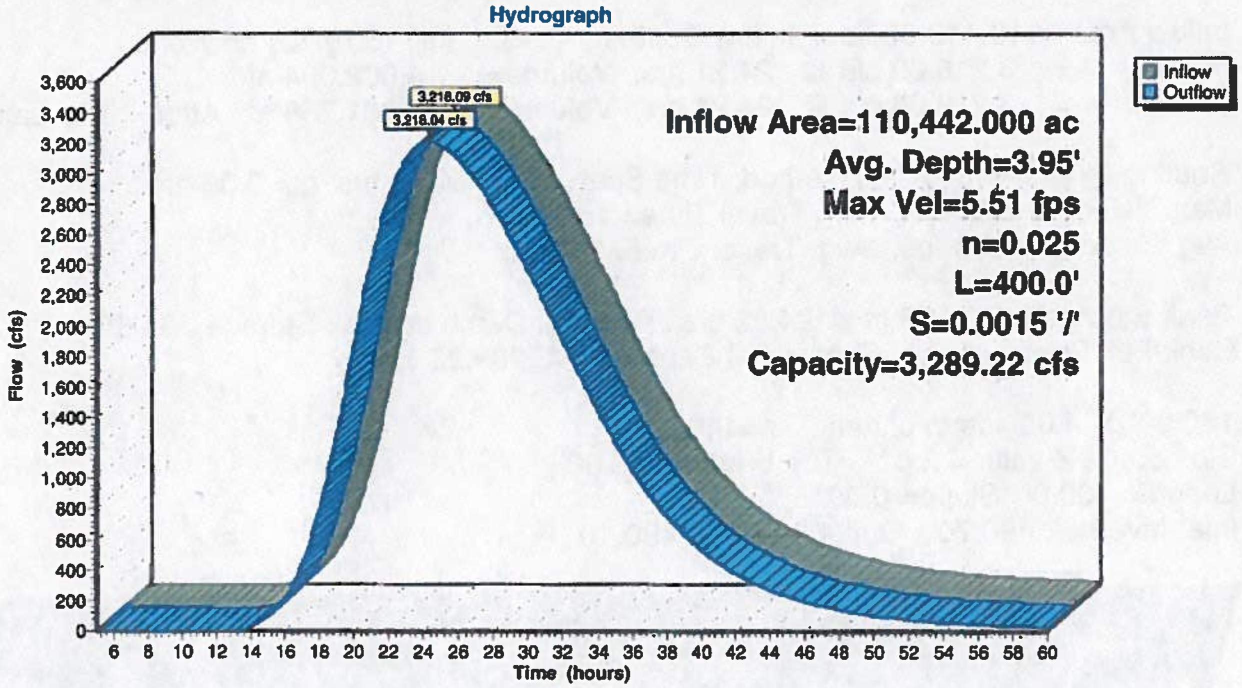
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.51 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 2.91 fps, Avg. Travel Time= 2.3 min

Peak Storage= 233,575 cf @ 24.22 hrs, Average Depth at Peak Storage= 3.95'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 3,289.22 cfs

140.00' x 4.00' deep channel, n= 0.025
Side Slope Z-value= 2.0 '/' Top Width= 156.00'
Length= 400.0' Slope= 0.0015 '/'
Inlet Invert= 2,490.70', Outlet Invert= 2,490.10'



Reach 17R: CHANNEL 3



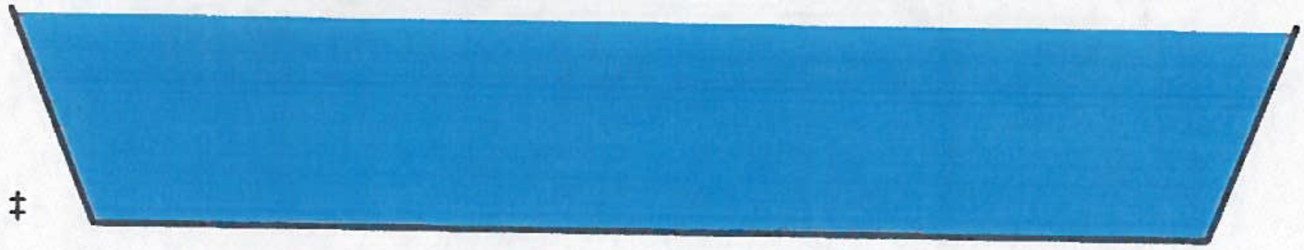
Reach 19R: CHANNEL 1

Inflow Area = 93,310.000 ac, Inflow Depth > 0.43" for 100 yr-24 hr event
Inflow = 2,754.22 cfs @ 24.34 hrs, Volume= 3,380.833 af
Outflow = 2,754.05 cfs @ 24.48 hrs, Volume= 3,379.652 af, Atten= 0%, Lag= 8.4 min

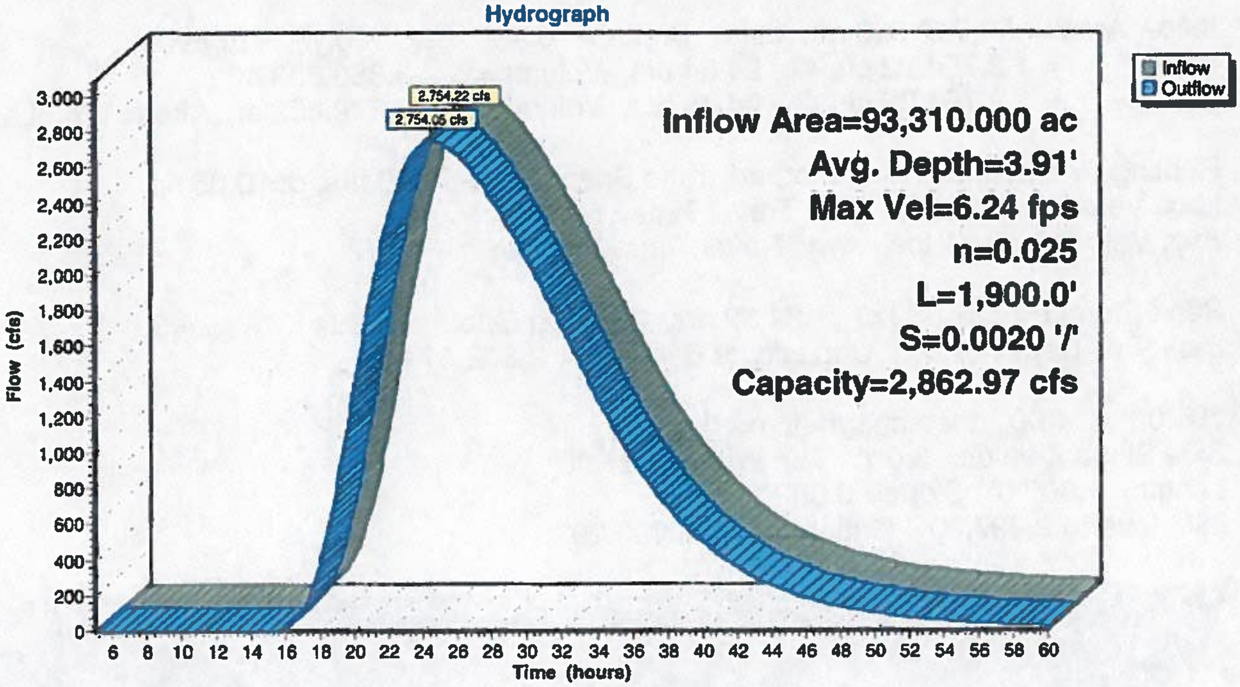
Routing by Stor-Ind+Trans method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.24 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 3.31 fps, Avg. Travel Time= 9.6 min

Peak Storage= 837,934 cf @ 24.39 hrs, Average Depth at Peak Storage= 3.91'
Bank-Full Depth= 4.00', Capacity at Bank-Full= 2,862.97 cfs

105.00' x 4.00' deep channel, n= 0.025
Side Slope Z-value= 2.0 '/' Top Width= 121.00'
Length= 1,900.0' Slope= 0.0020 '/'
Inlet Invert= 2,497.00', Outlet Invert= 2,493.20'



Reach 19R: CHANNEL 1

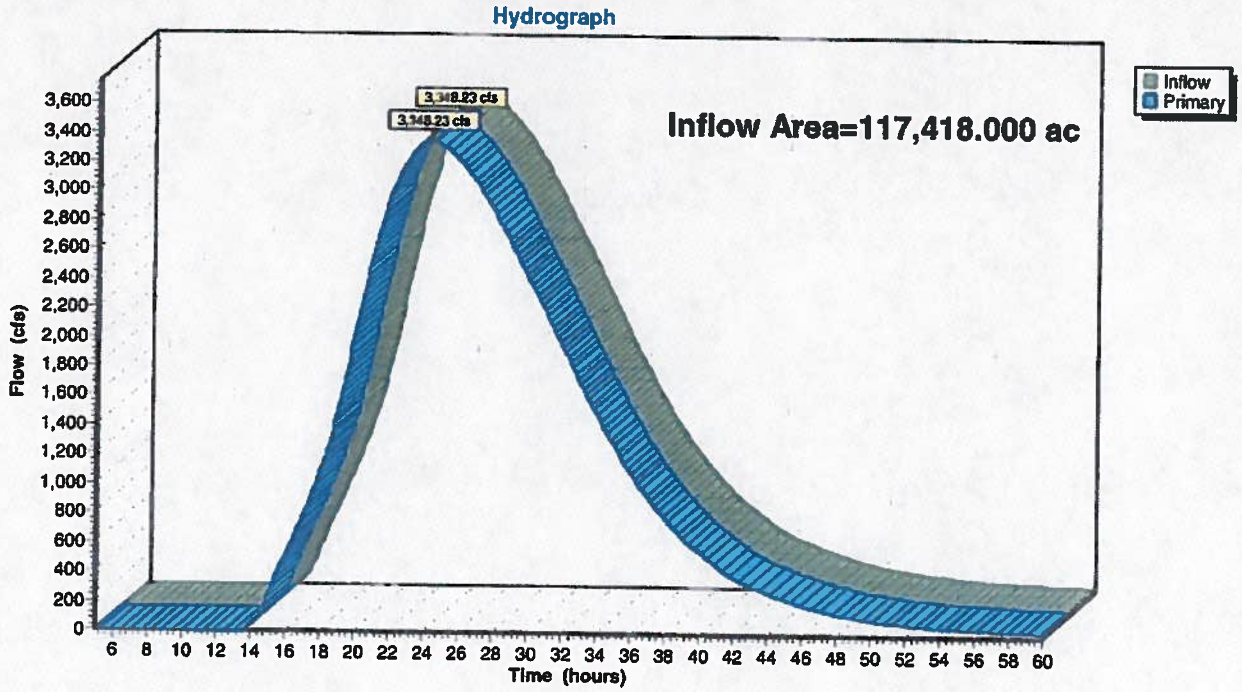


Link 14L: (new Link)

Inflow Area =117,418.000 ac, Inflow Depth > 0.43" for 100 yr-24 hr event
Inflow = 3,348.23 cfs @ 24.29 hrs, Volume= 4,254.216 af
Primary = 3,348.23 cfs @ 24.29 hrs, Volume= 4,254.216 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs

Link 14L: (new Link)



Appendix VI

SECTION 02200

EARTHWORK

PART 1 -GENERAL

1.01 SCOPE

A. The Work covered by this specification consists of furnishing all labor, equipment and materials to perform general grading; excavation; and placement and compaction of structural fill for foundations, perimeter berms, embankments and structures, as shown on the Drawings.

B. All excavation shall be unclassified regardless of material encountered, except for Rock as defined in this specification.

C. A layer is defined as a compacted stratum composed of several lifts constructed without joints. A lift is defined as a segment of a layer composed of the maximum thickness of soil permitted to be placed / compacted at one time.

D. All fill materials shall be subject to the approval of the CQA Consultant.

E. The CONTRACTOR is solely responsible for the placement of all fill material and shall not rely on the CQA Consultant for recommendations and directions. It is recommended the CONTRACTOR employs his own geotechnical consultant to provide construction assistance and recommendations.

F. The CQA Consultant will perform field and laboratory testing as required and in accordance with the CQA Plan.

G. Store and use explosives in accordance with federal, state and local regulations. The CONTRACTOR shall be responsible for and shall satisfactorily correct all damage resulting from use of explosives.

1.02 CONSTRUCTION QUALITY CONTROL (CQC)

A. The CONTRACTOR will provide a testing program to perform the following minimum laboratory tests on soil materials being used for construction. All testing will be performed by an independent qualified geotechnical consultant and testing laboratory and under the direction of a Registered Professional Engineer licensed in the State in which the project work is conducted.

B. Laboratory Testing - Soils:

1. Visual Classification
   Visual classification (ASTM D2487) shall be conducted at a frequency of one test for each soil type.

2. Gradation Analysis
   Gradation analysis (ASTM D422) shall be conducted at a frequency of one test for each soil type.
3. Atterberg Limits and Moisture Content
   Atterberg limits (ASTM D4318) and moisture content test (ASTM 2216) shall be conducted at a frequency of one test for each soil type.
4. Standard Proctor Density Test
   Standard Proctor density test (ASTM D698) shall be conducted at a frequency of one test for each soil type.
5. Specific Gravity
   Specific gravity test (ASTM D854) shall be conducted at a frequency of one test for each soil type.
6. Triaxial Compression Testing
   Consolidated Undrained Triaxial with Pore Pressure Measurements Series (ASTM D4767), Three Point Series, Remolded, shall be conducted at a frequency of one test for each soil type.

PART 2 - PRODUCTS

2.01 FILL MATERIAL

All fill material used to establish necessary grades as shown on the Drawings shall be free of debris, roots, stumps, brush, vegetation, frozen material, organic matter, rock, or gravel larger than two inches in any dimension, or other harmful matter, unless allowed by the CQA Consultant.

All fill materials shall be subject to the approval of the CQA Consultant. CONTRACTOR shall notify the CQA Consultant at least 10 working days in advance of intention to begin filling operations. Notification shall include designation of the proposed borrow source and all necessary laboratory testing data to demonstrate the adequacy of the material to perform its intended use. CONTRACTOR shall provide the CQA Consultant with 120 pounds of the proposed material in three, five-gallon, PVC, sample buckets with lids and handles at the time of notification. CONTRACTOR shall not initiate filling activities without the approval of the CQA Consultant to use the intended material for filling activities.

2.02 ROCK

Rock shall be construed as solid mineral material with a volume in excess of two (2) cubic yards or solid material that cannot be fractured and/or removed with conventional earth moving equipment. Conventional earth moving equipment shall be defined as a Cat D8L or equivalent tractor with a single-shank ripper, or Cat 330 sized or equivalent hydraulic excavator.

2.03 UNSUITABLE MATERIAL

Material such as clay mass, frozen materials, cinders, ashes, refuse, vegetation, organic material and muck shall be construed as unsuitable material for backfill. All unsuitable material under access roads, structural fills and berms shall be removed from the area to be filled.

PART 3 - EXECUTION

3.01 GENERAL

A. Strip topsoil to full depth, and stockpile separate from other excavated materials and pile free of roots, stones, and other undesirable materials. Follow local erosion and sediment control guidelines to prevent erosion. Any depressions caused by removal of stumps of the clearing shall be excavated to firm subgrade.

B. The CONTRACTOR shall perform all excavation described in whatever material encountered to dimensions and elevations shown on the Drawings.

C. Existing utilities, structures, and fencing shall be protected during the construction period, and if damaged or removed by the CONTRACTOR in his operations, shall be repaired or replaced at the CONTRACTOR'S expense.

D. Where unauthorized excavations have been carried below or beyond points required, restore these areas to the elevations and dimensions shown on the Drawings with material approved by CQA Consultant and compact as specified, at no additional cost to the OWNER.

E. Material rendered not suitable for construction due to fault or negligence of the CONTRACTOR, shall be removed and replaced at no additional cost to the OWNER.

3.02 UTILITIES TO BE ABANDONED OR REMOVED

A. When underground utilities are to be abandoned in place, plug, cap, or seal with concrete at the "Construction Limits" or at points designated by the CQA Consultant.

B. Remove underground utilities indicated on the Drawings to be removed and backfill resulting excavation with suitable material, compacted as specified. Plug, cap or seal utilities with concrete at the construction limits or at points designated by the CQA Consultant.

3.03 PROOFROLLING

A. Prior to the placement of any fill material, the subgrade, or bridge lift, shall be proofrolled.

B. Prior to the placement of the liner system, the natural ground or excavated subgrade, shall be proofrolled.

C. Prior to the placement of the liner system, the top of fill shall be proofrolled

D. Proofrolling shall be performed using a rubber-tired device having a static weight of at least 10 tons (such as a loaded tandem axle dump truck). This shall be performed during dry weather conditions and under the direction of the CQA Consultant. Areas that "pump" or otherwise exhibit instability shall be repaired as directed by the CQA Consultant.

3.04 WETLANDS PROTECTION

Prior to the placement of any fill material, the Best Management Practices (BMPs), such as stormwater conveyance channels, sediment basins, outlet protection, and silt fence, shown on the contract documents must be installed. In addition, the CONTRACTOR is responsible for flagging the maximum limits of disturbance prior to the start of on-site construction activities. At no time shall the CONTRACTOR impact any areas beyond the maximum limits of disturbance, without prior approval from the ENGINEER and CQA Consultant.

3.05 EXCAVATION

A. Areas that receive permanent seeding shall be graded below finished grades shown, leaving space for the vegetative support layer.

B. Stockpile excavated soil material satisfactory for backfill or fill until required. Place, grade and shape stockpiles for proper drainage. Proper erosion and sediment control measures shall be installed in conjunction with stockpile development.

C. Remove existing pavement as required.

D. Dispose of materials unsatisfactory for backfill or fill continuously with the progress of work.

E. Dispose of trash and debris, and all excess material continuously with the progress of the work.

F. All excavation shall be dewatered as necessary to provide proper protection. The CQA Consultant may require excavation to be continuously dewatered 24 hours per day byadequate pumping or well-points satisfactory to the CQA Consultant until backfilling has been completed.

G. Where underground streams or springs are found, provide temporary drainage and notify ENGINEER and CQA Consultant.

H. Extreme caution shall be taken when excavating in the vicinity of existing facilities. Any damage to the facilities will be repaired to original condition at no additional cost to the OWNER.

I. Excavate unsuitable soil materials encountered that extend below required elevations. The limits of the unsuitable material and depth of removal shall be determined by the CONTRACTOR, and agreed to by the ENGINEER and/or the CQA Consultant.

J. Remove shoring and all form materials.

K. Grade site to prevent surface water run-on into excavations.

3.06 EXCAVATION FOR STRUCTURES

A. Conform to elevations and dimensions shown on the Drawings. Extend excavation sufficient distance from footings and foundations to permit placing and removal of concrete form work, installation of services, and for other required construction. Foundation concrete shall not be poured until the bearing stratum has been examined and found satisfactory for the design bearing capacity.

B. Where rock is encountered, notify ENGINEER. When the entire structure will bear on rock, it shall be used to support the foundation. Where only a part of the foundation would bear on rock, excavate 12 inches below the entire structure and backfill with aggregate fill and thoroughly compact.

C. Provide a 12-inch minimum clearance between rock excavation and walls of structure when forming is not used. Provide a two (2) feet clearance when forming is used.

3.07 ROCK REMOVAL

A. Rock removal will be by mechanical method only unless prior approval is received from the OWNER, ENGINEER, and CQA Consultant.

B. If Rock is encountered as defined in this specification, The CONTRACTOR will before proceeding:

1. Demonstrate findings to the CQA Consultant;
2. Determine limits of the rock above the base grade; and
3. Quantify the rock and provide information, including limits, to the CQA Consultant for assessment.

C. Remove rock at bottom of excavations to form level bearings.

D. In utility trenches, excavate to 4 inches below invert elevation of pipe and to width indicated on Standard Details.

E. Remove rock loosened by mechanical method. Over-excavation of six inches to one foot will be allowed.

F. Correct unauthorized rock removal in accordance with backfilling and compaction requirements of the project specifications.

G. Excavated rock will be removed from the site or segregated and stockpiled on-site as directed by the OWNER.

3.08 COMPACTION OF FILL

A. Compaction of each layer shall be continuous over the entire area and the compaction equipment shall make sufficient trips to assure that the density has been obtained. Fill shall be placed and compacted in uniform lifts and shall not exceed 6 inches in compacted thickness. All fill shall be compacted to within 95 percent of maximum density (standard proctor) as determined by ASTM D698. This compaction method shall apply to all fills, berms, embankments, paved areas and for a distance of at least 25 feet beyond structures and at least five feet beyond fills, berms, embankments and paved areas. All other unpaved areas shall be compacted to within 90 percent of maximum density as determined by ASTM D698.

B. Compaction equipment shall be of such design that it will be able to compact the fill to the specified density. Use power-driven hand tampers for compacting materials adjacent to structures.

3.09 COMPACTION TESTS

Field tests of the compaction of fill will be made by the CQA Consultant. If a test fails to meet the required compaction level or moisture content, then the area represented by that test shall be reworked and retested, at no additional cost to the OWNER, until a passing test results. The CONTRACTOR may elect at his own expense to remove the failing material.

3.10 SURFACE WATER

All excavations and fill areas shall be kept free of standing water. Grade surfaces and ditches to drain. Pumping of water shall be required to remove water from areas that cannot drain naturally.

3.11 FILL AND BACKFILL

A. Remove vegetation, debris, unsatisfactory materials prior to placement of fill. Plow, strip or break up sloped surfaces steeper than 4 to 1 so that fill material shall bond with existing surface.

B. Obtain clean earth fill from excavation or other approved sources. The material shall be compacted in accordance with these Specifications. Rock fragments and stones up to 2 feet in its greatest dimension may be placed in an embankment fill to within 10 feet of the top of the earth fill. The remainder of the embankment to within 2 feet of the top of the earth fill shall not contain rock more than 6 inches in its greatest dimension. The top 2 feet of the embankment shall not contain rock more than 2 inches in its greatest dimension. Rock, fines and earth shall be distributed throughout each lift so that voids are filled. Rock shall not be placed in the embankment where, piling, borings, monitoring wells or boundary probes are to be driven, drilled or constructed. Prevent nesting of large rocks and compact fill to prevent voids. Maximum rock size within 12 inches of footing elevations shall be 2 inch diameter.

C. Provide borrow material when on-site excavation is not sufficient to grade site to contours and finished grade elevations shown on the Drawings. All necessary costs shall be included in Bid Price.

D. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified percentage of maximum density.

E. Do not backfill with or compact over frozen soil material.

F. Soil material that has been removed as too wet to permit compaction may be stockpiled or spread to dry. When moisture content is reduced to a satisfactory value, soil material may be used as fill or backfill.

G. Place clean earth fill to obtain elevations shown on the Drawings.

H. Excavate depression caused by removed stumps or other clearing operations to firm subgrade, fill with clean earth and compact as specified.

I. When the existing ground surface has been disturbed and has a density of less than that specified for the particular area, scarify the ground surface, adjust moisture content and compact to required depth and percentage of maximum density.

J. Place backfill and fill materials in layers which, when compacted, shall not exceed six inches in lift thickness at depths less than four feet below finished grade and 12 inches in lift thickness at depths greater than four feet below finished grade. Each layer shall be spread evenly and shall be thoroughly bladed and mixed during the spreading to ensure uniformity of material in each layer. If required, the fill material shall be dried by aerating with a scarifier, disc harrow, blade or other equipment or by such other means as may be necessary. If required, the fill material shall be wetted by the use of water trucks. Dried or wetted fill material shall be thoroughly mixed to provide optimum moisture content. Compact each layer to the required density.

K. Place backfill and fill materials evenly adjacent to structures. Prevent wedging of the backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.

L. Place aggregate fill material under all structures as shown on the Drawings. Compact to density required for fill under buildings and structures.

3.12 GRADING

A. Uniformly grade all areas within the limits designated on the Drawings, including adjacent transition areas. Finish surfaces within specified tolerances with uniform levels or slopes between points where elevations are shown and existing grades.

B. Finish all surfaces free from irregular changes and grade to drain as shown on the Drawings.

C. Finish areas to receive geosynthetic liner to within 0.10 feet of required subgrade elevations, unless approved in writing by ENGINEER.

D. Shape subgrade under unpaved areas to line, grade and cross-section to within 0.25 feet of required subgrade elevation.

E. Shape subgrade under pavement to line, grade, and cross-section to within 0.05 feet of required subgrade elevations.

F. Grade for structures to required elevation within tolerance of 0.05 feet.

G. Protect newly graded areas from traffic, erosion, desiccation or other damage. Repair and re-establish grade in settled, eroded, or rutted areas to the specified tolerances.

H. Where compacted areas are disturbed by subsequent construction or adverse weather, scarify the surface, reshape and compact to the required density. Use hand tamper for recompaction over underground utilities. Portions of the fill damaged due to exposure shall be reworked to meet the project specifications or, at the discretion of the CQA Consultant, removed and replaced with conforming material at no additional cost to the OWNER.

I. Place vegetative support layer to a minimum depth of 6 inches. Where existing on-site supply of topsoil is inadequate to provide the required amount, supply additional topsoil, meeting the specification for Topsoil, from off-site sources. Source and quality of additional material shall be approved by ENGINEER. Cost of off-site material shall be at no additional cost to OWNER. Reference shall be made to the project specifications for requirements of topsoil testing and topsoil amendment options.

3.13 GEOSYNTHETIC AREA PREPARATION

Surfaces to receive a geosynthetic material shall be kept smooth and free of debris, roots, sticks, bones and angular or sharp rocks larger than 3/8 inch in any dimension. The surface should provide a firm, unyielding foundation with no sudden, sharp, or abrupt changes or break in grade. No standing water or excessive moisture shall be allowed. Final compaction of any area to receive a geosynthetic shall be with smooth steel wheel roller. The CONTRACTOR shall certify in writing that the surface on which the material is to be installed is acceptable before commencing placement of geosynthetic materials.

3.14 SEASONAL LIMITS

No fill material shall be placed, spread, or rolled while the ground is frozen or thawing, or during unfavorable weather conditions. When the work is interrupted by inclement weather, fill operations shall not be resumed until approved by the CQA Consultant. Repairs from inclement weather must be corrected by the CONTRACTOR to the satisfaction of the CQA Consultant at no additional cost to OWNER.

END OF SECTION 02200

SECTION 02210

COMPACTED SOIL LINER/CAP

PART 1 - GENERAL

1.01 SCOPE

A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, installing and compacting the low permeability soil layer of the liner/cap system (soil liner/cap) as shown, specified or required.

B. The construction methods and the related material properties including, but not limited to: type of compaction equipment, method of operation, number of passes, operating frequency, moisture content of the material, compacted density, and permeability of the material, shall be determined by the results obtained from the Test Pad.

C. Acceptance by the CQA Consultant of the compacted soil liner/cap shall be dependent on the CONTRACTOR satisfying the requirements imposed by the CQA plan during the course of the work, and test results showing that all requirements of the project specifications and results obtained from the Test Pad have been met. Such acceptance shall be based on the soil liner/cap meeting the required moisture content, density and permeability, in combination with approval of all CONTRACTOR operations, based on visual observation and tests conducted by the CQA Consultant.

D. The cost of all sampling and retesting associated with any reconstruction of the compacted soil liner/cap shall be borne by the CONTRACTOR.

E. Field and laboratory testing conducted by the CQA Consultant under Paragraph 1.03 of this Section will be done at the OWNER'S expense.

F. A separate test pad will be required for each borrow source, change in material or change in construction method.

G. Placement of the compacted soil liner/cap shall not start until the test pad and all associated testing have been completed and approved by the CQA Consultant in writing.

1.02 SUBMITTALS

The following submittals shall be furnished by the CONTRACTOR for the work of this Section as specified herein.

A. All submittals as required by the project specification applicable to the work being performed, or as requested by the CQA Consultant.

1.03 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. The Construction Quality Assurance Plan will be administered by the CQA Consultant. CQA

Testing by the CQA Consultant shall include, but not necessarily be limited to the following:

1. In-place moisture content and density;
2. Standard proctor density test; and
3. Permeability testing.

B. The CONTRACTOR shall provide time and space for the CQA tests to be conducted. The CONTRACTOR shall inform the CQA Consultant when an area is suitable for testing. The CQA Consultant reserves the right to test any area at any time at the CQA Consultants discretion.

The CONTRACTOR shall prepare level areas on which testing or sampling shall be performed and shall repair any disturbances to the soil liner generated through testing and sampling. If ASTM D1556 (Sand-Cone Method) is used for density/moisture content tests, all sand shall be removed from the test hole prior to backfilling. All test and sample holes shall be backfilled with soil liner/cap material and recompacted by compaction equipment at the proper moisture content to achieve the minimum liner permeability.

C. In all areas where permeability requirements are not achieved, as determined based on moisture content and density tests, and/or visual observations, the representative area, as determined by the CQA Consultant, shall be reconstructedby reworking and recompacting, or removal and replacement, at no additional cost to the OWNER, and retested until the quality requirements set forth in this Section are met. All additional CQA costs associated with any reconstruction, reworking or replacement of the compacted soil liner/cap and associated laboratory testing fees will be included in a Change Order and deducted from the Contract Price.

D. The soil liner/cap construction shall proceed in orderly manner to allow for CQA field and laboratory testing results prior to continuing with subsequent lifts. No lift shall be covered by new material until laboratory test results have been reviewed and found to meet the permeability requirement for the soil liner/cap.

E. The CONTRACTOR is solely responsible for the construction of the compacted soil liner/cap and shall not rely on the CQA Consultant for recommendations and directions. It is recommended the CONTRACTOR employs his own geotechnical consultant to provide construction assistance and recommendations.

PART 2 - PRODUCTS

2.01 MATERIALS

Material supplied for use to construct the soil liner/cap shall be a mineral soil with cohesive characteristics, free of organic matter, shall not contain particles larger than two inches, and shall have a hydraulic conductivity (permeability) as indicated on the Drawings. The material supplied for use to construct the soil liner/cap shall be the same material used to construct the approved test pad.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

Areas to receive soil liner/cap shall be cleared, grubbed, and stripped of topsoil in accordance with the requirements set forth in the project specifications. After stripping all topsoil and organic soil, any soft natural soil or soft existing fill shall be removed. Removed soils shall be replaced with compacted layers of fill. Any soil that softens due to precipitation, groundwater, disturbance, exposure, or any other cause shall be removed and replaced at no additional cost to the OWNER. The area shall then be observed and approved by the CQA Consultant before placement of the soil liner/cap.

The surface shall be free from ruts, hummocks, or other uneven features which would tend to prevent uniform compaction.

The CONTRACTOR shall employ a professional land surveyor licensed in the State in which the project work is conducted to obtain surveyed elevations, at 50-foot intervals on a grid pattern across the subgrade/intermediate cover prior to placement of the soil liner/cap. From this survey, a contour plan showing contours at no more than two-foot intervals shall be generated. This survey information and contour plan shall become part of the Record Drawings.

3.02 SITE DRAINAGE

At all times, the CONTRACTOR shall maintain and operate proper and adequate surface and subsurface drainage to keep the construction site dry and in such condition that placement and compaction of the soil liner/cap may proceed unhindered by saturation of the area.

Construction of the soil liner/cap material on a saturated subgrade is prohibited. After a rainfall the subgrade shall be given sufficient time to drain and dry to the design moisture content before placing soil.

3.03 INSTALLATION

A. PLACEMENT OF SOIL LINER/CAP MATERIAL

The soil shall be thoroughly mixed and spread immediately after dumping, by mechanical equipment above the approved subgrade, and shall be built up in even horizontal layers. Prior to compaction, the soil shall be mixed by disc-harrow or an equivalent method to a homogeneous consistency. Lift thickness shall be no greater than six compacted inches. The loose lift thickness shall not exceed the effective depth of compaction for the equipment utilized.

The soil liner/cap shall be constructed in such a manner that bonding between lifts is achieved.

The final grades of the soil liner/cap shall result in a smooth surface through fine finishing with a road grader and a smooth drum roller. The final grades of the soil liner/cap shall be true to grade and shall not allow the ponding of water, with deviations of no more than 0.1 foot for soil liners and 0.2 feet for soil caps, measured across any 10-foot section. The minimum thickness, measured perpendicularly to slope, as shown on the plans, shall be achieved.

The CONTRACTOR shall employ a professional land surveyor licensed in the licensed in the State in which the project work is conducted to obtain surveyed elevations of the top of the compacted soil liner/cap, at the same 50-foot grid locations used to survey the subgrade/intermediate cover. From this survey, a contour plan showing contours at no more than two-foot intervals shall be generated. This survey information and contour plan shall become part of the Record Drawings.

B. MOISTURE CONTROL

Material that is too wet shall be spread and permitted to dry, assisted by discing or harrowing, if necessary, and the work shall be delayed until the moisture is reduced to the required limits.

When the material is too dry, the CONTRACTOR shall add moisture to each layer. Water must be allowed to soak into the soil for a period of time sufficient to permit hydration of the soil. Harrowing, or other approved methods shall be required to work the moisture into the soil and break up any dry clods until a uniform distribution of moisture is obtained. The moisture content after compaction shall be uniform throughout any one layer.

If it is impractical to obtain the required moisture/density by wetting or drying the soil at the site, the CONTRACTOR shall condition the material off the site.

C. COMPACTION

The soil liner/cap shall be compacted to the moisture/density determined from the results of the Test Pad. The CONTRACTOR may be permitted to modify the compaction and moisture content to fit site conditions and material requirements if he can demonstrate that all design parameters can be satisfied as determined and approved by the CQA Consultant. The compaction procedures (e.g., equipment and methods, operating frequency, number of passes, etc.) shall be in accordance with the results determined by the Test Pad.

Successive lifts of soil liner/cap shall not be placed until the previous lift is accepted by the CQA Consultant.

To avoid damage to structures and pipes, hand-operated vibratory type plate compactor, jumping jack, or other suitable equipment shall be used in areas not accessible to larger roller or compactor. The compaction around penetrations shall be as specified and able to achieve the hydraulic conductivity requirements.

3.04 FROST

No soil liner/cap materials shall be placed when either the soil or the previous lift (or subgrade) on which it is to be placed is frozen. In the event that any installed soil liner/cap or subgrade becomes frozen, it shall be scarified, thawed and recompacted, or removed to the approval of the CQA Consultant before the next lift is placed. Any soft spots resulting from frost shall be removed or recompacted to the satisfaction of the CQA Consultant before new soil lift material is placed. No frozen material shall be used as soil liner/cap.

3.05 PROTECTION OF WORK

It is imperative that the CONTRACTOR schedule his work to prevent the soil liner/cap from drying and/or cracking due to exposure, or from softening due to precipitation. This applies to every layer of soil liner/cap material placed. The CONTRACTOR shall develop a construction contingency plan for responding to construction deficiencies resulting from circumstances including, but not limited to: inclement weather, sediment deposits run-on, defective materials, or construction inconsistent with the project specifications as demonstrated by quality assurance testing and observations by the CQA Consultant. The plan shall provide a methodology for selecting and implementing the corrective action.

Any portion of the soil liner/cap damaged due to exposure shall be reworked, removed or replaced with conforming material to meet the project specifications. Payment for the soil liner/cap will not be made until it has been covered with the overlying material and protected from damage.

3.06 REMEDIAL MAINTENANCE

The CONTRACTOR shall maintain all compacted soil liner/cap fill in an undisturbed and compacted state until covered and protected from damage. All work and materials required for remedial maintenance shall be performed at no additional cost to the OWNER. In the event of slides, sloughing, or erosion in any part of the work, the CONTRACTOR shall remove the disturbed material from the damaged area and shall rebuild such portion as directed by the CQA Consultant. The removal of material and the rebuilding of any slide area shall be performed at no additional cost to the OWNER.

END OF SECTION 02210

SECTION 02218

TEST PAD

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section shall include all labor, equipment and materials necessary to construct a test pad(s) as specified herein.

B. The test pad shall include construction of a trial section of a compacted soil layer as shown on the Drawings. The test pad shall include, but not be limited to:

1. Preparation of subgrade in accordance with Section 02200 - Earthwork; and
2. Construction of compacted soil test pad or amended soil test pad.

C. The purpose of the test pad is to develop and demonstrate construction methods to produce a compacted low permeability soil layer of the liner/cap system (soil liner/cap) satisfying the requirements of the project specification in all respects. Of particular concern are the construction methods to be adopted to construct a compacted soil liner/cap to achieve the required permeability.

The construction methods and the related material properties to be noted shall include, but are not limited to: type of compaction equipment, method of construction, number of passes, moisture content of the material, compacted density, and the resulting permeability of the material.

D. A separate test pad will be required for each borrow source, change in material or change in construction method.

E. Acceptance by the CQA Consultant of the test pad shall be dependent on the CONTRACTOR satisfying the requirements imposed by the CQA plan during the course of the work, and test results showing that all requirements of the project specifications have been met. Such acceptance shall be based on the test pad meeting the required permeability, in combination with approval of all CONTRACTOR operations, based on visual observation and tests conducted by the CQA Consultant.

F. Testing of soil samples as required under Paragraph 1.03 of this Specification shall be paid for by CONTRACTOR. The cost of all sampling and retesting associated with additional or separate test pads or any reconstruction of the test pad shall be borne by the CONTRACTOR.

G. Field and laboratory testing conducted by the CQA Consultant under Paragraph 1.04 of this Specification will be performed at the OWNER'S expense.

1.02 SUBMITTALS

A. CONTRACTOR shall notify the CQA Consultant at least 10 working days in advance of intention to begin filling operations. Notification shall include designation of the proposed borrow source and all necessary laboratory testing data to demonstrate the adequacy of the material to perform its intended use. CONTRACTOR shall provide the CQA Consultant with 120 pounds of the proposed material in three, five-gallon, PVC, sample buckets with lids and handles at the time of notification. CONTRACTOR shall not initiate filling activities without the approval of the CQA Consultant to use the intended material for filling activities.

B. The results of analyses required under Paragraph 1.03 of this Specification shall be submitted to the CQA Consultant at least two weeks prior to beginning construction of the test pad.

The equipment used for compacting the soil liner/cap material shall be a sheepsfoot roller that can effectively compact the loose lift thickness to meet the specifications.

1.03 CONSTRUCTION QUALITY CONTROL (CQC)

A. The CONTRACTOR shall perform a borrow evaluation to determine the moisture content / dry density / permeability relationship for the material. These tests shall be run to develop an acceptable window of density and moisture to obtain the permeability criteria.

B. If an alternate borrow material is proposed or required, the CONTRACTOR shall perform a borrow evaluation to determine the moisture content / dry density / permeability relationship of the material. These tests shall be run to develop an acceptable window of density and moisture to obtain the permeability criteria.

C. Final criteria for construction of the compacted soil liner/cap (including moisture content, compactive effort, and density) shall be determined based on the results of the Test Pad demonstration.

D. For all soils to be used to construct the test pad, the CONTRACTOR shall perform:

1. Sieve analyses in accordance with ASTM D 422. Frequency: A minimum of one test per test pad.
2. Testing for Atterberg Limits accordance with ASTM D 4318. Frequency: A minimum of one test per test pad.
3. Testing for PROCTOR in accordance with ASTM D 698. Frequency: A minimum of one test per test pad.
4. Remolded permeability testing in accordance with ASTM D 5084. Frequency: One test per test pad (composite sample). Conduct tests using a confining pressure of 5 psi, and a hydraulic gradient of 10.

1.04 CONSTRUCTION QUALITY ASSURANCE (CQA)

A. The Construction Quality Assurance Plan will be administered by the CQA Consultant. CQA testing by the CQA Consultant shall include, but not necessarily be limited to the following:

1. In-place moisture content and density; and
2. Permeability testing.

B. The CONTRACTOR shall provide time and space for the CQA tests to be conducted. The CONTRACTOR shall inform the CQA Consultant when an area is suitable for testing. The CQA Consultant reserves the right to test any area at any time at the CQA Consultants discretion.

The CONTRACTOR shall prepare level pads on which tests or sampling shall be performed and shall repair disturbances to the test pad generated through testing and sampling. If ASTM D1556 (Sand-Cone Method) is used for density/moisture content tests, the CONTRACTOR shall remove all sand from the test hole prior to backfilling. All test and sample holes shall be backfilled with soil liner/cap material and recompacted to achieve the minimumspecified permeability.

C. The test pad construction shall proceed in orderly manner to allow for CQA field and laboratory testing. In all areas where permeability requirements are not achieved, as determined based on direct testing, moisture content and density tests, and/or visual observations, the representative area, as determined by the CQA Consultant, shall be reconstructed, such as by reworking and recompacting, or removal and replacement, at no additional cost to the OWNER, and retested until the quality requirements set forth in this Section are met. All additional CQA costs associated with any reconstruction, reworking or replacement of the test pad and associated laboratory testing fees will be included in a Change Order and deducted from the Contract Price.

D. The CONTRACTOR is solely responsible for the construction of the compacted soil layer test pad and shall not rely on the CQA Consultant for recommendations and directions. The CONTRACTOR shall employ his own geotechnical consultant to provide construction assistance and recommendations.

PART 2 - PRODUCTS

2.01 MATERIALS

A Borrow materials for the test pad shall be tested and approved in accordance with procedures as outlined in this specification and the CQA Plan.

PART 3 – EXECUTION

3.01 GENERAL

A. The plan area for the test pad shall be a minimum of 50 by 150 feet. It shall be constructed and tested prior to the placement of the compacted soil liner/cap. The location of the test pad shall be selected by the CONTRACTOR and approved by the CQA Consultant. The test pad shall be located on a slope equal to the steepest slope proposed to receive the compacted soil liner/cap.

B. The test pad shall be constructed with the equipment and methods proposed for the compacted soil liner/cap. The compacted lift thickness shall not exceed six inches, unless otherwise approved in writing by the CQA Consultant.

C. The test pad may be part of the landfill compacted soil liner/cap. If the CONTRACTOR chooses to construct the test pad as part of the landfill liner/cap, all component materials of the test pad and the associated testing must be in accordance with the Specifications. Unsuccessful trial or defective sections shall be replaced at no additional cost to the OWNER.

D. Should the CONTRACTOR change the borrow source for the compacted soil liner/cap material, or the properties of material at borrow source have significantly changed as determined by the CQA Consultant, a new test pad 50 feet by 150 feet shall be constructed from this material.

E. The Contractor shall keep equipment used for the test pad construction on the test pad at all times to avoid contamination of the low-permeability soil with the adjacent soils.

F. If in the opinion of the CQA Consultant, the construction methods, equipment or materials result in unsatisfactory placement, the CONTRACTOR shall make necessary modifications and reconstruct the appropriate sections or layer of the test pad. This will be done at no additional cost to the OWNER.

G. Placement of the compacted soil liner/cap shall not start until the test pad and all associated testing have been completed and approved by the CQA Consultant in writing.

PART 4 - PAYMENT

4.01 The test pad shall be considered incidental to the soil liner/cap and will not be measured for separate payment.

END OF SECTION 02218

SECTION 13302

GEOCOMPOSITE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This specification covers the technical requirements for the furnishing and installation of the geocomposite described herein. All materials used and work performed shall meet the requirements of this specification and the Contract Drawings, or the manufacturer's manufacturing and installation procedures, whichever are more stringent.

B. The Geosynthetics Installer shall be prepared to install the geocomposite in conjunction with earthwork and other components of the cover system.

1.02 REFERENCES

A. Geosynthetic Research Institute (GRI) standard specifications and guides, latest versions.

B. The most recent versions of the following American Society for Testing and Materials (ASTM) standards:

1. ASTM D 792 Standard Test Methods for Specific Gravity and Density of Plastics Displacement;
2. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique;
3. ASTM D 1603 Standard Test Method for Carbon Black in Olefin Plastics;
4. ASTM D 4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by Muffle-Furnace Technique;
5. ASTM D 4491 Standard Test Method for Water Permeability of Geocomposites by Permeability;
6. ASTM D 4632 Standard Test Method for Breaking Load and Elongation of Geocomposites (Grab Method);
7. ASTM D 4716 Standard Test Method for Constant Head Hydraulic Transmissivity (In-Place Flow) of Geocomposites and Geocomposite Related Products;
8. ASTM D 4751 Standard Test Method for Determining Apparent Opening Size of Geocomposite;
9. ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geocomposites, Geomembranes, and Related Products;
10. ASTM D 5199 Standard Test Method for Measuring Nominal Thickness of Unit Area of Geocomposites;
11. ASTM D 5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method;

12. ASTM D7005 Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites;
13. Geosynthetic Research Institute (GRI) Test GC-7: Determination of Adhesion and Bond Strength of Geocomposites; and
14. Geosynthetic Research Institute (GRI) Test GC-8: Determination of the Allowable Flow rate of a Drainage Geocomposite.

1.03 SUBMITTALS

A. The following submittals shall be furnished by the CONTRACTOR for the work of this Section within 30 days prior to material delivery to the site and as specified herein:

1. A representative sample of all materials to be used on this Project.
2. A list of similar completed projects in which the proposed materials have been successfully used.
3. Manufacturer's instructions for installation and handling, and material data sheets giving full details of the material physical properties and test methods.
4. Draft warranties and guarantees as described hereinafter.

B. At least seven days prior to the loading and shipment of any geocomposite material the CONTRACTOR shall provide the CQA Consultant with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name, number) and production date of the resin.
2. A copy of the quality control certificates issued by the resin supplier.
3. Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geocomposite rolls assigned to the project. At a minimum, these tests should include density [ASTM D1505 or ASTM 792 method B], and melt index [ASTM D1238].
4. A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2 percent by weight).
5. The manufacturer's data and samples of the geocomposite to be used, giving full details of the minimum physical properties and test methods, as specified herein, certified test reports indicating the physical properties of the materials to be used, and roll numbers and identification.
6. The manufacturer's certificate shall state that the finished geocomposite meets MARV requirements of this specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest the certificate.

1.04 CONSTRUCTION QUALITY CONTROL

The CONTRACTOR shall have an individual experienced in the installation of geocomposites on-site at all times during the installation. The designated individual shall be responsible for ensuring that the geocomposite is installed according to this specification and the Contract Drawings.

1.05 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geocomposite shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

1.06 WARRANTY

A. The CONTRACTOR shall provide a written warranty for a minimum 10 years pro-rated relative to materials and one year on installation certifying the geocomposite materials provided and work performed under this project shall be free from any defects. Said warranty shall apply to normal use and service by the OWNER. Such written warranty shall provide for the repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the OWNER of the specific non-conformance of the lining material with the project specifications. Such defects or non-conformance shall be repaired or replaced within a reasonable period of time at no cost to the OWNER.

PART 2 - PRODUCTS

2.01 GEOCOMPOSITE MATERIAL

A. The geocomposite shall be composed of a high density polyethylene drainage net with a U.V. stabilized, nonwoven, needle punched geocomposite bonded to each side of the drainage net. The geocomposite shall not be glued or bonded to the geonet in any manner other than heat bonding. Along edges, approximately six inches of the geocomposite shall not be heat bonded to the geonet to allow connection in the field.

B. The net strands shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Any defects discovered in the field shall be repaired by cutting out the defect and joining a new piece of net material in its place. The joint shall be placed in accordance with the requirements for field joints.

2.02 GEOCOMPOSITE MATERIAL PROPERTIES

A. The geocomposite properties shall meet the minimum average roll requirements stated in Table 1.

B. In addition to the property values listed in Table 1, the geocomposite shall be chemically inert when immersed in a leachate representative of that from a typical landfill. The geonet shall contain a maximum of one percent by weight of additives, fillers, or extenders (not including carbon black) and shall not contain foaming agents or voids within the ribs of the geonet. The resin used to manufacture the HDPE must be of first quality, the same resin must be used throughout the project.

2.03 MANUFACTURING QUALITY CONTROL

A. Manufacturer's Quality Control (MQC) testing (test methods and frequencies) shall be conducted in accordance with Table 1, or the manufacturer quality control guide, whichever is more stringent.

2.04 ACCEPTANCE AND CONFORMANCE TESTING

A. Conformance testing must be performed, prior to shipment to the site, at the manufacturer's facility. The CONTRACTOR shall notify the ENGINEER at least three weeks prior to shipping in order to arrange for conformance testing. No material shall be shipped to the site until conformance sampling has been performed. When completed, the particular approved lot should be marked for the particular site under investigation. The expressed purpose of in-plant Material Conformance Test Sampling is to verify that geocomposite material designated for the project is confirmed as meeting the project specifications prior to shipment to the site. The Manufacturer shall make available all necessary personnel and equipment to assist the CQA Consultant in retrieving conformance samples of the geocomposite material.

B. Procedures in the Event of a Conformance Test Failure

The following procedure shall apply whenever a sample fails a conformance test that is conducted by the CQA Laboratory:

1. The Manufacturer shall replace the roll of geocomposite that is not in conformance with these Specifications with a roll that meets Specifications.
2. The CONTRACTOR shall remove conformance samples for testing by the CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to these Specifications. If either of these samples fail, the two numerically closest untested rolls on both sides of the failed sample shall be tested by the CQA Laboratory. These four samples must conform to the Specifications. If any of these samples fail, every roll of geocomposite on site and every subsequently delivered roll that is from the same supplier must be tested by the CQA Laboratory for conformance to the Specifications. This additional conformance testing shall be at the expense of the CONTRACTOR.

2.05 HANDLING OF MATERIALS

A. Protective Wrapping - All rolls of geocomposite, irrespective of their type, must be enclosed in a protective wrapping that is opaque and waterproof. The objective is to prevent any degradation from atmospheric exposure (ultraviolet light, ozone, etc.), moisture uptake (rain, snow), and, to a limited extent, accidental damage. The following important issues shall be considered:

1. The protective wrapping shall be wrapped around (or placed around) the geocomposite in the manufacturing facility and shall be included as the final step in the manufacturing process.
2. The packaging shall not interfere with the handling of the rolls either by slings or by the utilization of the central core upon which the geocomposite is wound.

3. The protective wrapping shall prevent exposure of the geocomposite to ultraviolet light, prevent it from moisture uptake and limit minor damage to the roll.
4. Every roll must be labeled with the manufacturers name, geocomposite style and type, lot and roll numbers, and roll dimensions (length, width and gross weight).

B. Shipment

1. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's quality control certificates.
2. The method of loading the geocomposite rolls, transporting them, and off-loading them at the job site should not cause any damage to the geocomposite, its core, nor its protective wrapping.
3. The protective wrapping shall be maintained during periods of shipping and storage.
4. All rolls, where the protective wrapping is damaged or stripped from the rolls, shall be moved to an enclosed facility until its repair can be made to the approval of the CQA Consultant.

C. Storage at the Site

1. Handling of geocomposite rolls shall be done in a competent manner such that damage does not occur to the geocomposite or to its protective wrapping.
2. The CONTRACTOR shall be responsible for the storage of the geocomposite on site in an area that is well drained and remains dry during material storage, and is protected from theft, vandalism, passage of vehicles, etc.
3. The rolls shall be stacked in such a way that cores are not crushed nor is the geocomposite damaged.
4. Outdoor storage of rolls should not exceed manufacturer's recommendations, or longer than six months, whichever is less. For storage periods longer than six months a temporary enclosure should be placed over the rolls, or they should be moved within an enclosed facility.
5. Additionally, if any special handling of the geocomposite is required, it shall be so marked on the top surface of the geocomposite.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install geocomposite as shown on the Contract Drawings.

3.02 PLACEMENT

A. The CONTRACTOR shall remove the protective wrappings from the geocomposite rolls to be deployed only after the substrate layer, soil, or other geosynthetic have been documented and approved by the CQA Consultant. Items to be considered are the following:

1. The installer shall take the necessary precautions to protect the underlying layers upon which the geocomposite shall be placed. If the substrate is soil, construction equipment can be used, provided that rutting is not created. If the substrate is a geosynthetic material, deployment must be by hand, or by use of low ground contact pressure all-terrain vehicles (ATVs).
2. During placement, care must be taken not to entrap sandbags, stones, moisture, or other materials that could damage a geocomposite, cause clogging of drains or filters, or hamper subsequent seaming.
3. On side slopes, the geocomposite shall be anchored at the top and then unrolled to keep the geocomposite free of wrinkles and folds.
4. The geocomposite shall be positioned by hand after being unrolled, to be free of wrinkles.
5. When the geocomposite is placed on another geosynthetic, trimming should be performed using only an upward-cutting hook blade.
6. The geocomposite shall be weighted with sandbags, to provide resistance against wind uplift.
7. A visual examination of the deployed geocomposite shall be carried out to ensure that no potentially harmful objects are present, e.g., stones, sharp objects, small tools, sandbags, etc.
8. After un-wrapping the geocomposite material from its protective cover, soil backfilling or covering by another geosynthetic shall be done within the period stipulated for the particular type of geotextile. Typical time frames for geotextile are within 14 days for polypropylene and 28 days for polyester geotextile.

3.03 SEAMS AND OVERLAPS

A. The components of the geocomposite (i.e., geocomposite-geonet-geocomposite) will be secured or seamed to the like component at overlaps.

B. Geonet Components

1. The geonet components shall be overlapped by at least 4 inches along the roll length.
2. Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.
3. Overlaps shall be secured by tying. Tying shall be achieved by plastic fasteners, or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices shall not be used.
4. Tying shall be every 5 feet along the roll length, and every 12 inches along the roll width.

C. Geotextile Components

1. Seaming of geotextile layers shall be performed by either sewing or heat bonding. The overlap shall be a minimum of four inches for each method.

2. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geocomposite component, shall be used for all sewing.

3.04 REPAIR

A. If the geonet is undamaged but the geocomposite is damaged, then the Geosynthetic Installer shall repair the damaged area as follows:

1. Remove damaged geocomposite. Cut patch of new geocomposite to provide minimum 12-inch overlap in all directions.
2. Thermally bond geocomposite patch to existing geocomposite.

B. All seams that have no geocomposite flaps available for sewing shall be thermally bonded with patch that extends 12 inches beyond the edges of the panel.

C. Any holes or tears in the geocomposite material shall be repaired by first removing the damaged portion of the geonet and placing a patch under the panel that extends six inches beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the patch, and through the panel. The patch shall then be secured every six inches with approved tying devices. A geocomposite patch shall be heat-sealed to the top of the geocomposite needing repair. If the hole or tear width across the roll exceeds 50 percent of the width of the roll, then the entire damaged geocomposite panel shall be removed and replaced.

3.05 PLACEMENT OF COVER MATERIALS

A. CONTRACTOR shall place all soil materials over geocomposite such that:

1. The geocomposite and underlying materials are not damaged;
2. Prevent slippage between the geocomposite layer and underlying layers; and
3. Tensile stresses are not produced in the geocomposite.

B. Equipment shall not be driven directly atop the geocomposite. Placement of the cover material shall occur as soon as practical and shall proceed from the base of the slope upwards. Unless otherwise specified by ENGINEER, all equipment operating on soil material overlying the geocomposite shall be a D-5 class low Ground Pressure Dozer or smaller. No traffic by rubber-tired vehicles shall occur on the geocomposite without a combined thickness of four feet above the geocomposite layer. Turning of all vehicles will be kept to a minimum and the speed of all vehicles will be limited to less than 10 miles per hour.

C. Anchor trenches must be allowed to drain to prevent ponding and softening of the soils while the trench is open. Anchor trenches shall be backfilled and compacted by the CONTRACTOR. Care shall be taken when backfilling the trenches to prevent damage to the geocomposite.

3.06 PRODUCTION PROTECTION

A. CONTRACTOR shall use all means necessary to protect all prior work and all materials and completed work of other Sections.

B. In the event of damage, CONTRACTOR shall immediately make all repairs and replacements necessary, to the approval of the CQA Consultant and at no additional cost to OWNER.

3.07 ACCEPTANCE

A. The CONTRACTOR shall retain all responsibility for the geocomposite in the landfill cell or cap until acceptance by the OWNER.

B. The geocomposite shall be accepted by the OWNER when:

1. The installation is finished.
2. The OWNER and CONTRACTOR have signed a certificate of Substantial Completion, and all conditions identified on the certificate have been met for the OWNER to assume responsibility for the geocomposite.

Table 1 – Geocomposite
MANUFACTURING QUALITY CONTROL TEST FREQUENCY

CHARACTERISTICS	TEST METHOD	UNITS	FREQUENCY	MARV
Resin				
POLYMER DENSITY	ASTM D1505	g/cm^3	Once per Lot	> 0.94
MELT FLOW INDEX	ASTM D1238	g/10 min	Once per Lot	$\leq$1.0
Geonet Tests				
DENSITY	ASTM D1505	g/cm^3	1 per 50,000 ft^2	0.94
CARBON BLACK	ASTM D1603	%	1 per 50,000 ft^2	2 to 3
TENSILE STRENGTH, MD	ASTM D5035	lbs/in^2	1 per 50,000 ft^2	50
Geotextile Tests				
AOS	ASTM D4751	US sieve (mm)	1 per 540,000 ft^2	70 0.212
MASS PER UNIT AREA	ASTM D5261	oz/yd^2	1 per 90,000 ft^2	6.0
FLOW RATE	ASTM D4491	gpm/ft^2	1 per 540,000 ft^2	110
GRAB TENSILE STRENGTH	ASTM D4632	lb	1 per 90,000 ft^2	170
PUNCTURE STRENGTH	ASTM D4833	lb	1 per 90,000 ft^2	90
Geocomposite Tests				
PLY ADHESION	ASTM D7005	lbs/in	1 per 50,000 ft^2	1.0
TRANSMISSIVITY	ASTM D4716	m^2/sec	1 per 540,000 ft^2	$5.4\text{x}10^{-3}$(a)

(a) Minimum value @ hydraulic gradient of 0.33 ft/ft for the cap (vertical loading of 300 psf)
(b) Minimum value @ hydraulic gradient of 0.05 ft/ft for the cap (vertical loading of 300 psf)
(c) Minimum value @ hydraulic gradient of 0.33 ft/ft for the liner (vertical loading of 300 psf)

END OF SECTION 13302

SECTION 13310

GEOTEXTILE

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

This specification covers the technical requirements for the furnishing and installation of the geotextile described herein. All materials used and work performed shall meet the requirements of this specification and the Contract Drawings, or the manufacturer's manufacturing and installation procedures, whichever are more stringent.

1.02 REFERENCES

A. Geosynthetic Research Institute (GRI) standard specifications and guides, latest versions.

B. The most recent versions of the following American Society for Testing and Materials (ASTM) standards.

1. D3786 Mullen Burst
2. D4354 Standard Practice for Sampling of Geosynthetics for Testing
3. D4355 Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
4. D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
5. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
6. D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
7. D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
8. D4759 Standard Practice for Determining the Specification Conformance of Geosynthetics
9. D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
10. D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls
11. D4884 Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles
12. D5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
13. D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles

1.03 SUBMITTALS

A. The following submittals shall be furnished by the CONTRACTOR for the work of this Section within 30 days prior to material delivery to the site, and as specified herein:

1. A representative sample of all materials to be used on this Project.
2. A list of similar completed projects in which the proposed materials have been successfully used.
3. Manufacturer's instructions for installation and handling, and material data sheets giving full details of the material physical properties and test methods.
4. Draft warranties and guarantees as described hereinafter.

B. The following submittals shall be furnished by the CONTRACTOR for the work of this Section within 7 days prior to material delivery to the site, and as specified herein:

1. The manufacturer's data and samples of the geotextile to be used, giving full details of the minimum physical properties and test methods, as specified herein, certified test reports indicating the physical properties of the materials to be used, and roll numbers and identification.
2. The manufacturer's certificate shall state that the finished geotextile meets MARV requirements of this specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest the certificate.
3. "Needle-Free" statement for non-woven geotextile.

C. The following submittals shall be furnished by the CONTRACTOR for the work of this Section prior to the issuance of a certificate of substantial completion for the Project:

1. Signed subgrade Acceptance forms, if applicable.
2. Final warranties and guarantees as described hereinafter.

1.04 WARRANTY AND GUARANTEE

The CONTRACTOR shall provide a written warranty for a minimum 10 years pro-rated relative to materials and 1 year on installation certifying the geotextile materials provided and work performed under this project shall be free from any defects. Said warranty shall apply to normal use and service by the OWNER. Such written warranty shall provide for the repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the OWNER of the specific non-conformance of the lining material with the project specifications. Such defects or non-conformance shall be repaired or replaced within a reasonable period of time at no cost to the OWNER.

1.05 CONSTRUCTION QUALITY CONTROL

The CONTRACTOR shall have an individual experienced in the installation of geotextile on-site at all times during the installation. The designated individual shall be responsible for ensuring that the geotextile is installed according to this specification and the Contract Drawings. The designated individual shall be subject to approval by the OWNER or CQA Consultant.

1.06 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geotextile shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All geotextile shall be manufactured of 100 percent polyester or polypropylene. The fabric shall be a continuous filament, non-woven, needle punched geotextile that is UV stabilized and is mildew, rot, insect, and rodent resistant. The fabric shall be guaranteed free of any treatment, coating, or deleterious elements, which might significantly alter its physical properties, or its proper functioning.

B. All geotextile shall have a minimum mass per unit area as indicated on the Contract Drawings.

C. The geotextile properties shall meet the minimum average roll requirements stated in the most recent versions of GRI Test Method GT12(a) for geotextile cushions and GRI Test Method GT13(a) (moderate survivability) for geotextile separators.

D. Manufacturer's Quality Control (MQC) testing (test methods and frequencies) shall be conducted in accordance with the most recent versions of GRI Test Method GT12(a) for geotextile cushions and GRI Test Method GT13(a) (moderate survivability) for geotextile separators, or the manufacturer quality control guide, whichever is more stringent.

E. Other types of geotextile may be considered that differ from the requirements of Section 2.01.A. These must be approved by the ENGINEER in writing prior to any bidding or construction. Any geotextile used must meet the requirements of Section 2.01.C.

2.02 ACCEPTANCE AND CONFORMANCE TESTING

A. Conformance testing must be performed, prior to shipment to the site, at the manufacturer's facility. The CONTRACTOR shall notify the ENGINEER at least three (3) weeks prior to shipping in order to arrange for conformance testing. No material shall be shipped to the site until conformance sampling has been performed. When completed, the particular approved lot should be marked for the particular site under investigation. The expressed purpose of in-plant Material Conformance Test Sampling is to verify that geotextile material designated for the project is confirmed as meeting the project specifications prior to shipment to the site. The Manufacturer shall make available all necessary personnel and equipment to assist the CQA Consultant in retrieving conformance samples of the geotextile material.

B. Procedures in the Event of a Conformance Test Failure

The following procedure shall apply whenever a sample fails a conformance test that is conducted by the CQA Laboratory:

1. The Manufacturer shall replace the roll of geotextile that is not in conformance with these Specifications with a roll that meets Specifications.
2. The CONTRACTOR shall remove conformance samples for testing by the CQA Laboratory from the closest numerical roll on both sides of the failed roll. These two samples must conform to these Specifications. If either of these samples fail, the two (2) numerically closest untested rolls on both sides of the failed sample shall be tested by the CQA Laboratory. These four samples must conform to the Specifications. If any of these samples fail, every roll of geotextile on site and every subsequently delivered roll that is from the same supplier must be tested by the CQA Laboratory for conformance to the Specifications. This additional conformance testing shall be at the expense of the CONTRACTOR.

2.03 HANDLING OF MATERIALS

A. Protective Wrapping - All rolls of geotextile, irrespective of their type, must be enclosed in a protective wrapping that is opaque and waterproof. The objective is to prevent any degradation from atmospheric exposure (ultraviolet light, ozone, etc.), moisture uptake (rain, snow), and, to a limited extent, accidental damage. The following important issues shall be considered:

1. The protective wrapping shall be wrapped around (or placed around) the geotextile in the manufacturing facility and shall be included as the final step in the manufacturing process.
2. The packaging shall not interfere with the handling of the rolls either by slings or by the utilization of the central core upon which the geotextile is wound.
3. The protective wrapping shall prevent exposure of the geotextile to ultraviolet light, prevent it from moisture uptake and limit minor damage to the roll.
4. Every roll must be labeled with the manufacturers name, geotextile style and type, lot and roll numbers, and roll dimensions (length, width and gross weight).

B. Shipment

1. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's quality control certificates.
2. The method of loading the geotextile rolls, transporting them, and off-loading them at the job site should not cause any damage to the geotextile, its core, nor its protective wrapping.
3. The protective wrapping shall be maintained during periods of shipping and storage.
4. All rolls, where the protective wrapping is damaged or stripped from the rolls, shall be moved to an enclosed facility until its repair can be made to the approval of the CQA Consultant.

C. Storage at the Site

1. Handling of geotextile rolls shall be done in a competent manner such that damage does not occur to the geotextile or to its protective wrapping.
2. The CONTRACTOR shall be responsible for the storage of the geotextile on site in an area that is well drained and remains dry during material storage, and is protected from theft, vandalism, passage of vehicles, etc.
3. The rolls shall be stacked in such a way that cores are not crushed nor is the geotextile damaged.
4. Outdoor storage of rolls should not exceed manufacturer's recommendations, or longer than six months, whichever is less. For storage periods longer than six months a temporary enclosure should be placed over the rolls, or they should be moved within an enclosed facility.
5. Additionally, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install geotextile as shown on the Contract Drawings.

3.02 PLACEMENT

A. The CONTRACTOR shall remove the protective wrappings from the geotextile rolls to be deployed only after the substrate layer, soil, or other geosynthetic have been documented and approved by the CQA Consultant. Items to be considered are the following:

1. The installer shall take the necessary precautions to protect the underlying layers upon which the geotextile shall be placed. If the substrate is soil, construction equipment can be used, provided that rutting is not created. If the substrate is a geosynthetic material, deployment must be by hand, or by use of low ground contact pressure all-terrain vehicles (ATVs).
2. During placement, care must be taken not to entrap sandbags, stones, moisture, or other materials that could damage a geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.
3. On side slopes, the geotextile shall be anchored at the top and then unrolled to keep the geotextile free of wrinkles and folds.
4. The geotextile shall be positioned by hand after being unrolled, to be free of wrinkles.
5. When the geotextile is placed on another geosynthetic, trimming should be performed using only an upward-cutting hook blade.
6. The geotextile shall be weighted with sandbags, to provide resistance against wind uplift.

7. A visual examination of the deployed geotextile shall be carried out to ensure that no potentially harmful objects are present, e.g., stones, sharp objects, small tools, sandbags, etc.

3.03 SEAMING/JOINING REQUIREMENTS

Seaming of geotextile may be performed by either sewing or heat bonding. The overlap shall be a minimum of six (6) inches for each method.

Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile, shall be used for all sewing.

3.04 REPAIR PROCEDURES

Holes, or tears, in geotextile made during placement or anytime before backfilling shall be repaired by patching. The following shall be observed:

1. The patch material used for repair of a hole or tear shall be the same type of polymeric material as the damaged geotextile, or as approved by the CQA Consultant.
2. The patch shall extend at least 12 inches beyond any portion of the damaged geotextile.
3. The patch shall be sewn in place by hand or machine, or possibly heat bonded, so as not to accidentally shift out of position or be moved during backfilling or covering operations.

3.05 PROTECTION AND BACKFILLING OR COVERING

A. If soil is to cover the geotextile, it shall be done such that the geotextile is not shifted from its intended position and underlying materials are not exposed or damaged.

B. If a geosynthetic is to cover the geotextile, both the underlying geotextile and the newly deployed material shall not be damaged during the process.

C. The overlying material shall not be deployed such that tensile stress is exerted in the geotextile. On side slopes, this requires soil backfill to proceed from the bottom of the slope upward.

D. Equipment shall not be driven directly atop the geotextile layer. Placement of the cover material shall occur as soon as practical and shall proceed from the base of the slope upwards. Unless otherwise specified by ENGINEER, all equipment operating on soil material overlying the geotextile layer shall be a D-5 class low Ground Pressure Dozer or smaller. No traffic by rubber-tired vehicles shall occur on the geotextile without a combined thickness of four (4) feet above the geotextile layer. Turning of all vehicles will be kept to a minimum and the speed of all vehicles will be limited to less than 10 miles per hour.

E. Soil backfilling or covering by another geosynthetic shall be done within the period stipulated for the particular type of geotextile. Typical time frames for geotextile are within 14 days for polypropylene and 28 days for polyester geotextile.

F. Anchor trenches must be allowed to drain to prevent ponding and softening of the soils while the trench is open. Anchor trenches shall be backfilled and compacted by the CONTRACTOR. Care shall be taken when backfilling the trenches to prevent damage to the geotextile.

3.06 ACCEPTANCE

A. The CONTRACTOR shall retain all responsibility for the geotextile in the landfill cell or cap until acceptance by the OWNER.

B. The geotextile shall be accepted by the OWNER when:

1. The installation is finished;
2. The OWNER and CONTRACTOR have signed a certificate of Substantial Completion, and all conditions identified on the certificate have been met for the OWNER to assume responsibility for the geotextile.

END OF SECTION 13310

SECTION 13320

GEOMEMBRANE

PART 1 – GENERAL

1.01 SCOPE OF APPLICATION

This specification covers the technical requirements for the furnishing and installation of the geomembrane described herein. All materials used and work performed shall meet the requirements of this specification and the Contract Drawings, or the manufacturer's manufacturing and installation procedures, whichever are more stringent.

1.02 REFERENCES

A. Geosynthetic Research Institute (GRI) standard specifications and guides, latest versions.

B. The most recent versions of the following American Society for Testing and Materials (ASTM) standards:

1. D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
2. D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
3. D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique.
4. D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
5. D638 Standard Test Method for Tensile Properties of Plastics.
6. D5199 Standard Test Method for Measuring Nominal Thickness of Geosynthetics.
7. D5994 Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
8. D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
9. D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
10. D1603 Standard Test Method for Carbon Black in Olefin Plastics.
11. D3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.
12. D5885 Standard Test Method for Oxidative-Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

1.03 SUBMITTALS

A. The following submittals shall be furnished by the CONTRACTOR for the work of this Section within 30 days prior to material delivery to the site, and as specified herein.

1. A representative sample of the geomembrane material.
2. Manufacturer's instructions for installation and handling, and material data sheets giving full details of the material physical properties and test methods.
3. A project reference list totaling at least 1 million square feet in size;
4. Draft warranties and guarantees as described herein.
5. Proposed panel layout drawing showing anchor trenches, seams, and panel numbering.
6. List of proposed seaming personnel and their experience records.
7. Current (within 12 months of the geomembrane installation) calibration certificates for all tensiometers to be used for field shear and peel strength testing.

B. The following submittals shall be furnished by the CONTRACTOR prior to the issuance of the certificate of substantial completion for the Project:

1. Warranties and guarantees as described herein.
2. QC Daily field reports.
3. Subgrade Acceptance.
4. Panel Placement records.
5. Panel seaming records.
6. Destructive test records.
7. Non-destructive test records.
8. Trial seam records.
9. Repair records.
10. Inventory sheets/Bills of Lading.
11. Record drawing showing and identifying all panels, seams, seam types, destructive test locations, and all repairs to the geomembrane.

1.04 CONSTRUCTION QUALITY CONTROL

The CONTRACTOR shall have an individual experienced in the installation of geomembrane on-site at all times during the installation. The designated individual shall be responsible for ensuring that the geomembrane is installed according to this specification and the Contract Drawings. The designated individual shall be subject to approval by the OWNER or CQA Consultant.

1.05 WARRANTY AND GUARANTEE

The CONTRACTOR shall provide a written warranty for a minimum 20 years pro-rated relative to materials and 1 year on installation certifying the geomembrane materials provided and work performed under this project shall be free from any defects. Said warranty shall apply to normal use and service by the OWNER. Such written warranty shall provide for the repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the OWNER of the specific non-conformance of the lining material with the project specifications. Such defects or non-conformance shall be repaired or replaced within a reasonable period of time at no cost to the OWNER.

1.06 CONSTRUCTION QUALITY ASSURANCE

A. The installation of the geomembrane shall be monitored by the CQA Consultant as outlined in the CQA Plan.

B. CONTRACTOR shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

PART 2 – PRODUCTS

2.01 RAW MATERIALS

A. The raw material from which the HDPE geomembrane will be made shall be first quality polyethylene resin containing no more than 2 percent clean recycled polymer by weight, and meeting the following specifications:

1. Density [ASTM D1505 or ASTM 792 Method B]: 0.932 g/ml or higher (without carbon black); and
2. Melt Index [ASTM D1238]: <1.0 g/10 minutes

B. The raw material from which the LLDPE geomembrane will be made shall be first quality polyethylene resin containing no more than 2 percent clean recycled polymer by weight, and meeting the following specifications:

1. Density [ASTM D1505 or ASTM 792 Method B]: 0.926 g/ml or lower (without carbon black); and
2. Melt Index [ASTM D1238]: <1.0 g/10 minutes

2.02 GEOMEMBRANE

A. The materials supplied under these Specifications shall be first quality industrial grade products designed and manufactured specifically for the purposes of this work, and which have been satisfactorily demonstrated by prior use to be suitable and durable for use in sanitary landfills accepting municipal waste.

B. The geomembrane shall be uniform in thickness and surface texture, and free of undispersed raw materials, streaks, gels, blisters, cracks, tears, or pinholes. Material shall be chemically and temperature stable under the intended conditions, and shall contain no additives or filler that can leach out and cause deterioration over time.

C. The geomembrane properties shall meet the minimum average roll requirements stated in Tables 1 and 2 of GRI Test Method GM13 (latest version) for HDPE geomembrane and Tables 1 and 2 of GRI Test Method GM17 (latest version) for LLDPE geomembrane.

D. Manufacturer's Quality Control (MQC) testing (test methods and frequencies) shall be conducted in accordance with the most recent versions of Tables 1 and 2 of GRI Test Method GM13 for

HDPE geomembrane and Tables 1 and 2 of GRI Test Method GM17 for LLDPE geomembrane, or the manufacturer quality control guide, whichever is more stringent.

E. At least seven (7) days prior to the loading and shipment of any geomembrane material, the CONTRACTOR shall provide the CQA Consultant with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name, number) and production date of the resin;
2. A copy of the quality control certificates issued by the resin supplier;
3. Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project. At a minimum, these tests should include density [ASTM D1505 or ASTM 792 method B], and melt index [ASTM D1238]; and
4. A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2 percent by weight).
5. The manufacturer's data and samples of the geomembrane to be used, giving full details of the minimum physical properties and test methods, as specified herein, certified test reports indicating the physical properties of the materials to be used, and roll numbers and identification.
6. The manufacturer's certificate shall state that the finished geomembrane meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest the certificate.

2.03 CONFORMANCE TESTING

A. Conformance testing sampling must be performed, prior to shipment to the site, at the manufacturer's facility. The CONTRACTOR shall notify the CQA Consultant at least three (3) weeks prior to shipment in order to arrange for conformance sampling. No material shall be shipped to the site until conformance sampling has been performed and reports reviewed by the CQA Consultant. When completed, the particular approved lot should be marked for the particular site under investigation. The expressed purpose of in-plant Material Conformance Test Sampling is to verify that geomembrane material designated for the project is confirmed as meeting the project specifications prior to shipment to the site. The Manufacturer shall make available all necessary personnel and equipment to assist the CQA Consultant in retrieving conformance samples of the geomembrane material.

B. Procedures in the Event of a Conformance Test Failure

The following procedure shall apply whenever a sample fails a conformance test conducted by the CQA Laboratory:

1. The Manufacturer shall replace the roll of geomembrane that is in nonconformance with the Specifications with a roll that meets Specifications.

2. The CONTRACTOR shall remove conformance samples for testing by the CQA Laboratory from the next numbered rolls on each side of the failed roll. These two samples must both conform to Specifications. If either of these samples fails, every roll of geomembrane on site and every roll delivered subsequently must be tested by the CQA Laboratory for conformance to the Specifications. This additional conformance testing shall be at the expense of the CONTRACTOR.

2.04 DELIVERY

Transportation and unloading of the geomembrane is the responsibility of the CONTRACTOR. The CONTRACTOR is responsible for the shipping manifests and all other relevant documents. Shipping manifests and all other relevant documents shall be submitted to the CQA Consultant, as the rolls are unloaded from the truck.

2.05 STORAGE

The CONTRACTOR shall be responsible for the storage of the geomembrane on site in an area that is well drained and remains dry during material storage, and is protected from theft, vandalism, passage of vehicles, etc.

PART 3 – EXECUTION

3.01 SUBGRADE PREPARATION

A. The subgrade shall be unyielding, smoothly graded, with no abrupt changes or break in grade, and constructed to elevations indicated on the Contract Drawings. No standing water or excessive moisture shall be allowed. The surface shall be free of loose soil, rocks, roots, sticks, vegetation, sharp objects, debris, frost or other materials. Final compaction shall be with a smooth steel wheel roller.

B. The CONTRACTOR shall inspect the entire subgrade and certify in writing that the subgrade on which the geomembrane shall be installed is acceptable before commencing placement. This inspection shall be performed in the presence of the CQA Consultant. The CONTRACTOR shall repair any defects noted in the underlying material prior to the installation of the geomembrane.

C. Placement of the geomembrane on a saturated subgrade is prohibited. After a rain event, the subgrade shall be given sufficient time to dry or drain to the design moisture content before placing the geomembrane.

3.02 INSTALLATION

The CONTRACTOR shall certify in writing that the surface on which the geomembrane shall be installed is acceptable. The CONTRACTOR shall give the certificate of acceptance to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration.

A. Geomembrane Placement

1. A field panel is the unit area of geomembrane, which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll installed in the field.
2. The CONTRACTOR shall submit to the CQA Consultant a panel layout plan at least 30 days prior to installation.
3. It shall be the responsibility of the CONTRACTOR to ensure that each field panel is marked with the original roll number. The roll number shall be marked at a location agreed upon by the CQA Consultant.

B. Field Panel Placement

1. The CQA Consultant shall verify that field panels installation follows the proposed CONTRACTOR's layout plan, or as approved or modified.
2. The CONTRACTOR shall be responsible for providing calculations verifying the required amount of compensation, which must be installed. .
3. Field panels shall be placed one at a time, and each field panel shall be seamed immediately after its placement (in order to minimize the number of unseamed field panels exposed to wind).
4. It is usually beneficial to "shingle" overlaps in the down slope direction to facilitate drainage in the event of precipitation. It is also beneficial to proceed in the direction of prevailing winds. Scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the CONTRACTOR shall be fully responsible for the decisions made regarding placement procedures.
5. Geomembrane placement shall not proceed at ambient temperatures below 40 degrees Fahrenheit or above 104 degrees Fahrenheit unless otherwise authorized by the CQA Consultant. Geomembrane placement shall not be done during any precipitation, in an area of ponded water, or during excessive winds.
6. The CONTRACTOR shall assure that:
    a. Any equipment used does not damage the geomembrane by handling, trafficking, heat, leakage of hydrocarbons or other means;
    b. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement; any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;
    c. Personnel working on the geomembrane do not smoke, wear shoes which may damage the geomembrane, or engage in other activities which could damage the geomembrane;
    d. The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
    e. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
    f. Adequate temporary loading and/or anchoring using sand bags or other means not damaging the geomembrane, has been placed to prevent uplift by wind. The loading

should be continuous along the edges of panels to minimize the risk of wind flow under the panels;

g. All field seaming and installation of appurtenances (sumps, etc.) are done in accordance with Section 3.02.C; and

h. Direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextile, additional geomembrane, or other suitable material, in areas where traffic may be expected.

C. Field Seaming

1. The CONTRACTOR and CQA Consultant shall review the proposed panel layout and reach an agreement on any changes to accommodate field conditions.

2. In general:

a. Seams should be oriented parallel to the line of maximum slope, i.e., oriented with, not across, the slope.

b. In corners and other geometrically complex locations, the number of seams should be minimized.

c. No base seam or tee seam shall be less than 5 feet from the toe of slopes, or areas of potential stress concentrations, unless otherwise authorized by the CQA Consultant.

d. Panels of geomembrane have a finished overlap, sufficient to allow peel tests to be performed on the seam;

e. No solvent or adhesive is used unless the product is approved in writing by the CQA Consultant (samples shall be submitted to the CQA Consultant for testing and evaluation); and

f. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane (in particular, the temperature of hot air at the nozzle of any spot seaming apparatus is controlled such that the geomembrane is not damaged. "Damage" includes a loss in durability).

3. The finished overlap of the seam shall be sufficient to allow peel tests to be performed. No solvent or adhesive shall be used for temporary bonding unless the CQA Consultant approves the product in writing. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. In particular, the temperature of hot air at the nozzle of a spot seaming apparatus shall be controlled such that the geomembrane is not damaged. "Damage" includes a loss in durability.

4. Requirements of Personnel

a. All personnel performing seaming operations shall be qualified by experience.

b. Seaming personnel must have seamed at least 2,000 feet of geomembrane seams using the same type of seaming apparatus to be used on this project.

c. At least one seamer shall have experience seaming a minimum of 20,000 feet of geomembrane seams using the same type of seaming apparatus to be used on this site-specific geomembrane.

d. The most experienced seamer, the "master seamer," shall provide direct supervision over less experienced seamers.

5. Seaming Equipment and Products

Approved methods for field seaming are extrusion seaming and fusion seaming. Proposed alternate methods shall be documented and submitted to the CQA Consultant for approval. Only apparatus that has been specifically approved by make and model shall be used. The CONTRACTOR shall use appropriate measuring equipment to ensure that accurate temperatures are being achieved.

6. Extrusion Process

a. The extrusion-seaming apparatus shall be equipped with gauges giving the relevant temperatures of the apparatus such as the preheat and operating temperature.

b. The CONTRACTOR shall provide documentation regarding the extrudate to the CQA Consultant, and shall verify that the extrudate is compatible with the Specifications, and is comprised of the same resin as the geomembrane sheeting.

c. The CONTRACTOR shall perform his work so that:

- Apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane temperatures are verified at appropriate intervals
- Abrading is performed perpendicular to the seam and is completed no more than one hour prior to seaming;
- Abrading of the seam area must not extend beyond either side of the extrusion weld;
- The depth of the abrasion must not exceed 10 percent of the nominal material thickness;
- The extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel;
- The electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
- A smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage; and
- The geomembrane is protected from damage in heavily trafficked areas.

7. Fusion Process

a. The fusion-seaming equipment must be an automated roller-mounted device, and equipped with gauges giving the applicable temperatures. The CONTRACTOR shall establish the appropriate machine operating temperature and speed settings by trial seam testing prior to each seaming period.

b. The CONTRACTOR shall perform his work so that:

- For tee seam intersections, any flap on the cross seam is cut back to the edge of the outer track of the seam prior to seaming;
- The electric generator is placed on a smooth base such that no damage occurs to the geomembrane;

- A smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage;
- The geomembrane is protected from damage in heavily-trafficked areas; and
- Build-up of moisture between the sheets shall be prevented; any moisture shall be wiped dry prior to welding.

8. Weather Conditions for Seaming

a. The following protocols shall be observed during seaming:

- Unless authorized in writing by the CQA Consultant, no seaming shall be attempted at ambient temperatures below 40°F or above 104°F.
- If geomembrane temperature is below 50°F, pre-heating may be required.
- The geomembrane seaming area shall be dry and protected from wind.
- Ambient temperatures shall be measured 2 inches above the geomembrane surface.

b. If the CONTRACTOR wishes to use methods which may allow seaming at ambient temperatures below 40°F or above 104°F, the CONTRACTOR shall demonstrate and certify that such methods produce seams that are equivalent to seams produced at geomembrane temperatures above 40°F and below 104°F, and that the overall quality and durability of the geomembrane is not adversely affected.

c. In addition, an addendum to the contract between the OWNER and the CONTRACTOR is required to specifically state that the seaming procedure does not cause any physical or chemical modification to the geomembrane that shall generate any short or long-term damage to the geomembrane. Then, the temperatures in the above quality assurance procedure shall be modified.

9. Trial Seams

a. Trial seams shall be made on same geomembrane material that will be used on the project installation to verify that seaming conditions are adequate. In general, trial seams shall be conducted as follows:

	Fusion Welding	Extrusion Welding
Equipment	Before each welding period (every shift)	Before each welding period (every shift)
Technicians	Before each welding period (one per day)	Before each welding period (every shift)

b. A welding period or shift shall not exceed five hours. A trial seam shall also be made in the event that the ambient temperature varies more than 20°F since the last passing trial seam. Trial seams shall be made under the same conditions as actual seams. If any seaming apparatus is turned off for any reason, regardless of the length of time, a new passing trial seam must be completed for that specific seaming apparatus.

c. The trial seam sample shall be at least 2 feet long by 1 foot wide with the sample centered lengthwise.

d. The CONTRACTOR shall cut six (6) specimens, each one (1) inch wide and a minimum of six (6) inches long from the trial seam sample. Three specimens shall be tested in shear and three in peel using a calibrated field tensiometer, and the test results shall meet or exceed the values given in Tables 1 and 2 of GRI Test Method GM19 (latest version). If any specimen fails, the entire operation should be repeated. If the additional seam sample fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams are achieved.

10. General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the CONTRACTOR shall be as follows:

a. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions. If approved by the CQA Consultant, fishmouths or wrinkles may be repaired in the field by the CONTRACTOR.

b. Seaming shall be performed during hours of adequate natural light. If approved by the CQA Consultant, seaming operations may be carried out at night; provided adequate illumination is supplied.

c. Seaming shall extend entire length of panels including the portion placed in the anchor trench.

D. Nondestructive Seam Continuity Testing

1. The CONTRACTOR shall nondestructively test all field seams over their full-length using air pressure test (for double fusion seams only), or other approved method. Vacuum testing and air pressure testing are described in Sections 3.02.D.5 and 3.02.D.6, respectively. The purpose of nondestructive test is to verify the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. Nondestructive testing shall not be permitted before sunrise or after sunset unless there is, in the opinion of the CQA Consultant, adequate illumination.

2. The CONTRACTOR shall complete any required repairs in accordance with Section 3.02.F.

3. The following procedures applies to segments of seams that cannot be nondestructively tested:

   a. All such seam segments shall be capped with the same geomembrane.

   b. If the seam is accessible to testing equipment prior to final installation, the seam shall be nondestructively tested prior to final installation.

c. The CQA Consultant and CONTRACTOR shall observe the seaming and cap-stripping operations for uniformity and completeness.

4. Vacuum Testing

a. The equipment shall be comprised of the following:

b. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole, valve assembly, and a vacuum gauge;

c. A vacuum tank and pump assembly equipped with a pressure controller and pipe connections; and

d. A pressure/vacuum hose with fittings and connections.

The following procedure shall be followed:

- If vacuum testing a fusion seam, the seam flap must be cut off prior to exposing the seam for testing;
- Energize the vacuum pump and reduce the tank pressure to approximately 5 psi gauge;
- With a soapy solution, wet geomembrane few inches wider and longer than the vacuum box;
- Place the box over the wetted area;
- Close the bleed valve and open the vacuum valve;
- Ensure that a leak-tight seal is created;
- Examine the geomembrane seam through the viewing window for the presence of soap bubbles for a period of not less than 10 seconds;
- If no bubbles or foam appears after 10 seconds, close the vacuum valve and open the bleed valve. Before moving the box over the next adjoining area, place a mark on the geomembrane at the leading edge of the viewing window, then move the box over the next adjoining area so that the last mark on the geomembrane is within the viewing window, and repeat the process; and
- All areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.02.F.

5. Air Pressure Testing (For Double Fusion Seam Only)

a. The equipment shall be comprised of the following:

- An air pump equipped with a pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi;
- A pressure gauge display with one psi increments;
- A hose with fittings and connections; and
- A sharp hollow needle or other approved pressure-feed device.

b. The following procedures shall be followed:

- Seal both ends of the seam to be tested;
- Insert the needle or other approved pressure-feed device into the channel created by the fusion seam;
- Energize the air pump to a pressure between 25 and 30 psi and maintain the pressure for approximately 2 minutes to allow the temperature of the air in the channel to stabilize;
- Close the valve and verify that the pressure is between 25 and 30 psi and observe the pressure for a minimum of 5 minutes;
- If loss of pressure exceeds 3 psi or if the pressure does not stabilize, locate the faulty area and repair it in accordance with Section 3.02.F.
- To verify that there is airflow through the entire channel, the air pressure gauge shall be observed for a decrease in pressure when the technician removes the seal at the end of the channel away from the air pump. If it is found that there is a blockage in the channel, the entire seam must be capped and nondestructively tested; and
- Remove the needle or other approved pressure-feed device and seal the hole.

E. Destructive Testing

1. Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate field seam strength as the seaming work progresses not at the completion of all field seaming.
2. The CQA Consultant shall select locations where seam samples shall be cut out for laboratory testing. These locations shall be established as follows:
    a. A minimum frequency of one sample for every 500 feet of seam.
    b. Test locations shall be determined during seaming at the CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.
    c. The CONTRACTOR shall not be informed in advance of the locations where the seam samples shall be taken.
3. Samples shall be cut by the CONTRACTOR as the seaming progresses in order to have laboratory test results before the geomembrane is covered by other material.
4. All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 3.02.F. The continuity of the resulting extruded seams in the repaired area shall be non-destructively tested according to Section 3.02.D.
5. The destructive sample shall be 12 inches wide by 48 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:
    a. One portion, measuring 12 inches x 18 inches, to the CONTRACTOR for field testing;

   b. One portion, measuring 12 inches x 12 inches, to the CQA Consultant for archive storage; and
   c. One portion, measuring 12 inches x 18 inches, for CQA Laboratory testing.

6. Ten 1-inch wide specimens shall be tested in the field, by calibrated gauged tensiometer, five in peel for adhesion and five in shear for shear strength. If any field test sample fails to pass the criteria stated in GRI Test Method GM19 (latest version), then the procedures outlined in Section 3.02.E. shall be followed.

7. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the CQA Laboratory, the CONTRACTOR's laboratory, or by field tensiometer. The CONTRACTOR has two options:

   a. Reconstruct the seam between any two passed destructive seam test locations.

   b. Trace the seaming path to an intermediate location (at 10 feet - maximum from the point of the failed test in each direction) and take a small sample for an additional field test at each location. If these additional samples pass tensiometer testing, then full destructive laboratory samples should be taken. If these destructive laboratory samples pass the tests, then the seam should be reconstructed between these locations by capping. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

8. If a fusion-type seam fails destructive testing and the CONTRACTOR chooses to cap the seam, the only acceptable capping method is as described in Section 3.02.F.4. Applying topping (bead of extrudate) is not an approved method of capping seams.

9. All acceptable reconstructed seams must be bounded by two locations from which destructive samples passing laboratory tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample shall be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined in this section must be repeated.

F. Defects and Repairs

1. All seams and the geomembrane shall be examined by the CONTRACTOR and the CQA Consultant for identification of defects, penetrating stones, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the CONTRACTOR if the amount of dust or mud inhibits examination.

2. Each suspect location shall be nondestructively tested using the methods described in Section 3.02.D. Each location that fails the nondestructive testing shall be marked by the CQA Consultant and repaired by the CONTRACTOR. Work shall not proceed that would cover locations that have been repaired until laboratory results with passing values are available.

3. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the CONTRACTOR, and CQA Consultant. The procedures available include:

   a. Patching, used to repair all penetration holes, tears, undispersed raw materials, and contamination by other matter;

   b. Spot seaming, used to repair small scratches, or other minor, localized flaws; and

   c. Capping, used to repair large lengths of failed seams.

4. In addition, the following provisions shall be satisfied:

   a. Surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair;

   b. All surfaces must be clean and dry at the time of the repair;

   c. All seaming equipment used in repairing procedures must be approved;

   d. The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the CQA Consultant, and CONTRACTOR; and

   e. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

5. Each repair shall be logged. Each repair shall be nondestructively tested using the methods described in this specification. Repairs that pass the nondestructive test shall be considered acceptable. Failed tests shall require the repair to be redone and retested until a passing test is achieved.

6. When seaming of the geomembrane is completed (or when seaming of a large area of the geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall observe the geomembrane for wrinkles.

   a. Bridging of the geomembrane shall be considered unacceptable. Compensating materials shall be installed at these locations.

G. Backfilling of Anchor Trench

Anchor trenches must be allowed to drain to prevent ponding and softening of the soils while the trench is open. Anchor trenches shall be backfilled and compacted by the CONTRACTOR. Care shall be taken when backfilling the trenches to prevent damage to the membrane liner system.

H. Acceptance

1. The CONTRACTOR shall retain all responsibility for the geomembrane in the landfill cell or cap until acceptance by the OWNER.

2. The geomembrane shall be accepted by the OWNER when:

   a. The installation is finished.

   b. Verification of all seams and repairs, including testing, is complete.

   c. CONTRACTOR furnishes the CQA Consultant with written warranty in accordance with Section 1.05 of this specification.

   d. All documentation of installation required by the Contract Documents has been received by the CQA Consultant.

e. The OWNER and CONTRACTOR have signed a certificate of Substantial Completion, and all conditions identified on the certificate have been met for the OWNER to assume responsibility for the geomembrane.

END OF SECTION 13320

Appendix VII

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

CONSTRUCTION QUALITY ASSURANCE PLAN

OCTOBER 2013

PROFESSIONAL ENGINEER-STATE OF NEVADA
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10/23/13

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CONSTRUCTION QUALITY ASSURANCE PLAN

1.0 INTRODUCTION

1.1 PURPOSE

This plan addresses the construction quality assurance (CQA) procedures and requirements to be employed during construction of the project. The plan is intended to supplement, but not supersede, the Contract Drawings and Specifications; where a conflict arises, the Contract Documents or approved Contract Drawings and Specifications will govern.

All parties involved in the project should obtain a copy of this plan from the OWNER or ENGINEER. They should also obtain copies of any supplemental CQA documents prepared specifically for the project.

The overall goals of the CQA program are to ensure that proper construction techniques and procedures are employed, and to verify that the materials used meet the approved Contract Specifications. Additionally, the program will identify and define problems that may occur during construction, allowing corrective activities to be implemented in a timely manner. At the completion of the work, the program requires the certifying ENGINEER(s) to prepare certification reports indicating that the facility has been constructed in accordance with the approved design standards and Contract Specifications.

1.2 DEFINITIONS

The following definitions are applicable to this plan:

1.2.1 Quality Control

Definition (ASTM D3740): - a planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the needs of users. The objective of quality control is to provide quality that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification of what is wanted, production to meet the full intent of the specification, inspection to determine whether the resulting material, product, service, etc... is in accordance with the Specifications, and review of usage to determine necessary revisions of Specifications.

In practice, Quality Control refers to those procedures, criteria, and tests employed and paid for by the CONTRACTOR(s) to confirm that the work satisfies the CONTRACTOR's standards, and is in compliance with the Contract Drawings and Specifications. This plan does not address Quality Control procedures, criteria, and/or tests employed by the CONTRACTOR.

1.2.2 Quality Assurance

Definition (ASTM D3740): - a planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with the ability to have corrective measures initiated where necessary. For a specific material, product, service, etc…, this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment.

In practice, Quality Assurance refers to those procedures, criteria, and tests required and paid for by the OWNER to confirm that the work performed by the CONTRACTOR(s) is in compliance with the approved Contract Drawings and Specifications and any additional requirements of this plan.

1.3 PARTIES

1.3.1 OWNER

The OWNER is the owner of the solid waste permit, and bears the ultimate responsibility for the facility; the OWNER may or may not also be the Operator of the facility. The OWNER shall contract and manage the CONTRACTOR(s), and the CQA consultant(s) and laboratories. For this project, Bedroc Limited, LLC is both the OWNER and Operator.

1.3.2 ENGINEER

The ENGINEER is the official representative of the OWNER, and is responsible for the preparation of the Contract Drawings, Technical Specifications, and CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for the resolution of technical matters that may arise during construction.

1.3.3 Construction Representative

The Construction Representative is a representative of the OWNER. The Construction Representative reports to the ENGINEER.

1.3.4 Soils CQA Consultant

The Soils CQA Consultant is an agency, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing, and documenting activities related to the Quality Assurance of the earthwork at the site. The Soils CQA Consultant is also responsible for issuing a certification report, sealed by a registered Professional Engineer, licensed in the State of Nevada.

1.3.5 Geosynthetic CQA Consultant

The Geosynthetic CQA Consultant is an agency, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing, and documenting activities related to the Quality Assurance of the geosynthetic components of the project. The Geosynthetic CQA Consultant is responsible for issuing a certification report, sealed by a registered Professional Engineer, licensed in the State of Nevada.

1.3.6 Geosynthetic CQA Laboratory

The Geosynthetic CQA Laboratory is an agency, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, responsible for performing the required laboratory testing of the project geosynthetics.

1.3.7 CONTRACTOR

The CONTRACTOR has the primary responsibility for ensuring that the work is performed in accordance with the Contract Drawings and Specifications developed by the ENGINEER and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, procurement, supervision, Construction Quality Control, installation, and subcontracting. The CONTRACTOR is responsible for the protection of completed work until it is accepted by the OWNER. The CONTRACTOR is also responsible for informing the OWNER and Quality Assurance Consultants of the scheduling and occurrence of all construction activities.

1.3.8 Geomembrane Manufacturer(s)

The geomembrane manufacturer is responsible for the production of geomembrane rolls from resin.

1.3.9 Geomembrane Installer(s)

The Geomembrane Installer is responsible for the handling, sorting, placing, seaming, loading (against wind), and other construction-related aspects of the project geosynthetics. The Installer is also responsible for transportation of the materials to the site and the protection of the materials once they arrive on site, until the work is accepted by the CONTRACTOR.

1.3.10 Surveyor

The Surveyor is responsible for establishing and maintaining lines and grades and temporary benchmarks throughout all relevant areas of the construction site. The Surveyor will issue a complete set of Record Drawings certified by a Professional Land Surveyor, licensed in the State of Nevada.

1.4 COMMUNICATIONS AND MEETINGS

Frequent and open communications are a necessary and essential component of this plan in order to achieve a high degree of coordination, cooperation, and quality in the finished product, and to minimize or avoid delays. It is one goal of this plan to resolve problems at the lowest possible level of authority while maintaining thorough documentation, informing all responsible parties, and obtaining approvals as necessary or appropriate. The documentation requirements of CQA activities are addressed in various sections of this plan. A series of meetings will be held before, during, and after construction to facilitate planning, progress reports and problem resolution. Minutes are to be kept of all meetings as directed by the ENGINEER. The meetings shall be as follows unless otherwise directed by the OWNER:

- Preconstruction Meeting to be attended by consultants, contractors, significant subcontractors and suppliers as directed by the ENGINEER.
- Bi-weekly Progress Meetings to be held as directed by the ENGINEER and to be attended by the OWNER or Owner's Representative, CONTRACTOR, CQA Consultant(s), and representatives of parties actively involved in the construction as designated by the ENGINEER.
- Post-Construction Resolution Meeting to be attended by consultants, contractors, significant subcontractors and suppliers as directed by the ENGINEER.

2.0 GEOSYNTHETICS

2.1 INTRODUCTION

This section of the plan describes Construction Quality Assurance (CQA) procedures for the installation of all geosynthetic components of the project. This section is devoted to Quality Assurance, not to Quality Control. A separate geosynthetic Quality Control manual shall be submitted by the CONTRACTOR in accordance with the Shop Drawings Submittals of the project.

2.2 SCOPE

2.2.1 General

The work addressed under this section shall facilitate proper construction of all geosynthetic components for the project. All work shall be constructed to the lines, grades, and dimensions indicated on the Contract Drawings, in accordance with the Contract Specifications, and as required by the ENGINEER, OWNER, or the OWNER'S Representative.

The Geosynthetic CQA Consultant shall issue a written daily report of activities. These reports shall include, at a minimum, observations and test results as well as problems encountered and solutions. Construction reports summarizing significant events, as well as addressing all problems encountered and their solutions shall be issued weekly to the OWNER'S Construction Representative and to the ENGINEER. The format of these reports shall be established at the pre-construction meeting.

2.2.2 Installation

The Geosynthetic CQA Consultant shall ensure that the geosynthetics are installed in accordance with the Contract Drawings and Specifications.

2.3 HDPE GEOMEMBRANE MANUFACTURE, FABRICATION, AND DELIVERY

2.3.1 High Density Polyethylene (HDPE) Geomembrane Manufacturing

The HDPE geomembrane shall be comprised of HDPE material manufactured of new, first-quality products designed and manufactured specifically for the purpose of liquid containment in hydraulic structures.

Only one type of resin (one manufacturer, one resin classification) shall be used to manufacture geomembranes for this project. In addition, all geomembrane used for this project shall be from the same batch unless otherwise approved in writing by the ENGINEER and the installer or manufacturer agree to pay for any additional conformance testing required.

2.3.2 Manufacturing

2.3.2.1 Submittals

The Geosynthetics CQA Consultant will verify that:

- the property values certified by the Manufacturer meet all of the Specifications; and

- the measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the geomembrane meets the Manufacturer's and Project Specifications

The Manufacturer shall provide QC certificates for every roll of material to the Geosynthetics CQA Consultant at least seven days prior to the loading and shipping of geomembranes to the site. The Geosynthetics CQA Consultant shall immediately review the QC certificates and notify the Manufacturer in writing which geomembrane rolls are approved for shipping.

The Geosynthetics CQA Consultant will review these documents and report any discrepancies with the above requirements to the ENGINEER and Construction Representative.

2.3.2.2 Rolls

The Geosynthetics CQA Consultant will:

- verify that the quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it; and
- review the quality control certificates and verify that the certified roll properties meet the Specifications.

2.3.2.3 Conformance Testing

2.3.2.3.1 In-Plant Material Conformance Test Sampling

The Geosynthetics CQA Consultant shall send to the CQA Laboratory conformance samples for testing as outlined in the appropriate Technical Specifications.

The Geosynthetics CQA Consultant shall report any nonconformance of sampling procedures as outlined in the appropriate Technical Specifications to the ENGINEER and OWNER.

2.3.2.4 Test Results

The Geosynthetics CQA Consultant will examine all results from laboratory conformance testing and will report any nonconformance to the ENGINEER.

2.3.2.4.1 Procedures in Event of a Conformance Test Failure

The Geosynthetics CQA Consultant will document actions taken in conjunction with conformance test failures.

2.3.3 Delivery

2.3.3.1 Transportation and Handling

The Geosynthetics CQA Consultant will verify that:

- handling equipment used on the site is adequate and does not pose any risk of damage to the geomembrane;
- the Installer's personnel handle the geomembranes with care; and
- trailer beds are free of nails and other items which could damage the geomembrane.

Upon delivery at the site, the Installer and the Geosynthetics CQA Consultant will conduct a surface observation of all rolls or factory panels for defects and for damage. This examination will be conducted without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The Geosynthetics CQA Consultant will indicate to the Construction Representative:

- rolls, or portions thereof, which should be rejected and removed from the site because they have severe flaws; and
- rolls which include minor repairable flaws.

2.3.3.2 Storage

The Geosynthetics CQA Consultant will verify that storage space selected is not in an area of low elevation and that cribbing techniques have been utilized which will help ensure that the materials will not be sitting in ponded water in the event of rainfall.

2.4 HIGH DENSITY POLYETHYLENE GEOMEMBRANE INSTALLATION

2.4.1 Earthwork

2.4.1.1 Surface Preparation

The CONTRACTOR will be responsible for preparing the supporting soil according to the Specifications.

The Geosynthetics CQA Consultant will verify that:

- a qualified land surveyor, licensed in Nevada, has verified all lines and grades;
- the Soils CQA Consultant has verified that the supporting soils meet the density specification and provide a firm foundation;

- the surface of the subgrade has been prepared and has been certified as acceptable to the Installer. In general, the surface should be free of irregularities, sticks, roots, large quantities of loose soil, and abrupt changes in grade which may cause damage to the geomembrane and require its repair after deployment;
- the surface of the supporting soil does not contain rocks which may be damaging to the geomembrane; and
- there is no area excessively softened by high water content.

In general, at any time before and during the geomembrane installation, the Geosynthetics CQA Consultant shall indicate to the CONTRACTOR locations, which may not provide adequate support to the geomembrane.

2.4.2 Geomembrane Placement

2.4.2.1 Field Panel Identification

It will be the responsibility of the Geosynthetics CQA Consultant to ensure that each field panel is given an "identification code" (number or letter-number) consistent with the layout plan. The ENGINEER, Installer, and Geosynthetics CQA Consultant will agree upon this identification code. This field panel identification code should be as simple and logical as possible. (Note: Roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field.)

2.4.2.2 Field Panel Placement

2.4.2.2.1 Location

The Geosynthetics CQA Consultant will verify that field panels are installed at the location indicated in the Installer's layout plan, as approved or modified.

2.4.2.2.2 Installation Schedule

The Geosynthetics CQA Consultant will evaluate every change in the schedule proposed by the Installer and advise the ENGINEER on the acceptability of that change. The Geosynthetics CQA Consultant will verify that the condition of the supporting soil has not changed detrimentally during installation.

The Geosynthetics CQA Consultant will record the identification code, location, and date of installation of each field panel.

2.4.2.2.3 Weather Conditions

Geomembrane placement will not proceed at geomembrane temperatures below 40°F unless otherwise authorized by the ENGINEER and Geosynthetic CQA Consultant.

Geomembrane placement will not be done during any precipitation, in an area of ponded water, or during excessive winds.

The Geosynthetics CQA Consultant will verify that the above conditions are fulfilled. Additionally, the Geosynthetics CQA Consultant will verify that the supporting soil has not been damaged by weather conditions.

The Geosynthetics CQA Consultant will inform the Construction Representative if the above conditions are not fulfilled.

2.4.2.2.4 Method of Placement

The Geosynthetics CQA Consultant will verify that:

- any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
- the prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement; any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and are free of debris;
- all personnel working on the geomembrane do not smoke, wear shoes which may damage the geomembrane, or engage in other activities which could damage the geomembrane;
- the method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- the method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- adequate temporary loading and/or anchoring using tires free of loose soil and any material which may damage the geomembrane (sand bags shall not be used), has been placed to prevent uplift by wind. The loading should be continuous along the edges of panels to minimize the risk of wind flow under the panels;
- all field seaming and installation of appurtenances (sumps, etc.) are done in accordance with the plans and Specifications; and
- direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The Geosynthetics CQA Consultant will inform the Construction Representative if the above conditions are not fulfilled.

2.4.2.2.5 Damage

The Geosynthetics CQA Consultant will visually examine each panel, after placement and prior to seaming, for damage. The Geosynthetics CQA Consultant will advise the ENGINEER and Construction Representative which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels, which have been rejected, will be marked, and their removal from the work area recorded by the Geosynthetics CQA Consultant. Repairs will be made according to procedures described in Section 2.4.6.3.

As a minimum, the Geosynthetics CQA Consultant will ensure:

- each panel is placed in such a manner that it is unlikely to be damaged; and
- any tears, punctures, holes, thin spots, etc., are marked for repair or the panel is rejected.

2.4.3 Field Damage

2.4.3.1 Extrusion Process

The Geosynthetics CQA Consultant will log apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane temperatures at appropriate intervals.

The Geosynthetics CQA Consultant will verify that:

- the Installer maintains on-site the number of spare operable seaming machines decided at the Pre-Construction Meeting;
- equipment used for seaming will not pose a risk to damaging the geomembrane;
- abrading is performed perpendicular to the seam and is completed no more than one hour prior to seaming;
- abrading of the seam area must not extend beyond either side of the extrusion weld;
- the depth of the abrasion must not exceed 10 percent of the nominal material thickness;
- the extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel;

- the electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
- a smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage; and,
- the geomembrane is protected from damage in heavily trafficked areas.

2.4.3.2 Fusion Process

The Geosynthetics CQA Consultant will log ambient and geomembrane temperatures, seaming apparatus temperatures, and speeds.

The Geosynthetics CQA Consultant will also verify that:

- the Installer maintains on-site the number of spare operable seaming machines decided at the Pre-Construction Meeting;
- equipment used for seaming does not damage the geomembrane;
- for tee seam intersections, any flap on the cross seam is cut back to the edge of the outer track of the seam prior to seaming;
- the electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
- a smooth insulating plate or fabric is placed beneath the hot seaming apparatus after usage;
- the geomembrane is protected from damage in heavily-trafficked areas; and
- build-up of moisture between the sheets is prevented (a movable protective layer may be used as required directly below each overlap of geomembrane that is to be seamed to accomplish this).

2.4.3.3 Seam Preparation

The Geosynthetics CQA Consultant will verify that:

- prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
- if seam overlap grinding is required, the process is completed according to the Manufacturer's Specification, and in a way that does not damage the geomembrane;

- seams are aligned with the fewest possible number of wrinkles and "fishmouths".

2.4.3.4 Weather Conditions for Seaming

The Geosynthetics CQA Consultant will verify that the weather conditions specified in Section 13320 are fulfilled and will advise the Construction Representative if they are not. The Construction Representative and ENGINEER will then decide if the installation will be stopped or postponed.

2.4.3.5 Overlapping and Temporary Bonding

The Geosynthetics CQA Consultant will verify that:

- the panels of geomembrane have a finished overlap, sufficient to allow peel tests to be performed on the seam;
- no solvent or adhesive is used unless the product is approved in writing by the ENGINEER (samples will be submitted to the ENGINEER for testing and evaluation); and
- the procedure used to temporarily bond adjacent panels together does not damage the geomembrane (in particular, the temperature of hot air at the nozzle of any spot seaming apparatus is controlled such that the geomembrane is not damaged. "Damage" includes a loss in durability).

The Geosynthetics CQA Consultant will log all appropriate temperatures and conditions, and will log and report to the Construction Representative any non-compliance.

The Geosynthetics CQA Consultant will observe all trial seam procedures. The remainder of the successful trial seam sample will be assigned a number and marked accordingly by the Geosynthetics CQA Consultant, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. Additional samples may be cut from the remainder of the trial seam to be archived by the OWNER, and/or tested by the CQA Laboratory or CQA Consultant.

2.4.3.6 General Seaming Procedure

The Geosynthetics CQA Consultant will verify that the seaming procedures listed in Section 13320 are followed, and will inform the Construction Representative if they are not.

2.4.4 Nondestructive Seam Continuity Testing

2.4.4.1 Vacuum Testing

2.4.4.1.1 Trial Vacuum Test

Prior to vacuum testing each day, the technician who will be performing the vacuum testing shall conduct a trial vacuum test. The test shall be supervised by the Installer's Superintendent or his designated representative. The Geosynthetics CQA Consultant shall provide the extrusion seam sample to the Installer for vacuum testing. The seam sample shall be approximately 3 feet long by 1 foot wide (it is suggested that trial seam samples be used to conduct this test). If desired, the Geosynthetics CQA Consultant can make holes of various sizes in the sample next to the seam to simulate a hole which could potentially be found during actual vacuum testing. The technician shall perform the vacuum test procedure outlined in Section 2.4.4.1.2. If the vacuum testing equipment does not perform adequately, the equipment may not be used until it is repaired and passes a trial vacuum test. If the technician fails to locate a hole that has been placed in the seam sample by the Geosynthetics CQA Consultant, that technician shall not be allowed to perform vacuum testing.

2.4.4.1.2 Vacuum Testing Procedure

The equipment will be comprised of the following:

- a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole, valve assembly, and a vacuum gauge;
- a vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
- a pressure/vacuum hose with fittings and connections;
- an approved applicator; and
- a soapy solution that does not cause environmental stress cracking in the geomembrane.

The following procedure will be followed:

- if vacuum testing a fusion seam, the flap must be cut off with an approved cutter prior to exposing the seam for testing;
- energize the vacuum pump and reduce the tank pressure to approximately 5 gauge;
- with a soapy solution, wet a strip of geomembrane which is 6 inches wider and longer than the vacuum box;
- place the box over the wetted area; close the bleed valve and open the vacuum

valve;

- ensure that a leak-tight seal is created;
- examine the geomembrane seam through the viewing window for the presence of soap bubbles for a period of not less than 15 seconds;
- if no bubbles or foam appear after 15 seconds, close the vacuum valve and open the bleed valve. Before moving the box over the next adjoining area, place a mark (with an approved marker) on the geomembrane at the leading edge of the viewing window, then move the box over the next adjoining area so that the last mark on the geomembrane is at the rear of the viewing window, and repeat the process; and
- all areas where soap bubbles appear will be marked and repaired in accordance with Section 2.4.6.3.

2.4.4.2 Air Pressure Testing (For Double Fusion Seam Only)

The following procedures are applicable to those processes which produce a double seam with a central channel.

The equipment will be comprised of the following:

- an air pump equipped with a pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane;
- a hose with fittings and connections; and
- a sharp hollow needle, or other approved pressure-feed device.

The following procedures will be followed:

- seal both ends of the seam to be tested;
- insert the needle or other approved pressure-feed device into the channel created by the fusion seam;
- insert a protective cushion between the air pump and the geomembrane;
- energize the air pump to a pressure between 25 and 30 psi and maintain the pressure for approximately 2 minutes to allow the temperature of the air in the channel to stabilize;
- close the valve and verify that the pressure is between 25 and 30 psi and observe

the pressure for a minimum of 5 minutes;

- if loss of pressure exceeds 3 psi or if the pressure does not stabilize, locate the faulty area and repair it in accordance with Section 2.4.6.3.
- to verify that there is airflow through the entire channel, observe the air pressure gauge for a decrease in pressure when the Installer's technician remove the seal at the end of the channel away from the air pump. If it is found that there is a blockage in the channel, the entire seam must be capped and nondestructively tested; and
- remove the needle or other approved pressure-feed device and seal the hole.

The Geosynthetics CQA Consultant will:

- observe all continuity testing;
- record location, date, time, test unit number, name of tester, and outcome of all testing; and
- inform the Installer and Construction Representative of any required repairs.

The Installer will complete any required repairs in accordance with Section 2.4.6.3.

The Geosynthetics CQA Consultant will then:

- observe the repair and re-testing of the repair;
- mark on the geomembrane that the repair has been made; and
- document the results.

The seam number, date of observation, time of test, name of tester, and outcome of the test shall be recorded by the Geosynthetics CQA Consultant.

2.4.5 Destructive Testing

2.4.5.1 Concept

Destructive seam tests will be performed at selected locations. The purpose of these tests is to evaluate field seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

2.4.5.2 Location and Frequency

The Geosynthetics CQA Consultant will select locations where seam samples will be cut out for laboratory testing. These locations will be established as follows:

- A minimum frequency of one sample every 500 feet of seam.
- Test locations will be determined during seaming at the Geosynthetics CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming.

The Installer will not be informed in advance of the locations where the seam samples will be taken.

2.4.5.3 Sampling Procedure

Samples will be cut by the Installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The Geosynthetics CQA Consultant will:

- observe sample cutting;
- assign a number to each sample, and mark it accordingly;
- record the reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling will be immediately repaired in accordance with repair procedures described in Section 2.4.6.3. The continuity of the new seams in the repaired area will be tested according to Section 2.4.4.

2.4.5.4 Size of Samples

At a given sampling location, two types of samples will be taken by the Installer.

First, two (2) specimens for field testing should be taken. Each of these specimens will be one (1) inch wide by eight (8) inches long, with the seam centered across the width. The distance between these two specimens will be 48 inches. If both specimens pass the field test described in Section 2.4.5.5, a sample for laboratory testing will be taken.

The sample for laboratory testing will be located between the two (2) specimens for field testing. The destructive sample will be 12 inches wide by 48 inches long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:

- one portion, measuring 12 inches x 18 inches, to the Installer for laboratory testing;

- one portion, measuring 12 in. x 12 in., to the OWNER for archive storage; and
- one portion, measuring 12 inches x 18 inches, for CQA Laboratory testing.

2.4.5.5 Field Testing

The two 1-inch wide specimens mentioned in Section 2.4.5.4 will be tested in the field, by calibrated gauged tensiometer, one in peel for adhesion and one in shear for shear strength. If any field test sample fails to pass the criteria of Section 2.4.5.8 and the Specifications, then the procedures outlined in Section 2.4.5.9 will be followed.

The Geosynthetics CQA Consultant will witness all field tests and mark all samples and portions with their number. The Geosynthetics CQA Consultant will also log the date and time, geomembrane temperature, number of seaming unit, name of technician, seaming apparatus temperatures and speeds, pass or fail description, and attach a copy to each sample portion.

2.4.5.6 Construction Quality Assurance Laboratory Testing

Destructive test samples will be packaged and shipped, if necessary, by the Geosynthetics CQA Consultant in a manner which will not damage the test sample. The Geosynthetic CQA Consultant will verify that packaging and shipping conditions are acceptable. The Geosynthetic CQA Consultant will be responsible for storing the archive samples. Test samples will be tested by CQA Laboratory.

Testing will follow ASTM D4437-84 as modified in NSF 54, Appendix A and with no requirements for sample conditioning time. The minimum acceptable values to be obtained in these tests are those indicated in the Specifications. At least five specimens will be tested from the samples (e.g., peel, shear, peel, shear, etc.).

The CQA Laboratory will provide test results no more than 24 hours after they receive the samples. The Geosynthetics CQA Consultant will review laboratory test results as soon as they become available, and make appropriate recommendations to the ENGINEER

If the two specimens meet the project specification, the sample qualifies for testing in the laboratory; if it fails, the seam shall be repaired in accordance to Section 2.4.6.3.

2.4.5.7 Installer's Laboratory Testing

The Installer's laboratory test results will be presented to the ENGINEER and the Geosynthetics CQA Consultant for comments.

2.4.5.8 Destructive Sample Pass/Fail Criteria

The peel criteria apply to both tracks of double track seams. Four out of five specimens from a destructive seam sample must meet the peel requirements and five out of five specimens must meet the shear requirements to be acceptable.

The following Pass/Fail criteria govern the acceptance of individual specimens from a seam sample.

Peel Test	**Fusion Welding**	**Extrusion Welding**
Strength	70 percent of the specified material yield strength	60 percent of the specified material yield strength
% Separation	10 percent or less	10 percent or less

Shear Test	**Criteria**
Strength	90 percent of the specified material yield strength
Percent Elongation	100 percent or greater
Location of Failure	Outside the weld area

Shear elongation is based on a one (1) inch gauge length between each edge of the seam and the nearer grip, i.e., the grip separation is two (2) inches plus the width of the seam. Therefore, 100 percent shear elongation is a cross head displacement of one (1) inch

2.4.5.9 Procedures for Destructive Test Failure

The following procedures will apply whenever a sample fails a destructive test, whether that test is conducted by the CQA Laboratory, the Installer's laboratory, or by field tensiometer. The Installer has two options:

- Reconstruct the seam between any two passed destructive seam test locations.
- Trace the seaming path to an intermediate location (at 10 feet - minimum from the point of the failed test in each direction) and take a small sample for an additional field test at each location. If these additional samples pass tensiometer testing, then full destructive laboratory samples should be taken. If these destructive laboratory samples pass the tests, then the seam should be reconstructed between these locations by capping. If either sample fails, then the process is repeated to establish the zone in which the seam should be reconstructed.

If a fusion-type seam fails destructive testing and the Installer chooses to cap the seam, the only acceptable capping method is as described in Section 2.4.6.3. Applying topping (bead of extrudate) is not an approved method of capping seams.

All acceptable seams must be bounded by two locations from which destructive samples passing laboratory tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample will be taken from the zone in which the seam has been reconstructed. This sample must pass destructive testing or the procedure outlined in this section must be repeated.

The Geosynthetics CQA Consultant will document all actions taken in conjunction with destructive test failures.

2.4.6 Defects and Repairs

2.4.6.1 Verification of Repairs

The Geosynthetics CQA Consultant should observe all nondestructive testing of repairs and will record the date of the repair and test outcome.

2.4.6.2 Large Wrinkles

The Geosynthetics CQA Consultant will indicate to the ENGINEER which wrinkles should be cut and reseamed by the Installer. The seam thus produced will be tested like any other seam.

2.4.6.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, will be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure will be agreed upon between the ENGINEER, Installer, and Geosynthetics CQA Consultant. The procedures available include:

- patching, used to repair all penetrating holes, tears, undispersed raw materials, and contamination by foreign matter;
- spot seaming, used to repair small scratches, or other minor, localized flaws; and
- capping, used to repair large lengths of failed seams.

In addition, the following provisions will be satisfied:

- surfaces of the geomembrane which are to be repaired will be abraded no more than one hour prior to the repair;
- all surfaces must be clean and dry at the time of the repair;
- all seaming equipment used in repairing procedures must be approved;
- the repair procedures, materials, and techniques will be approved in advance of the specific repair by the ENGINEER, Geosynthetics CQA Consultant, and Installer; and
- patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.

2.4.6.4 Verification of Repairs

Each repair will be logged. Each repair will be nondestructively tested using the methods described in Section 2.4.4. Repairs which pass the nondestructive test will be considered acceptable. Failed tests will require the repair to be redone and retested until a passing test is achieved. The Geosynthetics CQA Consultant should observe all nondestructive testing of repairs and will record the date of the repair and test outcome.

2.4.7 Backfilling of Anchor Trench

The Geosynthetics CQA Consultant will observe the backfilling operation and advise the ENGINEER of any problems.

2.4.8 Lining System Acceptance

The Geosynthetics CQA Consultant will verify that installation has proceeded in accordance with the CQA Plan for the project, except as noted to the ENGINEER.

2.4.9 Materials in Contact with the HDPE Geomembrane

2.4.9.1 Soils

The Geosynthetics CQA Consultant shall verify that the Specifications are consistent with the state of practice such as:

- Placement of soils on the geomembrane shall not proceed at an ambient temperature below 40°F nor above 104°F unless otherwise specified;
- A geotextile or other cushion approved by the ENGINEER may be installed between a drainage layer and the geomembrane;
- Equipment used for placing soil shall not be driven directly on the geomembrane;

- A minimum thickness of 1 foot of drainage material is specified between a light dozer (such as a wide pad Caterpillar D-5 or lighter) and the geomembrane;
- A minimum thickness of 3 feet of soil/stone is specified between rubber-tired vehicles and the geomembrane; and
- In heavily trafficked areas such as access ramps, soil/stone thickness should be at least 3 ft.

The Geosynthetics CQA Consultant shall:

- Measure soil thickness and verify that the required thicknesses are present (or, if applicable, verify that required measurements have been completed by the Soils CQA Consultant, if any); and
- Verify that placement of soil is done in such a manner that geomembrane damage is unlikely.

The Geosynthetics CQA Consultant shall inform the ENGINEER if the above conditions are not fulfilled.

2.4.10 Sumps and Appurtenances

The Geosynthetics CQA Consultant shall review the Specifications and verify the use of geosynthetic layers between structures and geomembranes.

The Geosynthetics CQA Consultant shall verify that:

- installation of the geomembrane in sump and appurtenance areas, and connection of geomembrane to sumps and appurtenances have been made according to Drawings and Specifications;
- extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas; and
- the geomembrane has not been visibly damaged while making connections to sumps and appurtenances.

The Geosynthetics CQA Consultant shall inform the ENGINEER if the above conditions are not fulfilled.

2.5 GEOTEXTILES

2.5.1 Design

A copy of the geotextile drawings and Specifications prepared by the ENGINEER shall be given to the Geosynthetic CQA Consultant. The Geosynthetics CQA Consultant shall review these and verify that they are consistent with the state of practice, and are clear and complete.

2.5.2 Manufacturing

The Geosynthetics CQA Consultant shall examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile. Any deviations shall be reported to the ENGINEER.

2.5.3 Labeling

The Geosynthetics CQA Consultant shall examine rolls upon delivery and any deviation from the requirements listed in the specifications shall be reported to the ENGINEER.

2.5.4 Shipment and Storage

2.5.4.1 Geotextile

The Geosynthetics CQA Consultant shall observe rolls upon delivery at the site and any deviation from the requirements listed in the specifications shall be reported to the ENGINEER. Any damaged rolls shall be rejected and replaced at no additional cost to the OWNER.

2.5.5 Conformance Testing

2.5.5.1 Tests

Upon delivery of the rolls of geotextiles, the Geosynthetics CQA Consultant shall ensure that samples are removed and forwarded to the CQA Laboratory for testing to ensure conformance to both the design Specifications and the list of guaranteed properties.

NOTE: All geotextiles used for this project shall be from the same lot unless otherwise approved by the ENGINEER. The manufacturer or supplier shall perform additional conformance testing, at no additional cost to the OWNER.

As a minimum, the following tests shall be performed on geotextiles:

Mass per unit area	ASTM D5261
Grab strength	ASTM D4632
Tear strength	ASTM D4533
Puncture strength	ASTM D4833
Thickness	ASTM D5199
Permittivity*	ASTM D4491
Apparent opening size*	ASTM D4751

*Only if geotextile is to be used as a filter

2.5.5.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first outer wrap. Unless otherwise specified, samples shall be three (3 feet long by the roll width. The Geosynthetics CQA Consultant shall mark the machine direction on the samples with an arrow.

Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 100,000 ft^2, whichever is the greater frequency.

2.5.5.3 Test Results

The Geosynthetics CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the ENGINEER.

2.5.5.4 Conformance Test Failure

The Geosynthetics CQA Consultant will document actions taken in conjunction with conformance test failures.

2.5.6 Handling and Placement

The Installer shall handle all geotextiles in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

- On slopes, the geotextiles shall be securely anchored in the anchor trench and rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
- In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earth cover material.
- Geotextiles shall be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
- The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

In addition, the following applies to geotextiles only:

- During placement of geotextiles, care shall be taken not to entrap in the geotextile stones, excessive dust, or moisture that could damage the geomembrane, generate clogging of drains or filters, or hamper subsequent seaming.

- A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present. In addition, the Geosynthetic CQA Consultant may undertake a sweep of the entire geotextile surface using a metal detector to ensure their removal.

The Geosynthetic CQA Consultant shall note any noncompliance geotextiles and report them to the Construction Representative.

2.5.7 Seams and Overlaps

The Geosynthetic CQA Consultant shall note any noncompliance to the specifications for geotextiles and report them to the Construction Representative.

2.5.8 Repair

2.5.8.1 Geotextiles

Care shall be taken to remove any soil or other material that may have penetrated the torn geotextile. The Geosynthetic CQA Consultant shall observe any repair, note any noncompliance with the requirements listed in the specifications.

2.5.9 Placement of Soil Materials

The Installer shall place all soil materials located on top of a geotextile in such a manner as to ensure:

- No damage to the geotextile;
- Minimal slippage of the geotextile on underlying layers; and
- No excess tensile stresses in the geotextile.

Unless otherwise specified by the ENGINEER, all lifts of soil material shall be in conformance with the guidelines given in Section 2.4.9. Any noncompliant materials or procedure shall be noted by the Geosynthetics CQA Consultant and reported to the ENGINEER.

2.6 GEONET COMPOSITE

2.6.1 Design

A copy of the geonet composite drawings and Specifications prepared by the ENGINEER shall be given to the Geosynthetics CQA Consultant. The Geosynthetics CQA Consultant shall review these and verify that they are consistent with industry standards.

2.6.2 Manufacturing

The Geosynthetics CQA Consultant shall examine all manufacturer's certifications to ensure that the property values listed on the certifications meet or exceed those specified. Any deviations shall be reported to the ENGINEER.

2.6.3 Labeling

The Geosynthetics CQA Consultant shall examine rolls upon delivery and any deviation from the requirements listed in the specifications Section 13302 shall be reported to the ENGINEER.

2.6.4 Shipment and Storage

The Geosynthetics CQA Consultant shall verify that geonet composites are free of dirt and dust just before installation. The Geosynthetics CQA Consultant shall report the observation of this verification to the ENGINEER. Washing operations shall be observed by the Geosynthetics CQA Consultant and improper washing operations, which may damage the geonet composites, shall be reported to the ENGINEER.

2.6.5 Conformance Testing

2.6.5.1 Test Results

The Geosynthetics CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the ENGINEER.

2.6.5.2 Conformance Test Failure

The Geosynthetics CQA Consultant will document actions taken in conjunction with conformance test failures.

2.6.6 Handling and Placement

The Geosynthetics CQA Consultant shall note any noncompliance to the Specifications Section 13302, Part 3.02 and report it to the Construction Representative.

2.6.7 Stacking

The Geosynthetics CQA Consultant shall note any non-compliance to the Specification, Section 3.03 and report it to the Construction Representative.

2.6.8 Repair

The Geosynthetics CQA Consultant shall observe any repair, note any noncompliance to the Specifications, Section 3.05, paragraph A. and report them to the Construction Representative.

2.6.9 Placement of Soil Materials

Any noncompliance to the Specifications, Section 3.07, paragraph A. shall be noted by the Geosynthetics CQA Consultant and reported to the Construction Representative.

If portions of the geonet composites are exposed, the Geosynthetics CQA Consultant shall periodically place marks on the geonet composite and the underlying geomembrane and measure the elongation of the geonet composite during the placement of soil.

2.7 EARTH MATERIALS

2.7.1 INTRODUCTION

This section of the plan describes Construction Quality Assurance (CQA) procedures for the installation of the earth material components of the project.

2.7.2 SCOPE

2.7.2.1 General

The work addressed under this section shall facilitate proper construction of all earth material components of the project. All work shall be constructed to the lines, grades, and dimensions indicated on the approved Contract Drawings, in accordance with the Contract Specifications, or as required by the OWNER or OWNER's Representative.

2.7.3 EARTH MATERIALS CQA TESTING

2.7.3.1 General

Assurance that construction of the earth material components of the project has been performed in accordance with the approved Contract Drawings and Specifications shall be accomplished by use of CQA testing and visual observations.

CQA testing shall consist of the following:

- Construction Quality Evaluation; and
- Special Testing

2.7.3.2 Construction Quality Evaluation Testing

Construction quality evaluation shall be performed on all components of earthwork construction at the frequencies shown in Table 1. Criteria to be used for determination of acceptability of the work shall be as identified in the Contract Specifications and as detailed in this plan. Construction evaluation testing shall consist of visual observations of the work, in-place density/moisture content verification, investigations into the adequacy of layer bonding and clod destruction, elevation and thickness monitoring, and special testing. Evaluation of the construction work shall include the following:

- Observations and documentation of the water content, clod size and other physical properties of the soil during processing, placement and compaction;
- Observation and documentation of each compacted lift's ability to accept and bond to subsequent lifts;
- Observation and documentation of the thickness of compacted and loosely placed lifts;
- Observation and documentation of the performance of the compaction and heavy hauling equipment on the construction surface (sheepsfoot penetration, pumping, cracking, etc…); and
- Observation and documentation of the effectiveness of the procedures used to prevent desiccation and/or freezing of completed lifts and layers.

The in-place density test methods shall cause minimal delay to the placement of subsequent lifts; therefore, the nuclear method is preferred unless construction sequencing is such that fill placement is not interrupted by sand cone or drive cylinder testing. An acceptable test for soils used in structural or "controlled fill" applications (i.e. embankments, berms, backfill, soil liner, subgrade, etc.) shall be defined as one, which meets or exceeds the specified minimum density within the specified moisture range.

If there is any question as to the classification of the tested soil, and hence the appropriateness of a given moisture-density plot, a "one-point" Standard Proctor compaction test shall be performed for comparison with the available plots. The optimum moisture content and maximum dry density extrapolated from the one-point test result must fall on or near the plotted line of optimums for the classification of a soil to be confirmed. For controlled fill, the reference maximum dry density can be adjusted to accommodate the one-point data.

Questions concerning the accuracy of any single test shall be addressed by retesting in that or another representative location. Periodic sand cone or drive cylinder testing shall be performed to verify the adequacy of the nuclear gauge testing at the frequencies designated in Table 1. If a conflict exists between the sand cone or drive cylinder testing and the corresponding nuclear density test results, then the sand cone and/or drive cylinder results shall control.

It is important to bond lifts together to the greatest extent possible. Bonding of lifts is enhanced by:

- Ensuring that the surface of the previously compacted lift (or subgrade) is rough before placing the new lift of soil;
- Adding moisture to the previously compacted lift (or subgrade); and
- Using a fully penetrating footed roller.

Evaluation of lift bonding in soil liner and similar applications shall be done by using test pits or auger holes to visually observe the lift interfaces. Alternatively, Shelby tubes pushed through the lift interfaces can be visually inspected for proper lift bonding.

2.7.3.3 Test Pad

A test pad shall be constructed as outlined in the project specifications to develop and demonstrate construction methods that shall be used to produce a compacted soil liner/cap satisfying the requirements of the specifications.

2.7.4 DOCUMENTATION/CERTIFICATION

2.7.4.1 General

The CQA Consultant shall document the activities associated with the construction of the earth material components of the project. Such documentation shall include, as a minimum, daily reports of construction activities and a summary technical report on the construction project. Documentation and reporting shall meet all requirements of the Contract Specifications and this CQA Plan.

2.7.4.2 Construction Monitoring

Construction of earth material components of the project shall be monitored and documented by a CQA Consultant. Soils laboratory testing shall be performed and documented by an independent testing laboratory working under the direction of the CQA Consultant.

Written daily documents shall include a record of observations, test data sheets, identification of problems encountered during construction, corrective measures taken, weather conditions, and personnel and equipment on site.

2.7.4.3 Certification

The CQA Consultant(s) shall prepare a certification report addressing each major item identified above for each phase of construction under their areas of responsibility. Certification reports required by regulatory agencies shall also be prepared and submitted as required.

Certification shall include assessments of compliance with the Contract Drawings and Specifications and the results of the physical sampling and testing. At a minimum, the certification report shall include:

- Copies of all daily CQA field reports;
- Results of all field testing including drawings depicting the locations of construction testing when appropriate;
- Results of all laboratory testing;
- Photographic record of the project including representative photographs of each major construction activity; and
- Certification statement assessing compliance with the Contract Drawings and Specifications, sealed by a professional engineer, licensed in the State in which the project work is conducted.

2.7.5 GEOSYNTHETIC CLAY LINER (GCL)

2.7.5.1 Storage

Geosynthetic clay liner rolls must always be stored in a location where they will not be exposed to excessive moisture.

2.7.5.2 Handling & Placement

On slopes, geosynthetic clay liners should be placed with overlap oriented parallel to the maximum slope (i.e. down the slope, not across the slope).

Adjoining panels of geosynthetic clay liners should be overlapped a minimum of six inches (6").

Geosynthetic clay liners should never be installed in standing water or while rain is falling.

Geosynthetic clay liners should always be installed with appropriate side up.

Rolls should be pulled tight to smooth out any creases or irregularities.

Precautions should be taken to avoid damage to any underlying geosynthetic materials while placing the geosynthetic clay liners.

Cover geosynthetic clay liners with geomembrane or other cover materials after placement to avoid damage from precipitation.

2.7.5.3 Repairs

Repairs to cuts or tears in installed rolls should extend a minimum of six inches (6") beyond the area in need of repair. Repair pieces should be held in place until cover material has been placed.

2.8 DOCUMENTATION

2.8.1 Daily Reports

The Geosynthetics CQA Consultant shall complete a daily report and/or logs on prescribed forms, outlining all of the monitoring activities for that day. The precise area, panel numbers, and seams completed and approved, and measures taken to protect unfinished areas overnight should be identified. Failed seams or other panel areas requiring remedial action must be identified with regard to nature of action, required repair, and precise location. Repairs completed must also be identified. Any problems or concerns with regard to operations on site should also be noted. This report must be completed prior to leaving the site for the day. Any matters requiring action by the ENGINEER should be highlighted. A copy is to be submitted to the ENGINEER at the weekly construction meeting following the report date.

2.8.2 Progress Report

Progress reports shall be prepared by the Geosynthetics CQA Consultant and submitted to the ENGINEER. This report should include: an overview of progress to date; an outline of any changes made to the plans, drawings, or Specifications; any problems or deficiencies in operations at the site, and an outline of any action taken to remedy the situation(s); a summary of weather conditions; and a brief description of activities anticipated for the next reporting period. All destructive test reports for the period should be appended to each progress report.

2.8.3 Record Drawings

Record Drawings should be prepared by the Installer. The Record Drawings should include the following information for geomembranes:

- Dimensions of all geomembrane field panels;
- Location, as close as possible, of each panel;
- Identification of all seams and panels with appropriate numbers or "identification codes";
- Location of all patches and repairs; and
- Location of all destructive test samples.

The Record Drawings shall address each layer of geomembrane; and if necessary, another drawing shall identify problems or unusual conditions of the geotextile or geonet composite layers. In addition, applicable cross-sections shall show layouts of geonets composites and geotextiles that are unusual or different from the design drawings.

2.8.4 Final Certification Report

A Final Certification Report shall be prepared by the Geosynthetics CQA Consultant and submitted upon completion of the work. This report shall include all reports prepared by the Geosynthetic CQA Consultant personnel, summarize the activities of the project, and document all aspects of the quality assurance program performed. The Final Certification Report shall include as a minimum the following information:

- Personnel involved with the project;
- Scope of work and outline of project;
- Quality assurance methods;
- Test results (destructive and non-destructive, including laboratory tests);
- Certification sealed and signed by a registered Professional Engineer licensed in the State of Nevada; and
- Record Drawings, sealed and signed by a registered Professional Engineer, licensed in the State of Nevada.

3.0 LEACHATE COLLECTION PIPING

3.1 INTRODUCTION

This section of the plan addresses the quality assurance of the installation of all pipes and manholes used on the project in the leachate collection and removal system (LCRS) including, leachate collection pipes and leachate transmission pipes.

3.2 SCOPE

3.2.1 General

The work addressed under this section shall facilitate proper construction of all LCRS piping installed in or outside the disposal cells on the project. All work shall be constructed to the lines, grades, and dimensions indicated on the project plans, in accordance with the project specifications, or as required by the OWNER or his representative. OWNER's representative shall issue a written daily report of activities. These reports shall include, as a minimum, observations and test results as well as problems encountered and solutions achieved. Construction reports summarizing significant events, as well as addressing all problems encountered and their solutions, shall be issued weekly to the OWNER's Project Manager and to the Designer. The format of these reports shall be established at the pre-construction meeting.

3.3 MANUFACTURING AND DELIVERY OF MATERIALS

3.3.1 Pipe, Fittings, and Manholes

It is a requirement of the contract that prior to delivery of materials, the CONTRACTOR shall submit detailed or shop drawings and manufacturer's specifications of all materials to be furnished for the project. These drawings and specifications shall be reviewed by the Designer to determine if the materials meet the requirements of the contract specifications.

The submittals will be either approved or rejected. Rejection will require a resubmission of the information.

3.3.2 Delivery

Upon delivery, the Construction Representative shall inspect all pipes, fittings, and other appurtenances for conformity with the specifications and proper storage. The Construction Representative may prescribe corrective repairs or may reject the material as deemed necessary.

3.4 INSTALLATION OF PIPES AND MANHOLES

3.4.1 Testing

Testing shall be done on sections of pipeline as determined adequate and ready for testing by the Construction Representative.

3.4.1.1 Examination of Materials

All pipes, fittings, manholes, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and the deficiency shall be corrected or the material shall be rejected and replaced as deemed necessary by the Construction Representative.

3.4.1.2 Alignment and Gradient

The alignment of the pipe shall be surveyed by a surveyor licensed in the State of Nevada.

Alignment and gradient of gravity leachate pipes flowing between manholes will also be checked by the Construction Representative by sighting from one manhole to a strong light held at the next manhole. Should alignment vary horizontally more than 1/4 the diameter of the pipe or sags and high points be found in the slope, the CONTRACTOR shall locate and correct the defective joints to the satisfaction of the Construction Representative.

3.4.1.3 Leak Testing of Leachate Transmission Lines

3.4.1.3.1 Infiltration Test

Infiltration test shall be performed only when the line is sufficiently below the water table to provide a minimum of four feet of head above the top of the pipe at the highest elevation being tested. A weir shall be installed in the lower end of the section being tested and measurement of the depth of flow over the weir recorded at 15-minute intervals for one hour.

3.4.1.3.2 Exfiltration Test

Exfiltration test shall be performed after replacement of broken or cracked pipe, repair of defective joints and verification of the pipe installation for line and grade and after cleaning and conditioning the pipe free from deposits, joint drippings, extrusions, or from foreign matter of any kind, each section of line between manholes, or for longer distances if allowed before backfilling, shall be maintained completely full of water for a period of not less than 30 minutes to allow for absorption of water by the sewer. By use of pre-installed riser sections of pipes at manholes if necessary, or by plumbers plugs and riser, a column of water shall then be maintained at least four feet above the uppermost top section of pipe under test for lines with grades of one percent or less and to one inch above the crown of the upper end of the pipe, for grade between one to five percent, and as the Construction Representative directs, for greater grades. In case the water table in the trench at the time of the test is above the highest invert of the sewer section under test, the column of water above specified shall be accordingly increased.

3.4.1.3.3 Air Test

Air test shall be performed on all leachate transmission lines with slope greater than five percent as outlined below.

Make air test when pipe is clean. Plug line at each manhole with pneumatic balls. Introduce low pressure air into plugged line until internal air pressure reaches 4.0 psig greater than average back pressure of any ground water pressure that may submerge the pipe. Allow at least two minutes for air temperature to stabilize before readings are taken and timing started.

Portion being tested shall pass if it does not lose air at a rate to cause pressure to drop from 3.6 to 3.0 psig (greater than average back pressure of any ground waste that may submerge the pipe) in less time than listed below:

Pipe Diameter in Inches	Minimum Allowable Minutes 3.6 - 3.0 psig Pressure
8 or less	4.0

In lieu of standard exfiltration test, CONTRACTOR may make air tests on lines.

3.4.1.3.4 Infiltration - Exfiltration Test

Infiltration - exfiltration test shall be made by the CONTRACTOR immediately upon completion of the first run of pipe between two manholes, under the direction of the Construction Representative. The remainder of the sewer installation may be tested as the work progresses or upon completion of the project at the option of the CONTRACTOR.

3.4.1.3.5 Leakage

Leakage shall not exceed 200 gallons per day per mile of pipe per inch of pipe diameter.

Acceptance of line shall not be made until test requirements have been met. CONTRACTOR shall locate and repair defects until leakage is within permitted allowance.

3.4.1.4 Pipe Bedding and Backfill

The gradation and compaction of pipe bedding will be tested by the contractor to verify compliance with contract specifications.

END OF CONSTRUCTION QUALITY ASSURANCE PLAN

TABLE 1 - SOIL TESTING METHODS AND FREQUENCIES

Test Method	Fill		Test Pad		Soil Liner/Cap	Drainage Layer	
	Pre-Construction	Construction	Pre-Construction	Construction	Construction	Pre-Construction	Construction
Particle Size Analysis of Soils ASTM D422	One/Material	One/Material[1]	One/Material	NA	NA	NA	1/10,000 CY[2]
Unified Soil Classification System ASTM D2487	One/Material	One/Material[1]	One/Material	NA	NA	NA	NA
Moisture Content of Soil Lab Method ASTM D2216	One/Material	One/Material[1]	One/Material	NA	NA	NA	NA
Atterberg Limits ASTM D4318	One/Material	One/Material[1]	One/Material	NA	NA	NA	NA
Specific Gravity ASTM D854	One/Material	One/Material[1]	One/Material	NA	NA	NA	NA
Standard Proctor ASTM D698	One/Material	One/Material[1]	One/Material	NA	NA	NA	NA
In-place Density by Sand Cone ASTM D1556 or Drive Cylinder ASTM D2937	NA	1/Acre	NA	1/Lift	1/Lift/Acre	NA	NA
In-place Density and Water Content by Nuclear Method ASTM D6398	NA	5/Acre	NA	5/Lift	5/Lift/Acre	NA	NA
Soil Moisture By Direct Heating ASTM D4959	NA	1/Acre	NA	1/Lift	1/Lift/Acre	NA	NA
Undisturbed Hydraulic Conductivity ASTM D5084	NA	NA	NA	1/Lift	1/Lift/Acre	NA	NA
Laboratory Compacted Hydraulic Conductivity ASTM D5084	NA	NA	One/Material	NA	One/Material	NA	One/Material
Two-Stage Field Permeameter ASTM D6391 (VA liner only)	NA	NA	NA	One/TP	NA	NA	NA

NA – Not Applicable
(1) required only if material changes
(2) for each material provided

Appendix F

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

DECOMPOSITION GAS MONITORING PLAN

OCTOBER 2013
REVISED MAY 2014

PROFESSIONAL ENGINEER - STATE OF NEVADA
LEONARD E JOYCE JR.
CIVIL
No. 1307[illegible]

5/13/14

PREPARED BY:

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ENGINEERING

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JOYCE PROJECT NO. 00383.1401.01 01

Decomposition Gas Monitoring Plan
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

Table of Contents

Decomposition Gas Monitoring Plan
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

1.0 INTRODUCTION

Bedroc Limited, LLC (Bedroc) proposes to construct and operate a Class I municipal solid waste landfill for the disposal of waste residue derived from residential, commercial and industrial waste streams. The site of the Class I facility is located in Coyote Spring Valley adjacent to State Route 93, approximately 65 miles north of Las Vegas, Nevada. A site location map is presented on the permit drawings. Topographic features of the site and surrounding area are shown on the existing conditions plan as presented on the permit drawings.

The permitted areas identified as Cells 1-16 in the permit application will accept Class I materials and hence is equipped with a soil and synthetic liner and leachate collection system for the disposal of waste. The facility is constructed in phases, and when completed, will cover approximately 115 acres.

This plan has been prepared for the facility to address the monitoring requirement for odors and explosive gases as required by the Nevada Administrative Code (NAC) 444.667., which requires the owner/operator of Class I landfills to provide safeguards against the uncontrolled migration of decomposition gases (methane and carbon dioxide), collectively referred to as landfill gas, originating from the waste being disposed of at the site. Additional requirements addressed by this plan include those under NAC 444.686, which specifies that landfills shall have provisions in their *Operating Plans* for controlling odors that may be associated with the landfills. The plan has been prepared in general accordance with NAC 444.667, which contains operating criteria for the control of explosive gases at municipal solid waste facilities.

Specifically, this plan addresses means for monitoring for the presence and concentration of decomposition gases, the concentrations limits, above which will require remedial actions for the control of decomposition gases, and establishes a schedule for the submission of a *Decomposition Gas Remediation Plan* in the event one is required based on routine monitoring results.

Based on the chemical and physical nature of the material being processed and of the material proposed for disposal at the facility, methane is expected to be the primary nuisance gas generated at the facility. Therefore, this plan proposes procedures for monitoring for releases of this gas from these disposal areas.

The proposed compliance levels for methane at the facility are:

- Methane concentrations less than 25% of the lower explosive limit (LEL) for methane in facility structures (1.25% by volume); and,
- Methane concentrations less than 100% of the LEL for methane at the facility property boundary (5% by volume);

Bedroc will perform quarterly monitoring of the on-site structures (currently only the scale house) and facility property boundary for methane.

The required monitoring will be performed by qualified and properly trained landfill personnel or qualified third party under contract by the facility. Landfill gas monitoring will be completed using a portable, gas monitoring meter designed to detect combustible gases or vapors. The meter will be calibrated in accordance with to the manufacture's guidelines. Several examples of industry accepted landfill gas monitoring equipment include the following:

- CES LandTec GEM-500
- CES LandTec GEM-2000
- CES LandTec GA-90
- MDU-420.

One of these meters or equivalent will be used by facility. Please note that the manuals produced by the manufacturers of this equipment (outlining calibration frequencies etc.) will be kept onsite and referred to when needed.

This plan describes a phased monitoring program proposed to ensure detection of migrating landfill gas (there are no discernible preferential pathways at the site) into on-site structures and at the facility boundary. The phases include boundary probe installation; monitoring of boundary probes and on-site structures for methane; and monitoring of the atmospheric concentrations of methane at the facility property boundary. This monitoring will be completed by facility personnel using one of the landfill gas meters described above. This plan also details the requirement and time frame for submitting a *Decomposition Gas Remediation Plan* in the event that routine monitoring results indicate that established compliance levels for either gas have been exceeded.

Landfill gas migration from the landfill is unlikely due to the presence of a low-permeability composite liner system and the use of a passive venting to collect and remove gas from the landfill. Perimeter subsurface landfill gas monitoring and indoor structure monitoring is conducted to verify adequate control of landfill gas. Perimeter landfill gas monitoring will consist of quarterly sampling and testing of gas probes located at the landfill property boundary. The locations of the 24 new probes to be installed have been shown in the design drawings.

Structure monitoring is conducted to verify that concentrations remain below the allowable upper limit of 25 percent of the LEL, equivalent to 1.25 percent methane by volume.

In the event methane is detected at a concentration greater than 5 percent by volume in the perimeter probes, or greater than 1.25 percent by volume in a landfill structure, steps will be taken to protect human health and the source of the methane is investigated. Corrective measures will be implemented to reduce methane concentrations to acceptable levels.

2.0 DECOMPOSITION GAS MONITORING NETWORK

The following sections discuss the proposed decomposition gas monitoring network.

2.1 Boundary Probe Installation

Twenty four (24) new boundary probes (BP-35 through BP-58) will be installed in phases prior to the acceptance of Class I material at the facility. The locations of the new probes are shown on the Site Monitoring Plan, Drawing No. 15 of the permit drawings.

The gas probes will be constructed to a bottom elevation of 2455 amsl. The approximate elevation of the bottom of the soil liner, at its lowest point, is 2458 amsl. The elevation of the bottom of waste will be at least 2462 amsl. All of the gas probes will be nested and consist of three tiers as follows:

- A shallow probe installed approximately 10 feet below the surface;
- An intermediate probe installed at or near half the depth of the well bore; and
- A deep probe at or near the depth of the well bore.

The specified depths of monitoring probes within the well bore may be adjusted, based on geologic data obtained during drilling, This type of probe will be appropriate for monitoring the complete vertical direction from below the bottom of waste to within approximately two feet of the ground surface. By screening at alternate depths, the probes are able to effectively monitor the potential preferential migration pathways (sand and gravel lenses) for decomposition gases, ensuring that any releases to the subsurface are detected in a timely manner, providing protection to public health and safety, and the environment A schematic of the gas probe and the specifications for the construction of the probes (Specification Section 13900) are included in Appendix I.

2.2 Decomposition Gas Monitoring Program

Quarterly monitoring of the boundary probes (in the borehole) and on-site structures (in the scale house) are being performed to detect the presence of migrating decomposition gases. The existing boundary probes, proposed new probes and on-site structures to be monitored are shown on the permit drawings (Drawing No. 15). In addition to the monitoring stations discussed above, atmospheric monitoring is being conducted along the facility property boundary.

Prior to each monitoring event, the equipment is calibrated with known standards in accordance with the manufacturer's specifications. The calibration activities (and the schedule of calibration provided by the manufacturer) are recorded for future reference, as needed. Please note that the manuals produced by the manufacturers of this equipment (demonstrating how the equipment is to be operated etc.) will be kept onsite and referred to when needed.

At each probe, the technician (who is properly trained as outlined in the Integrated Sitewide Contingency Plan) monitors the pressure in the probe, both instantaneous and static, prior to obtaining readings on gas concentrations using a digital or analog type manometer. After obtaining the pressure readings, the monitoring meter is connected to the air-tight quick connect fitting and the probe is purged with the built-in vacuum pump for a period of 3 to 5 minutes. After purging is complete, the technician records the steady state concentrations of the target gases at each monitoring location on the gas monitoring log.

The required monitoring will be completed by a properly trained facility employee or consultant. The portable equipment to be used will be designed for the detection of combustible gases or vapors. It will be calibrated in accordance with the manufacturer's instructions and indicate the percentage of LEL or methane.

The standard operating procedure for this type of monitoring is as follows:

- Legibly complete the top portion of the Landfill Gas Monitoring Log. An example of a LFG Monitoring Log is presented in Appendix III;
- Calibrate the monitoring equipment in accordance with the manufacturer's instructions;
- Measure and record the undisturbed probe pressure/vacuum. This requires connecting the pressure gauge to a labcock valve, quick connect, or other valve device, and then opening the valve to measure the pressure;
- Leak check the entire sample train. This is done by sealing the end of the monitoring hose and verifying that air does not leak into the sample train, either through stoppage of the pump or maintaining a complete seal. Air infiltration must be allowed during probe purging and monitoring;
- Purge the probe casing (piping). Based on probe casing volume and sample pump flow rate, determine the pumping time to pump just over two probe volumes from the casing using the sample pump. The probe casing should be sealed during purging. The objective is to monitor soil gas from void spaces surrounding the probe screened interval;

- Read and record the stablized concentration of methane;
- If the methane reading is slowly increasing as the probe is pumped, the value at two probe volumes is recorded. The objective is to record the conditions of the gas around the probe rather than gases that can be pulled to the probe via the purging process; and,
- The completed original Landfill Gas Monitoring Log is to be left with the landfill operator for inclusion in the operating record.

Monitoring will not be limited to using detection equipment. Monitoring will also include visual observations of site conditions including:

- Distressed vegetation, including signs of stunted growth, wilting, color changes, death during the growing season, and bare spots;
- Increased odors around the landfill, indicating the presence of methane and other gases; and
- Air bubbles permeating through standing water outside the limits of waste that may be from gas laterally migrating and finding its way to the surface.

Special attention will be given to the following possible site conditions:

- Development of surrounding areas, such as placing impermeable ground covers (i.e., paved parking areas, building slabs), can force landfill gas to remain underground and promote lateral migration. Additionally, off-site structures and utilities can provide enclosed areas in which landfill gas may collect and pose a safety hazard;
- Heavy irrigation or rainfall that saturates the soil may provide an impermeable barrier to landfill gas causing lateral migration;
- Excavation activities such as utility trenches may cause landfill gas to escape through the adjacent soils and into the excavation. The landfill gas may accumulate to explosive levels or displace oxygen within the excavation. Both possibilities compromise safety;
- Surface cracks or settlement can cause uncontrolled venting of landfill gas or air intrusion into the landfill that could reduce landfill gas quality (decrease methane concentration) or increase the potential for a landfill fire;
- Barometric pressure, wind, and temperature can affect the net pressure of landfill gas present. At a lower barometric pressure, more landfill gas will tend to escape through the cover or the surrounding surface; and
- Snow or frozen ground cover, as with saturated soil, can reduce surface

permeability and increase lateral migration of landfill gas.

Results of the monitoring program will be reviewed by a party designated by the facility who is knowledgeable in the area of landfill gas hazards and control systems and is familiar with the terrain and local site conditions. The gas monitoring will be conducted for the duration of the landfill's active life and post closure care period. If methane is not detected for long periods of time, the facility may request from the Director that landfill gas monitoring and control cease based on a demonstration that there is no potential for gas migration beyond the property boundary or into facility structures.

Atmospheric monitoring at the facility property boundary conducted with a hand-held meter designed for monitoring methane. Monitoring is accomplished by walking the entire perimeter of the facility while continuously reading the atmospheric concentration of methane. The highest recorded reading on each of the north, west, south, and east boundaries of the facility is recorded on the gas monitoring log.

2.3 Recordkeeping

Records of the results of the landfill gas migration monitoring program will be kept throughout the active life of the facility and the post-closure care period. An example monitoring log for recording the monitoring results is presented in Appendix III. The recordkeeping that will be maintained at the facility will include:

- Accuracy of reported sampling results
- Percent of attempted sampling events that were successful
- Precision of reported sampling results
- Oxygen levels in samples that would indicate leaking well casing or faulty sampling equipment
- What percent of the boundary probes were saturated with water or did not provide a consistent methane reading
- The concentrations of methane and hydrogen sulfide as measured at each boundary probe, within each on-site structure, and the highest measured hydrogen sulfide concentration measured along each boundary of the facility; Date, time, general weather conditions, barometric pressure, lagging 24-hour trend in the barometric pressure, atmospheric temperature, and boundary probe pressure; and,
- Names of sampling personnel, equipment used, and a brief description of methodology, including calibration.

3.0 DECOMPOSITION GAS CONTROL

Should the monitoring results indicate that concentrations of methane in excess of the compliance levels are present in facility structures, the facility boundary probes, or in ambient air along the perimeter of the facility, the owner/operator will:

- Take all immediate steps necessary to protect public health and safety;
- Notify the NDEP in writing within five working days of learning that the compliance level for one or both of the decomposition gases has been exceeded, and indicate what action has been or is taken to resolve the problem;
- Commence weekly monitoring of the affected monitoring point(s) for the gas of concern until such time as the measured concentrations have decreased to below the compliance level for a period of four consecutive monitoring events;
- Submit a proposed *Decomposition Gas Remediation Plan* to mitigate the release of decomposition gases within 60 days of learning that the compliance level for one or both of the decomposition gases has been exceeded. The Plan will describe the nature and extent of the problem and the proposed remedy; and,
- Design and construct a decomposition gas control system (this may include the installation of LFG vents within the waste mass to alleviate pressure in the waste as described in Appendix II, Specification 13910) within the period specified in the approved plan. Installation of the system shall be in accordance with the design and in the manner approved for construction by the NDEP.

The selected remedy will depend on the source of the decomposition gases. If the decomposition gases are derived from the lined unit, a *Decomposition Gas Remediation Plan* based on the installation of a gas collection and control system, or other remedial option as available at the time, is submitted to the NDEP for approval.

If a remedial system is required, the design criteria for the remedial system will be based on the need to:

- Prevent decomposition gases from accumulating in on-site structures;
- Reduce the concentrations of the decomposition gas(es) at the facility boundary to below compliance levels as determined based on monitoring of the boundary probes; and,
- Provide for the collection and treatment and/or disposal of any gas condensate produced at the surface.

Appendices

Appendix I

SECTION 13900

LANDFILL GAS MIGRATION MONITORING PROBE (BOUNDARY PROBE)

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

A. Supply all equipment, materials and labor needed to install the boundary probes as specified herein and as indicated on the Drawings.

PART 2 MATERIALS

2.01 PIPE AND FITTINGS

A. All pipe and fittings shall be rigid PVC Schedule 80 as indicated on the Drawings.

2.02 AGGREGATE

A. The gravel pack shall be crushed, natural stone or crushed slag, meeting the Nevada Department of Transportation (DOT) Standard Specifications for pea gravel (Class B Backfill).

2.03 BENTONITE SLURRY MIX

A. Coarse-ground, granulized bentonite from an approved source is to be mixed thoroughly with potable water at a ratio of five (5) gallons of water to every 50 pounds of bentonite.

PART 3 EXECUTION

3.01 DRILLING

A. Boundary probe boreholes are to be a minimum eight (8) inch diameter and drilled to the depth shown on the Drawings. The CONTRACTOR must use dry drilling equipment; wet rotary drilling equipment may not be used. All borings shall be made with hollow stem auger drilling equipment.

B. The boring depths shown on the Drawings are estimated and may be adjusted in the field by the ENGINEER or GEOLOGIST. Two reasons limiting depth might be as follows:

1. If water is encountered in a boring, the CONTRACTOR may be directed to cease drilling beyond the point at which it was encountered. If wet conditions remain, the boring may be terminated and the length of perforated pipe adjusted by the ENGINEER or GEOLOGIST, or the well may be relocated. If wet conditions cease (e.g. due to trapped water layer), then drilling will continue to the design depth.

2. If bedrock is encountered in a boring, the CONTRACTOR may be directed to cease drilling beyond the point at which it was encountered. The boring may be terminated and the length of perforated pipe adjusted by the ENGINEER or GEOLOGIST, or the well may be relocated.

3.02 BACKFILLING

A. Backfilling of the boundary probe shall commence immediately after drilling is completed and the well piping has been installed in the borehole. Backfill materials shall be installed as indicated on the Drawings and as approved by the ENGINEER.

B. The gravel pack shall be poured or scooped through the screen at a rate that will not endanger the integrity of the well casing.

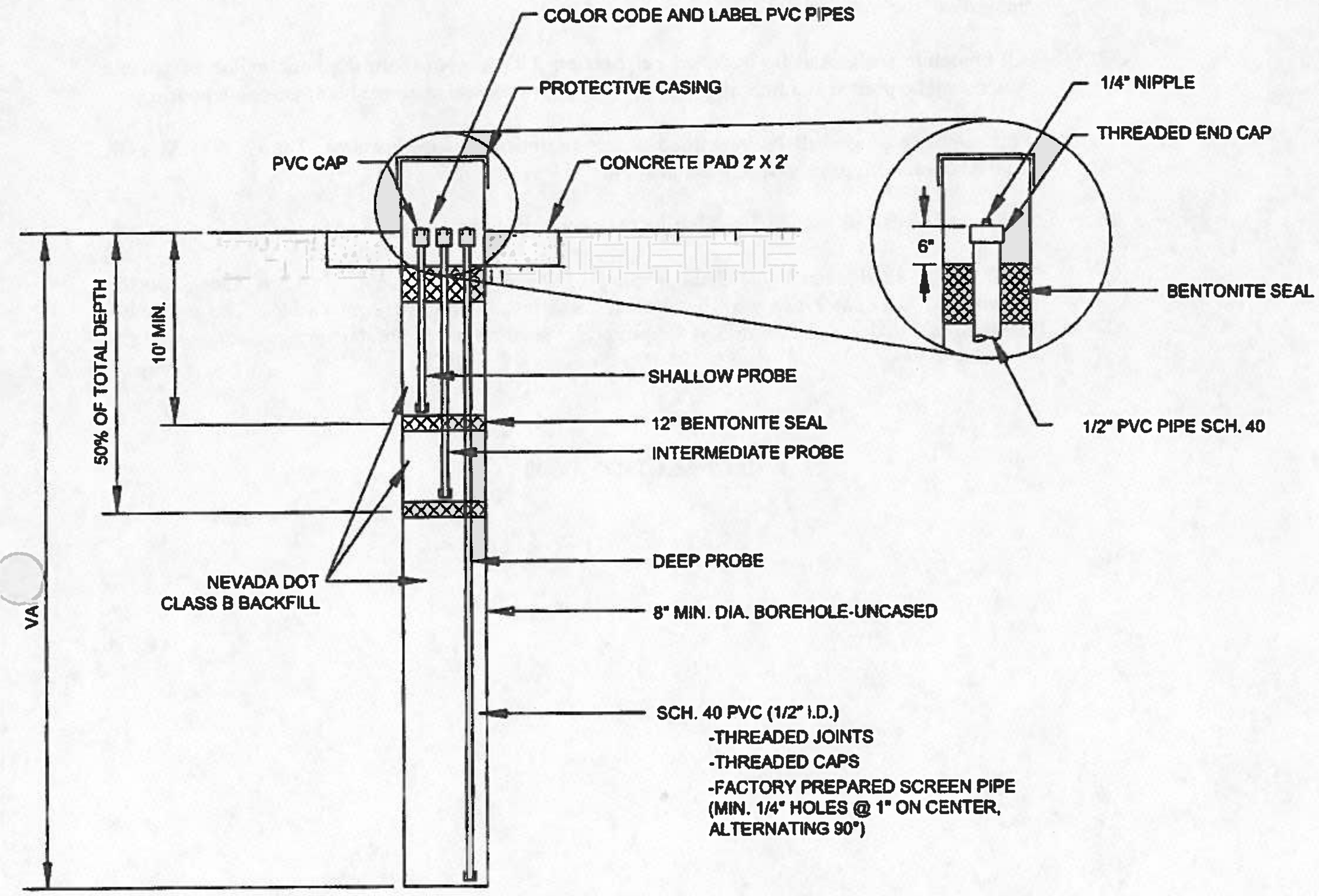
C. All bentonite seals shall be hydrated per Section 2.03.A. No more than one gallon of potable water shall be poured at a time with no less than a five minute increment between each pouring.

D. Soil/bentonite plug shall be backfilled as per the material specifications. The CONTRACTOR shall soak each lift prior to filling the next one.

E. Soil backfill shall be rodded in the boring to provide even distribution and compaction.

F. Steel casing shall extend above the surface of the protective concrete pad as shown on the Drawings. A lockable cap shall be provided and installed on the steel casing. The protective concrete pad shall be placed around the protective steel casing at ground surface as shown on the Drawings.

END OF SECTION 13900



NOTES:

1. NUMBER OF SAMPLING TUBES WILL VARY DEPENDING ON GEOLOGY.

LANDFILL GAS PROBE

N.T.S.

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

LANDFILL GAS DETAIL

JOYCE
ENGINEERING
1604 OWNBY LANE
RICHMOND, VA 23220
PHONE: (804) 355-4520

DESIGNED LBB
DRAWN DAS
CHECKED LBB
APPROVED LEJ
DATE 10/23/13

SCALE
N.T.S.

PROJECT NO.
383.1401.01

DRAWING NO.
1

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Appendix II

SECTION 13910

PASSIVE LANDFILL GAS VENT

PART 1 GENERAL

1.01 SCOPE OF APPLICATION

A. Supply all equipment, materials and labor needed to install the passive landfill gas (LFG) vents as specified herein and as indicated on the Drawings. This specification applies only to the vents that will be installed in the landfill and not to the "boundary probes" that are installed in the soil adjacent to the landfill.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM C136 - Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM C702 - Standard Practice for Reducing Field Samples of Aggregate to Testing Size.
3. ASTM D1557 - Standard Test Method of Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10 lb. (4.54 kg) Rammer and 18-in. (457 mm) Drop.
4. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes.
5. ASTM D2488 - Standard Practice for Description of Soils (Visual-Manual Procedure).
6. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).
7. ASTM 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

A. Submit to the ENGINEER Certificates of Compliance on materials furnished, and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of pipe and appurtenances furnished.

B. The CONTRACTOR shall submit to the ENGINEER samples of all well backfill materials furnished.

C. The CONTRACTOR shall keep detailed well logs and construction diagrams for all wells drilled, including the total depth of the well, the static water level, depth, thickness, and description of soil or waste strata, (including dates from any readable material), and the occurrence of any water bearing zones. Well logs shall be submitted to the ENGINEER.

1.04 SITE CONDITIONS

A. Obstructions and saturated conditions are sometimes encountered when drilling in a landfill, many of which can be drilled through. The CONTRACTOR is expected to make reasonable effort to drill through obstructions and saturated conditions and will be paid for offset redrilling and boring abandonment only if prior approval is granted in writing by OWNER. CONTRACTOR will be paid for abandonment of abandoned hole and for well installation at new location.

PART 2 PRODUCTS

2.01 AGGREGATE

A. Gravel pack shall be Nevada DOT “Class B Backfill”.

2.02 SOLID WALL PIPE

A. All pipe and fittings shall be rigid PVC Schedule 80.

2.03 PERFORATED/SLOTTED PIPE

A. Perforations in PVC vent piping shall be as indicated on the Drawings.

PART 3 EXECUTION

3.01 DRILLING

A. LFG vents are to be a minimum of 30-inch diameter, drilled to a minimum of 80 percent of the total waste depth. CONTRACTOR must use dry drilling equipment; wet rotary drilling equipment may not be used. All borings shall be made with bucket type augers.

B. The boring depths may be adjusted in the field by the ENGINEER. Two reasons limiting depth might be as follows:

1. If water is encountered in a boring, the CONTRACTOR may be directed to drill beyond the point at which it was encountered. If wet conditions remain, the boring may be terminated and the length of perforated pipe adjusted by the ENGINEER, or the well may be relocated. If wet conditions cease (e.g. due to trapped water layer), then drilling will continue to the design depth.

2. If base grades are encountered, then the drilling will be terminated. A soil/bentonite mixture will be placed to create a 2’ plug at the bottom of the borehole.

C. As soon as drilling is completed, a safety screen shall be placed over the top of the bore. This screen shall stay in place until backfilling is within 4 feet of the surface. Safety screen size should be large enough to accommodate all backfill materials and any tools used during backfill yet not large enough for any human to accidentally fall through.

D. The bore for the well shall be straight and the well pipe shall be installed in the center of the bore hole. The CONTRACTOR will take all tension off of the pipe by mechanical means and center the pipe in the middle of the borehole before starting to backfill.

E. PVC vent pipe shall be solvent cemented and lag bolted.

3.02 BACKFILLING

A. Backfilling of the well shall commence immediately after well drilling is completed and the well piping has been installed in the borehole. Backfill materials shall be installed as indicated on the Drawings and as approved by the ENGINEER.

B. Gravel pack shall be poured or scooped through the screen at a rate that will not endanger the integrity of the well casing.

C. Soil backfill shall be rodded in the boring to provide even distribution and compaction.

3.05 DISPOSAL

A. Refuse transport and disposal from well drilling operations shall be the CONTRACTOR'S responsibility. All materials shall be disposed of at an appropriate disposal facility.

END OF SECTION 13910

Appendix III

JOYCE ENGINEERING

LANDFILL GAS MONITORING LOG

Facility:____________________________________ Date:________________

General Weather Conditions:______________________________________

Atmospheric Temperature:_____________ Barometric Pressure:________________

Sampling Personnel:____

Sampling Equipment Used:____

Sampling Methodology:____

Monitoring Point	**Time**	**Methane Concentration (% of LEL)**	**Oxygen Concentration (%)**	**Probe Pressure (Inches of water)**	**Comments**
East Perimeter (ambient sample mid-point of landfill)					
South Perimeter (ambient sample mid-point of landfill)					
West Perimeter (ambient sample mid-point of landfill)					
North Perimeter (ambient sample mid-point of landfill)					
Scale House					
BP-35					
BP-36					
BP-37					
BP-38					
BP-39					
BP-40					
BP-41					
BP-42					
BP-43					

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Monitoring Point	Time	Methane Concentration (% of LEL	Oxygen Concentration (%)	Probe Pressure (Inches of water)	Comments
BP-44					
BP-45					
BP-46					
BP-47					
BP-48					
BP-49					
BP-50					
BP-51					
BP-52					
BP-53					
BP-54					
BP-55					
BP-56					
BP-57					
BP-58					
BP-59					

Appendix G

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

CLOSURE PLAN

OCTOBER 2013
REVISED FEBRUARY 2014
REVISED MAY 2014

PROFESSIONAL ENGINEER-STATE OF NEVADA
LEONARD E. JOYCE, JR.
CIVIL
No. 13876

5/15/14

PREPARED BY:

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JOYCE PROJECT NO. 00383.1401.01.01

Closure Plan
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

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Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

1.0 CLOSURE PLAN

This plan has been prepared for Bedroc Limited, LLC (Bedroc) for the Class I Bedroc Landfill and Waste Management Facility (facility) to address the closure and post-closure requirements as required by the Nevada Administrative Code (NAC) 444.6895 and NAC 444.6896. This plan provides a description of the final cover and the actions associated with closure of the facility, an estimate of the area and quantity of waste subject to closure, and the maintenance and monitoring activities to be performed during the post-closure period.

This Closure Plan and future modifications or additions to this plan will be maintained in the facility's operating record at the site or at Bedroc's office in Las Vegas, Nevada. Changes or modifications to the Closure Plan will be approved by the Nevada Department of Environmental Protection (NDEP) prior to implementation at the facility.

1.1 Closure Activities (NAC 444.6891)

The closure of the facility will be completed in accordance with this plan and the requirements of NAC 444.6891 through 444.6894.

1.2 Closure Time Frames (NAC 444.6892)

At least 15 days prior to beginning closure of the facility, and the initiation of closure activities (solicitation of bids for construction), the NDEP will be notified of the intent to close. Closure activities shall begin no later than 30 days after the date on which the facility receives the final load of waste. Closure of the facility will be completed within six months after initiation of the closure construction activities unless construction conditions dictate a longer period. Extensions of the period for closure may be granted by the Department of Environmental Protection provided Bedroc demonstrates that closure will, by necessity, take longer than 180 days and the facility has taken actions to prevents threats to public health and safety and the environment from the open unit.

1.3 Closure Performance Standard

Closure of the facility will be conducted in a manner that minimizes the need for further maintenance and controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, the post-closure escape of uncontrolled leachate, surface runoff, or waste decomposition products to the groundwater, surface water, or the atmosphere, and adequately prepares the facility for the post-closure care period.

1.4 Closure of Waste Units

Waste that has been deposited in the disposal areas of the facility, will remain in place after closure.

Prior to final cover construction, areas that have settled will be filled in and slopes will be uniformly graded. The final cover will be constructed on slopes no greater than 3:1 (33 percent) or less than 5 percent.

1.3.1 Closure of Surface Impoundments

The leachate pond will be closed at the end of the post-closure period in either of the two ways described below.

1.3.1.1 In-Place Closure

Under this alternative, all standing water in the pond would be removed and treated, as necessary. Any residue remaining would be analyzed, removed, and properly disposed. The liner would then be washed down, and the wash water analyzed, removed, and treated, as necessary. Locally available soils would be used to fill in the leachate pond to an elevation higher than the surrounding ground to provide a 5 percent slope away from the center. The pond area would then be capped in the same manner as the landfill.

1.3.1.2 Removal of the Pond

Under this alternative, all standing water in the pond would be removed and treated, as necessary. Any residue remaining would be analyzed, removed, and properly disposed. The liner would then be washed down, and the wash water analyzed, removed, and treated, as necessary. The liner and any geotextiles would be removed and properly disposed. Next, the underlying soils would be tested for contaminants. If contaminants are detected, all contaminated soils will be removed, the site would be graded and seeded with native plant species.

1.3.2 Cover Design (NAC 444.6891)

The final cover, meeting requirements of the NAC 444.6891, will be placed over all waste as described in the following sections.

1.3.2.1 Plan Sheets, Drawings and Details

Closure design plans and details are included in the Report for Design drawings submitted as part of the facility's application for a permit to operate a Class I disposal site.

1.3.2.2 Description of Final Cover

The final cover will have a permeability less than or equal to the permeability of the bottom liner system and will be constructed as follows (top to bottom):

- 24-inch soil layer comprised of local soil compacted to an unspecified permeability with the top six inches consisting of seeded top soil, native soil, or soil suitably amended to support native vegetation
- A geonet composite
- 40-mil linear low density polyethylene (LLDPE) geomembrane
- A geonet composite
- local soil placed as an intermediate cover during filling operations

Installation of the geosynthetic materials will be in accordance with the provisions of the Construction Quality Assurance (CQA) Plan and the Technical Specifications submitted as part of this permit application and amended, if necessary, prior to closure construction..

The soil layer above the geosynthetic cap materials will consist of 24 inches of native materials produced in the excavation of the landfill and from adjoining land owned by Bedroc. The final cover will be seeded with native plant species and/or amended with organic materials (mulch) produced on-site, and native gravels.

1.3.3 Erosion & Sediment Control

Drainage and erosion will be controlled by a combination of benches and down slope pipes, storm water detention areas, native vegetation, mulch and gravels. The construction of drainage channels along the exterior of the access road will minimize storm water run-off on to adjacent property owners.

1.3.3.1 Characterize Design Storm

The design storm for all calculations is a 25-year, 24-hour rainfall event.

1.3.3.2 Estimate of Peak Runoff & Volume

Supporting calculations are provided in the Report for Design submitted as part of the Class I permit application.

1.4 Settlement, Subsidence, and Displacement

Given the expected life of the facility, the majority of settlement is expected prior to construction of the cap. Thus, closure slopes will be constructed to allow for uniform settlement.

Monthly inspection of the final cover will reveal any substantial displacement of the cap. Should these inspections indicate ponding, deep cracks, etc., then repairs will be initiated. The intended function of the cap is to reduce infiltration. This function is not expected to deteriorate over the post-closure period.

Cap stability in static and seismic loading conditions and slope stability calculations are provided in the Report for Design submitted as part of the Class I permit application.

1.5 Groundwater Monitoring System

A groundwater monitoring program has been developed in accordance with NAC444.683. Details of the groundwater monitoring program are contained in the Groundwater Monitoring Plan.

1.6 Leachate Collection System

Landfill leachate will be collected in the sump areas located in Cells 1, 5, 8, 11 and 14, then pumped to the leachate pond. Details of the Leachate Collection/Removal System are included in the Report for Design drawings.

1.7 Landfill Gas Monitoring System

A landfill gas monitoring program has been developed in accordance with NAC 444.667. Details of the landfill gas monitoring program can be found in the Decomposition Gas Management Plan.

1.8 Schedule for Closure

The following is an estimated schedule for final closure of the landfill. The estimated date is based on the anticipated incoming waste stream and compaction ratios. Deviations from the assumptions noted will affect the date accordingly. Phasing drawings can be found in the Report for Design.

Estimated Year of Final Closure	Total Area Closed (Ac.)
2104	115.2

Closure is anticipated to occur on a phased basis as described below. As shown, the largest area of uncapped waste during the entire estimated life of the facility is approximately 32.3 acres.

Phase	Total Lined Area (ac)	Total Area Open (ac)	Total Area Closed (ac)
I	10.8	10.8	0.00
II	20.3	20.3	0.00
III	27.6	25.8	1.88
IV	34.5	26.8	7.69
V	41.0	31.4	9.56
VI	47.1	21.8	25.34
VII	53.3	25.5	27.81
VIII	60.5	29.7	30.77
IX	66.6	22.9	43.73
X	72.8	26.2	46.55
XI	78.2	27.3	50.93
XII	85.0	22.4	62.63
XIII	92.9	28.3	64.59
XIV	100.2	32.3	67.87
XV	108.4	26.5	81.89
XVI	115.2	29.3	85.91
XVII	115.2	21.0	94.18
Final Closure	115.2	0.0	115.19

Upon completion of partial and final closure activities and certification signed by a licensed professional engineer verifying that closure activities have been completed in accordance with this Closure Plan, NDEP will be notified and requested to perform a site visit and inspection to confirm the closure activities and release of appropriate financial assurance funds.

All waste upon reaching final grade will be covered with intermediate cover soil. These areas will be inspected quarterly and after every major storm event for excessive erosion, and will be repaired accordingly.

1.9 Site Capacity

The life of the disposal facility, estimated based on disposal capacity, and the anticipated incoming waste stream and compaction ratios, is approximately 89 years. The volume of airspace available for waste and soil cover is approximately 17,735,000 cubic yards.

1.10 Notification (NAC 444.6893)

Upon the final closure of the landfill site, Bedroc will record a notation on the property's deed indicating that the property has been used as a landfill and that the site is restricted in accordance with NAC 444.6893. Bedroc will also notify NDEP that the notation has been recorded and a copy of the notation has been placed in the operating records of the site.

2.0 POST-CLOSURE CARE PLAN (NAC 444.6897)

Bedroc proposes to perform post-closure maintenance and monitoring at the facility for 30 years following final closure. The length of the post-closure care period may be decreased by NDEP if Bedroc demonstrates, to NDEP's approval, that the reduced period is sufficient to protect public health and safety and the environment. The length of the post-closure care period may be increased by NDEP if it determines that the lengthened period is necessary to protect public health and safety and the environment.

Maintenance activities resulting from the monitoring program will be initiated as soon as possible, and in no case, later than 30 days after discovery. Necessary resources for the performance of maintenance will be available from Bedroc.

2.1 Contact

Questions and/or problems which may occur during the post-closure period will be handled by Western Elite, Inc.

CONTACT PERSON:	Ryan Williams
OWNER:	Bedroc Limited, LLC
ADDRESS:	2745 N. Nellis Blvd. Las Vegas, Nevada 89115
PHONE NUMBER:	702-369-4242

2.2 Security

Access to the site will be controlled by use of barriers and/or gates at all roads to the property. All barriers and gates will be clearly marked with signs stating the name of the facility, that solid waste was disposed of on this site and that the site is no longer in use for disposal purposes. No solid waste will be left exposed after completion of the landfill closure. Therefore, there this facility should not pose a health hazard to the public or domestic livestock.

2.3 Maintenance Plan

Post-closure maintenance will consist of the following preventive and corrective maintenance activities:

2.3.1 Security Control Devices

Security control devices include gates and posted signs at all roads to the property. The gate and signs will be inspected monthly and any damages recorded. Any damage which would interfere with the function of the devices will be corrected as soon as possible.

2.3.2 Run-on and Run-off Controls

The landfill will be inspected quarterly and after every major storm event for signs of erosion damage. Areas to be inspected will include benches, down slope pipes and slopes. Any gullies will be filled with native soil and revegetated as necessary. Ditches filled with sediment will be cleaned as needed. The storm water detention area will be cleaned as required.

2.3.3 Correction of Settlement, Subsidence, and Settlement

The landfill cover will be inspected quarterly. It is not expected that the landfill will experience significant settlement. However, if any areas appear to have settled and standing water is observed, these areas will be regraded to promote positive drainage and will be reseeded.

2.3.4 Leachate Collection System

The leachate collection system will be inspected monthly. Leachate management will continue throughout the post-closure care period of the site. Inspections will be made monthly to insure the safe operation of the facility and to maintain the collection throughout the post-closure period. Repairs to the system will be completed as necessary to maintain the leachate management system.

2.3.5 Landfill Gas Monitoring System

The landfill gas boundary probes will be inspected quarterly. Any signs of damage will be recorded. Minor damages shall be repaired immediately. If major damage is suspected, a professional geologist will be retained to evaluate the condition of the probe. If the probe must be replaced, the old probe will be abandoned. New probe construction shall be in accordance with the Decomposition Gas Management Plan.

2.3.6 Groundwater Monitoring Wells

Groundwater monitoring wells will be inspected quarterly. Any signs of damage or contamination will be recorded. Minor damages shall be repaired immediately. If major damage or contamination is suspected, a professional geologist will be retained to evaluate the condition of the well. If the well must be replaced, the old well will be abandoned in accordance with the facility's Groundwater Monitoring Plan. New well construction shall be in accordance with the Groundwater Monitoring Plan.

2.4 Inspection Plan

An inspection program will be conducted throughout the post-closure care period for the site. If problems arise, the inspections will be made more frequently and the interval will depend upon the severity of the problem. The potential effect to the public and environment will be a factor in determining the inspection interval.

Areas to be included in the monthly inspection would be as follows:

- Access and security control
- Posting and signs
- Leachate collection and removal system

Areas to be included in the quarterly inspection would be as follows:

- Leachate collection and removal system
- Access and security control
- Posting and signs
- Run-on and run-off controls
- Final cover settlement, subsidence and displacement
- Groundwater monitoring system
- Integrity of site benchmarks

Inspection logs will be developed and completed for each inspection. Copies of the inspections will be kept by Bedroc and available to the NDEP for their review.

2.5 Monitoring Plan

2.5.1 Groundwater Monitoring

Groundwater monitoring will continue at the facility throughout the duration of the post-closure care period in accordance with facility's Groundwater Monitoring Plan.

2.5.2 Landfill Gas Collection and Venting

A landfill gas monitoring program has been developed in accordance with NAC 444.667. Details of the landfill gas monitoring program can be found in the Decomposition Gas Management Plan.

2.6 Post-Closure Land Use

The primary land use expected for the site after the closure of the landfill will be for open dormant land. Any use of the property during or after the period of post-closure must not disturb the integrity of the final cover, liners, any other components of the system for containment or the function of the monitoring system unless necessary to comply with the requirements of NAC 444.570 through 444.7499.

3.0 FINANCIAL ASSURANCE

Detailed estimates of the cost to implement the closure plan (NAC 444.6851) and the cost of operating the post closure program (NAC 444.68515) are attached as Appendix I to this Plan. Bedroc has established a trust fund (included in Appendix II) in accordance with NAC 444.68525. Evidence of completion of the first payment will be provided to NDEP prior to the initial placement of waste in the Class I landfill.

The closure cost estimate is based on 32.3 acres being the largest area of uncapped waste during the entire estimated life of the facility. The post closure care cost estimate is based on the lined acreage in Cell 1. The financial assurance instrument will be revised accordingly prior to the placement of waste in each of the subsequent cells.

Appendix I

Closure and Post-Closure Care Cost Estimates

Opinion of Cost for Financial Assurance

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Facility Name: Bedroc Landfill & WMF
Permit No.:
Facility Address: 2745 North Nellis Boulevard
Las Vegas, NV 89115
Facility Owner: Western Elite, Inc.

Date: 10/23/13
Calculated By: LHB
Reviewed By:
Revision No.: 2 (5/16/14)
Project No.: 383.1401.01
Task No.: 1

CLOSURE COSTS:

I. Native Soil for Slope and Fill (Site Preparation)

			Notes & Guidance Values	
a.	Area to be capped	0.0	acres x 4840 yd2/acre =	0 yd^2
b.	Depth of native soil for slope and fill	0	inches x 1yd/36 inches =	0.00 yd
c.	Quantity of native soil needed		(a x b)	0 yd^3
d.	Percentage of soil from off-site		0	0%
e.	Excavation unit cost (on-site material)		$3.30	$3.30 /$yd^3$
f.	Purchase unit cost (off-site material)		$8.05	$8.05 /$yd^3$
g.	Delivery Cost (off-site material)		$8.35/yd3 for 5 mi RT	$8.35 /$yd^3$
h.	Placement/Spreading unit cost		$1.32	$1.32 /$yd^3$
i.	Compaction unit cost		$0.68	$0.68 /$yd^3$
j.	Total on-site native soil unit cost		(e + h + i)	$5.30 /$yd^3$
k.	Total off-site native soil unit cost		(f + g + h + i)	$18.40 /$yd^3$
l.	Total on-site native soil cost		[j x (1-d) x c]	$0
m.	Total off-site native soil cost		(c x d x k)	$0
n.	Percent compaction		20	20%
o.	*Total native soil cost*		(l + m * (1 + n))	**$0.00**

II. Topsoil

a.	Area to be capped	0.0	acres x 4840 yd2/acre =	0 yd^2
b.	Depth of topsoil needed	0	inches x 1yd/36 inches =	0.00 yd
c.	Quantity of topsoil needed		(a x b)	0 yd^3
d.	Percentage of soil from off-site		0	0%
e.	Excavation unit cost (on-site material)		$1.50	$1.50 /$yd^3$
f.	Purchase unit cost (off-site material)		$0.00	$0.00 /$yd^3$
g.	Delivery Cost (off-site material)		$0/yd3 for 5 mi RT	$0.00 /$yd^3$
h.	Placement/Spreading unit cost		$1.00	$1.00 /$yd^3$
i.	Compaction unit cost		$0.00	$0.00 /$yd^3$
j.	Total on-site topsoil unit cost		(e + h + i)	$2.50 /$yd^3$
k.	Total off-site topsoil unit cost		(f + g + h + i)	$1.00 /$yd^3$
l.	Total on-site topsoil cost		[j x (1-d) x c]	$0
m.	Total off-site topsoil cost		(c x d x k)	$0
n.	Percent compaction		0	0%
o.	*Total topsoil cost*		(l + m * (1 + n))	**$0.00**

III. Drainage Layer

a.	Area to be capped	0.0	acres x 4840 yd2/acre =	0 yd^2
b.	Depth of sand or gravel needed	0	inches x 1yd/36 inches =	0.00 yd
c.	Quantity of sand or gravel needed		(a x b)	0 yd^3
d.	Purchase unit cost		$8.90	$8.90 /$yd^3$
e.	Delivery cost (for off-site material)		$8.25/yd3 for 10 mi RT	$8.25 /$yd^3$
f.	Spreading unit cost		$1.32	$1.32 /$yd^3$
g.	Compaction unit cost		$0.49	$0.49 /$yd^3$
h.	Percent compaction		sand = 10%, gravel = 5%	10 %
i.	Total drainage layer unit cost		(d + e + f + g)	$18.96 /$yd^3$
j.	*Total drainage layer cost*		[c x i x (1+h)]	**$0.00**

IV. On-Site Clay

a.	Area to be capped	0.0	acres x 4840 yd2/acre =	0 yd^2
b.	Depth of clay needed	0	inches x 1yd/36 inches =	0.00 yd
c.	Quantity of clay needed		(a x b)	0 yd^3
d.	Excavation unit cost		$5.30	$5.30 /$yd^3$
e.	Placement/Spreading unit cost		$1.32	$1.32 /$yd^3$
f.	Compaction unit cost		$0.91	$0.91 /$yd^3$
g.	Total on-site clay unit cost		(d + e + f + g)	$7.53 /$yd^3$
h.	Percent compaction		25%	25 %
i.	*Total on-site clay cost*		[c x g x (1 + h)]	**$0.00**

V. Off-Site Clay

a.	Area to be capped (1acre=4840yd²)	0.0	acres x 4840 yd2/acre =	0 yd^2
b.	Depth of clay needed (6" = 0.16 yd)	0	inches x 1yd/36 inches =	0.00 yd
c.	Quantity of clay needed (a x b)		(a x b)	0 yd^3
d.	Purchase unit cost		$6.35	$6.35 /$yd^3$
e.	Delivery cost (for off site material)		$8.25/yd3 for 10 mi RT	$8.25 /$yd^3$
f.	Spreading unit cost		$1.32	$1.32 /$yd^3$
g.	Compaction unit cost		$0.91	$0.91 /$yd^3$
h.	Total off-site clay unit cost		(d + e + f + g)	$16.83 /$yd^3$
i.	Percent compaction		25%	25 %
j.	*Total on-site clay cost*		[c x h x (1 + i)]	**$0.00**

VI. Drainage Tile

a.	Length of drainage tile needed		LF	0 LF
b.	Tile unit cost		$0.50	$0.50 /LF
c.	Trenching and backfilling cost		$0.56	$0.56 /LF
d.	Total drainage tile unit cost		(b + c)	$1.06 /LF
e.	*Total drainage tile cost*		(a x d)	**$0.00**

VII. Synthetic Membrane

a.	Area to be capped with FML	32.3	acres x 43560 ft2/acre =	1,406,988 ft^2
b.	Purchase unit cost		$0.16	$0.16 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.10	$0.10 /$ft^2$
e.	Total synthetic membrane unit cost		(b + c + d)	$0.26 /$ft^2$
f.	*Total synthetic membrane cost*		(a x e)	**$365,816.88**

VIII. Geotextile Filter Fabric

a.	Quantity of filter fabric needed	0.0	acres x 43560 ft2/acre =	0 ft^2
b.	Purchase unit cost		$0.08	$0.08 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.02	$0.02 /$ft^2$
e.	Total synthetic membrane unit cost		(b + c + d)	$0.10 /$ft^2$
f.	*Total synthetic membrane cost*		(a x e)	**$0.00**

Notes:
Guidance values attained from DEQ and Means 2001 Cost Data
Material Costs for Geosynthetics include Delivery

Material Cost List

	Material (per ft²)	Installation (per ft²)
Synthetic Membrane		
60 mil HDPE	$0.22	$0.10
40 mil LLDPE	$0.16	$0.10
30 mil PVC	$0.18	$0.06
Geonet Composite		
6 oz	$0.27	$0.06
8 oz	$0.31	$0.06
Geosynthetic Clay Liner		
Type I (Regular)	$0.23	$0.09
Type II (Reinforced)	$0.27	$0.09

VIII-a. Geonet Composite

			Notes & Guidance Values	
a.	Quantity of Geonet Composite needed	64.6	acres x 43560 ft2/acre =	2,813,976 ft^2
b.	Purchase unit cost		$0.27	$0.27 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.06	$0.06 /$ft^2$
e.	Total synthetic membrane unit cost		(b + c + d)	$0.33 /$ft^2$
f.	*Total synthetic membrane cost*		(a x e)	**$928,612.08**

VIII-b. Geosynthetic Clay Liner

a.	Quantity of Geonet Composite needed	0.0	acres x 43560 ft2/acre =	0 ft^2
b.	Purchase unit cost		$0.23	$0.23 /$ft^2$
c.	Delivery unit cost		$0.00	$0.00 /$ft^2$
d.	Installation unit cost		$0.09	$0.09 /$ft^2$
e.	Total synthetic membrane unit cost		(b + c + d)	$0.32 /$ft^2$
f.	*Total synthetic membrane cost*		(a x e)	**$0.00**

IX. Soil Admixture

a.	Area to be capped	0.0	acres x 4840 yd2/acre =	0 yd^2
b.	Soil admixture unit cost		$2.66	$2.66 /$yd^3$
c.	*Total soil admixture cost*		(a x b)	**$0.00**

X. Protective Soil Cover

a.	Area to be capped	32.3	acres x 4840 yd2/acre =	156,332 yd^2
b.	Depth of soil needed	24	inches x 1yd/36 inches =	0.67 yd
c.	Quantity of soil needed		(a x b)	104,221 yd^3
d.	Percentage of soil from off-site		0	0%
e.	Excavation unit cost (on-site material)		$0.75	$0.75 /$yd^3$
f.	Purchase unit cost (off-site material)		$0.00	$0.00 /$yd^3$
g.	Delivery Cost (off-site material)		$0/yd3 for 5 mi RT	$0.00 /$yd^3$
h.	Placement/Spreading unit cost		$0.75	$0.75 /$yd^3$
i.	Compaction unit cost		$0.00	$0.00 /$yd^3$
j.	Total on-site soil unit cost		(e + h + i)	$1.50 /$yd^3$
k.	Total off-site soil unit cost		(f + g + h + i)	$0.75 /$yd^3$
l.	Total on-site soil cost		[j x (1-d) x c]	$156,332
m.	Total off-site soil cost		(c x d x k)	$0
n.	Percent compaction		0	0%
o.	*Total protective soil cover cost*		(l + m * (1 + n))	**$156,332.00**

XI. Soil Testing

a.	Number of acres to be capped		0.0	0.0 acres
b.	Testing unit cost (Includes density & permeability tests and technician)		$2,266	$2,266 /acre
c.	*Total Soil Testing Unit Cost*		(a x b)	**$0.00**

XII. Vegetative Cover

a.	Number of acres to be vegetated		33.1	33.1 acres
b.	Unit cost for prep, seed, and fert.		$600	$600 /acre
c.	*Total Vegetative Cover Cost*		(a x b)	**$19,860.00**

XIII. Landfill Gas (LFG) Management System

a.	Number of acres of landfill to be closed		33.1	33.1 acres
b.	Number of LFG detection probes to be installed		(every 500' around cell)	0 probes
c.	Average number of LFG vents required per acre		1	1 /acre
d.	Length of LFG detection probe in linear feet		0	0 LF
e.	Average cost per LFG vent		$2,500.00	$2,500 /vent
f.	LFG detection probe unit cost		$40.00	$40.00 /LF
g.	Total cost for LFG vents		(a x c x e)	$82,750
h.	Total cost for LFG detection probes		(b x d x f)	$0
i.	*Total gas management cost*		(g + h)	**$82,750.00**

XIV. Groundwater monitoring system

a.	Hydrogeologic study		$10,000 or as needed	$0
b.	Monitoring well construction/well		$1,225 per well	$1,225.00 /well
c.	Number of wells to be installed		minimum of 4	0 wells
d.	Additional well length of 50'		0	0 LF
e.	Unit cost for additional well length over 50'		$22.00	$22.00 /LF
f.	Total additional cost for well length over 50'		(c x d)	$0
g.	Total monitoring well construction cost		(b x c)	$0
h.	*Total Groundwater monitoring system cost*		(a + c + f)	**$0.00**

XV. Mobilization/demobilization

a.	*Cost for mobilization/demobilization*		$15,000 or as needed	**$15,000.00**

XVI. Survey and deed notation

a.	*Cost for survey and deed notation*		$2,000 or as needed	**$2,000.00**

XVII. Closure Certification

a.	*Closure certification costs*		$2,000 or as needed	**$2,000.00**

XVIII. Miscellaneous Costs to Close

a.	*Erosion Control*	**$5,000.00**
b.	*Storm Water Control*	**$5,000.00**
c.	*Removal of Leachate Ponds*	**$10,000.00**
d.	*Characterization of Leachate Pond Residue*	**$5,000.00**

Total Construction Closure Costs

Total Unadjusted Closure Costs	**$1,553,370.96**
City Cost Index (CCI)	105.0 Las Vegas
Total Adjusted Closure Costs CCI x (I..XIV)	**$1,631,039.51**
Closure Cost-Estimate Subtotal (Total adj. closure costs +XV + XVI + XVII + XVIII)	**$1,660,233**
Contingency (10%)	$166,023
Engineering Fees	
Construction Documents	$30,000
Construction Quality Assurance	$100,000
Total Closure Cost	**$1,956,256**
Total Area to be capped	32.3 acres
Approximate closure cost per acre	$60,565 /acre

Opinion of Cost for Financial Assurance

JOYCE ENGINEERING

1604 Ownby Lane
Richmond, Virginia 23220
phone - 804.355.4520
fax - 804.355.4282
www.joyceengineering.com

Facility Name: Bedroc Landfill & WMF
Permit No.:
Facility Address: 2745 North Nellis Boulevard
Las Vegas, NV 89115
Facility Owner: Western Elite, Inc.

Date: 10/23/13
Calculated By: LBB
Reviewed By:
Revision No.: 2 (5/16/14)
Project No.: 383.1401.01
Task No.: 1

POST CLOSURE COSTS:

		Notes & Guidance Values		
I. Groundwater Monitoring				
a.	Total number of monitoring wells	5	5	wells
b.	Number of sampling events per year	2 sampling events per year	2	events
c.	Monitoring costs per sample	$1,500	$1,500	/sample
d.	Miscellaneous Engineering Fees	$10,000 or as required	$10,000	/year
e.	*Total annual monitoring costs*	[(a x b x c) + d]	*$25,000*	*/year*
f.	Post-closure period	30	30	years
g.	*Total cost for post-closure period*	(e x f)	***$750,000.00***	
II. Landfill Gas Monitoring				
a.	Frequency of testing	(4 rounds per year)	4	events/year
b.	Number of LFG monitoring probes installed	4	4	probes
c.	Cost of sampling per probe	$35.00	$35.00	/round
d.	*Total LFG Monitoring unit cost per year*	(a x c)	*$560.00*	*/year*
e.	Post-closure period	30	30	years
f.	*Total cost for post-closure period*	(d x e)	***$16,800.00***	
III. Leachate Management				
a	Private disposal unit cost	$0.10	$0.10	/gal
b.	POTW disposal unit cost	$0.04	$0.04	/gal
c	Direct discharge to a POTW unit cost	$0.02 per gal or POTW charge	$0.02	/gal
d.	Amount of leachate generated (varies per landfill)	0	3,650	gal/yr
e.	Load/unload unit cost	$150	$150.00	/truck
f.	Capacity of truck	5,500	5,500	gallons
g.	Number of trucks required per year	(d ÷ f)	1	trucks/year
h.	Distance over 5 miles of hauling (one way)	0	0	miles
i.	Cost of hauling per mile	$1.25	$1.25	/mile
j.	Total cost for loading / unloading and hauling	[(e x g) + (h x i)]	$99.55	/year
k.	Total annual cost for Private Disposal	(a x d)	$365.00	/year
l.	Total annual cost for POTW Disposal (delivered)	[(b x d) + j]	$245.55	/year
m.	Total annual cost for POTW Disposal (direct)	(c x d)	$86	/year
n.	*Total leachate management cost*	(k or l or m)	*$245.55*	*/year*
o.	Post-closure period	30	30	years
p.	*Total cost for post-closure period*	(n x o)	***$7,366.36***	
IV. Routine Maintenance and Repairs				
a.	Maintenance frequency	1	1	visits/year
b.	Area to be maintained (acres)	10.8	10.8	acres
c.	Maintenance unit cost per visit	$600	$600	/acre/visit
d.	*Total maintenance and repairs cost per year*	(a x b x c)	*$6,480.00*	*/year*
e.	Post-closure period	30	30	years
f.	*Total cost for post-closure period*	(d x e)	***$194,400***	
V. Vector and Rodent Control				
a.	*Total vector and rodent control costs per year*	$2,000 or as required	*$500.00*	*/year*
b.	Post-closure period	30	30	years
c.	*Total cost for post-closure period*	(a x b)	***$15,000***	

Total Post-Closure Costs

Total Unadjusted Post-Closure Costs	$983,566.36
City Cost Index (CCI)	105 Las Vegas
Total Adjusted Post-Closure Costs CCI x (I.-V)	*$1,012,744.68*
Contingency (10%)	$103,274.47
Total Post-Closure Cost-Estimate	***$1,136,019***

Overall Total Costs

Total Post-Closure Cost-Estimate		*1,136,019.15*
Total Closure Cost-Estimate (From previous page)		*1,956,256.00*
TOTAL CLOSURE & POST-CLOSURE COST ESTIMATE =		$3,092,375.15
FY 2006 (adjusted by Implicit GDP Deflator)	1.028	$3,178,858.85
FY 2007 (adjusted by Implicit GDP Deflator)	1.029	$3,271,045.76
FY 2008 (adjusted by Implicit GDP Deflator)	1.024	$3,349,550.86
FY 2009 (adjusted by Implicit GDP Deflator)	1.025	$3,433,289.63
FY 2010 (adjusted by Implicit GDP Deflator)	1.017	$3,492,342.21
FY 2011 (adjusted by Implicit GDP Deflator)	1.017	$3,552,410.50
FY 2012 (adjusted by Implicit GDP Deflator)	1.024	$3,637,668.35
FY 2013 (adjusted by Implicit GDP Deflator)	1.017	$3,699,508.71

Appendix II

Trust Agreement

Preferred
Trust Company, LLC

May 15, 2014

To Whom It May Concern:

The trust fund, Bedroc Limited, LLC Fund FBO Nevada Division of Environmental Protection, was established on Mat 12th, 2014. Preferred Trust Company confirms that the fund is open and readily available for use by Bedroc Limited, LLC.

Should any questions arise, please contact Preferred Trust Company directly.

Thank you,

Nicole Weis
Senior Client Service Agent
Preferred Trust Company
P: 888-990-7892
F: 702-946-0136
nweis@ptcemail.com
www.preferredtrustcompany.com

2471 W. Horizon Ridge Parkway, Suite 100
Henderson, Nevada 89052
P. 702.990.7892
877.990.7892
F. 702.946.0136
W. preferredtrustcompany.com

TRUST AGREEMENT

Trust agreement, the "Agreement," entered into as of ______________ by and between Bedroc Limited, LLC, a Nevada corporation, the "Grantor," and Preferred Trust Company, LLC, the "Trustee."

Whereas, the Nevada State Environmental Commission has established certain regulations applicable to the Grantor, requiring that the owner or operator of a solid waste facility must provide assurance that funds will be available when needed for closure, and post-closure care, of the facility,

Whereas, the Grantor has elected to establish a trust to provide all such financial assurance for the facility identified herein,

Whereas, the Grantor, acting through its duly authorized officers, has selected the Trustee to be the trustee under this agreement, and the Trustee is willing to act as trustee,

Now, therefore, the Grantor and the Trustee agree as follows:

Section 1. Definitions. As used in this Agreement:

A. The term "fiduciary" means any person who exercises any power of control, management, or disposition or renders investment advice for a fee or other compensation, direct or indirect, with respect to any moneys or other property of this trust fund, or has any authority or responsibility to do so, or who has any authority or responsibility in the administration of this trust fund.

B. The term "Grantor" means the owner or operator who enters into this Agreement and any successors or assigns of the Grantor.

C. The term "Trustee" means the Trustee who enters into this Agreement and any successor Trustee.

Section 2. Identification of Facility and Cost Estimates. This Agreement pertains to the facility and cost estimates identified on attached Schedule A.

Section 3. Establishment of Fund. The Grantor and the Trustee hereby establish a trust fund, the "Fund," for the benefit of the Nevada Division of Environmental Protection. The Grantor and the Trustee intend that no third party have access to the Fund except as herein provided. The Fund is established initially as property consisting of cash or securities, which are acceptable to the Trustee. Such property and any other property subsequently transferred to the Trustee is referred to as the fund, together with all earnings and profits thereon, less any payments or distributions made by the Trustee pursuant to this Agreement. The Fund will be held by the Trustee, IN TRUST, as hereinafter provided. The Trustee undertakes no responsibility for the amount or adequacy of, nor any duty to collect from the Grantor, any payments to discharge any liabilities of the Grantor established by the Nevada Division of Environmental Protection.

Section 4. Payment for (Closure, Post-Closure Care, or Corrective Action). The Trustee will make such payments from the Fund as the Nevada Division of Environmental Protection, in writing, to provide for the payment of the costs of closure and post-closure care of the facility covered by this Agreement. The Trustee will reimburse the Grantor or other persons as specified by the Nevada Division of Environmental Protection, from the Fund for closure and post-closure care expenditures in such amounts as the Division of Environmental Protection will direct, in writing. In addition, the Trustee will refund to the Grantor such amounts as the Division of Environmental Protection specifies in writing. Upon refund, such funds will no longer constitute part of the Fund as defined herein.

Section 5. Payments Comprising the Fund. Payments made to the Trustee for the fund will consist of cash or securities acceptable to the Trustee.

Section 6. Trustee Management. The Trustee will invest and reinvest the principal and income of the Fund and keep the Fund invested as a single fund, without distinction between principal and income, in accordance with investment guidelines and objectives communicated in writing to the Trustee from time to time by the Grantor, subject, however, to the provisions of this Section. In investing, reinvesting, exchanging, selling and managing the Fund, the Trustee or any other fiduciary will discharge his duties with respect to the trust fund solely in the interest of the beneficiary and with the care, skill, prudence, and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of any enterprise of a like character and with like aims; except that:

A. Securities or other obligations of the Grantor, or any other owner or operator of the facility, or any of their affiliates as defined in the Investment Company Act of 1940, as amended, 15 USC §80a-2(a), will not be acquired or held, unless they are securities or other obligations of the federal or a state government;

B. The Trustee is authorized to invest the Fund in time or demand deposits of the Trustee, to the extent insured by an agency of the federal or state government; and

C. The Trustee is authorized to hold cash awaiting investment or distribution uninvested for a reasonable time and without liability for the payment of interest thereon.

Section 7. Commingling and Investment. The Trustee is expressly authorized in its discretion:

A. To transfer from time to time any or all of the assets of the Fund to any common, commingled or collective trust fund created by the Trustee in which the Fund is eligible to participate subject to all of the provisions thereof, to be commingled with the assets of other trusts participating herein. To the extent of the equitable share of the Fund in any such commingled trust, such commingled trust will be part of the Fund; and

B. To purchase shares in any investment company registered under the Investment Company Act of 1940, 15 USC §80a-1 et seq., of one which may be created, managed, underwritten, or to which investment advice is rendered or the shares of which are sold by the Trustee. The Trustees may vote such shares in its discretion.

Section 8. Express Powers of Trustee. Without in any way limiting the powers and discretions conferred upon the Trustee by the other provisions of this Agreement or by law, the Trustee is expressly authorized and empowered:

A. To sell, exchange, convey, transfer or otherwise dispose of any property held by it, by private contract or at public auction. No person dealing with the Trustee will be bound to see to the application of the purchase money or to inquire into the validity or expediency of any such sale or other dispositions;

B. To make, execute, acknowledge and deliver any and all documents of transfer and conveyance and any and all other instruments that may be necessary or appropriate to carry out the powers herein granted;

C. To register any securities held in the fund in its own name or in the name of a nominee and to hold any security in bearer form or in book entry, or to combine certificates representing such securities with certificates of the same issue held by the Trustee in other fiduciary capacities, or to deposit or arrange for the deposit of such securities in a qualified central depository even though, when so deposited, such securities may be merged and held in bulk in the name of the nominee of such depository with other securities deposited therein by another person, or to deposit or arrange for the deposit of any securities issued by the United State government, or any agency or instrumentality thereof with a Federal Reserve Bank, but the books and records of the Trustee will at all times show that all such securities are part of the Fund;

D. To deposit any cash in the fund in interest-bearing accounts maintained or savings certificates issued by the Trustee, in its separate corporate capacity, or in any other banking institution affiliated with the Trustee, to the extent insured by an agency of the Federal or State government; and

E. To compromise or otherwise adjust all claims in favor of or against the Fund.

Section 9. Taxes and Expenses. All taxes of any kind that may be assessed or levied against or in respect of the Fund and all brokerage commissions incurred by the Fund will be paid from the Fund. All other expenses incurred by the Trustee in connection with the administration of this Trust, including fees for legal services rendered to the Trustee, the compensation of the Trustee to the extent not paid directly by the Grantor, and all other proper charges and disbursements of the Trustee will be paid from the Fund.

Section 10. Annual Valuation. The Trustee will annually, at the end of the month coincident with or preceding the anniversary date of establishment of the Fund, furnish the Grantor and to the Administrator of the Nevada Division of Environmental Protection, a statement confirming the value of the Trust. Any securities in the Fund will be valued at market value as of no more than 30 days prior to the date of the statement. The failure of the Grantor to object in writing to the Trustee within 90 days after the statement has been furnished to the Grantor and the Administrator of the Nevada Division of Environmental Protection, will constitute a conclusively binding assent by the Grantor, barring the Grantor from asserting any claim or liability against the Trustee with respect to matters disclosed in the statement.

Section 11. Advice of Counsel. The Trustee may from time to time consult with counsel, who may be counsel to the Grantor, with respect to any question arising as to the construction of this Agreement or any action to be taken hereunder. The Trustee will be fully protected, to the extent permitted by law, in acting upon the advice of counsel.

Section 12. Trustee Compensation. The Trustee will be entitled to reasonable compensation for its services as agreed upon in writing from time to time with the Grantor.

Section 13. Successor Trustee. The Trustee may resign or the Grantor may replace the Trustee, but such resignation or replacement shall not be effective until the Grantor has appointed a successor trustee and this successor accepts the appointment. The successor trustee shall have the same powers and duties as those conferred upon the Trustee hereunder. Upon acceptance of the appointment by the successor trustee, the Trustee will assign, transfer and pay over to the successor trustee the funds and properties then constituting the Fund. If for any reason the grantor cannot or does not act in the event of the resignation of the Trustee, the Trustee may apply to a court of competent jurisdiction for the appointment of a successor trustee or for instructions. The successor trustee and the date on which he assumes administration of the trust will be specified in writing and sent to the Grantor, the Administrator of the Nevada Division of Environmental Protection, and the present trustees by certified mail 10 days before such change becomes effective. Any expenses incurred by the Trustee as a result of any of the acts contemplated by this section will be paid as provided in Part IX.

Section 14. Instructions to the Trustee. All orders, requests and instructions by the Grantor to the Trustee will be in writing, signed by such persons as are designated in the attached Exhibit A or such other designees as the grantor may designate by amendment to Exhibit A. The Trustee will be fully protected in acting without inquiry in accordance with the Grantor's orders, requests and instructions. All orders, requests, and instructions by the Administrator of the Nevada Division of Environmental Protection, to the Trustee will be in writing, signed by the Administrator and the Trustee will act and will be fully protected in acting in accordance with such orders, requests and instructions. The Trustee will have the right to assume, in the absence of written notice to the contrary, that no event constituting a change or a termination of the authority of any person to act on behalf of the Grantor or the Nevada Division of Environmental Protection hereunder has occurred. The Trustee will have no duty to act in the absence of such orders, requests and instructions from the Grantor and/or the Nevada Division of Environmental Protection, except as provided for herein.

Section 15. Notice of Nonpayment. The Trustee will notify the Grantor and the Administrator of the Nevada Division of Environmental Protection, by certified mail within 10 days following the expiration of the 30-day period after the anniversary of the establishment of the Trust, if no payment is received from the Grantor during that period. After the pay-in period is completed, the Trustee is not required to send a notice of nonpayment.

Section 16. Amendment of Agreement. This Agreement may be amended by an instrument in writing executed by the Grantor, the Trustee, and the Administrator of the Nevada Division of Environmental Protection, or by the Trustee and the Administrator of the Nevada Division of Environmental Protection, if the Grantor ceases to exist.

Section 17. Irrevocability and Termination. Subject to the right of the parties to amend this Agreement as provided in Section 16, this Trust will be irrevocable and will continue until terminated at the written agreement of the Grantor, the Trustee, and the Administrator of the Nevada Division of Environmental Protection, or by the Trustee and the Administrator if the Grantor ceases to exist. Upon termination of the Trust, all remaining trust property, less final trust administration expenses, will be delivered to the Grantor.

Section 18. Immunity and Indemnification. The Trustee will not incur personal liability of any nature in connection with any act or omission, made in good faith, in the administration of this Trust, or in carrying out any directions by the Grantor or the Administrator of the Nevada Division of Environmental Protection, issued in accordance with this Agreement. The Trustee will be indemnified and saved harmless by the Grantor or from the Trust Fund, or both, from and against any personal liability to which the Trustee may be subjected by reason of any act or conduct in its official capacity, including all expenses reasonably incurred in its defense in the event the Grantor fails to provide such defense.

Section 19. Choice of Law. This Agreement will be administered, construed and enforced according to the laws of Nevada.

Section 20. Interpretation. As used in the Agreement, words in the singular include the plural and words in the plural include the singular. The descriptive headings for each section of this Agreement will not affect the interpretation of the legal efficacy of this Agreement.

In witness whereof the parties have caused this Agreement to be executed by their respective officers duly authorized.

Ryan Williams

By: Ryan Williams
Title: President, Western Elite, Inc.
Date:

Attest:
Title:
Date: 5.15.14

Signature of Trustee
By: Kurt Weinrich
Title: President, Preferred Trust Company, LLC
Date: 5.15.14

Appendix H

PREPARED FOR:

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY

BEAUTIFICATION PLAN

OCTOBER 2013
REVISED MAY 2014

PROFESSIONAL ENGINEER · STATE OF NEVADA
LEONARD E. JOYCE, JR.
CIVIL
No. 13870

5/19/14

PREPARED BY:

JOYCE ENGINEERING
1604 OWNBY LANE
RICHMOND, VIRGINIA 23220
PHONE: (804) 355-4520
FAX: (804) 355-4282
JOYCE PROJECT NO. 00383.1401.01.01

Beautification Plan
Bedroc Landfill and Waste Management Facility
Lincoln County, Nevada

1.0 GENERAL

NAC 444.678 requires that Class I disposal sites be located at least one-fourth mile from the nearest inhabited domestic dwelling or place of public gathering or 1,000 feet from a public highway, unless special provisions for the beautification of the site and the control of litter and vectors are included in the design and approved by the solid waste management authority.

The site of the Bedroc Landfill and Waste Management Facility is located in excess of ¼ miles from the nearest inhabited dwelling and place of public gathering. However, because the proposed boundary of the facility falls within the 1,000 foot setback from U.S. Highway 93, the facility has prepared this plan to address the activities to provide visual screening of landfill activities from the general public.

2.0 PERIMETER BERM

Initial lifts of waste will be placed on the cell floor. As the base grades are below the surrounding ground surface, initial waste placement activities will be screened from U.S. Highway 93. To provide visual screening of landfill operations from U.S. Highway 93, perimeter berms will be constructed in advance of waste placement activities. The perimeter berms will be constructed on the northern, eastern and southern slopes of the landfill when disposal activities are within 1,000 feet from Highway 93. As necessary, the berms will be extended laterally beyond the waste limits to prevent the working face from being visible from the highway. These berms, approximately 10-15 feet in height will consist of soil material. As the waste surface reaches an elevation 5 feet below the surrounding ground surface, the initial perimeter berm will be constructed. As the surface of the waste increases in height, berms will be constructed in advance of disposal activities, so that at all times waste placement activities will be screened by the berms.

3.0 FINAL SLOPES

To blend in with the natural topography, the final shape of the landfill will be comprised of varying slopes on the sides and the top. Cross-slope drainage channels, formed in the side slopes as waste placement progresses, will provide variation in the side slopes. The top of the landfill, as well as the corners, will be rounded to minimize the rectilinear appearance. Storm water collected by the side slope channels will flow to riprap channels on the eastern and western sides of the landfill.

Native plant species in addition to native gravels will be used on the final slopes. The final surface and appearance should have variation. "Green" vegetation is not desirable because it will not blend with the native vegetation. Trees will not be planted as they would provide no screening benefit and would not be typical of the natural vegetation. Boulders will be placed, in groups and alone, at random locations on the northern, eastern and southern side slopes visible to U.S. Highway 93.

4.0 LITTER CONTROL

Litter at the site is controlled by several measures. Vehicles transporting waste are required to have their loads adequately covered in accordance with all transportation regulations. Once the waste is unloaded in the disposal area, it is compacted by heavy equipment and covered to prevent free blowing litter. Blowing litter is controlled through a series of either fences and/or dirt berms. Litter control fences and berms will be cleaned at least weekly and by patrolling daily. The site perimeter will be inspected daily and scattered litter will be returned to the working area. Additional litter control fences may be constructed and placed in strategic locations around the working face to capture wind-blown material. The perimeter berms will also serve to capture and contain wind blow debris from the landfill. During extremely windy conditions, all activities that could lead to blowing litter will be curtailed.

5.0 VECTOR CONTROL

An effective vector control plan involves preventing vectors from living and becoming established on the landfill by not providing sources of food, water, and/or shelter. The most important measures taken at the facility to minimized vector problems is prompt placement, compaction, cover and intermediate cover of all exposed waste. Slopes will be graded to a minimum of 3% for drainage purposes to prevent ponding of water. Waste accepted at the landfill such as dead animals and other highly putrescible wastes will be placed in a separate trench or area and covered immediately.

If vectors become a nuisance, additional measures will be taken to correct the problem. These measures may include the services of a pest control contractor who will be responsible to select the appropriate control measure(s) for the specific type of vector creating the nuisance.

Appendix I

SITE CHARACTERIZATION REPORT
PROPOSED CLASS I DISPOSAL FACILITY
BEDROC LIMITED LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

October 17, 2013
Project No. 20133247V1

GES

Prepared For:
Bedroc Limited, LLC.
2745 N. Nellis Boulevard
Las Vegas, NV 89115

Prepared By:
Geotechnical & Environmental Services, Inc.
7150 Placid Street
Las Vegas, Nevada 89119

TABLE OF CONTENTS

SITE CHARACTERIZATION REPORT
PROPOSED CLASS I DISPOSAL FACILITY
BEDROC LIMITED LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

EXECUTIVE SUMMARY

This report presents the results of a Site Characterization Investigation for the proposed landfill located in Coyote Spring Valley adjacent to Route 93, approximately 65 miles north of Las Vegas in Lincoln County, Nevada (Figure 1). It is GES' understanding that the proposed facility is approximately 140 acres and is located north of the current 80-acre facility (Figure 2). This report was prepared to comply with the NAC requirements as a supplement to the original *Site Characterization Report – Class III Disposal Facility* prepared by Joyce Engineering, Inc. (Joyce Engineering) prepared in 2004. For the purposes of permitting, and with technical guidance from NDEP, it was GES' scope to provide an evaluation of the proposed Class I landfill's geologic and hydrologic consistency as compared with the initial investigation for the adjacent Class III facility such that it would enable the extension the original characterization to include the proposed Class I disposal facility to the north.

It was observed in the proposed area that the soils encountered were consistent with the previously characterized soils to the south with soils ranging from poor to well sorted sand and gravel of alluvial origin to lacustrine fine silty sand grading to silty clay. Generally the lacustrine deposits are weakly consolidated and the alluvial deposits are unconsolidated to weakly cemented. Bed thicknesses vary across the site, due to the nature of geologic and hydrologic processes by which the sediments were deposited, and are likely to be laterally discontinuous.

Static water level data obtained from the monitoring wells indicate that the water table in the uppermost aquifer beneath the area of proposed Class I landfill is present at a depth of 50 to 80 feet below existing grade, depending on the topographic elevation.

SITE CHARACTERIZATION REPORT
PROPOSED CLASS I DISPOSAL FACILITY
BEDROC LIMITED LANDFILL AND WASTE MANAGEMENT FACILITY
LINCOLN COUNTY, NEVADA

1.0 INTRODUCTION

Bedroc Limited, LLC. (Bedroc Limited) proposes to operate a Class I Municipal Solid Waste Landfill for the disposal of waste residue derived from residential waste streams. The proposed 140-acre facility is located in the Coyote Spring Valley adjacent to State Route 93, approximately 65 miles north of Las Vegas (Figure 1). A site map is presented as Figure 2 showing features of the site and surrounding area.

This *Site Characterization Report* has been prepared pursuant to the Nevada Administrative Code (NAC) 444.681.2a to document the geologic and hydrogeologic conditions specific to the terrain underlying the proposed facility.

1.1 Project and Site Description

The cells for the permitted Class III disposal facility are currently permitted in Lot 5 and Lot 11. The proposed Class I disposal facility will be constructed in phases in all or portions of lots 6, 7, 8, 12, 13, and 14 (see Figure 2).

1.2 Report Preparation and Format

This report was prepared by Geotechnical & Environmental Services, and is being submitted on behalf of Bedroc Limited to satisfy the requirements of NAC 444.681.2a. The investigation was led by Mr. Kyle S. Hansen, Project Geologist who directed the field work used to prepare this report. Mr. Hansen has been a practicing Geologist for over twenty-five years, has a Bachelor of Science degree in Geology from Brigham Young University, and a Master of Science degree in Geology from Iowa State University. Mr. Hansen is a Certified Environmental Manager in the state of Nevada (#2167) and is a qualified groundwater scientist.

The investigation was performed under the responsible charge of Mr. Gregory P. DeSart, Principle Engineer who directed the conceptual and technical efforts of the investigation. Mr. DeSart is a Professional Civil Engineer, Nevada Certified Environmental Manager with a B.S. degree in Geologic Engineering from University of Nevada Reno. Mr. DeSart has over twenty-six years of experience with a variety of geotechnical and environmental projects throughout Nevada.

2.0 SITE CHARACTERIZATION

This report was prepared to comply with the NAC requirements as an addendum to the original *Site Characterization Report – Class III Disposal Facility* prepared by Joyce Engineering, Inc. (Joyce Engineering) prepared in 2004. For the purposes of permitting, and with technical guidance from NDEP, it was GES' scope to provide an evaluation of the proposed Class I landfill geologic and hydrologic consistency as compared with the initial investigation for the adjacent Class III facility such that it would enable the extension the original characterization to include the additional acreage of the proposed Class I facility to the north.

2.1 Investigative Methods

As presented in Figure 2, the proposed facility covers approximately 140 acres. The site characterization area extends between 100 to 200 feet beyond the approximate limits of the proposed liner, as established in personal conversations with Joyce Engineering, on their preliminary design area. Based on discussions with NDEP, Joyce Engineering, and Bedroc Limited personnel, 7 soil borings were located in the study area to identify and characterize the subsurface geologic and hydrologic conditions as part of this investigation.

2.2 Soil Borings

GES installed the 7 soil borings in the site characterization area (Figure 2) to depths ranging from 75 to 95 feet using Hollow Stem Auger techniques in order to document the soil properties using the Unified Soil Classification System and evaluate the groundwater levels in the proposed landfill area. Discrete soil samples were taken on five foot intervals using a ring-lined barrel sampler in order to provide material to log for size, lithology, grain characteristics, color, and mineralogy.

2.3 Monitoring Wells

The soil borings were converted into groundwater monitoring wells (completed to approximately 15 feet into the water table) to provide site specific data and refine our understanding of the spatial variations in the natural groundwater elevations. The monitoring well locations were positioned to provide data for characterization and possible future ongoing water quality monitoring points during and after landfill operation.

Monitoring well screens were constructed with 20 feet of 2-inch schedule 80 PVC with 0.020-inch factory slotted screen placed approximately 15 feet into the saturated zone. The remaining well configuration was constructed with 2-inch ID schedule 80 PVC well casing. Each well head was completed with a locking protective casing standpipe with a cement surface pad that is sloped away from the protective casing.

A filter pack, consisting of silica sand, was placed in the annular space surrounding the screened interval in each well to a depth of approximately 2 feet above the screened interval. A 2-foot thick (minimum) filter pack seal, consisting of hydrated granular bentonite, was then placed in the annular space of each borehole on top of the filter pack as required by NAC 534.4371. The remaining interval of the annular space was grouted with neat cement to grade, pursuant to NAC 534.380. Well construction details are summarized on the boring logs in Appendix A.

Following the completion of drilling activities, the locations and elevations of the monitoring wells were surveyed on September 3, 2013 using a Trimble R8 survey unit and water level elevations were recorded from the top of the PVC well casing to within 0.01 feet using an electronic water level indicator. Table 1 below is a summary of the survey data:

Table 1. Bedroc Limited Groundwater Monitoring Well Survey Data

Boring No.	Ground Elev.	Top of Casing	Latitude	Longitude	Stick up	WL-TOC	GW Elevation
OW-7R	2495.058	2497.782	36.97356159	-114.98478402	2.724	79.35	2418.432
OW-8	2498.511	2500.713	36.98441433	-114.98172295	2.202	74.79	2425.923
OW-9	2492.955	2493.423	36.98093588	-114.98134066	0.467	80.65	2412.773
OW-10	2491.810	2494.348	36.97727334	-114.98076484	2.538	80.93	2413.418
OW-11	2492.884	2495.786	36.97718445	-114.98503645	2.902	64.58	2431.206
OW-12	2498.413	2501.473	36.98084443	-114.98475842	3.059	60.30	2441.173
OW-13	2505.630	2508.482	36.98441304	-114.98536724	2.851	55.90	2452.582

2.4 Field Activities

The field investigation was initiated in July 2013 and was substantially complete in September 2013. Drilling was performed by Eagle Drilling Services, LLC of Las Vegas, Nevada. Drilling was performed using Hollow Stem Auger techniques and was observed by personnel from GES, who logged subsurface conditions during drilling, observed well construction, and conducted surveying activities. Site access and limited clearing was provided by personnel from

Bedroc Limited. The locations were selected to provide adequate subsurface information to characterize the site. The borings are approximately equally spaced across the study area and were located based on topographic breaks and existing infrastructure. The soil exploration logs and monitoring well construction details are presented in Appendix A.

3.0 INVESTIGATIVE FINDINGS

The following sections describe the existing conditions and the investigative findings as relate to the site geology, groundwater elevations.

3.1 Regional Geologic Setting

The Coyote Spring Valley is located within the Basin and Range Physiographic province and topography in the area is typically long northerly trending valleys separated by uplifted strata. Relief across the Coyote Springs Valley is approximately 4,500 feet. The subject site is bounded to the west and south by the Sheep and Elbow Ranges, to the northeast by the Delamar Mountains, and to the southeast by the Meadow Valley Mountains.

In the general vicinity of the site, there are three mapped faults upon which movement has occurred in the Quaternary Period (USGS, 2004), but not in the Holocene Epoch. Several miles to the east is the north trending west facing normal Wildcat Wash fault, which separates the southern Meadow Valley Mountains from Coyote Springs Valley. Structural and sedimentary data suggested that the latest displacement on wildcat Wash fault occurred approximately 750,000 years ago (USGS, 2004). The Arrow Canyon Range fault, located several miles to the southeast of the facility, separates Coyote Springs Valley from the Arrow Canyon Range. Structural and sedimentary data suggests that the latest displacement occurred approximately 1.6 million years ago (USGS, 2004). Several miles to the northwest of the proposed facility is the northerly trending Sheep Range fault, an east facing normal fault that separates the Coyote Springs Valley from the Sheep Mountains. Available data indicates that the most recent movement occurred approximately 130,000 years ago (USGS, 2004).

Surficial and underlying sediments in Coyote Springs Valley consist of interbedded lacustrine and alluvial deposits. The interbedded alluvial and lacustrine sediments from the Tertiary Period, mapped near the center of the valley in the vicinity of the site, have been mapped as part to the Muddy Creek Formation (Tschanz and Pampeyan, 1970). Late Quaternary alluvial sediments overlay the older deposits and form an anastomosing belt approximately 0.5 to 1 mile wide covering much of the valley floor (Tschanz and Pampeyan, 1970; Stewart and Carlson, 1978).

Surface drainage in the valley is provided by the southward draining Pahranagat Wash, which is immediately east of the proposed landfill expansion area and adjacent to Highway 93. The channel exhibits intermittent characteristics, attributed to sparse precipitation and the highly permeable nature of the shallow alluvium in the valley. Immediately south of the site, the Pahranagat Wash is joined by the southwesterly flowing Kane Springs Wash, which drains the northeast trending Kane Springs Valley.

3.2 Site Geology

Based on the previous Site Characterization Report (Joyce Engineering, 2004) the facility is underlain by sediments of the Muddy Creek Formation. Locally, there are reworked sediments associated with the Pahranagat Wash and its tributaries. At the site the Muddy Creek Formation consists of interbedded lacustrine and fluvial sand and gravel deposits of varying thickness. The previous investigation was able to map six different lacustrine members in the vicinity of the site, the lowest of which appeared to be laterally continuous beneath the existing landfill to the south. However, the overlying lacustrine members appear to be laterally discontinuous, apparently due to a limited area of deposition and/or erosion following deposition. The report further stated that the lacustrine units are generally separated by alluvial sand and gravel deposits, although locally the different lacustrine members are in contact.

Soils at the existing facility, as described from outcrops, test pits, and borings, range from poor to well sorted sand and gravel of alluvial origin to fine silty-sand grading to silty-clay of lacustrine orgin. Generally the lacustrine deposits are weakly consolidated and the alluvial deposits are unconsolidated to weakly cemented. Bed thicknesses vary across the site due to the processes by which the sediments were deposited; however, the thickest units are generally less than 30 feet thick. According to the Joyce Engineering Characterization Report (2004), soil ranging from CL, ML, and SM were believed to be lacustrine in origin, while SM, SP, GP, and GW were believed to be alluvial in origin.

The additional characterization borings installed during this site investigation for the proposed landfill show similar deposits as those found in the initial 2004 characterization report and can be used in conjunction with those findings. It was observed in the proposed area that the soils encountered were consistent with the previously characterized soils to the south, with soils ranging from poor to well sorted sand and gravel of alluvial origin to fine silty-sand grading to silty-clay of lacustrine origin. Generally the lacustrine deposits are weakly consolidated and the alluvial deposits are unconsolidated to weakly cemented. Bed thicknesses vary across the site due to the processes by which the sediments were deposited, eroded, and are likely to be laterally discontinuous.

3.3 Hydrogeology

This section describes the regional and site specific hydrogeology based on data obtained during this investigation at the site and in the region.

The proposed facility is located within the Coyote Spring Valley, a basin-fill aquifer. Information obtained during this investigation indicates that the uppermost aquifer in the valley is contained within the valley sediments. The aquifer in the basin is considered to be vertically continuous, extending from the unconsolidated fill into the fractured bedrock below.

Recharge to the aquifer is primarily derived from the infiltration of precipitation and melting snow pack that accumulated in the surrounding mountains during the winter season. The majority of the recharge to the valley aquifer is likely to occur along the mountain slopes where the highly permeable fanglomerate deposits are exposed. Consequently, the groundwater in the valley is expected to flow from areas of high head near the mountains towards areas of low head (major drainage channels).

Based on the information gathered during this and previous investigations at the facility, the uppermost water table, as defined by the potentiometric surface, is laterally continuous across the study area, cross-cutting the geologic strata encountered beneath the facility. Although groundwater movement in the uppermost aquifer appears to resemble a homogeneous, isotropic aquifer, each different geologic strata comprising that aquifer exhibits different hydraulic properties. This characteristic difference between geologic units is demonstrated by the highly variable pumping rates of irrigation wells installed at similar depths on the subject property.

To evaluate the local hydrologic conditions, seven monitoring wells were constructed at the proposed landfill area. Soil boring and well construction logs for the monitoring wells constructed within the characterization area are presented in Appendix A. Static water level data obtained from the monitoring wells indicate that the water table in the uppermost aquifer beneath the site is present at a depth of 50 to 80 feet below existing grade, depending on the topographic elevation.

Using the static water level data obtained on September 3, 2013, a Groundwater Potentiometric Surface Map was prepared and is present in Figure 3. The water table beneath the proposed facility ranges in elevation from 2,410 feet above MSL in the southeastern corner to 2,455 feet above MSL beneath the northwestern corner of the study area. The potentiometric surface lines indicate that groundwater flow in the uppermost aquifer is towards the east-southeast with an average gradient of approximately 0.02 foot per foot. Geologic information gathered during the site investigation indicates the uppermost water table is present in a soil matrix composed of both alluvial and lacustrine sediment.

4.0 CONCLUSIONS

It was observed in the proposed landfill area that the soils encountered were consistent with the previously characterized soils to the south with soils ranging from poor to well sorted sand and gravel of alluvial origin to lacustrine fine silty sand grading to silty clay. Static water level data obtained from the monitoring wells indicate that the water table in the uppermost aquifer beneath the area of proposed expansion is present at a depth of 50 to 80 feet below existing grade, depending on the topographic elevation.

We appreciate the opportunity to provide our professional services. Should you have any questions regarding this matter or have further need of our services, please feel free to contact us at your convenience.

Respectfully Submitted,
Geotechnical & Environmental Services, Inc.

PROFESSIONAL ENGINEER - STATE OF NEVADA
GREGORY P DESART
Expires 12/31/14
CIVIL
No. 9543

Kyle S. Hansen

10/17/13

Kyle S. Hansen, C.E.M.
Project Geologist

Gregory P. DeSart, P.E., C.E.M.
Principal Engineer

5.0 QUALIFICATIONS OF PROFESSIONALS

KYLE S. HANSEN, C.E.M.
ENVIRONMENTAL PROJECT GEOLOGIST

Mr. Hansen is a Project Geologist with Geotechnical & Environmental Services, Inc. He is a Nevada Certified Environmental Manager and a Geologist with a M.S. degree in Geology from Brigham Young University. Mr. Hansen has over twenty-five years of experience with a variety of environmental projects. He has performed environmental investigations including Phase I and II Assessments, Limited Compliance Audits, sampling of contaminated soils, groundwater monitoring and sampling, landfill gas monitoring, and groundwater monitoring well installation.

GREGORY P. DESART, P.E., C.E.M.
PRINCIPAL ENGINEER

Mr. DeSart is President of Geotechnical & Environmental Services, Inc. He is a Professional Civil Engineer, Nevada Certified Environmental Manager with a B.S. degree in Geologic Engineering from University of Nevada Reno. Mr. DeSart has over twenty-six years of experience with a variety of geotechnical and environmental projects throughout Nevada. He has performed geologic, geotechnical and environmental investigations including Phase I and II Assessments, Limited Compliance Audits, sampling of contaminated soils and groundwater, groundwater assessments, groundwater monitoring and sampling, landfill gas monitoring, and groundwater monitoring well installation.

6.0 REFERENCES

Joyce Engineering, Inc., 2004. *Site Characterization Report Class III Disposal Facility*, Western Elite, Inc., Western Elite Material Processing Facility, Lincoln County, Nevada.

Stewart, J.H. and J.E. Carlson, 1978. *Geologic Map of Nevada*, 1:500,000. United States Geological Survey and Nevada Bureau of Mines and Geology.

Tschanz, C.M. and E.H. Pampeyan, 1970. *Geology and Mineral Deposits of Lincoln County, Nevada*. Nevada Bureau of Mines and Geology, Bulletin 73.

USGS, 2004, USGS *Quaternary Faults and Fold Database*. http://qfaults.cr.usgs.gov/faults.

APPENDIX A

Approximate Scale

★ Bedroc Limited Landfill Located Approximately 65 Miles North of Las Vegas on State Route 93.

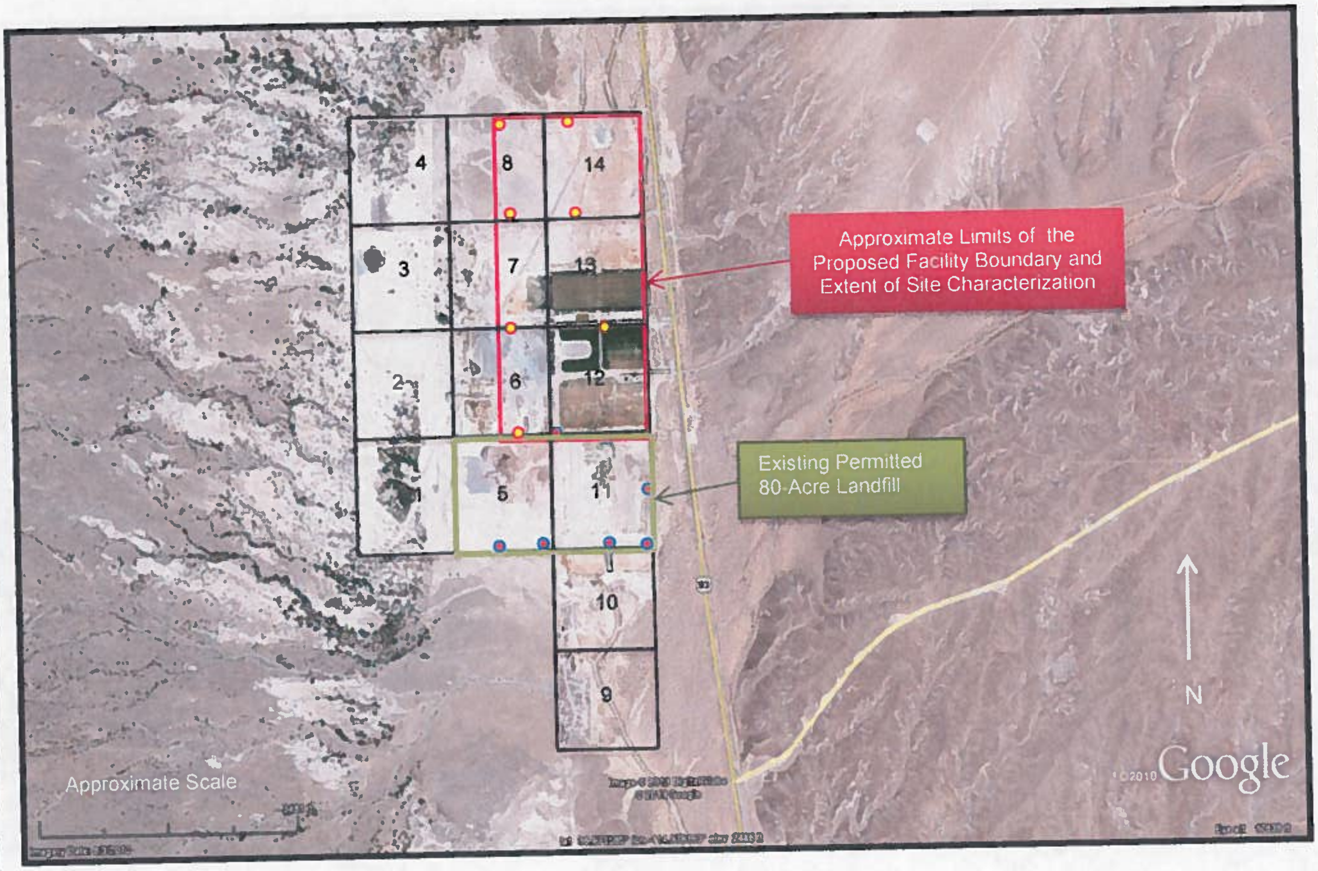
GISMO Image 2010

GEOTECHNICAL &
ENVIRONMENTAL
SERVICES, INC.
(702) 365-1001
7150 Placid Street
Las Vegas, Nevada 89119

AERIAL PHOTOGRAPH
Bedroc Limited Landfill Vicinity Map
Lincoln County, Nevada

Job #20123247V1

Figure 1



● Existing Monitoring Well Locations

○ Monitoring Wells Installed for this Characterization

☐ Approximate Subject Property Parcel Boundaries

GISMO Image 2010

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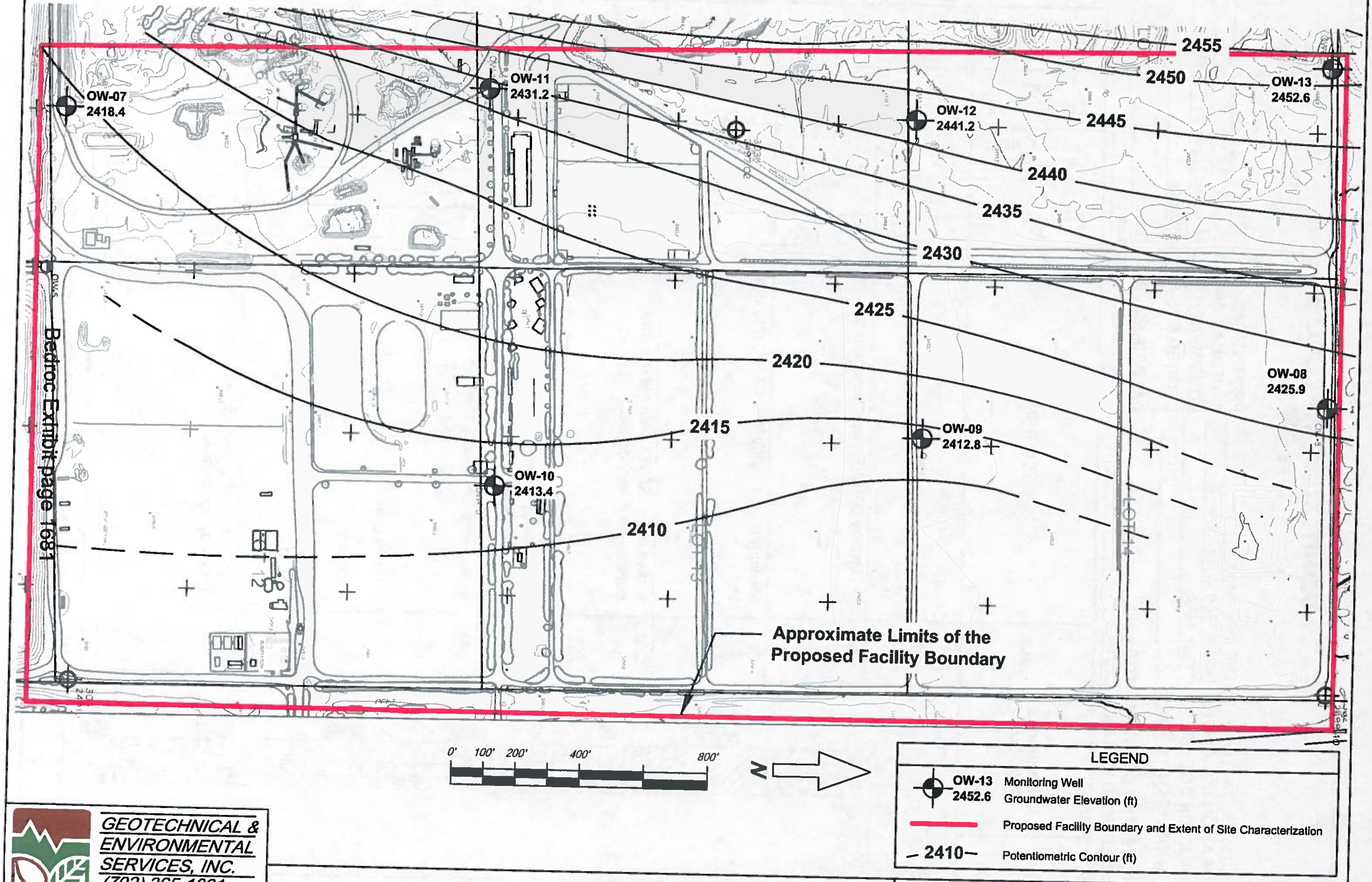
7150 Placid Street
Las Vegas, Nevada 89119

GES

Bedroc Limited Class I Landfill Site Characterization Map Lincoln County, Nevada	
Job #20123247V1	Figure 2



GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
(702) 365-1001
7150 Placid Street
Las Vegas, NV 89119
www.gesnevada.com

BEDROC LIMITED GROUNDWATER POTENTIOMETRIC SURFACE MAP
LINCOLN COUNTY, NEVADA

DRAWN BY:	REVIEWED BY:	DATE DRAWN:
AT	KSH	09/09/2013
PROJECT NO. 20133247V1		FIGURE NO. 3

j:\jobs\2013_jobs\20133247\v1\autocad\existing topo acad2010.dwg

MONITORING WELL LOG
OW-7R

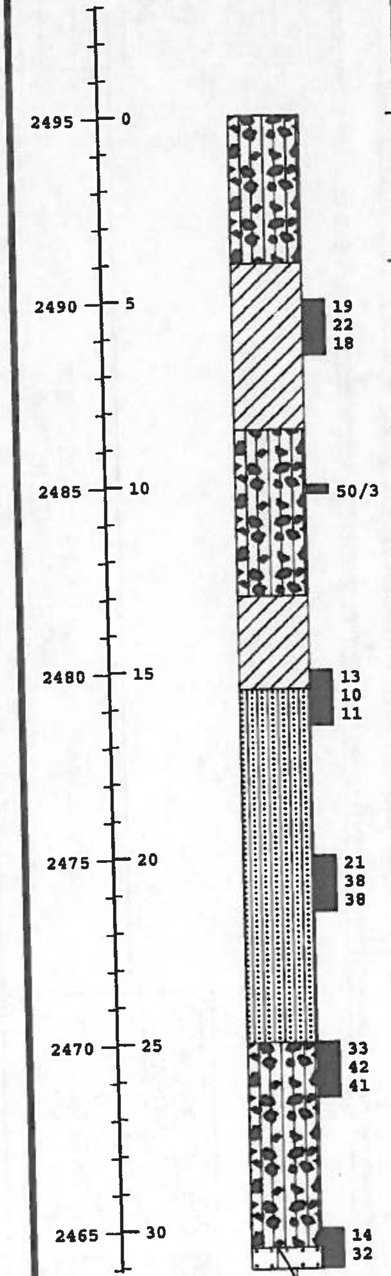
PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97356 W:114.98478
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2495.06 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 9/3/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 80.0 Feet
FINAL DEPTH TO WATER: 76.6 Feet

DATE MEASURED: 9/3/13
DATE MEASURED: 9/4/13

ELEVATION/ DEPTH — SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
GM	Brown silty GRAVEL with sand, moist, medium dense.					
CL	Medium brown sandy lean CLAY, dry, very stiff.					
GM	Brown silty GRAVEL with sand, some cobbles, dry, very dense.					
CL	Brown sandy lean CLAY, dry, very stiff.					
SM	Brown silty SAND, dry, medium dense. ...some gravel. ...dense.					
GM	Light brown silty GRAVEL with sand, trace cobbles, dry, dense.					

WELL CONSTRUCTION

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No. 5

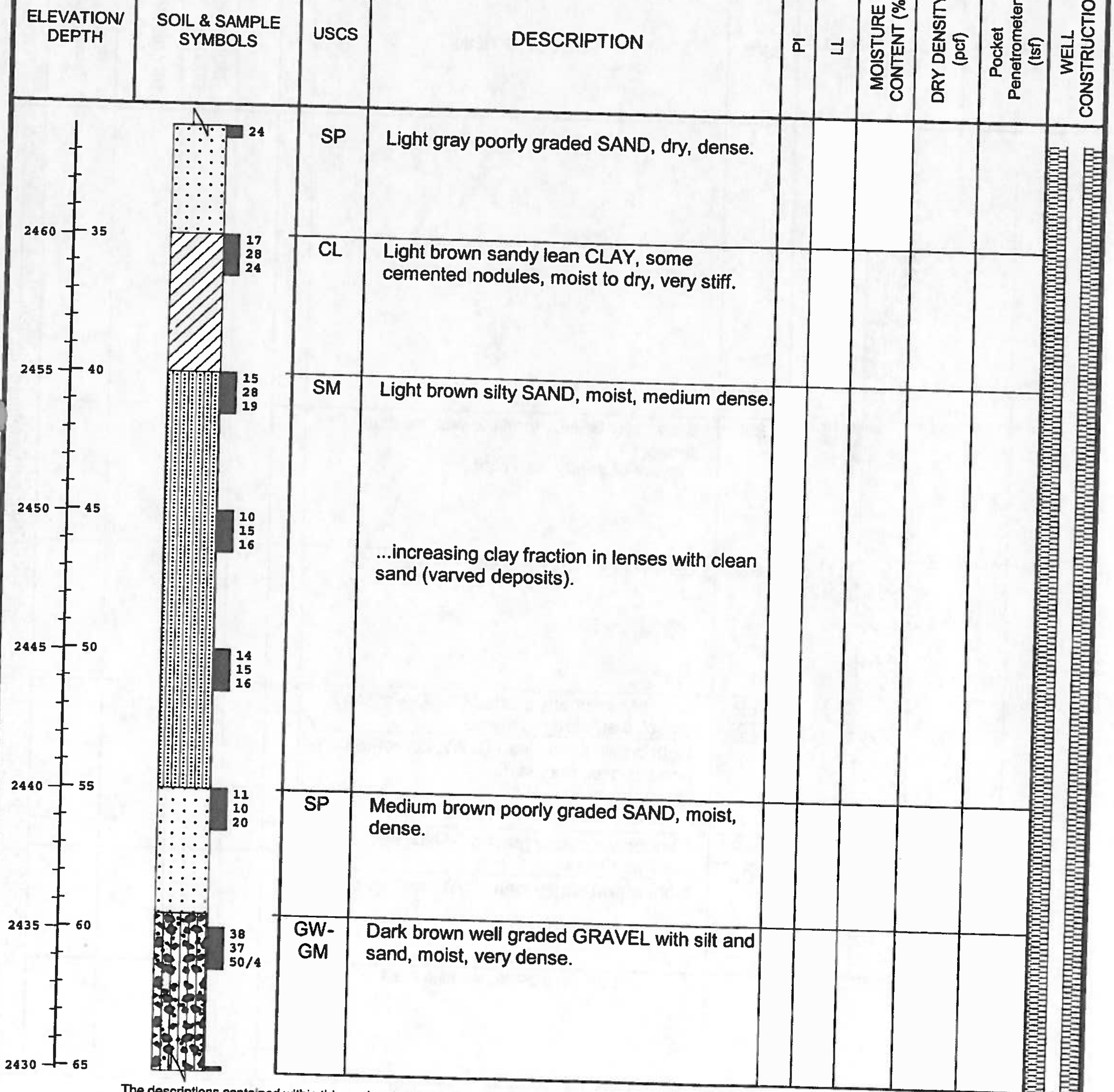
MONITORING WELL LOG
OW-7R

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97356 W:114.98478
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2495.06 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 9/3/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Hansen/Dorris

INITIAL DEPTH TO WATER: 80.0 Feet
FINAL DEPTH TO WATER: 76.6 Feet

DATE MEASURED: 9/3/13
DATE MEASURED: 9/4/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SP	Light gray poorly graded SAND, dry, dense.					
CL	Light brown sandy lean CLAY, some cemented nodules, moist to dry, very stiff.					
SM	Light brown silty SAND, moist, medium dense. ...increasing clay fraction in lenses with clean sand (varved deposits).					
SP	Medium brown poorly graded SAND, moist, dense.					
GW-GM	Dark brown well graded GRAVEL with silt and sand, moist, very dense.					

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

MONITORING WELL LOG
OW-7R

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97356 W:114.98478
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2495.06 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 9/3/13
EQUIPMENT: Truck Mounted Diedrich D-120
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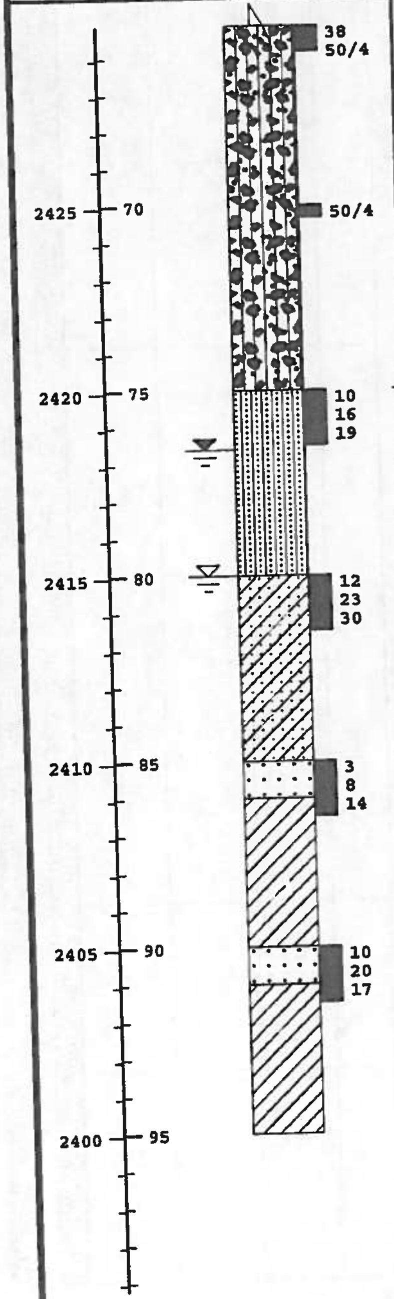
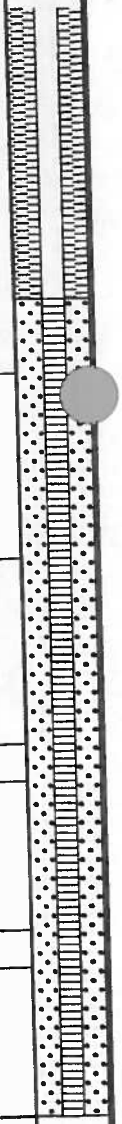
INITIAL DEPTH TO WATER: 80.0 Feet
FINAL DEPTH TO WATER: 76.6 Feet

DATE MEASURED: 9/3/13
DATE MEASURED: 9/4/13





ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
	38 50/4								
2425 70	50/4								
2420 75	10 16 19	SM	Brown silty SAND, moist to wet, medium dense. ...layers of sandy lean clay.						
2415 80	12 23 30	SC	Brown clayey SAND, moist, dense.						
2410 85	3 8 14	SP CL	Dark brown poorly graded SAND with trace gravel, wet, medium dense. Light brown sandy lean CLAY, cemented clay nodules, wet, very stiff.						
2405 90	10 20 17	SP CL	Dark brown poorly graded SAND, wet, medium dense. Light brown sandy lean CLAY, wet, very stiff.						
2400 95			**END OF BORING AT 95.0 FEET**						

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. 5

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

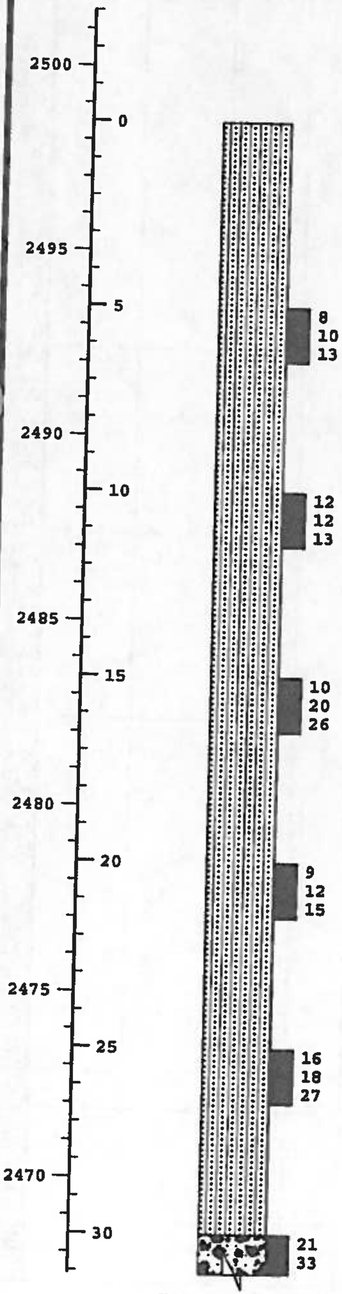
MONITORING WELL LOG
OW-8

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98441 W:114.98172
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.51 Feet

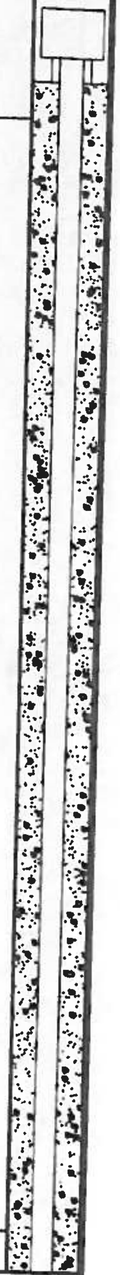
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/7/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 75 Feet
FINAL DEPTH TO WATER: 72.3 Feet

DATE MEASURED: 8/7/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SM	Light Brown silty SAND, dry, very loose.						
			...medium dense.						
			...slight increase in silt.						
		GW	Light brown well graded GRAVEL with sand,						



The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. **Figure No.** 6

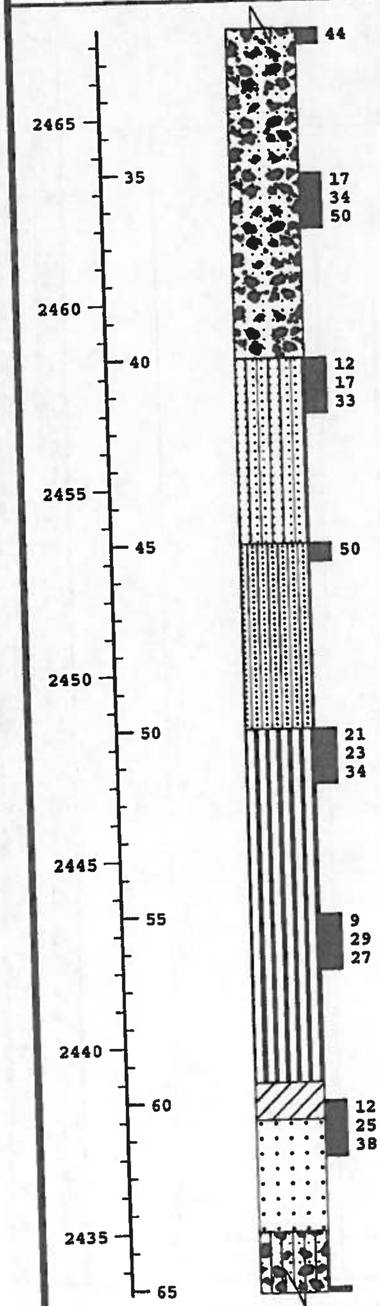
MONITORING WELL LOG
OW-8

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98441 W:114.98172
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.51 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/7/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 75 Feet
FINAL DEPTH TO WATER: 72.3 Feet

DATE MEASURED: 8/7/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
			dry, dense.						
		SW-SM	White to brown well graded SAND with silt, dry, dense.						
		SM	Light brown silty SAND, dry, very dense.						
		MH	Light grey elastic SILT, dry, very stiff, small clay fraction.						
		CL	Green to brown sandy lean CLAY, dry, very stiff.						
		SP	Red to brown poorly graded SAND, moist, dense.						
		GM	Red to brown silty GRAVEL with sand, dry, very dense.						

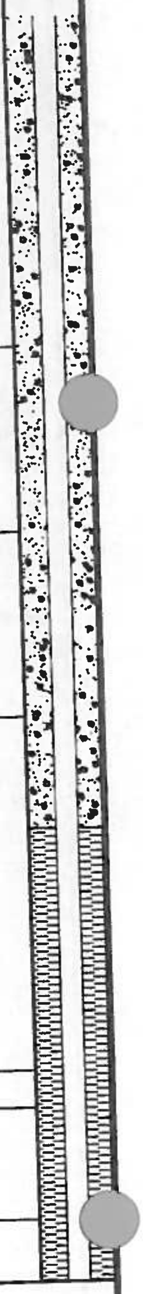


Figure No. 6

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

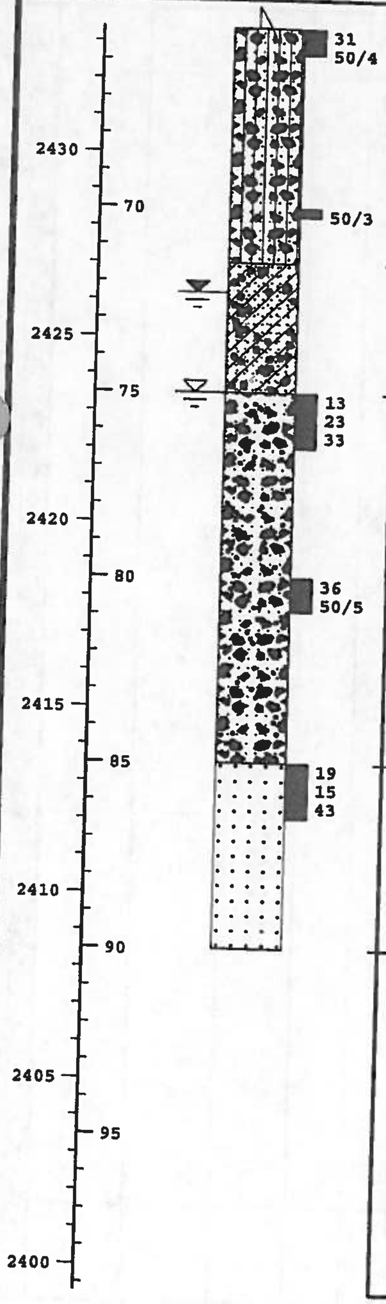
MONITORING WELL LOG
OW-8

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98441 W:114.98172
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.51 Feet

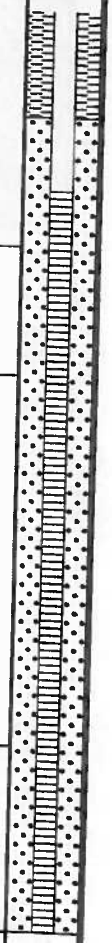
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/7/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 75 Feet
FINAL DEPTH TO WATER: 72.3 Feet

DATE MEASURED: 8/7/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		GP-GC	Light brown poorly graded GRAVEL with clay and sand, dry, dense.						
		GW	Dark brown well graded GRAVEL with sand, wet, dense.						
			...very dense.						
		SP	Dark brown poorly graded SAND, wet, dense.						
			END OF BORING AT 90.0 FEET						



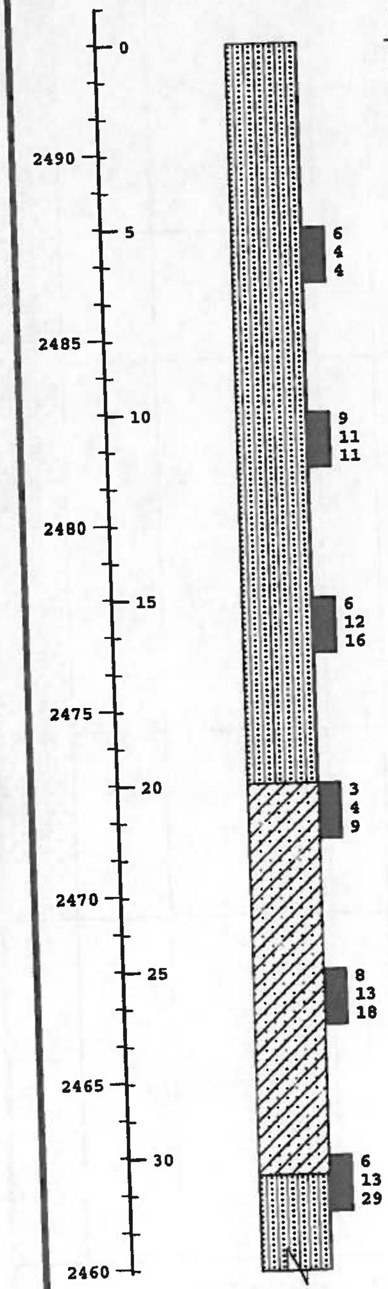
MONITORING WELL LOG
OW-9

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98094 W:114.98134
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2492.96 Feet

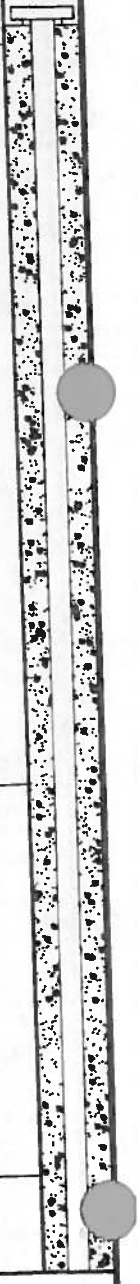
INITIAL DEPTH TO WATER: 83 Feet
FINAL DEPTH TO WATER: 80.18 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/9/2013
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

DATE MEASURED: 8/9/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SM	Dark brown silty SAND, moist, loose.					
	...slight clay fraction.					
	...medium dense.					
SC	Red to brown clayey SAND, moist, loose.					
	...medium dense.					
SM	Light brown silty SAND, dry, medium dense.					



The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No. 7

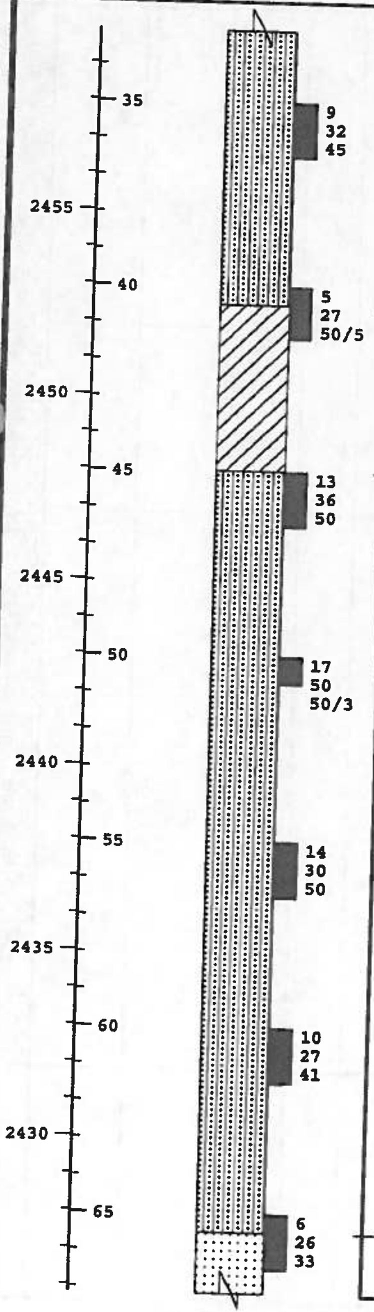
MONITORING WELL LOG
OW-9

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98094 W:114.98134
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2492.96 Feet

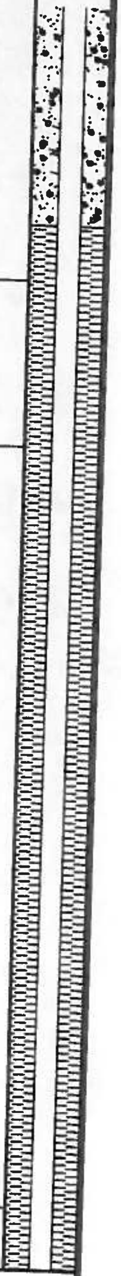
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/9/2013
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 83 Feet
FINAL DEPTH TO WATER: 80.18 Feet

DATE MEASURED: 8/9/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
			...dense.						
		CL	Dark brown lean CLAY with sand, dry, very stiff.						
		SM	Dark brown silty SAND, dry, dense.						
			...very dense.						
			...dense.						
		SW	Light brown well graded SAND with gravel, dry, dense.						



The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. **Figure No.** 7

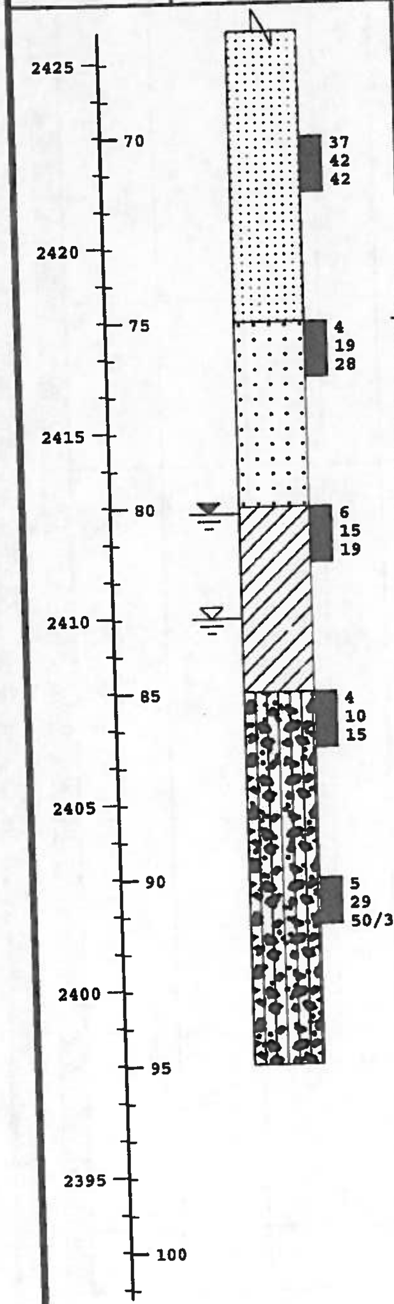
MONITORING WELL LOG
OW-9

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98094 W:114.98134
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2492.96 Feet

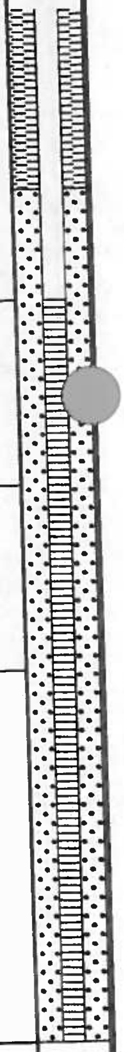
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/9/2013
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 83 Feet
FINAL DEPTH TO WATER: 80.18 Feet

DATE MEASURED: 8/9/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
			...moist.						
		SP	Light brown poorly graded SAND, moist, medium dense.						
		CL	Dark brown lean CLAY with sand, moist, very stiff.						
		GW-GM	Light brown well graded GRAVEL with silt and sand, wet, medium dense.						
			END OF BORING AT 95.0 FEET						



The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. 7

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

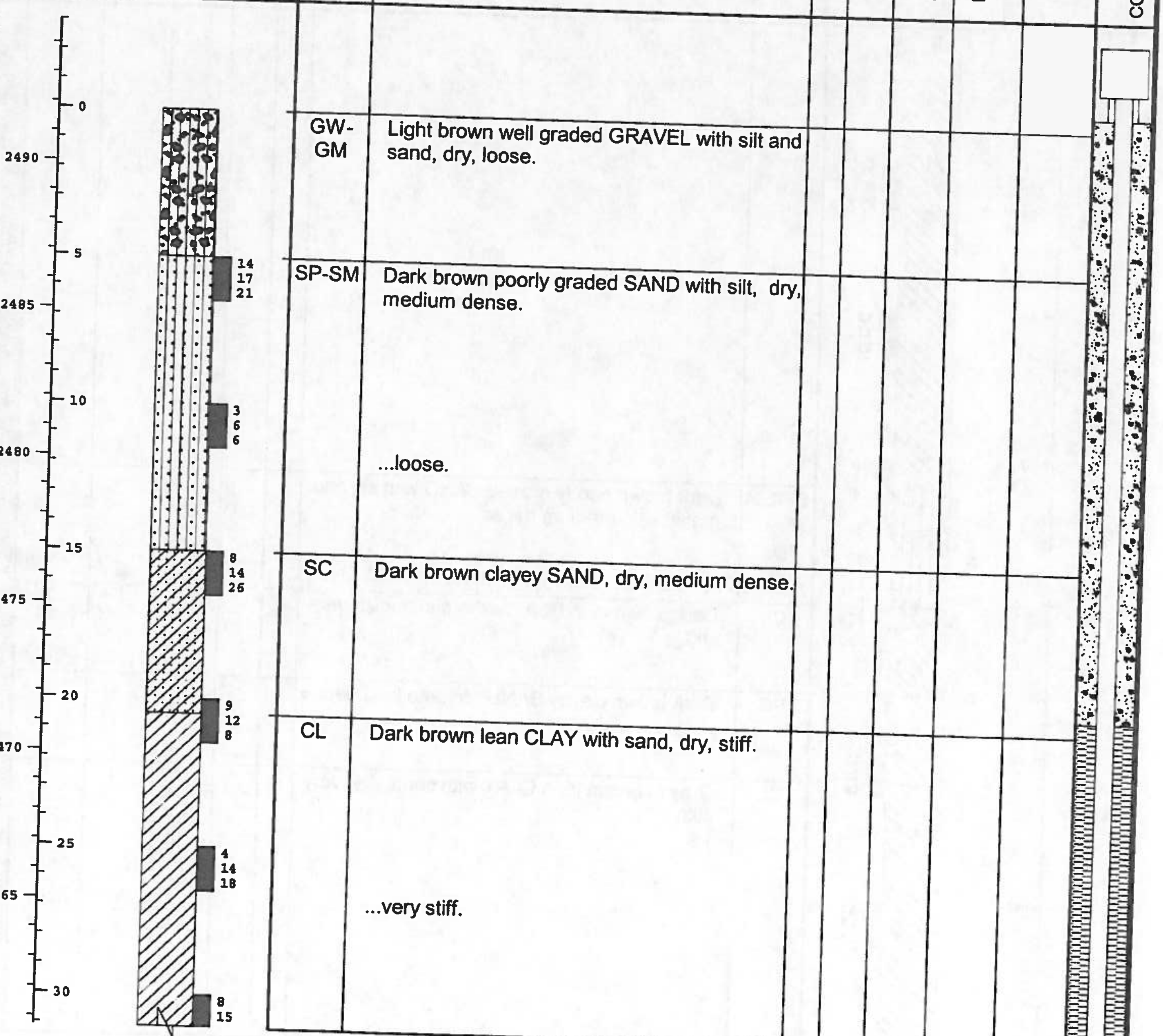
MONITORING WELL LOG
OW-10

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97727 W:114.98076
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2,491.81 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/15/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 78.23 Feet
FINAL DEPTH TO WATER: 78.16

DATE MEASURED: 8/15/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
0		GW-GM	Light brown well graded GRAVEL with silt and sand, dry, loose.						
5		SP-SM	Dark brown poorly graded SAND with silt, dry, medium dense.						
			...loose.						
15		SC	Dark brown clayey SAND, dry, medium dense.						
20		CL	Dark brown lean CLAY with sand, dry, stiff.						
			...very stiff.						

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. **Figure No.** 8

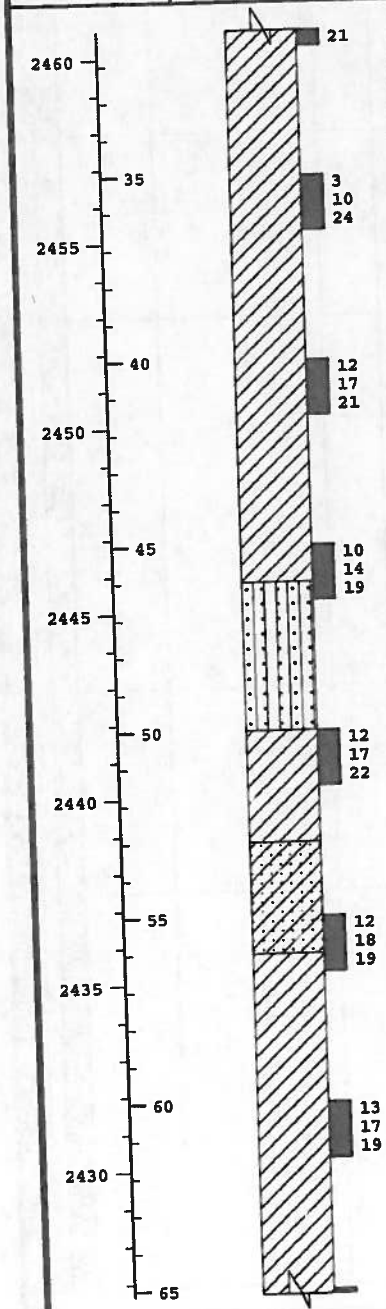
MONITORING WELL LOG
OW-10

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97727 W:114.98076
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2,491.81 Feet

INITIAL DEPTH TO WATER: 78.23 Feet
FINAL DEPTH TO WATER: 78.16

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/15/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

DATE MEASURED: 8/15/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SP-SM	Dark brown poorly graded SAND with silt and gravel, dry, medium dense.						
		CL	Dark brown lean CLAY with sand, moist, very stiff.						
		SC	Dark brown clayey SAND, dry, medium dense.						
		CL	Grey to brown lean CLAY with sand, dry, very stiff.						

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. 8

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

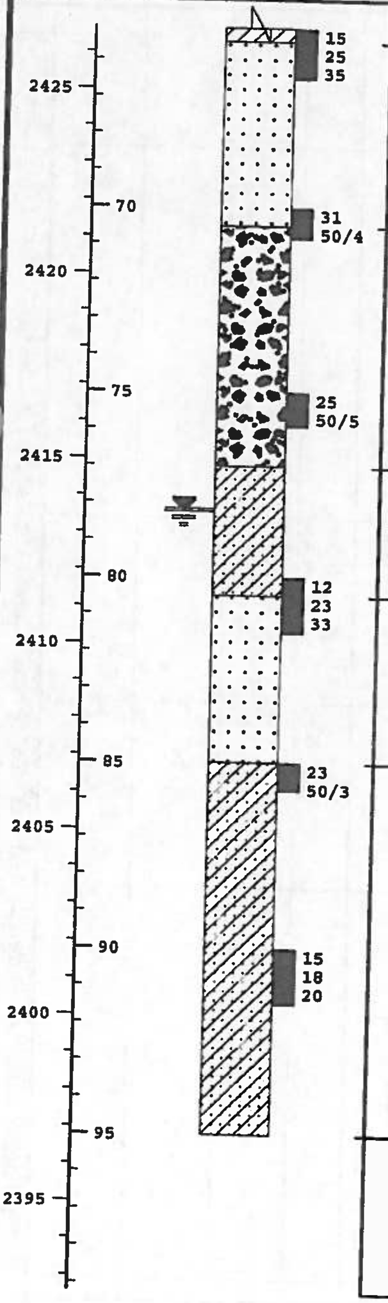
MONITORING WELL LOG
OW-10

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97727 W:114.98076
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2,491.81 Feet

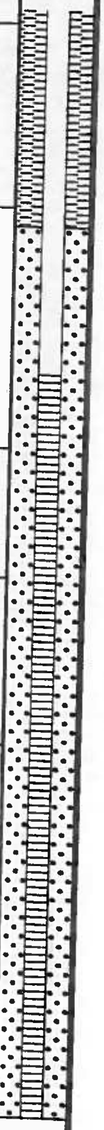
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/15/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 78.23 Feet
FINAL DEPTH TO WATER: 78.16

DATE MEASURED: 8/15/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SP	Grey to brown poorly graded SAND, moist, dense.					
GW	Dark brown well graded GRAVEL with sand, moist, very dense.					
SC	Dark brown clayey SAND, moist, medium dense.					
SP	Dark brown poorly graded SAND with gravel, wet, dense.					
SC	Dark brown clayey SAND, wet, very dense. ...medium dense.					
	END OF BORING AT 95.0 FEET					



MONITORING WELL LOG
OW-11

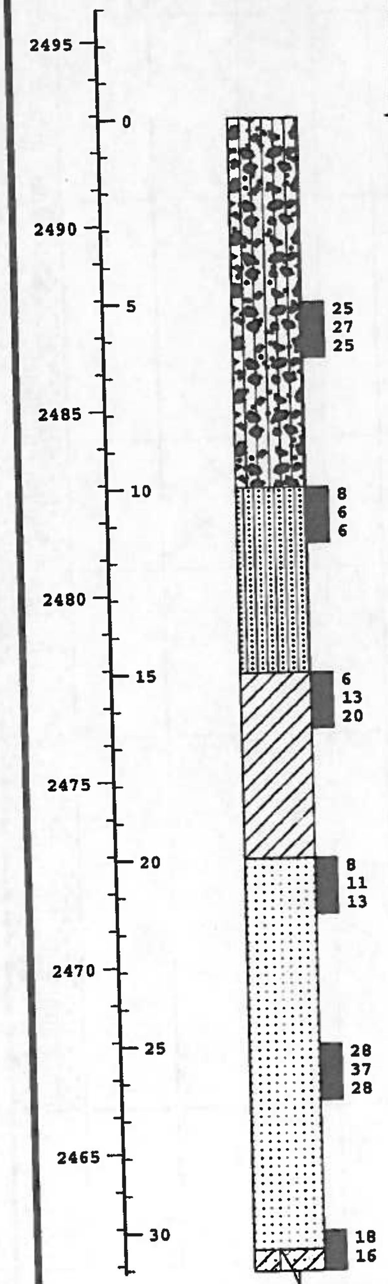
PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97718 W:114.98504
EXPLORATION SIZE (dia.): 7" O.D HSA
ELEVATION: 2492.88 Feet

INITIAL DEPTH TO WATER: 63 Feet
FINAL DEPTH TO WATER: 61.54 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

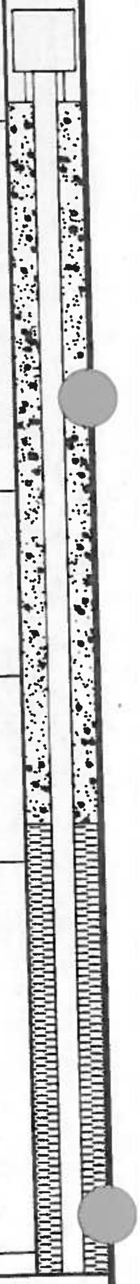
DATE MEASURED: 8/16/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH — SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
GW-GM	Dark brown well graded GRAVEL with silt and sand, dry, medium dense.					
	...dense.					
SM	Dark brown silty SAND dry, loose.					
CL	Green to brown lean CLAY with sand, dry, very stiff.					
SW	Dark brown well graded SAND with gravel, dry, medium dense.					
	...moist, dense.					

WELL CONSTRUCTION



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GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Figure No. 9

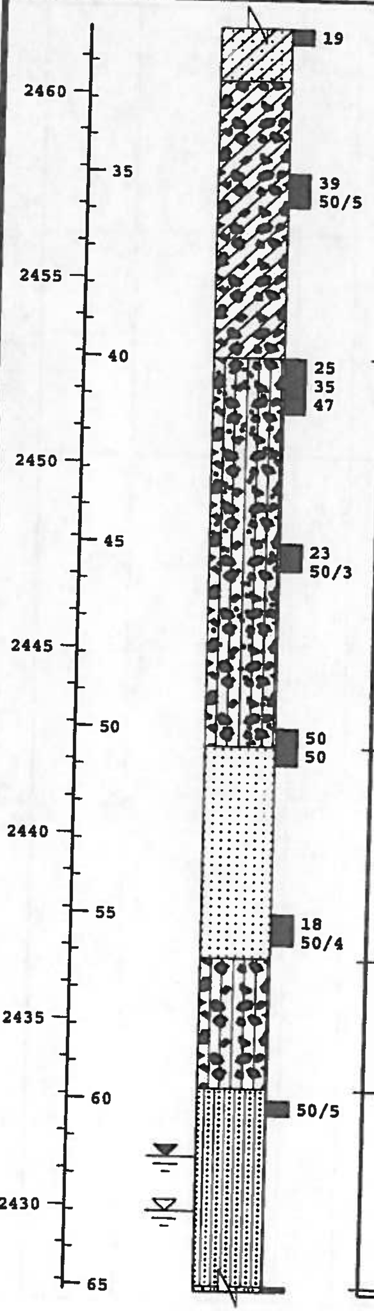
MONITORING WELL LOG
OW-11

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97718 W:114.98504
EXPLORATION SIZE (dia.): 7" O.D HSA
ELEVATION: 2492.88 Feet

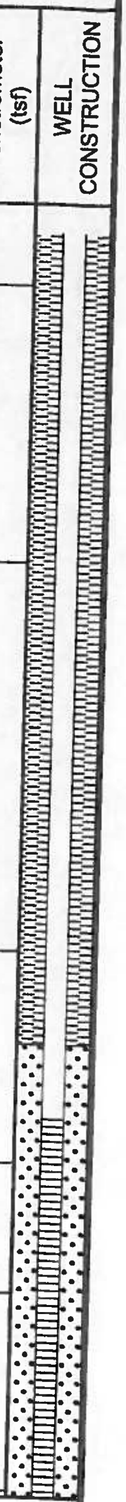
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 63 Feet
FINAL DEPTH TO WATER: 61.54 Feet

DATE MEASURED: 8/16/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SC	Dark brown clayey SAND, dry, medium dense.					
GC	Dark brown clayey GRAVEL with sand, moist, very dense ...increasing gravel. ...decreasing clay fraction.					
GW-GM	Dark brown well graded GRAVEL with silt and sand, moist, dense. ...very dense. ...drilling smoothed out at 48 feet.					
SW	Dark brown to black well graded SAND with gravel, moist, very dense. ...gravel layer. ...smoothed out.					
GM	...gravel layer. ...more consistent grinding.					
SM	Light brown weakly cemented silty SAND, moist, very dense. ...wet.					



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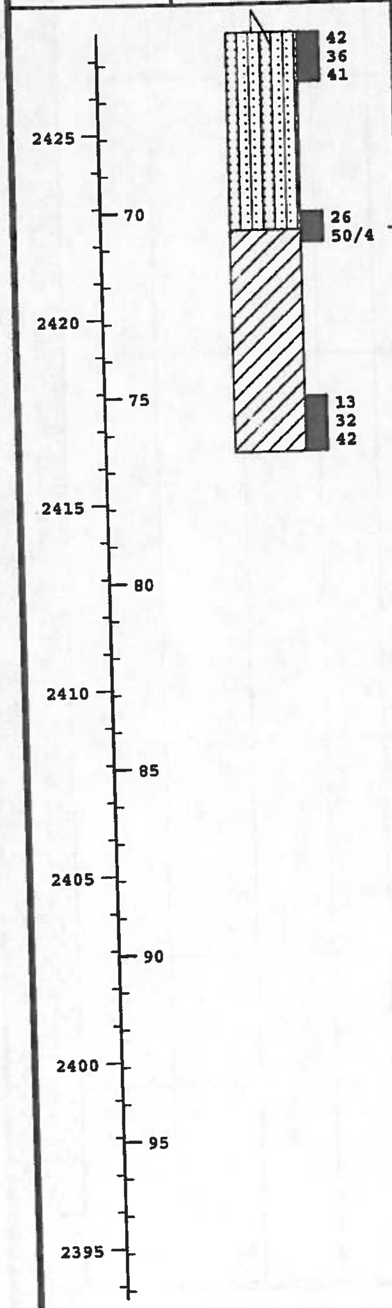
MONITORING WELL LOG
OW-11

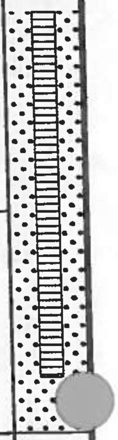
PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.97718 W:114.98504
EXPLORATION SIZE (dia.): 7" O.D HSA
ELEVATION: 2492.88 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/16/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 63 Feet
FINAL DEPTH TO WATER: 61.54 Feet

DATE MEASURED: 8/16/13
DATE MEASURED: 8/21/13





ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SW-SM	Brown well graded SAND with silt and gravel, wet, dense.						
		CL	Light brown nodular sandy lean CLAY, wet to moist, very stiff. ...moist.						
			END OF BORING AT 76.5 FEET						

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. 9

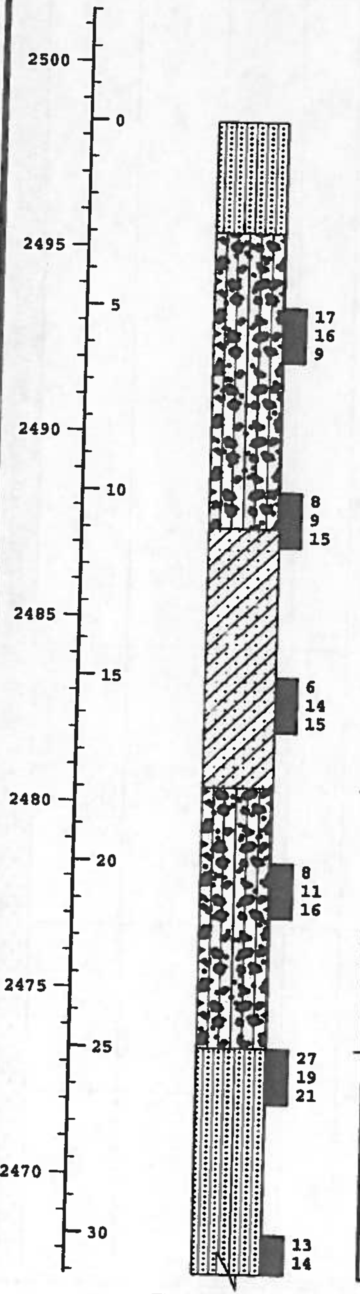
MONITORING WELL LOG
OW-12

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.9808 W:114.98476
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.41 Feet

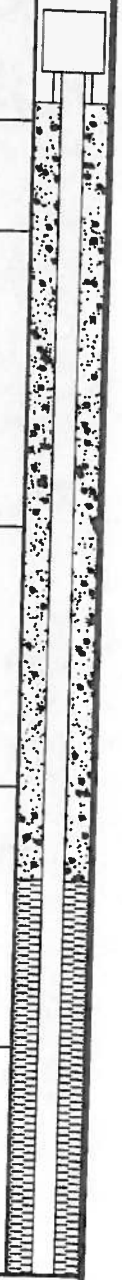
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/14/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 61.16 Feet
FINAL DEPTH TO WATER: 56.96 Feet

DATE MEASURED: 8/14/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SM	Light brown silty SAND with gravel, loose, dry.						
	17 16 9 8 9 15	GW-GM	Dark brown well graded GRAVEL with silt and sand, dry, medium dense.						
	6 14 15	SC	Green to brown clayey SAND, dry, medium dense.						
	8 11 16	GW-GM	Dark brown well graded GRAVEL with silt and sand, moist, medium dense.						
	27 19 21 13 14	SM	Dark brown silty SAND, dry, medium dense.						



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MONITORING WELL LOG
OW-12

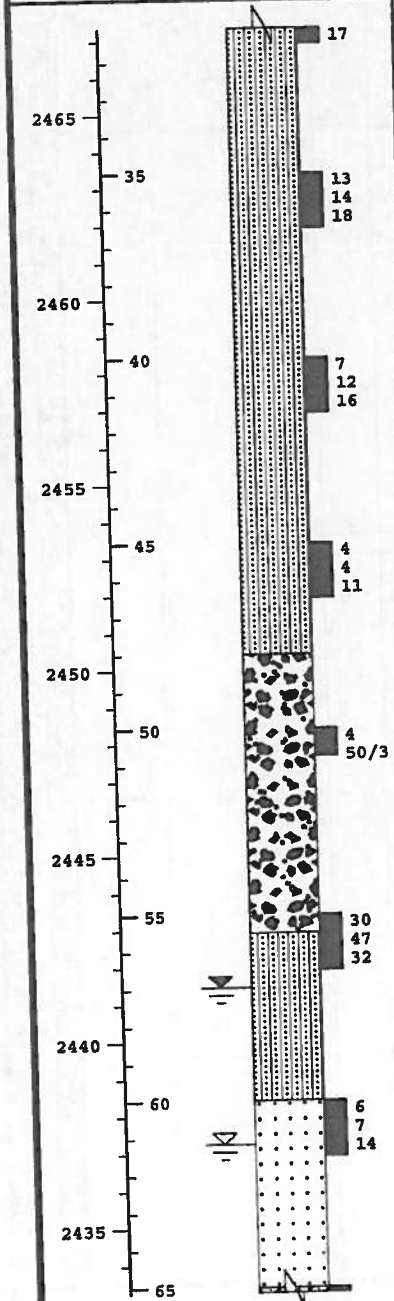
PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.9808 W:114.98476
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.41 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/14/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 61.16 Feet
FINAL DEPTH TO WATER: 56.96 Feet

DATE MEASURED: 8/14/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH | SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
	...increasing clay fraction.					
	...loose.					
GW	Grey to brown well graded GRAVEL with sand, dry, very dense.					
SM	Dark brown silty SAND with gravel, moist, dense.					
SP	Dark brown poorly graded SAND, wet, medium dense.					

WELL CONSTRUCTION

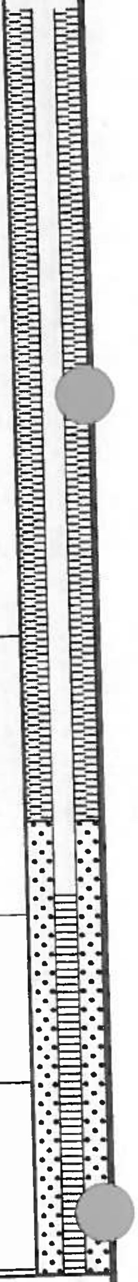


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Figure No. 10

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

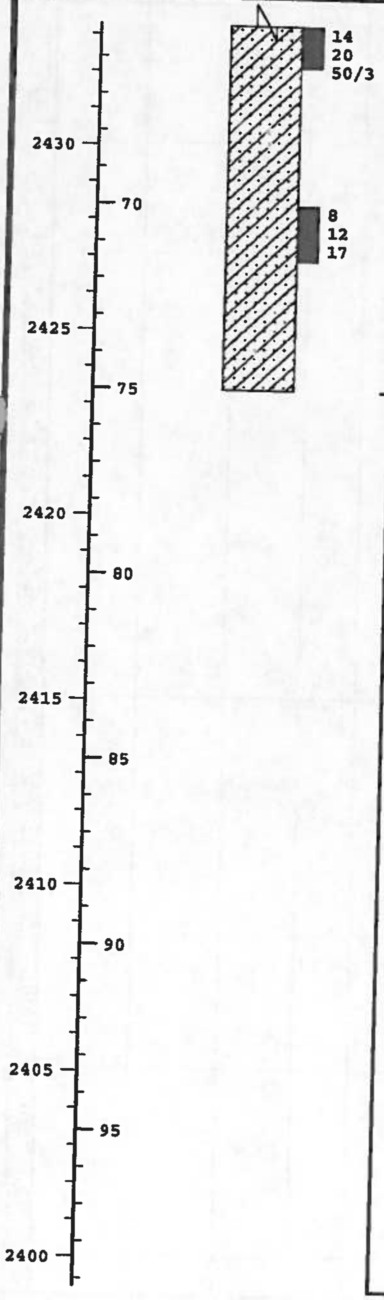
MONITORING WELL LOG
OW-12

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.9808 W:114.98476
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2498.41 Feet

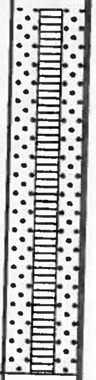
PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/14/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Dorris

INITIAL DEPTH TO WATER: 61.16 Feet
FINAL DEPTH TO WATER: 56.96 Feet

DATE MEASURED: 8/14/13
DATE MEASURED: 8/21/13



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)	WELL CONSTRUCTION
		SC	White to brown clayey SAND, wet, very dense.						
			...medium dense.						
			END OF BORING AT 75.0 FEET						



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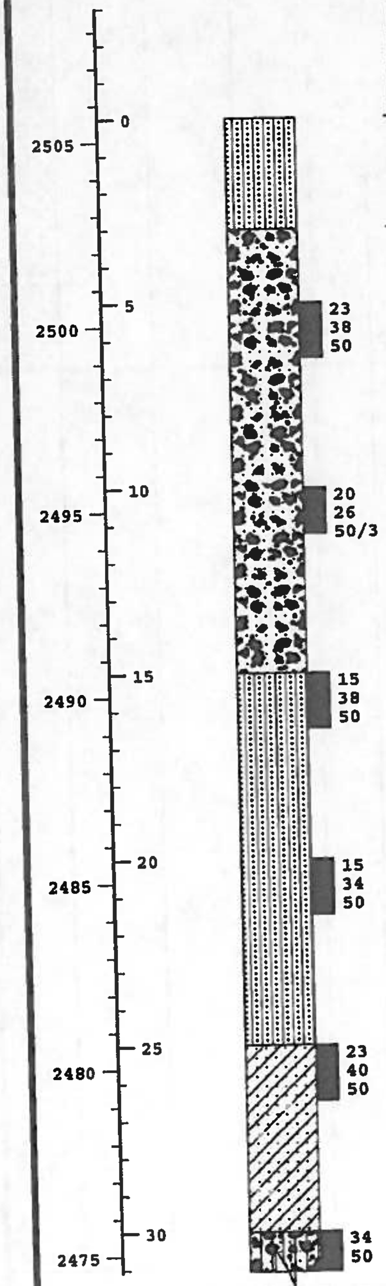
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. **Figure No.** 10

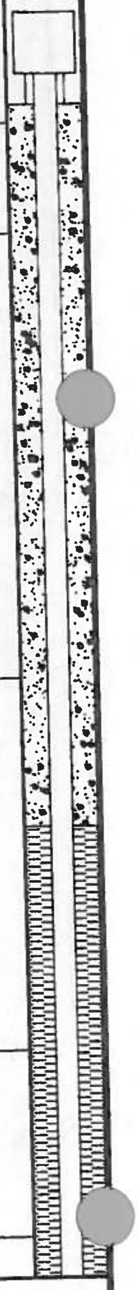
MONITORING WELL LOG
OW-13

PROJECT: Bedroc Limited Landfill Investigation
PROJECT NO.: 20133247V1
EXPLORATION LOCATION: N:36.98441 W:114.98537
EXPLORATION DATE: 8/13/13
EXPLORATION SIZE (dia.): 7" O.D. HSA
EQUIPMENT: Truck Mounted Diedrich D-120
ELEVATION: 2505.63 Feet
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 58.45 Feet
DATE MEASURED: 8/13/13
FINAL DEPTH TO WATER: 52.66 Feet
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SM	Light brown silty SAND, dry, loose.					
GW	Light brown well graded GRAVEL with sand, dry, dense.					
	...very dense.					
SM	Dark brown silty SAND, dry, dense.					
SC	Light brown clayey SAND, dry, very dense.					
GW-	Dark brown well graded GRAVEL with silt and					



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It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. 11

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

MONITORING WELL LOG
OW-13

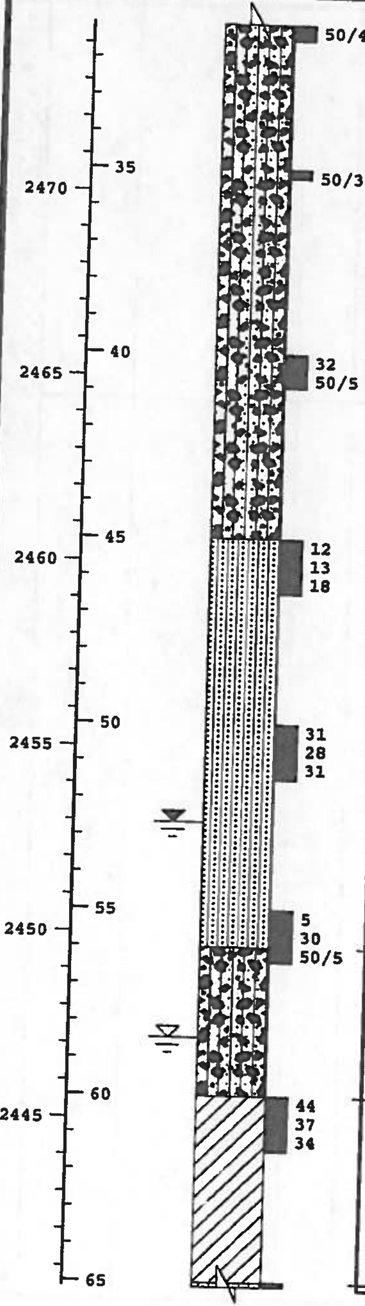
PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98441 W:114.98537
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2505.63 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/13/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 58.45 Feet
FINAL DEPTH TO WATER: 52.66 Feet

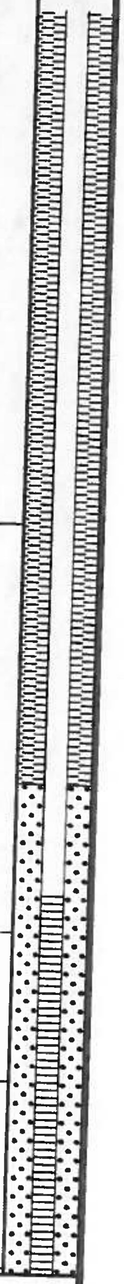
DATE MEASURED: 8/13/13
DATE MEASURED: 8/21/13

ELEVATION/ DEPTH | SOIL & SAMPLE SYMBOLS



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
GM	sand, dry, very dense.					
	...moist.					
SM	Dark brown silty SAND, moist, medium dense.					
	...dense.					
GW-GM	Light brown well graded GRAVEL with silt and sand, moist, very dense.					
CL	Light brown lean CLAY with sand, wet, very stiff.					

WELL CONSTRUCTION



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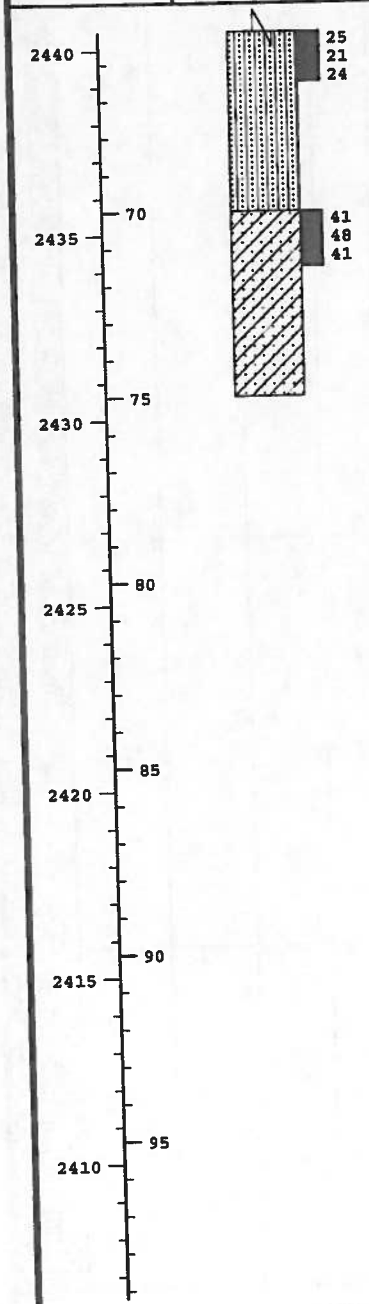
MONITORING WELL LOG
OW-13

PROJECT: Bedroc Limited Landfill Investigation
EXPLORATION LOCATION: N:36.98441 W:114.98537
EXPLORATION SIZE (dia.): 7" O.D. HSA
ELEVATION: 2505.63 Feet

PROJECT NO.: 20133247V1
EXPLORATION DATE: 8/13/13
EQUIPMENT: Truck Mounted Diedrich D-120
LOGGED BY: Robbins/Thompson

INITIAL DEPTH TO WATER: 58.45 Feet
FINAL DEPTH TO WATER: 52.66 Feet

DATE MEASURED: 8/13/13
DATE MEASURED: 8/21/13



USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	Pocket Penetrometer (tsf)
SM	Dark brown silty SAND, wet, medium dense.					
SC	Light brown clayey SAND, wet, dense.					
	END OF BORING AT 75.0 FEET					

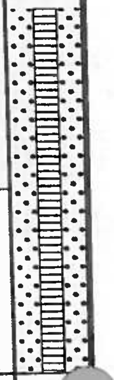


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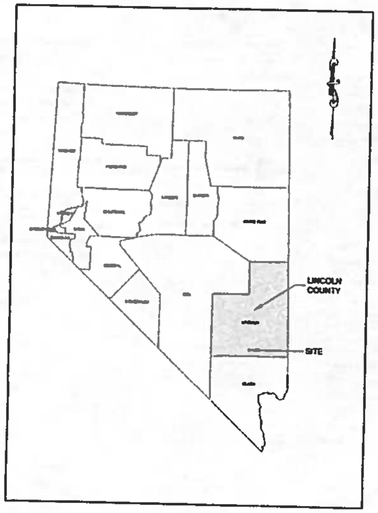
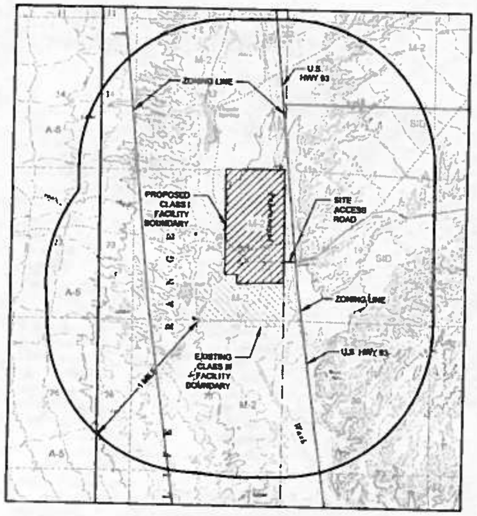
Figure No. 11

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY
DESIGN DRAWINGS
FOR A CLASS I DISPOSAL FACILITY
LINCOLN COUNTY, NEVADA



NEVADA
COUNTY LOCATION MAP
N.T.S.



GENERAL LOCATION MAP
LINCOLN COUNTY, NEVADA
SCALE - 1"=2,000'

ZONING

ID	DESCRIPTION
A-5	AGRICULTURAL (40 ACRES)
M-2	HEAVY MANUFACTURING
SID	SPECIAL INDUSTRIAL

DRAWING INDEX

SHEET	DESCRIPTION
1	COVER
2	GENERAL NOTES AND LEGEND
3	EXISTING CONDITIONS PLAN
4	BASE GRADING PLAN
5	LEACHATE COLLECTION / REMOVAL PLAN
6	FINAL GRADING PLAN
7	SECTIONS A-A TO D-D
8	SECTIONS E-E TO G-G
9	SECTION H-H
10	PHASING PLANS, PHASES I-IV
11	PHASING PLANS, PHASES V-VIII
12	PHASING PLANS, PHASES IX-XII
13	PHASING PLANS, PHASES XIII-XVI
14	PHASING PLANS, PHASES XVII-XIX
15	SITE MONITORING PLAN
16	DETAILS
17	DETAILS
18	DETAILS
19	LOCATION OF BORROW AREA
20	ADJACENT PROPERTY OWNERS
21	STORMWATER CHANNEL SECTIONS
22	STORMWATER CHANNEL SECTIONS
23	STORMWATER PROFILE

PREPARED FOR

BEDROC LIMITED, LLC
2745 N. NELLIS BLVD.
LAS VEGAS, NEVADA 89115

OCTOBER 2013
REVISED MAY 2014

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14		DAS	LBS	LBJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LBS	LBJ

LEONARD JOYCE JR.
CIVIL
No. 13578
5/21/14

JOYCE ENGINEERING
1604 OWNBY LANE
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PHONE (804) 355-4520

DESIGNED LBS
DRAWN DAS
CHECKED LBS
APPROVED LBJ
DATE 10/23/13

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

COVER

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
1

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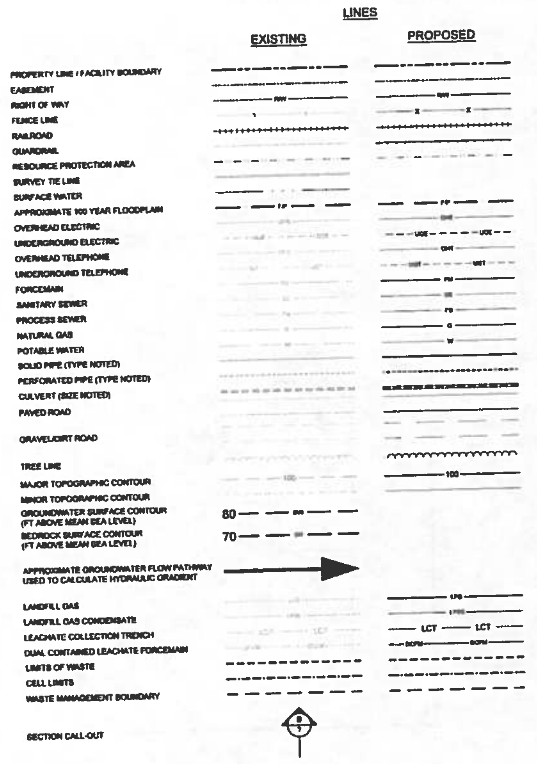
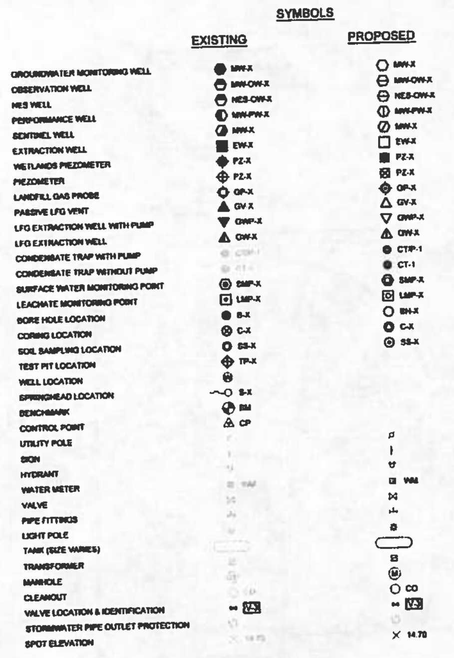
CONVENTIONAL SYMBOLS AND GENERAL NOTES

LINES



	EXISTING	PROPOSED
PROPERTY LINE / FACILITY BOUNDARY		
EASEMENT		
RIGHT OF WAY		
FENCE LINE		
RAILROAD		
GUARDRAIL		
RESOURCE PROTECTION AREA		
SURVEY TIE LINE		
SURFACE WATER		
APPROXIMATE 100 YEAR FLOODPLAIN		
OVERHEAD ELECTRIC		
UNDERGROUND ELECTRIC		
OVERHEAD TELEPHONE		
UNDERGROUND TELEPHONE		
FORCEMAIN		
SANITARY SEWER		
PROCESS SEWER		
NATURAL GAS		
POTABLE WATER		
SOLID PIPE (TYPE NOTED)		
PERFORATED PIPE (TYPE NOTED)		
CULVERT (SIZE NOTED)		
PAVED ROAD		
GRAVEL/DIRT ROAD		
TREE LINE		
MAJOR TOPOGRAPHIC CONTOUR	100	100
MINOR TOPOGRAPHIC CONTOUR		
GROUNDWATER SURFACE CONTOUR (FT ABOVE MEAN SEA LEVEL)	80	
BEDROCK SURFACE CONTOUR (FT ABOVE MEAN SEA LEVEL)	70	
APPROXIMATE GROUNDWATER FLOW PATHWAY USED TO CALCULATE HYDRAULIC GRADIENT		
LANDFILL GAS		
LANDFILL GAS CONDENSATE		
LEACHATE COLLECTION TRENCH	LCT	LCT
DUAL CONTAINED LEACHATE FORCEMAIN		
LIMITS OF WASTE		
CELL LIMITS		
WASTE MANAGEMENT BOUNDARY		
SECTION CALL-OUT		

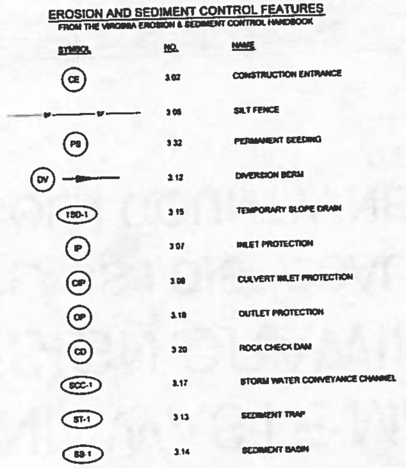
SYMBOLS



	EXISTING	PROPOSED
GROUNDWATER MONITORING WELL	MW-X	MW-X
OBSERVATION WELL	MW-OW-X	MW-OW-X
NES WELL	NES-OW-X	NES-OW-X
PERFORMANCE WELL	MW-PW-X	MW-PW-X
SENTINEL WELL	MW-X	MW-X
EXTRACTION WELL	EW-X	EW-X
WETLANDS PIEZOMETER	PZ-X	PZ-X
PIEZOMETER	PZ-X	PZ-X
LANDFILL GAS PROBE	GP-X	GP-X
PASSIVE LFG VENT	GV-X	GV-X
LFG EXTRACTION WELL WITH PUMP	GWP-X	GWP-X
LFG EXTRACTION WELL	GW-X	GW-X
CONDENSATE TRAP WITH PUMP	CTP-1	CTP-1
CONDENSATE TRAP WITHOUT PUMP	CT-1	CT-1
SURFACE WATER MONITORING POINT	SMP-X	SMP-X
LEACHATE MONITORING POINT	LMP-X	LMP-X
BORE HOLE LOCATION	B-X	BH-X
CORING LOCATION	C-X	C-X
SOIL SAMPLING LOCATION	SS-X	SS-X
TEST PIT LOCATION	TP-X	
WELL LOCATION		
SPRINGHEAD LOCATION	S-X	
BENCHMARK	BM	
CONTROL POINT	CP	
UTILITY POLE		
SIGN		
HYDRANT		
WATER METER	WM	WM
VALVE		
PIPE FITTINGS		
LIGHT POLE		
TANK (SIZE VARIES)		
TRANSFORMER		
MANHOLE		
CLEANOUT	CO	CO
VALVE LOCATION & IDENTIFICATION	V-X	V-X
STORMWATER PIPE OUTLET PROTECTION		
SPOT ELEVATION	14.70	14.70

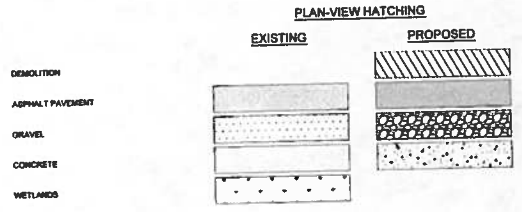
EROSION AND SEDIMENT CONTROL FEATURES

FROM THE VIRGINIA EROSION & SEDIMENT CONTROL HANDBOOK



SYMBOL	NO.	NAME
CE	3.02	CONSTRUCTION ENTRANCE
SF	3.05	SILT FENCE
PS	3.32	PERMANENT SEEDING
DV	3.12	DIVERSION BERM
TSD-1	3.15	TEMPORARY SLOPE DRAIN
IP	3.07	INLET PROTECTION
CIP	3.08	CULVERT INLET PROTECTION
OP	3.18	OUTLET PROTECTION
CD	3.20	ROCK CHECK DAM
SCC-1	3.17	STORM WATER CONVEYANCE CHANNEL
ST-1	3.13	SEDIMENT TRAP
SB-1	3.14	SEDIMENT BASIN

PLAN-VIEW HATCHING



	EXISTING	PROPOSED
DEMOLITION		▨
ASPHALT PAVEMENT	▨	▨
GRAVEL	▨	▨
CONCRETE	▨	▨
WETLANDS	▨	

GENERAL NOTES:

1. EXISTING TOPOGRAPHIC DATA FOR LOTS 2-4, 6-9 AND 12-14 WERE TAKEN FROM A TOPOGRAPHIC SURVEY MAP PREPARED BY WALLACE MORRIS SURVEYING, DATED 7/16/2013.
2. THE CONTRACTOR IS REQUIRED TO PROTECT STRUCTURES AND APPURTENANCES INCLUDING BUT NOT NECESSARILY LIMITED TO WELLS, DRAINAGE STRUCTURES, PROPERTY CORNERS, ETC. THE CONTRACTOR WILL BE REQUIRED TO REPAIR ANY DAMAGES AT NO EXPENSE TO THE OWNER.
3. THE CONTRACTOR MUST CONTACT MISS UTILITY, AT 1-800-227 2600, A MINIMUM OF 48 HRS. PRIOR TO ANY EXCAVATION
4. TOPOGRAPHIC CONTOUR INTERVAL = 2 FOOT
5. COORDINATE SYSTEM IS NAD83 NEVADA STATE PLANES, EAST ZONE, US FOOT (NV83-EF)
6. EXISTING GROUNDWATER SURFACE ESTABLISHED FROM STATIC WATER LEVELS MEASURED ON SEPTEMBER 3, 2013.

NO	BY	CK	APP	REVISIONS AND RECORD OF ISSUE	DATE
0	DAS	LBS	LEJ	ISSUED FOR DEP REVIEW	10/22/13

LEONARD E. JOYCE, JR.
CIVIL
No. 13971
3/14/14

DESIGNED LBS
DRAWN DAS
CHECKED LBS
APPROVED LEJ
DATE 10/22/13

JOYCE
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PHONE (804) 355-4520

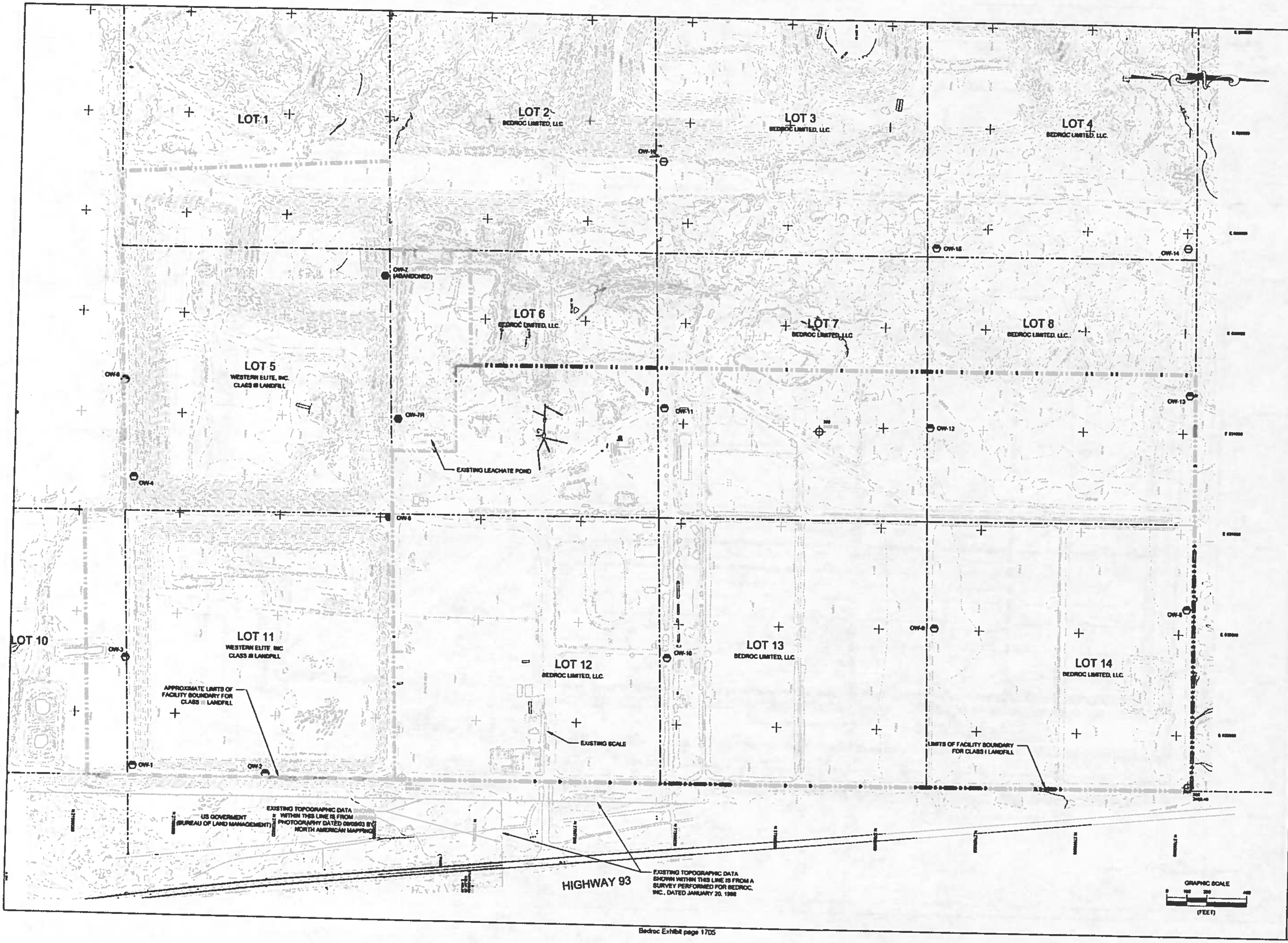
BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

GENERAL NOTES AND LEGEND

PROJECT NO. 383.1401.01

SCALE AS SHOWN

DRAWING NO. 2



DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14	1	DAS	LBB	LLJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LBB	LLJ

L. LEROY JOYCE JR.
No. 13571
CIVIL
5/19/14

DESIGNED LBB
DRAWN DAS
CHECKED LBB
APPROVED LLJ
DATE 10/23/13

JOYCE
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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

EXISTING CONDITIONS PLAN

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
3

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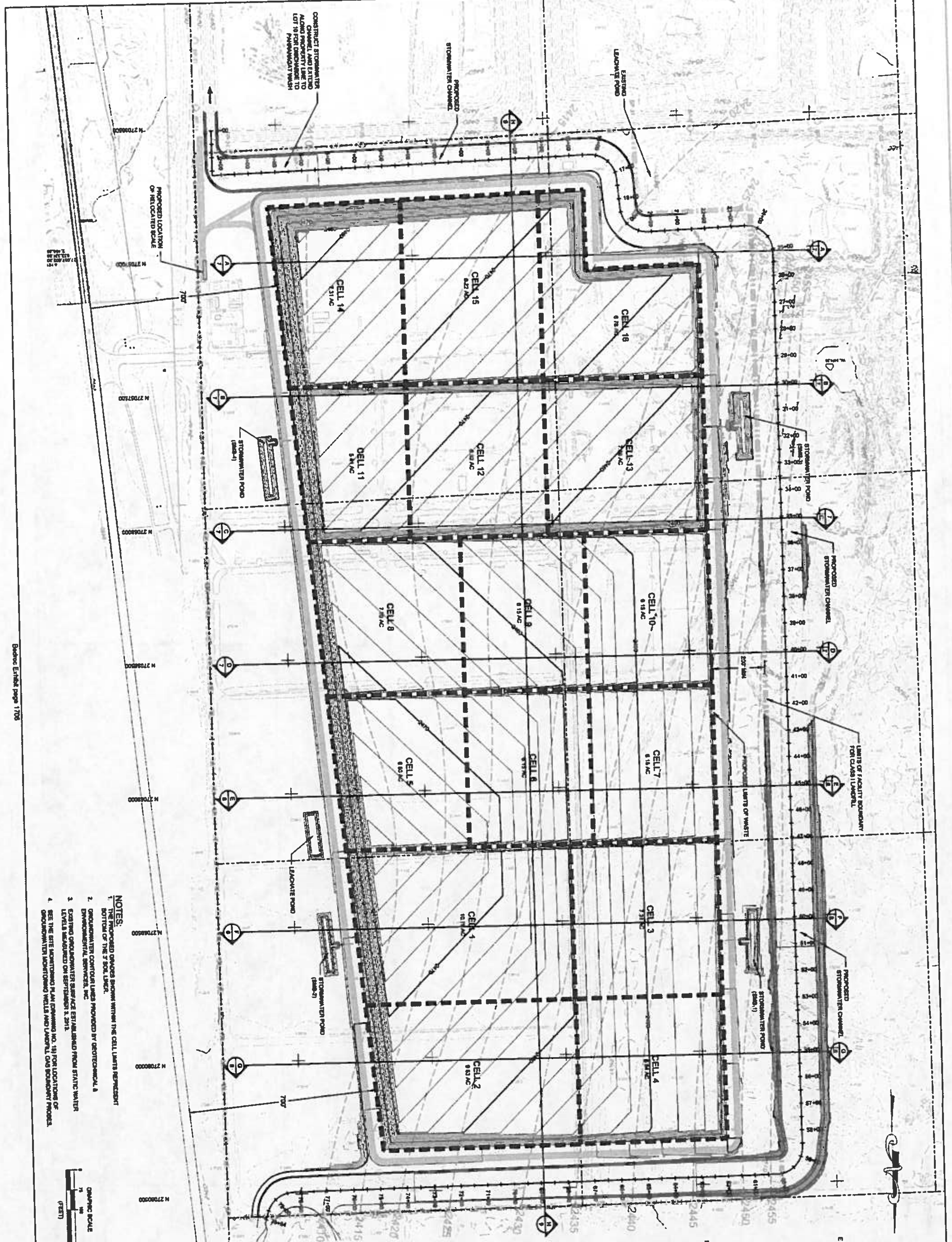

NOTES:
1. THE PROPOSED GRADES SHOWN WITHIN THE CELL LIMITS REPRESENT BOTTOM OF THE 3' SOIL LINER.
2. GROUNDWATER CONTOUR LINES PROVIDED BY GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
3. EXISTING GROUNDWATER SURFACE ESTABLISHED FROM STATIC WATER LEVELS MEASURED ON SEPTEMBER 3, 2013.
4. SEE THE SITE MONITORING PLAN (DRAWING NO. 19) FOR LOCATIONS OF GROUNDWATER MONITORING WELLS AND LANDFILL GAS BOUNDARY PROBES.

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/23/14	3	DAS	LBS	LEJ
5/7/14	REVISED IN RESPONSE TO NDEP COMMENTS	2	DAS	LBS	LEJ
2/6/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14	1	DAS	LBS	LEJ
10/22/13	ISSUED FOR DEP REVIEW	0	DAS	LBS	LEJ

LEONARD E. JOYCE, JR.
CIVIL
No. 13876
5/19/14

DESIGNED LBS
DRAWN DAS
CHECKED LBS
APPROVED LEJ
DATE 10/22/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

BASE GRADING PLAN

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
4

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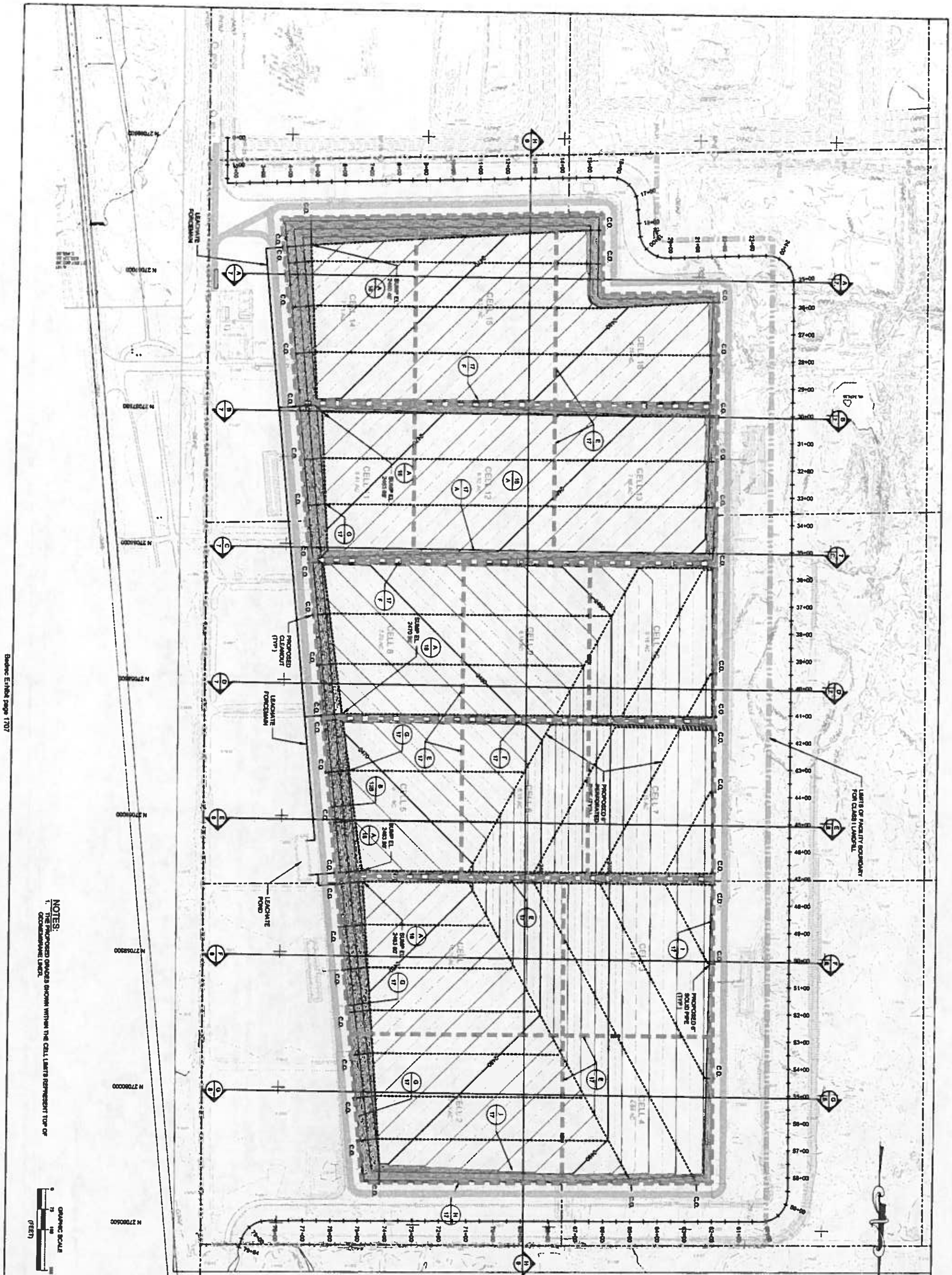

NOTES:

1. THE PROPOSED GRADES SHOWN WITHIN THE CELL LIMITS REPRESENT TOP OF GEOMEMBRANE LINER.

Bedroc Exhibit page 1707

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

LEACHATE MANAGEMENT PLAN

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DESIGNED	LBB
DRAWN	DAS
CHECKED	LBB
APPROVED	LEJ
DATE	10/23/13

LEONARD E. JOYCE JR.
CIVIL
No. 13378

5/19/14

5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14	2	DAS	LBB	LEJ
2/3/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14	1	DAS	LBB	LEJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LBB	LEJ
DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
5

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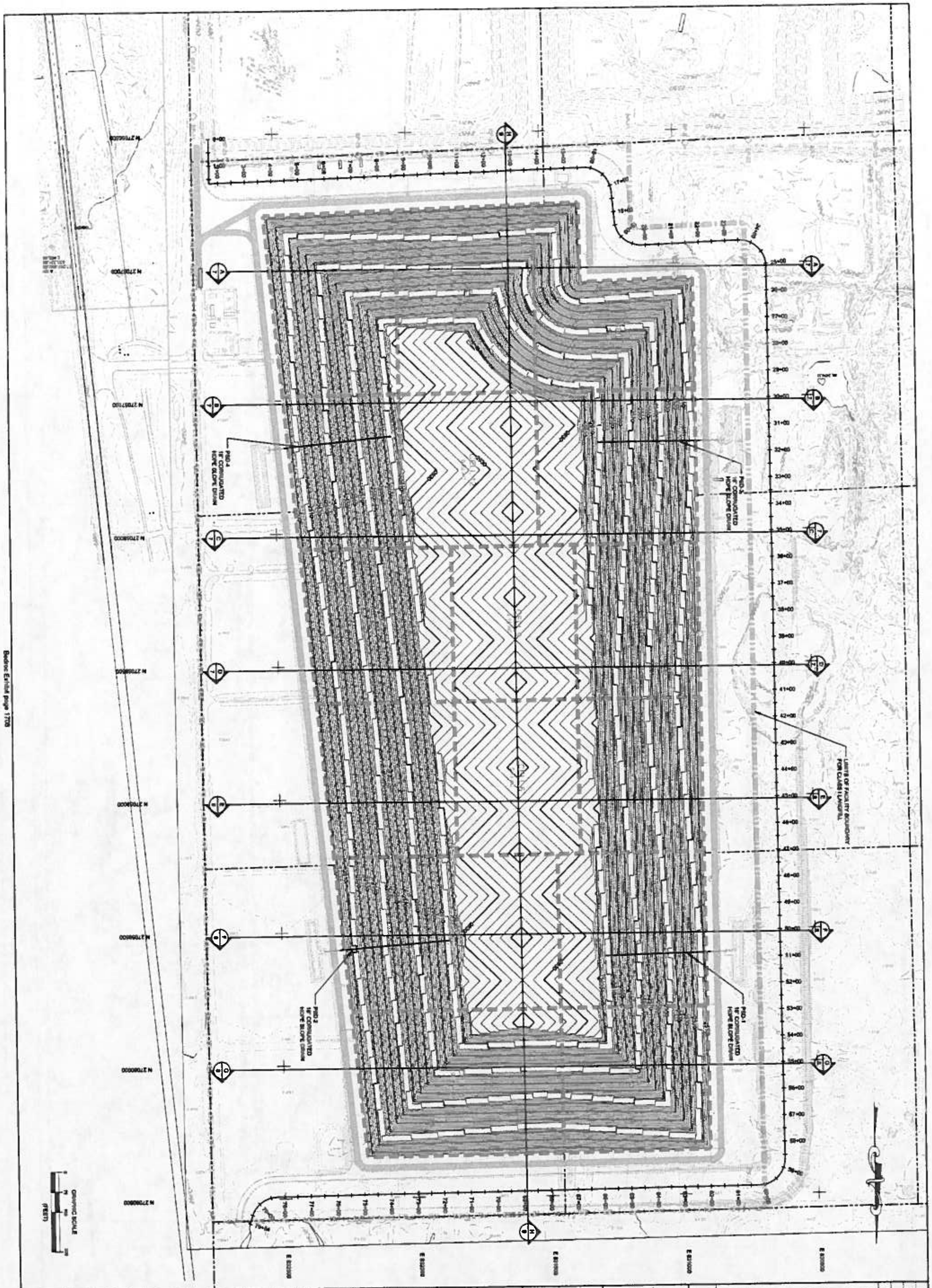

Bedroc Exhibit page 1705

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

FINAL GRADING PLAN

PROJECT NO. 383.1401.01
SCALE AS SHOWN
DRAWING NO. 6

JOYCE ENGINEERING
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RICHMOND, VA 23220
PHONE (804) 355-4520

DESIGNED LSB
DRAWN DAS
CHECKED LSB
APPROVED LEJ
DATE 10/23/13

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LEONARD E. JOYCE, JR.
CIVIL
No. 13876

5/19/14

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/13/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/23/14	2	DAS	LSB	LEJ
2/6/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14	1	DAS	LSB	LEJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LSB	LEJ

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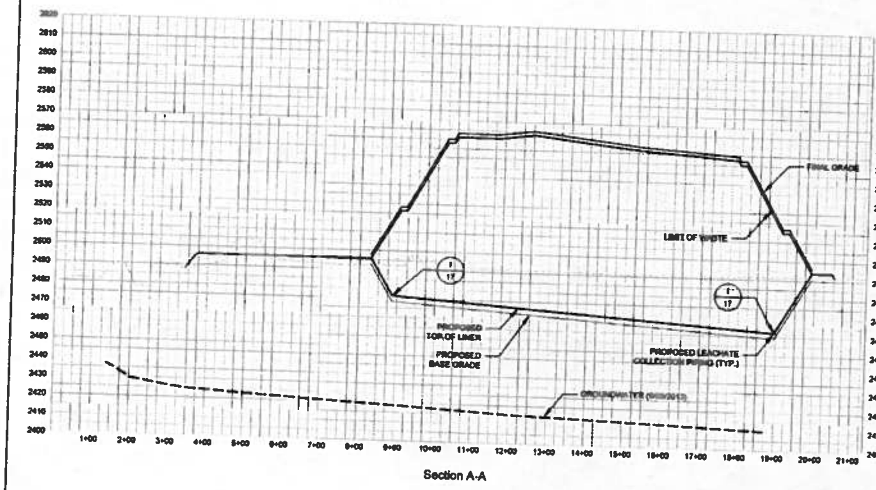
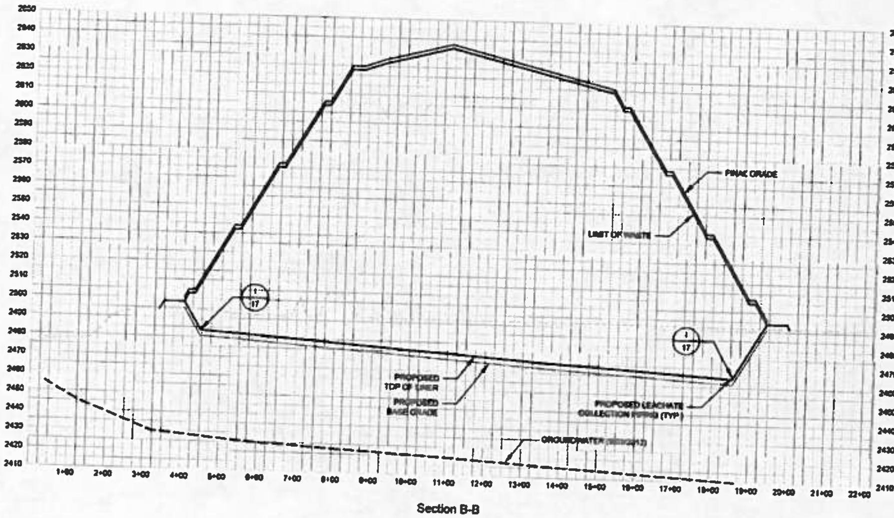
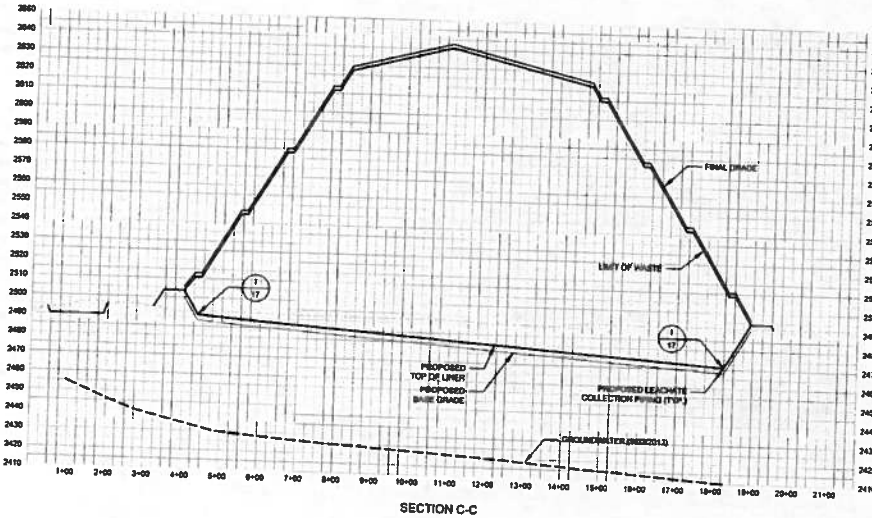


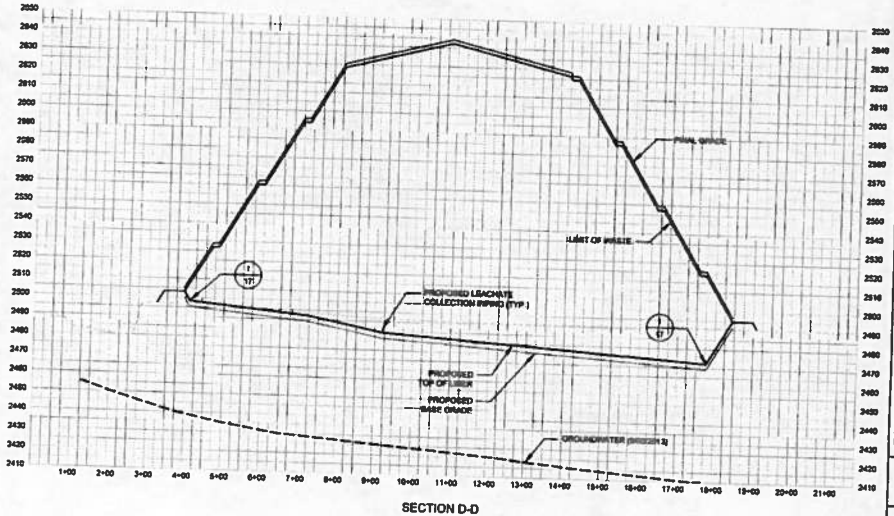
Section A-A



Section B-B



SECTION C-C



SECTION D-D

NO	DATE	REVISIONS AND RECORD OF ISSUE	BY	CK	APP
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	[illegible]	ISSUED FOR DEP REVIEW	DAS	LRB	LBJ

11/7/14

DESIGNED LRB
DRAWN DAS
CHECKED LRB
APPROVED LBJ
DATE 10/22/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

SECTIONS A-A TO D-D

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
7

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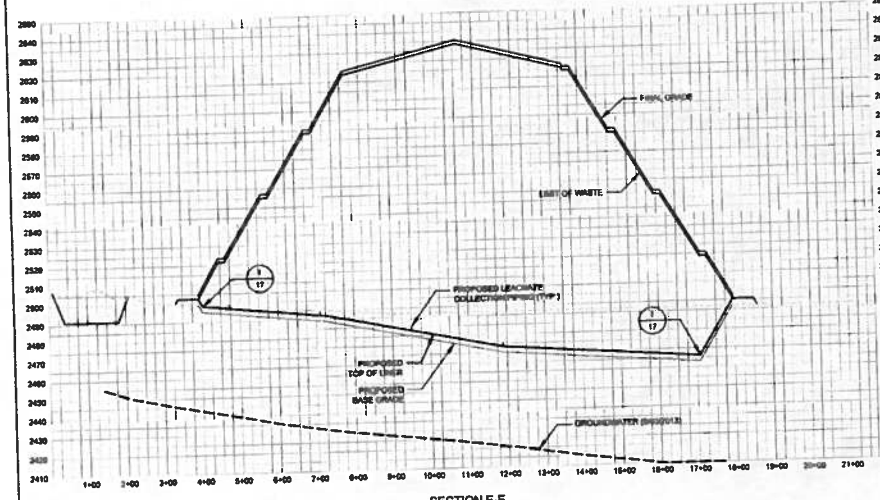
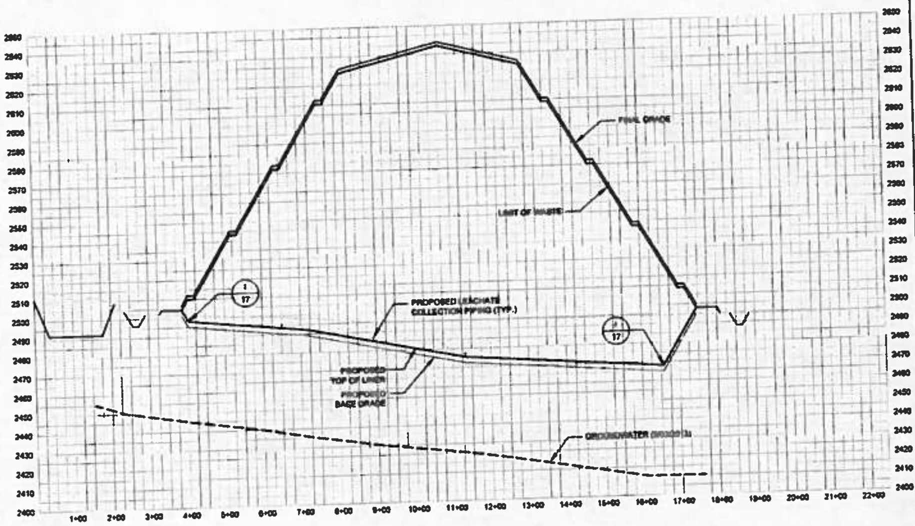


SECTION E-E



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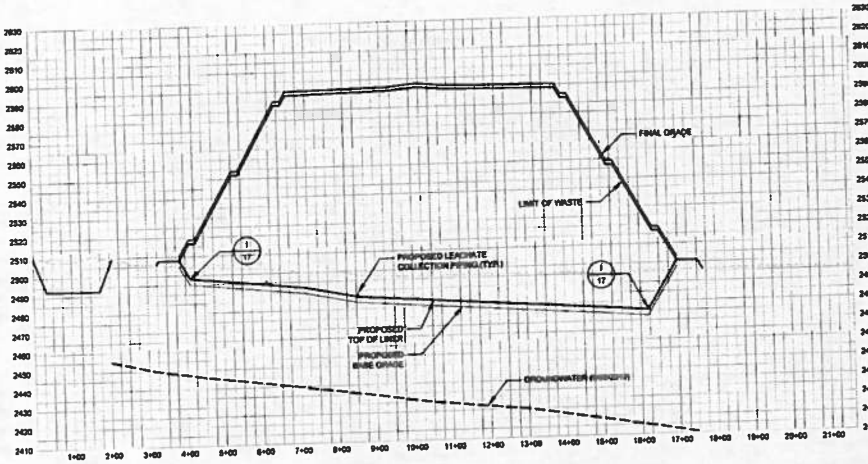

SECTION G-G

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0	10/23/13	ISSUED FOR DEP REVIEW	DAS	LBB	LLJ

LEONARD E. JOYCE JR.
No. 13575
5/19/14

DESIGNED LBB
DRAWN DAS
CHECKED LBB
APPROVED LLJ
DATE 10/23/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

SECTIONS E-E TO G-G

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
8

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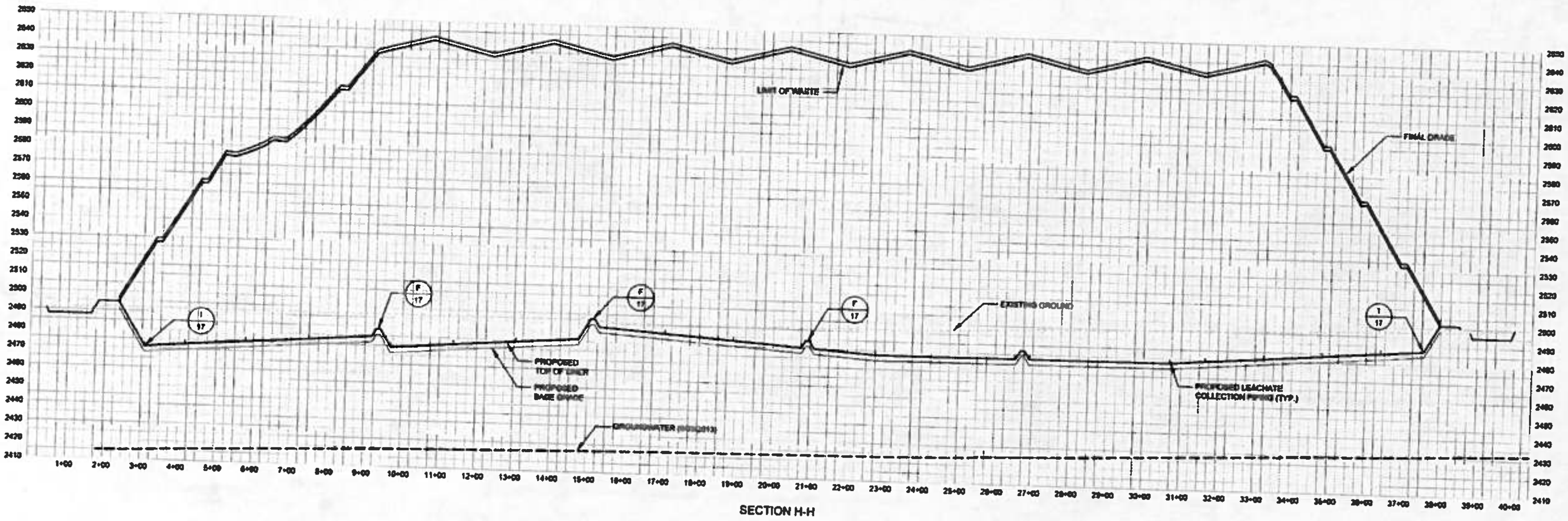

SECTION H-H

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED in RESPONSE TO NDEP COMMENTS DATED 4/22/14	1	DAS	LHS	LLJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LHS	LLJ

5/19/14

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DESIGNED LHS
DRAWN DAS
CHECKED LHS
APPROVED LLJ
DATE 10/23/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

SECTION H-H

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
9

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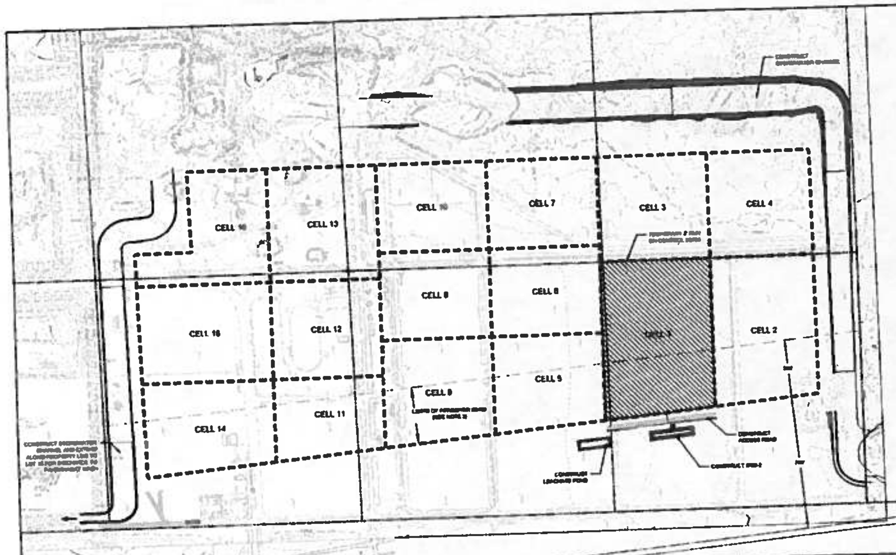
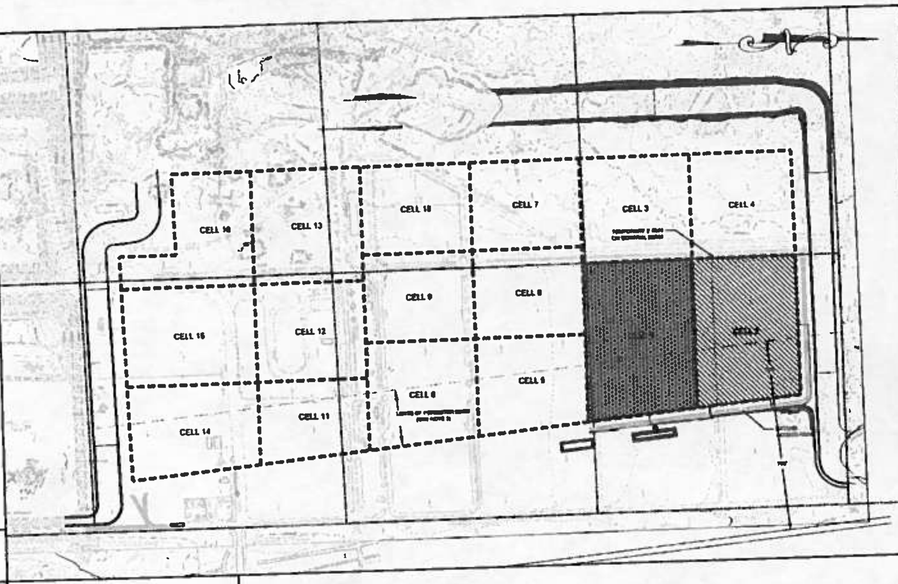


PHASE I
TOP OF LINER: CELL 1

CELL 1
AREA: ±10.78 AC.
CAPACITY: 7,033,846 C.Y

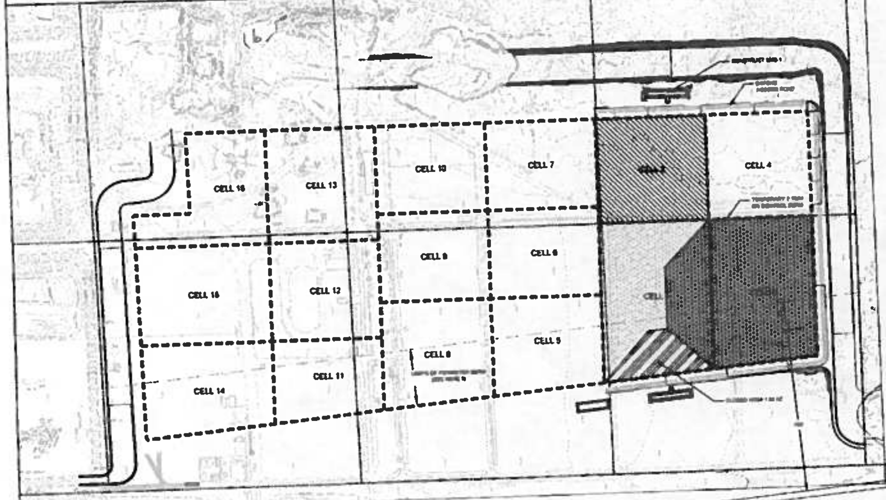


PHASE II
TOP OF WASTE: CELL 1
TOP OF LINER: CELL 2

CELL 2
AREA: ±9.53 AC
CAPACITY: 1,202,177 C.Y

NOTES:

1. CELL CAPACITY DETERMINED BY EXTENDING CELL LIMIT VERTICALLY TO THE TOP OF THE INTERMEDIATE COVER
2. LANDFILL GAS BOUNDARY PROBES AND GROUNDWATER MONITORING WELLS WILL BE INSTALLED IN ACCORDANCE WITH THE SCHEDULES ON THE SITE MONITORING PLAN (DRAWING NO. 15)
3. PERIMETER SCREENING BERMS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A WHEN WASTE DISPOSAL ACTIVITIES ARE WITHIN 1,000' OF HIGHWAY 93.



PHASE III
TOP OF WASTE: CELL 2
TOP OF LINER: CELL 3

CELL 3
AREA: ±7.31 AC.
CAPACITY: 1,[illegible],038 C.Y

▨	BASE GRADING AREA
▩	INTERMEDIATE GRADING AREA
░	PREVIOUSLY FILLED AREA
▧	AREA TO BE CLOSED

PHASE IV
TOP OF WASTE: CELL 3
TOP OF LINER: CELL 4

CELL 4
AREA: ±6.84 AC.
CAPACITY: 700,416 C.Y.

Bedroc Exhibit page 1712

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14	2	DAS	LRB	LRJ
2/6/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/10/14	1	DAS	LRB	LRJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LRB	LRJ

5/19/14

DESIGNED LRB
DRAWN DAS
CHECKED LRB
APPROVED LRJ
DATE 10/23/13

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PHONE: (804) 355-4520

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

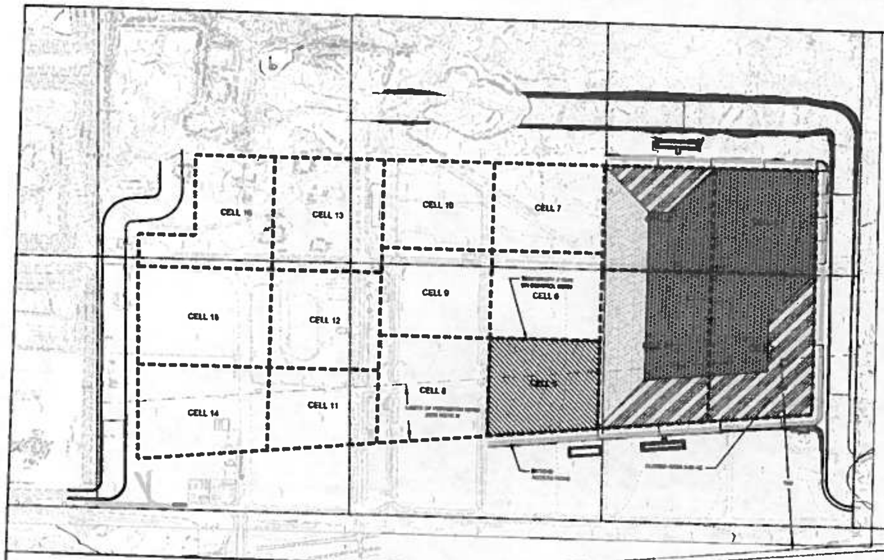
PHASING PLANS
PHASES I-IV

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

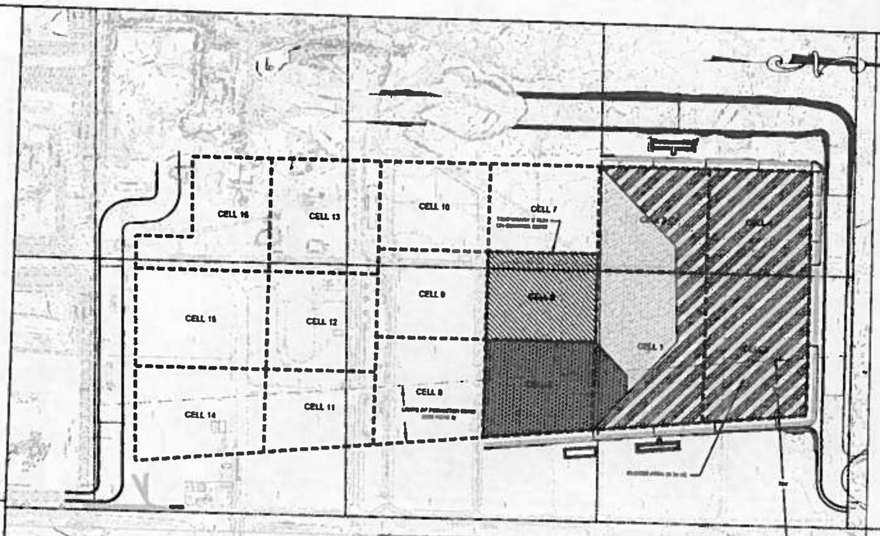
DRAWING NO.
10

L:\Western Elsberg\Northern Site Expansion\Current Working Drawings\Print Sheets\14 Phasing Plans - Phases XVII-XIX.dwg Layout=10 Phasing Plans - Phases I-IV



PHASE V
TOP OF WASTE: CELL 4
TOP OF LINER: CELL 5

CELL 5
AREA: ±6.80 AC.
CAPACITY: 980,367 C.Y.

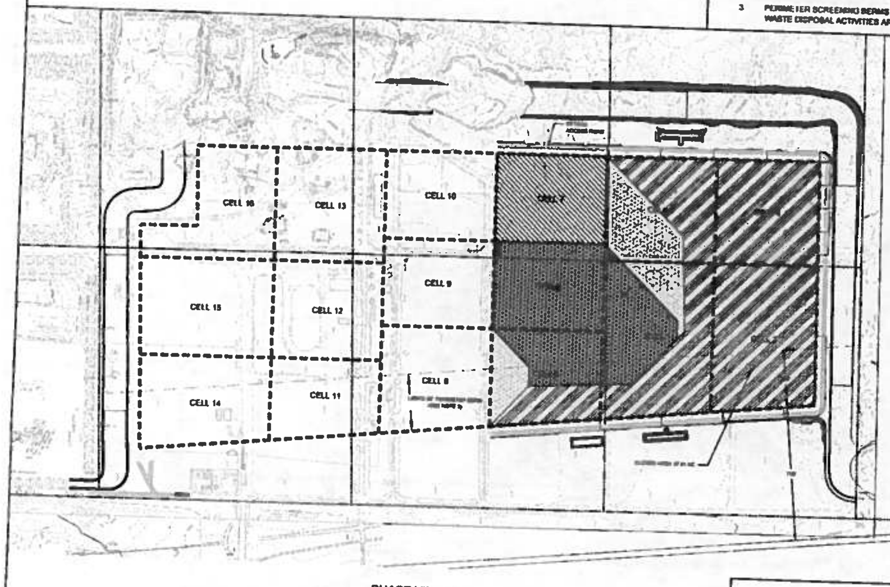


PHASE VI
TOP OF WASTE: CELL 5
TOP OF LINER: CELL 6

CELL 6
AREA: ±8.19 AC
CAPACITY: 1,460,504 C.Y.

NOTES:

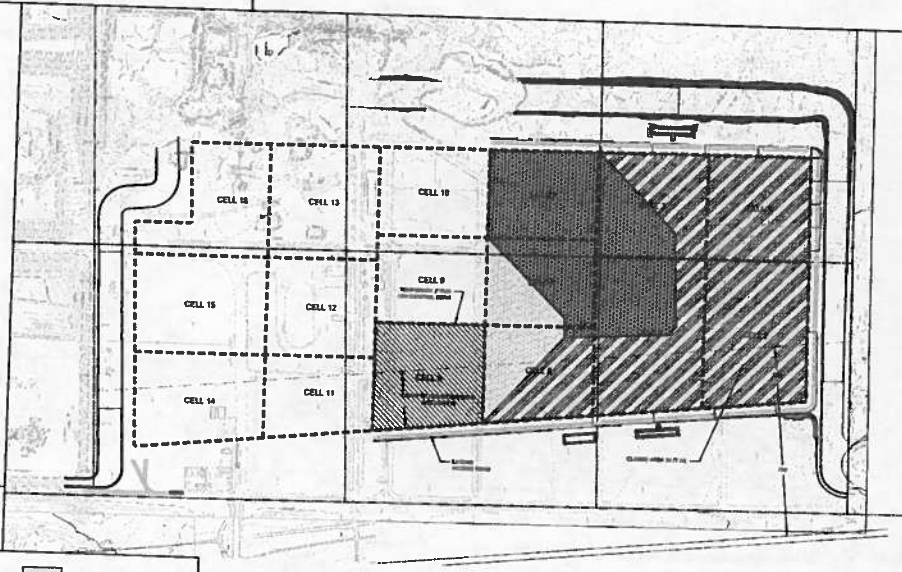
1. CELL CAPACITY DETERMINED BY EXTENDING CELL LIMIT VERTICALLY TO THE TOP OF THE INTERMEDIATE COVER.
2. LANDFILL GAS BOUNDARY PROBES AND GROUNDWATER MONITORING WELLS WILL BE INSTALLED IN ACCORDANCE WITH THE SCHEDULES ON THE SITE MONITORING PLAN (DRAWING NO. 15)
3. PERIMETER SCREENING BERMS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A WHEN WASTE DISPOSAL ACTIVITIES ARE WITHIN 1,000' OF HIGHWAY 93



PHASE VII
TOP OF WASTE: CELL 6
TOP OF LINER: CELL 7

CELL 7
AREA: ±6.16 AC.
CAPACITY: 743,137 C.Y.

▨ BASE GRADING AREA	░ PREVIOUSLY FILLED AREA
▩ INTERMEDIATE GRADING AREA	▧ AREA TO BE CLOSED



PHASE VIII
TOP OF WASTE: CELL 7
TOP OF LINER: CELL 8

CELL 8
AREA: ±7.20 AC.
CAPACITY: 1,051,216 C.Y.

GRAPHIC SCALE
0 100 200 400
(FEET)

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

PHASING PLANS
PHASES V-VII

JOYCE
ENGINEERING
1604 OWNBY LANE
RICHMOND, VA 23220
PHONE (804) 355-4520

DESIGNED LBB
DRAWN DAS
CHECKED LBB
APPROVED LEJ
DATE 10/23/13

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CIVIL
No. 13079
8/15/14

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
8/15/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/23/14	2	DAS	LBB	LEJ
2/5/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14	1	DAS	LBB	LEJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LBB	LEJ

PROJECT NO.
383.1401.01

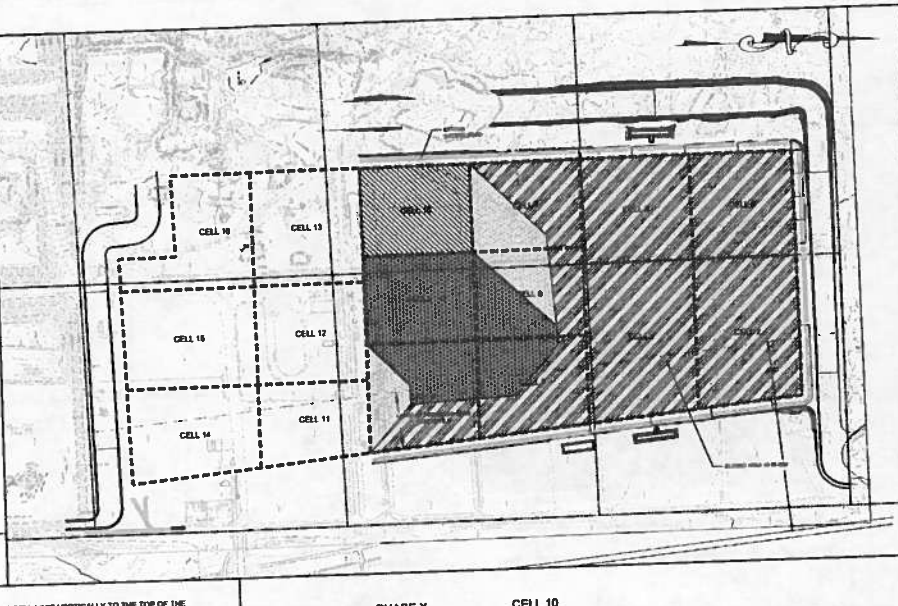
SCALE
AS SHOWN

DRAWING NO.
11

L:\Western Elsewhere\Bedroc Site Expansion\Current Working Drawings\Print Sheets\14 Phasing Plans - Phases XVII-XIX.dwg Layout=11 Phasing Plans - Phases V-VII

PHASE IX
TOP OF WASTE : CELL 8
TOP OF LINER: CELL 9

CELL 9
AREA: ±6.15 AC.
CAPACITY: 1,437,008 C.Y.



PHASE X
TOP OF WASTE : CELL 9
TOP OF LINER: CELL 10

CELL 10
AREA: ±6.15 AC.
CAPACITY: 728,597 C.Y.

NOTES:

1. CELL CAPACITY DETERMINED BY EXTENDING CELL LIMIT VERTICALLY TO THE TOP OF THE INTERMEDIATE COVER.
2. LANDFILL GAS BOUNDARY PROBES AND GROUNDWATER MONITORING WELLS WILL BE INSTALLED IN ACCORDANCE WITH THE SCHEDULES ON THE SITE MONITORING PLAN (DRAWING NO. 15)
3. PERIMETER SCREENING BERMS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A WHEN WASTE DISPOSAL ACTIVITIES ARE WITHIN 1,000' OF HIGHWAY 93

PHASE XI
TOP OF WASTE : CELL 10
TOP OF LINER: CELL 11

CELL 11
AREA: ±5.41 AC.
CAPACITY: 690,898 C.Y.

▨ BASE GRADING AREA	░ PREVIOUSLY FILLED AREA
▩ INTERMEDIATE GRADING AREA	▨ AREA TO BE CLOSED

PHASE XII
TOP OF WASTE: CELL 11
TOP OF LINER: CELL 12

CELL 12
AREA: ±6.82 AC.
CAPACITY: 1,846,807 C.Y.

GRAPHIC SCALE
0 100 200 400
(FEET)

Bedroc Exhibit page 1714

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/?/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/2/14	2	DAS	LBB	LJJ
2/?/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/?/14	1	DAS	LBB	LJJ
10/2/13	ISSUED FOR DEP REVIEW	0	DAS	LBB	LJJ

LEONARD E. JOYCE, JR.
CIVIL
No. 13870

DESIGNED LBB
DRAWN DAS
CHECKED LBB
APPROVED LJJ
DATE 10/2/13

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PHONE: (804) 355-4520

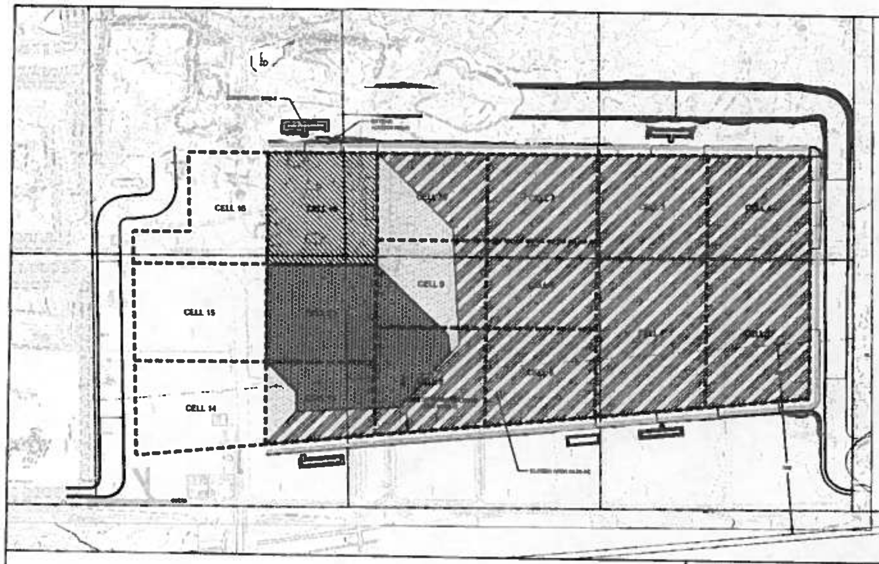
BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

PHASING PLANS
PHASES IX-XII

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
12

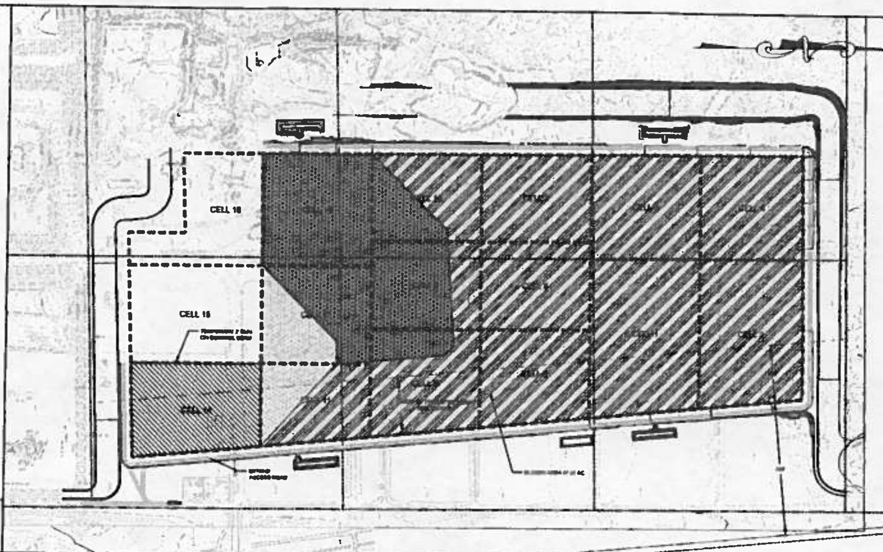


PHASE XIII
TOP OF WASTE : CELL 12
TOP OF LINER: CELL 13

CELL 13
AREA: ±7.90 AC.
CAPACITY: 1,185,430 C.Y.

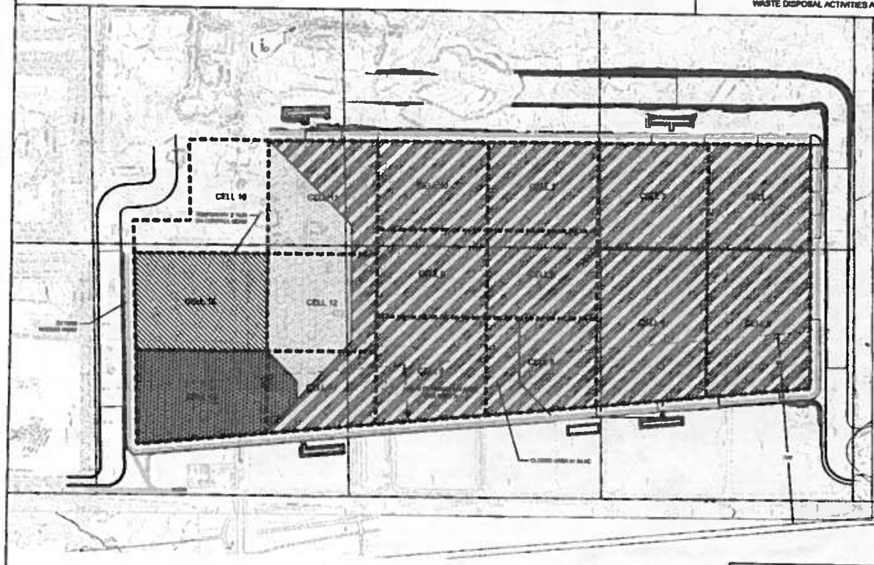
NOTES:

1. CELL CAPACITY DETERMINED BY EXTENDING CELL LIMIT VERTICALLY TO THE TOP OF THE INTERMEDIATE COVER
2. LANDFILL GAS BOUNDARY PROBES AND GROUNDWATER MONITORING WELLS WILL BE INSTALLED IN ACCORDANCE WITH THE SCHEDULES ON THE SITE MONITORING PLAN (DRAWING NO 15)
3. PERIMETER SCREENING BERMS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A WHEN WASTE DISPOSAL ACTIVITIES ARE WITHIN 1,000' OF HIGHWAY 93.



PHASE XIV
TOP OF WASTE : CELL 13
TOP OF LINER: CELL 14

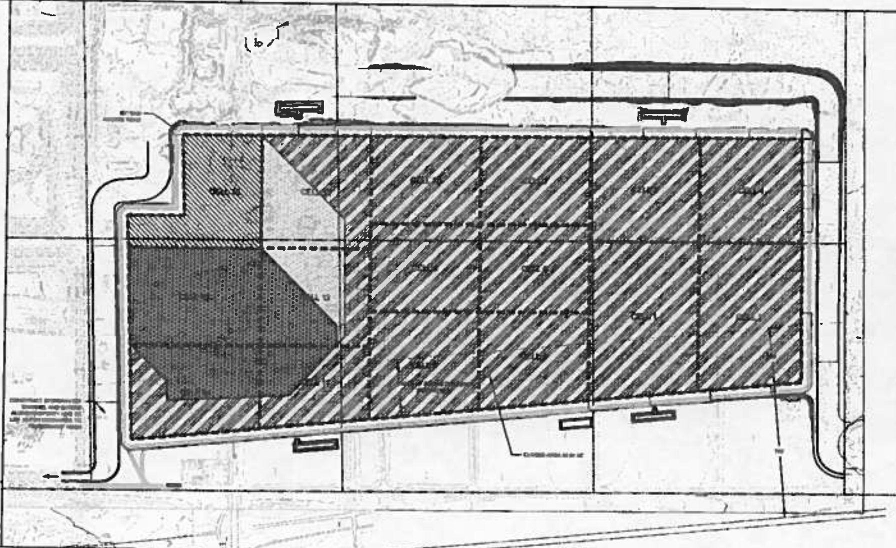
CELL 14
AREA: ±7.31 AC
CAPACITY: 687,767 C.Y.



PHASE XV
TOP OF WASTE : CELL 14
TOP OF LINER: CELL 15

CELL 15
AREA: ±8.22 AC
CAPACITY: 1,300,991 C.Y

▨ BASE GRADING AREA	░ PREVIOUSLY FILLED AREA
▩ INTERMEDIATE GRADING AREA	▨ AREA TO BE CLOSED



PHASE XVI
TOP OF WASTE : CELL 15
TOP OF LINER: CELL 16

CELL 16
AREA: ±8.78 AC.
CAPACITY: 600,028 C.Y.

GRAPHIC SCALE
0 100 200 500
(FEET)

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/29/14	2	DAS	LBS	LEJ
2/6/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14	1	DAS	LBS	LEJ
10/22/13	ISSUED FOR DEP REVIEW		DAS	LBS	LEJ

LEONARD JOYCE
CIVIL
No. 13270
5/19/14

DESIGNED LBS
DRAWN DAS
CHECKED LBS
APPROVED LEJ
DATE 10/22/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

PHASING PLANS
PHASES XIII-XVI

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
13

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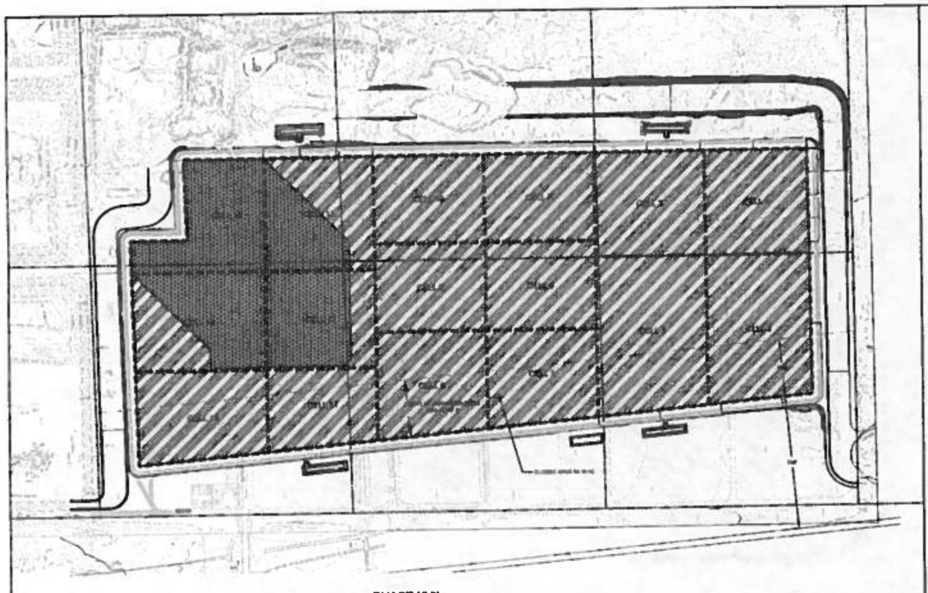

PHASE XVII
TOP OF WASTE CELL 16

▨ BASE GRADING AREA
▩ INTERMEDIATE GRADING AREA
▭ PREVIOUSLY FILLED AREA
▨ AREA TO BE CLOSED

NOTES:

1. CELL CAPACITY DETERMINED BY EXTENDING CELL LIMIT VERTICALLY TO THE TOP OF THE INTERMEDIATE COVER.
2. LANDFILL GAS BOUNDARY PROBES AND GROUNDWATER MONITORING WELLS WILL BE INSTALLED IN ACCORDANCE WITH THE SCHEDULES ON THE SITE MONITORING PLAN (DRAWING NO. 15)
3. PERIMETER SCREENING BERMS SHALL BE CONSTRUCTED IN ACCORDANCE WITH DETAIL A WHEN WASTE DISPOSAL ACTIVITIES ARE WITHIN 1,000' OF HIGHWAY 93

GRAPHIC SCALE
0 150 300 600
(FEET)

DATE	REVISIONS AND RECORD OF ISSUE	NO	BY	CK	APP
5/1/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14	2	DAS	LRB	LEJ
2/3/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14	1	DAS	LRB	LEJ
10/23/13	ISSUED FOR DEP REVIEW	0	DAS	LRB	LEJ

STATE OF NEVADA
LEONARD ATKELA
CIVIL
No. 13370
5/1/14

DESIGNED LRB
DRAWN DAS
CHECKED LRB
APPROVED LEJ
DATE 10/23/13

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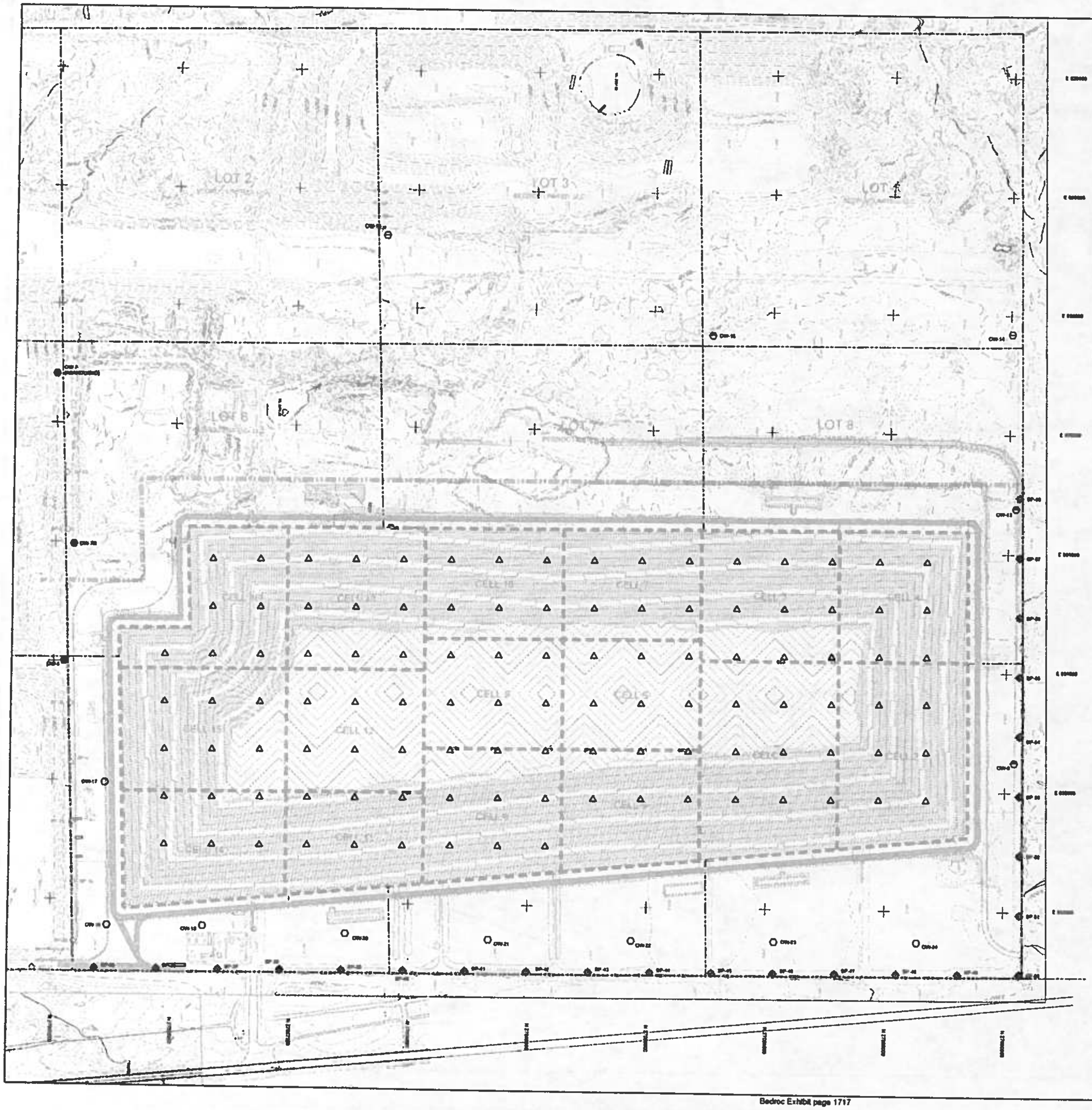
BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

PHASING PLANS
PHASES XVII-XIX

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
14



Bedroc Exhibit page 1717

SCHEDULE OF ADDITION AND REMOVAL OF WELLS FROM COMPLIANCE NETWORK BEDROC LANDFILL AND WASTE MANAGEMENT FACILITY LINCOLN COUNTY, NEVADA				
Cell No.	Monitoring Well Network Changes		Monitoring Well Network	
	Add		Upgradient	Downgradient
Cell 1	OW-14, OW-16, OW-22, OW-23 and OW-24	OW-9	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 2	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 3	–	OW-12	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 4	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 5	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 6	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 7	–	–	OW-14 and OW-16	OW-22, OW-23 and OW-24
Cell 8	OW-21	–	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 9	–	–	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 10	–	–	OW-14 and OW-16	OW-21, OW-22, OW-23 and OW-24
Cell 11	OW-20	OW-10	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 12	–	–	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 13	–	OW-11	OW-14 and OW-16	OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 14	OW-18 and OW-19	–	OW-14 and OW-16	OW-18, OW-19, OW-20, OW-21, OW-22, OW-23 and OW-24
Cell 15	OW-17	–	OW-14 and OW-16	OW-17, OW-18, OW-19, OW-20, OW-21, OW-22, OW-23, and OW-24
Cell 16	OW-6 (formerly Class III facility upgradient well)	–	OW-14 and OW-16	OW-6, OW-17, OW-18, OW-19, OW-20, OW-21, OW-22, OW-23, and OW-24

Boundary Probe Installation Schedule		
Cell	Add	Network
1	BP-44, 45, 46, 47 & 48	BP-44, 45, 46, 47 & 48
2	BP-47, 48, 49, 50, 51, 52, 53, 54, 55 & 56	BP-44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55 & 56
3		BP-44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55 & 56
4	BP-57 & 58	BP-44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
5	BP-42 & 43	BP-42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
6		BP-42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
7		BP-42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
8	BP-40 & 41	BP-40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
9		BP-40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
10		BP-40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
11	BP-37, 38 & 39	BP-37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
12		BP-37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
13		BP-37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
14	BP-35 & 36	BP-35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
15		BP-35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58
16		BP-35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57 & 58

GRAPHIC SCALE

(FEET)

NO	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE
3	DAS	LMB	LBJ	5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/23/14
2	DAS	LMB	LBJ	5/19/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/23/14
1	DAS	LMB	LBJ	3/4/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 1/16/14
0	DAS	LMB	LBJ	10/22/13	ISSUED FOR DEP REVIEW

5/12/14

DESIGNED LMB
DRAWN DAS
CHECKED LMB
APPROVED LBJ
DATE 10/22/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

SITE MONITORING PLAN

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
15

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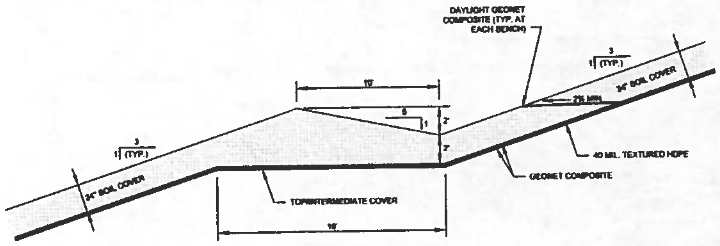


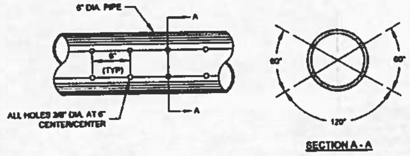
CAP BENCH DETAIL (B)
N.T.S

NOTES:

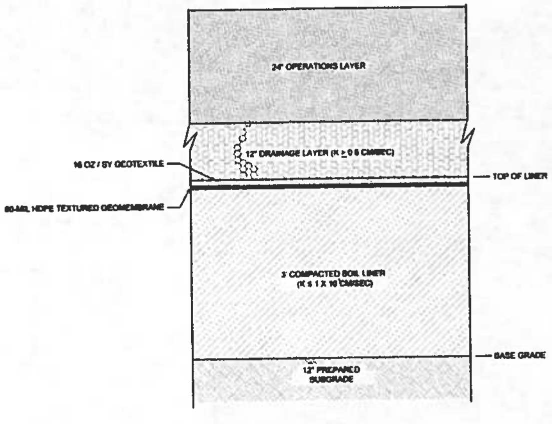
1. PREPARED SUBGRADE CONSISTS OF MATERIALS MEETING THE UNIFIED SOIL CLASSIFICATION CODES OF SC, ML, CL, MH, OR CH. IT WILL BE COMPACTED TO 90% OF THE MAXIMUM DRY DENSITY IN ACCORDANCE WITH ASTM D698. THE SURFACE WILL BE SMOOTH ROLLED AND FREE OF ROCKS OR STONE IN EXCESS OF 3/4".

2. THE OPERATIONS LAYER WILL CONSIST OF A MINIMUM OF 24 INCHES OF SELECT WASTE, AVOIDING BULKY AND LARGE RIGID ITEMS. THIS LAYER WILL NOT BE COMPACTED AND WILL SERVE AS A PROTECTIVE LAYER TO THE LINER AND DRAINAGE SYSTEM.

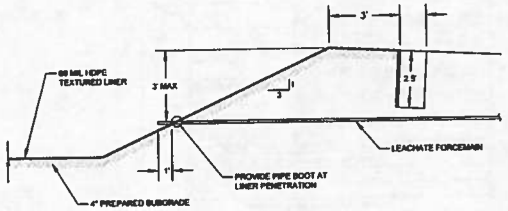
3 THE OPERATIONS LAYER SHOWN ON THESE DRAWINGS WILL NOT BE PLACED DURING CONSTRUCTION OF THE LINER. THIS LAYER WILL BE PLACED IN THE CELL AFTER THE CERTIFICATE TO OPERATE FOR THE CELL IS ISSUED FROM DEP.



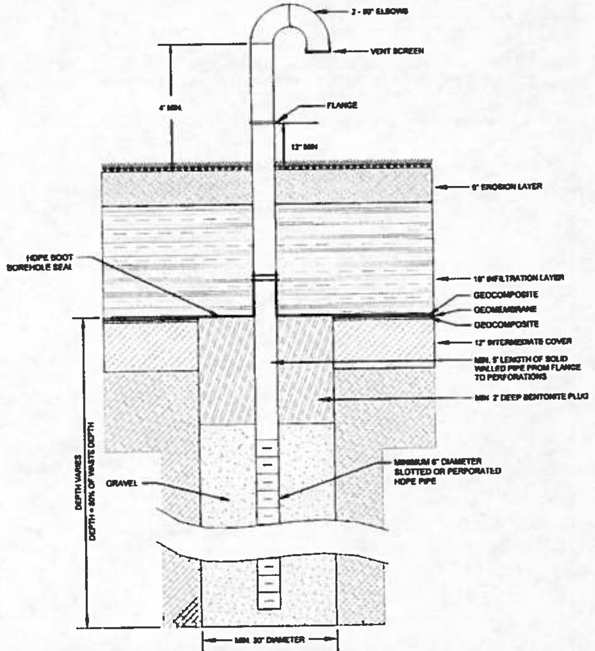
PERFORATED LEACHATE COLLECTION PIPE DETAIL (C)
N.T.S.



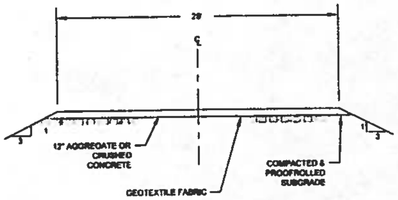
CLASS I BOTTOM LINER SECTION (A)
N.T.S



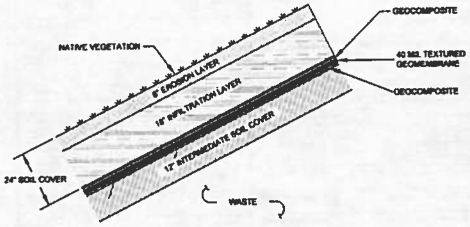
LEACHATE POND LINER DETAIL (D)
N.T.S.



TYPICAL PASSIVE LANDFILL GAS VENT (B)
N.T.S.



ROAD DETAIL (E)
N.T.S



FINAL COVER DETAIL (E)
N.T.S

NO	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE
0	JRJ	LRB	LBJ	10/23/13	ISSUED FOR DEP REVIEW

JOYCE ENGINEERING
1604 OWNBY LANE
RICHMOND, VA 23220
PHONE: (804) 355-4520

DESIGNED JRJ
DRAWN DAS
CHECKED LRB
APPROVED LBJ
DATE 10/23/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

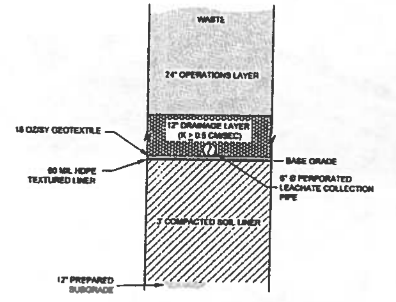
DETAILS

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

DRAWING NO.
16

L:\Western Elko\Bedroc\Northern Site Expansion\Current Working Drawings\Print Sheets\16 Details.dwg Layout=16 Details



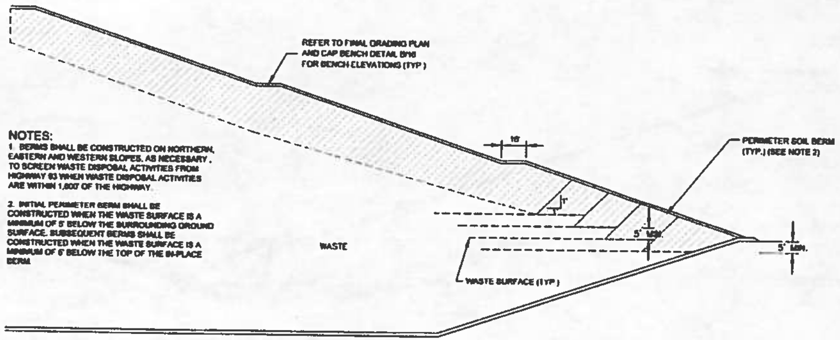
SECTION AT LEACHATE PIPE (A)
N.T.S.

NOTES:

1. PREPARED SUBGRADE CONSISTS OF MATERIALS MEETING THE UNIFIED SOIL CLASSIFICATION CODES OF SC, ML, CL, MH, OR CH. IT WILL BE COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY IN ACCORDANCE WITH ASTM D698. THE SURFACE WILL BE SMOOTH ROLLED AND FREE OF ROCKS OR STONE IN EXCESS OF 3/4"

2. THE OPERATIONS LAYER WILL CONSIST OF A MINIMUM OF 24 INCHES OF SELECT WASTE, AVOIDING BULKY AND LARGE RIGID ITEMS. THIS LAYER WILL NOT BE COMPACTED AND WILL SERVE AS A PROTECTIVE LAYER TO THE LINER AND DRAINAGE SYSTEM.

3. THE OPERATIONS LAYER SHOWN ON THESE DRAWINGS WILL NOT BE PLACED DURING CONSTRUCTION OF THE LINER. THIS LAYER WILL BE PLACED IN THE CELL AFTER THE CERTIFICATE TO OPERATE FOR THE CELL IS ISSUED FROM DEP

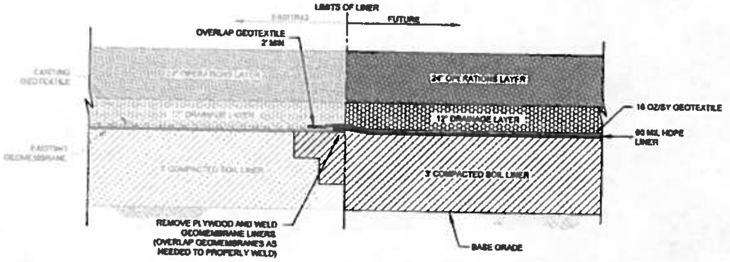


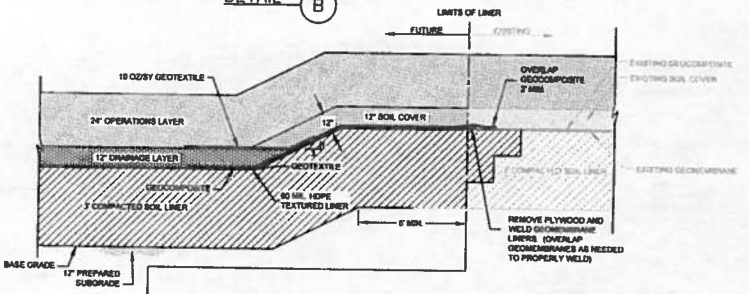
NOTES:

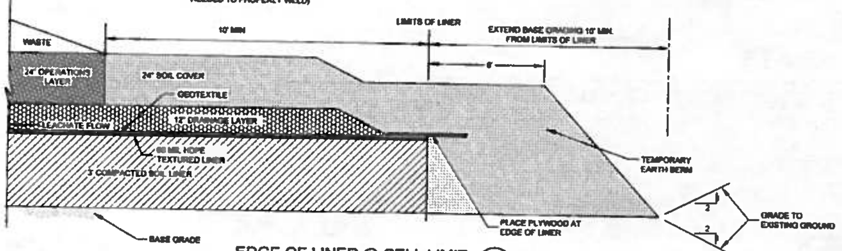
1. BERMS SHALL BE CONSTRUCTED ON NORTHERN, EASTERN AND WESTERN SLOPES, AS NECESSARY, TO SCREEN WASTE DISPOSAL ACTIVITIES FROM HIGHWAY 93 WHEN WASTE DISPOSAL ACTIVITIES ARE WITHIN 1,500' OF THE HIGHWAY.

2. INITIAL PERIMETER BERM SHALL BE CONSTRUCTED WHEN THE WASTE SURFACE IS A MINIMUM OF 5' BELOW THE SURROUNDING GROUND SURFACE. SUBSEQUENT BERMS SHALL BE CONSTRUCTED WHEN THE WASTE SURFACE IS A MINIMUM OF 6' BELOW THE TOP OF THE IN-PLACE BERM

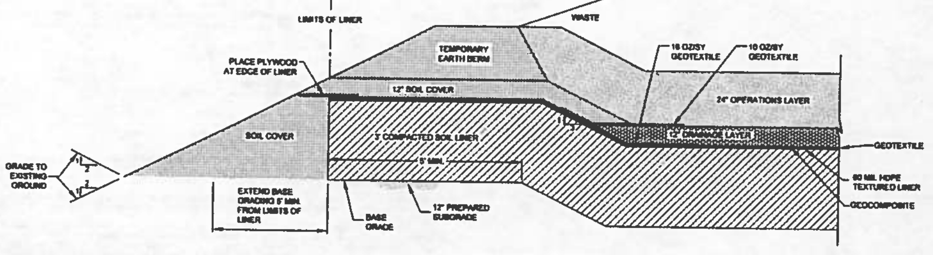
DETAIL (B)



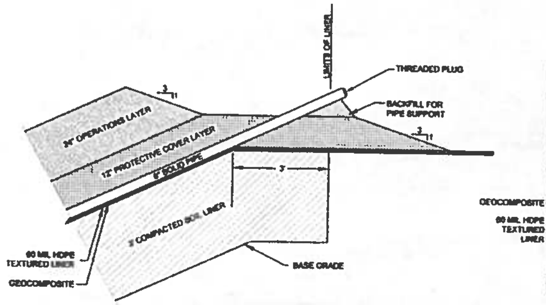




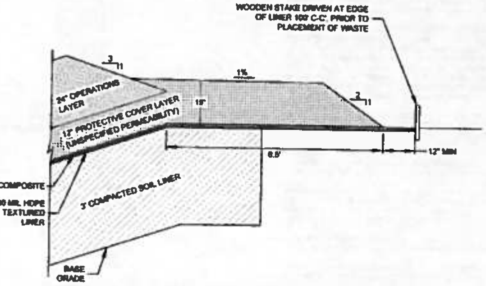
EDGE OF LINER @ CELL LIMIT (E)
NTS



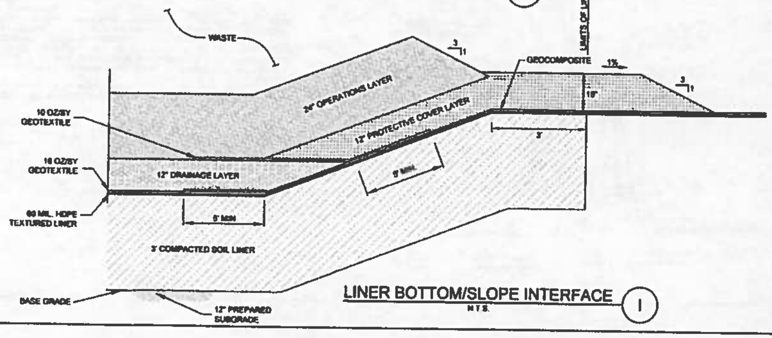
INTERMEDIATE CELL BERM (F)
N.T.S.



CLEAN-OUT DETAIL (G)
N.T.S.



LINER ANCHOR TRENCH DETAIL (H)
NTS



LINER BOTTOM/SLOPE INTERFACE (I)
N.T.S.

NO	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE
1	WWV	LRB	LLJ	5/19/14	REVISED in RESPONSE TO NDEP COMMENTS DATED 4/22/14
0	JB	LRB	LLJ	10/22/13	ISSUED FOR DEP REVIEW

LEONARD JOYCE JR.
CIVIL
No. 13876
5/17/14

DESIGNED JS
DRAWN DAS
CHECKED LRB
APPROVED LLJ
DATE 10/22/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

DETAILS

PROJECT NO.
383.1401.01

SCALE
AS SHOWN

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17

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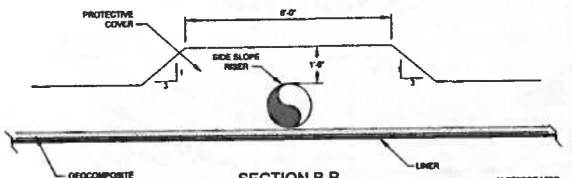

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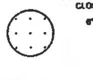

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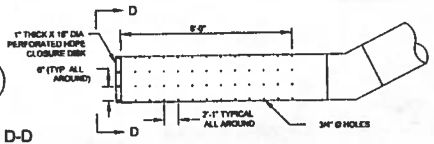
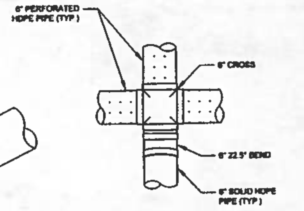


PERFORATION DETAIL FOR HDPE SIDE SLOPE RISER

N T S

E



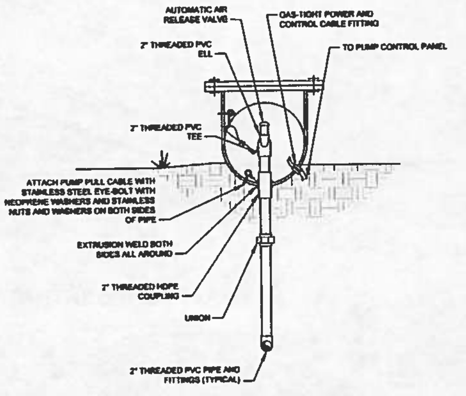
LEACHATE COLLECTION PIPE INTERSECTION DETAIL

N T S

F

TECHNICAL SPECIFICATIONS

1. SIDE SLOPE RISER PIPES SHALL BE HIGH DENSITY POLYETHYLENE (HDPE) WITH A STANDARD DIMENSION RATIO (SDR) OF 17. PIPES SHALL HAVE FUSION WELDED JOINTS, END CAPS, AND FITTINGS. ELBOWS MAY BE MITERED.
2. ALL TWO INCH DIAMETER AND SMALLER PIPES SHALL BE HIGH DENSITY POLYETHANE (HDPE) SDR 17 WITH FUSION WELDED JOINTS AND MOLDED FITTINGS.
3. LEACHATE PUMPS SHALL BE CONSTRUCTED OF ALL STAINLESS STEEL PARTS EXCEPT SEALS AND BEARINGS. PUMPS SHALL PUMP LEACHATE AT 3 GALLONS PER MINUTE AT 70 FEET OF TOTAL DYNAMIC HEAD WITH A MINIMUM LEACHATE DEPTH MEASURED FROM THE BOTTOM OF THE SUMP OF 4 INCHES. PROVIDE CERTIFIED PUMP PERFORMANCE CURVES AND MANUFACTURER'S DETAILS FOR APPROVAL BY THE ENGINEER BEFORE ORDERING THE PUMPS. PUMPS SHALL INCLUDE BUILT-IN CHECK VALVES. PUMPS SHALL BE CONSTRUCTED WITH WHEELS OR SLIDES DESIGNED SPECIFICALLY FOR LOWERING THE PUMPS INTO AND REMOVING THE PUMPS FROM THE SIDE SLOPE RISERS SHOWN ON THE PLANS. LOWERING AND REMOVING SHALL BE ACCOMPLISHED WITH STAINLESS STEEL PUMP LIFT CABLES OF SUFFICIENT STRENGTH TO SUPPORT THE WEIGHT OF THE PUMPS, DISCHARGE HOSES AND ACCESSORIES. PUMP LIFT CABLES SHALL BE 10' LONGER THAN THE SIDE SLOPE RISER PIPES.
4. PUMP MOTORS SHALL BE RATED EXPLOSION PROOF AND SEALED IN STAINLESS STEEL CONSTRUCTION. MOTORS SHALL BE CAPABLE OF STARTING A MINIMUM OF 120 TIMES PER 24 HOUR DAY WITHOUT DAMAGE.
5. PUMPS SHALL BE CONTROLLED BY AUTOMATIC LIQUID LEVEL SENSORS IN THE SUMP TO START AND STOP THE PUMPS AND ACTIVATE ALARM LIGHTS (MOUNTED OUTSIDE THE ENCLOSURE) AT THE LEACHATE LEVELS INDICATED ON THE PLANS. PROVIDE ALL CONTROLS IN A NEMA TYPE 4 ENCLOSURE. THE CONTROL PANEL SHALL CONTAIN HAND-OFF-AUTO SWITCHES, FAILURE, AND RUN LIGHT INDICATORS FOR EACH PUMP. PROVIDE LIGHTENING ARRESTORS AND GROUND RODS. LOCATE THE CONTROL ENCLOSURE APPROXIMATELY 4' ABOVE GROUND ON ALUMINUM OR, PRESSURE TREATED WOOD SUPPORTS. ELECTRIC POWER WILL BE PROVIDED TO THE AREA BY THE OWNER. CONTRACTOR SHALL COORDINATE THE POWER INSTALLATION WITH HIS WORK AND SHALL BE RESPONSIBLE FOR ALL CONNECTIONS, DISCONNECTS, WIRING, CONDUITS AND ALL MATERIALS, LABOR, PERMITS AND CONSTRUCTION NECESSARY TO COMPLETE THE WORK.
6. CONTRACTOR SHALL TEST PUMPS IN THE PRESENCE OF THE ENGINEER. TESTS SHALL INCLUDE DEMONSTRATING THAT THE PUMPS WILL AUTOMATICALLY START AND STOP AT THE WATER LEVELS INDICATED ON THE PLANS, AND ACTIVATE THE ALARM LEVEL INDICATOR. THERE SHALL BE NO VISIBLE LEAKS IN THE PIPING INSTALLED BY THE CONTRACTOR DURING THE TESTS. CONTRACTOR SHALL ALSO DEMONSTRATE THAT THE HOSE QUICK DISCONNECTS WORK PROPERLY AND THAT THE PUMPS CAN BE LIFTED AND REMOVED FROM THE SIDE SLOPE RISERS AND REPLACED AS SHOWN ON THE PLANS.
7. AIR VALVES SHALL BE 1 INCH WITH MINIMUM 5/64 INCH ORIFICE. VALVE SHALL BE A COMBINATION AIR RELEASE, AIR AND VACUUM VALVE. VALVE BODY SHALL BE CAST IRON. SEAT SHALL BE BUNA-N. ALL INTERNAL PARTS SHALL BE STAINLESS STEEL.
8. PUMP DISCHARGE HOSES SHALL BE MANUFACTURED OF VINYL NITRILE THERMOPLASTIC WITH POLYESTER, HELICAL WIRE REINFORCEMENT. HOSES SHALL BE RATED FOR A MINIMUM OF 200 PSI WORKING PRESSURE AT -10 TO +180 DEGREES F TEMPERATURE. HOSE FITTINGS AND CONNECTIONS SHALL BE STAINLESS STEEL.



SECTION C-C

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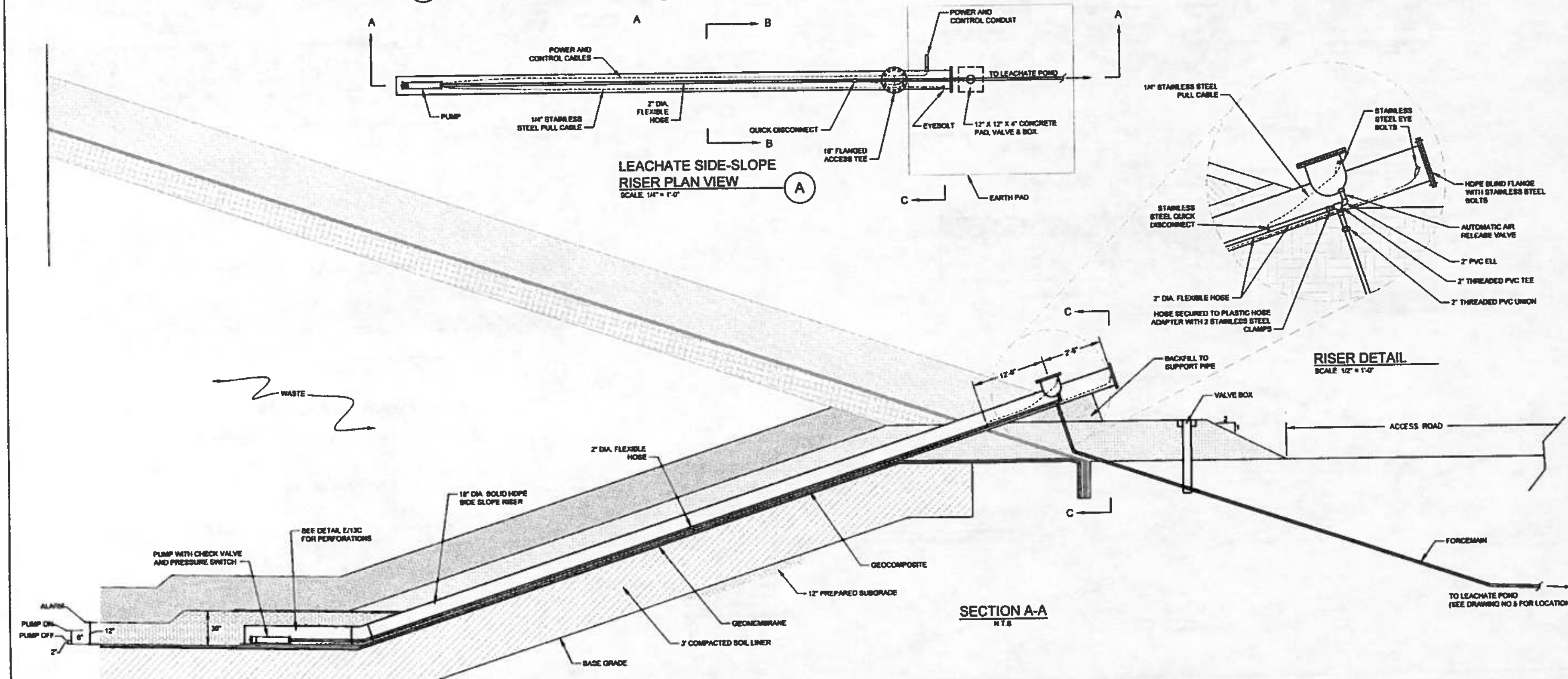

LEACHATE SIDE-SLOPE RISER PLAN VIEW

SCALE: 1/4" = 1'-0"

A

RISER DETAIL

SCALE: 1/2" = 1'-0"

SECTION A-A

N T S

NO	BY	CK	APP	REVISIONS AND RECORD OF ISSUE	DATE
1	[illegible]	LBS	LEJ	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/22/14	[illegible]
0	JS	LBS	LEJ	ISSUED FOR DEP REVIEW	10/22/13

LEONARD E. JOYCE JR.
CIVIL
5/17/14

DESIGNED JS
DRAWN DAS
CHECKED LBS
APPROVED LEJ
DATE 10/22/13

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

DETAILS

PROJECT NO.
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18

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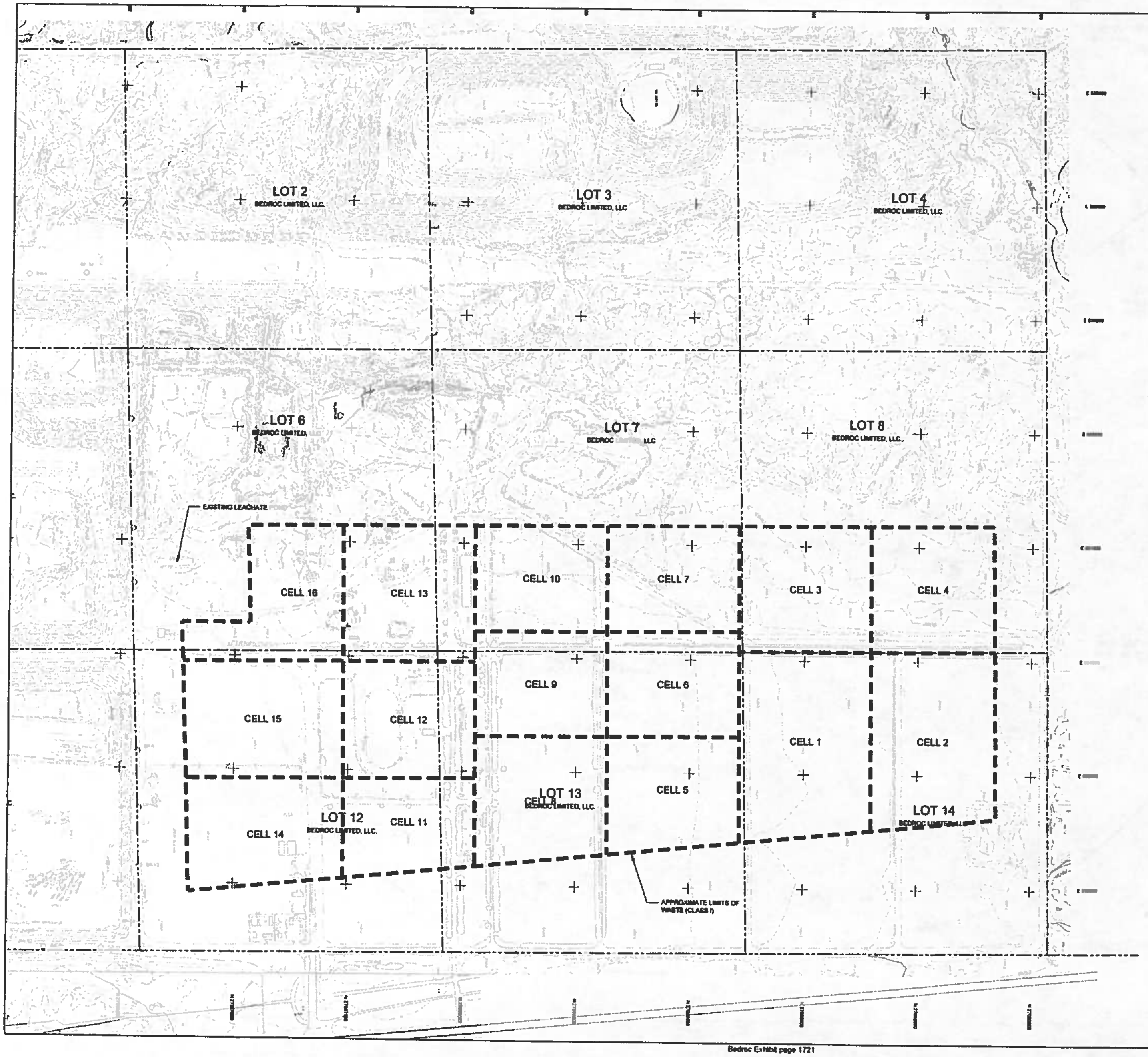

SOIL BALANCE (CY)	
CLASS I	
24" FINAL COVER	371,880
12" INTERMEDIATE COVER	185,840
12" PROTECTIVE COVER	4,450
12" PREPARED SUBGRADE	185,840
DAILY COVER (5% OF AIRSPACE)	886,730
SUBTOTAL	1,634,740
OVERALL	
EXCESS SOIL FROM CELL CONSTRUCTION	2,856,650
ADDITIONAL SOIL EXCAVATION REQUIRED FROM BORROW AREA	0
NET	+ 1,221,910

NOTES:

1. SOILS NEEDED FOR CONSTRUCTION AND LANDFILL OPERATION WILL BE EXCAVATED FROM THE PROPOSED CLASS I FOOTPRINT AND ADJACENT LOTS OWNED BY BEDROC, AS NEEDED.

GRAPHIC SCALE
0 100 200 400
(FEET)

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1	DAS	LEB	LEJ	5/1/14	REVISED IN RESPONSE TO NDEP COMMENTS DATED 4/23/14
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LEDFORD E. JOYCE III
CIVIL
No. 13878
5/1/14

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

LOCATION OF BORROW AREA

PROJECT NO.
383.1401.01

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DRAWING NO.
19

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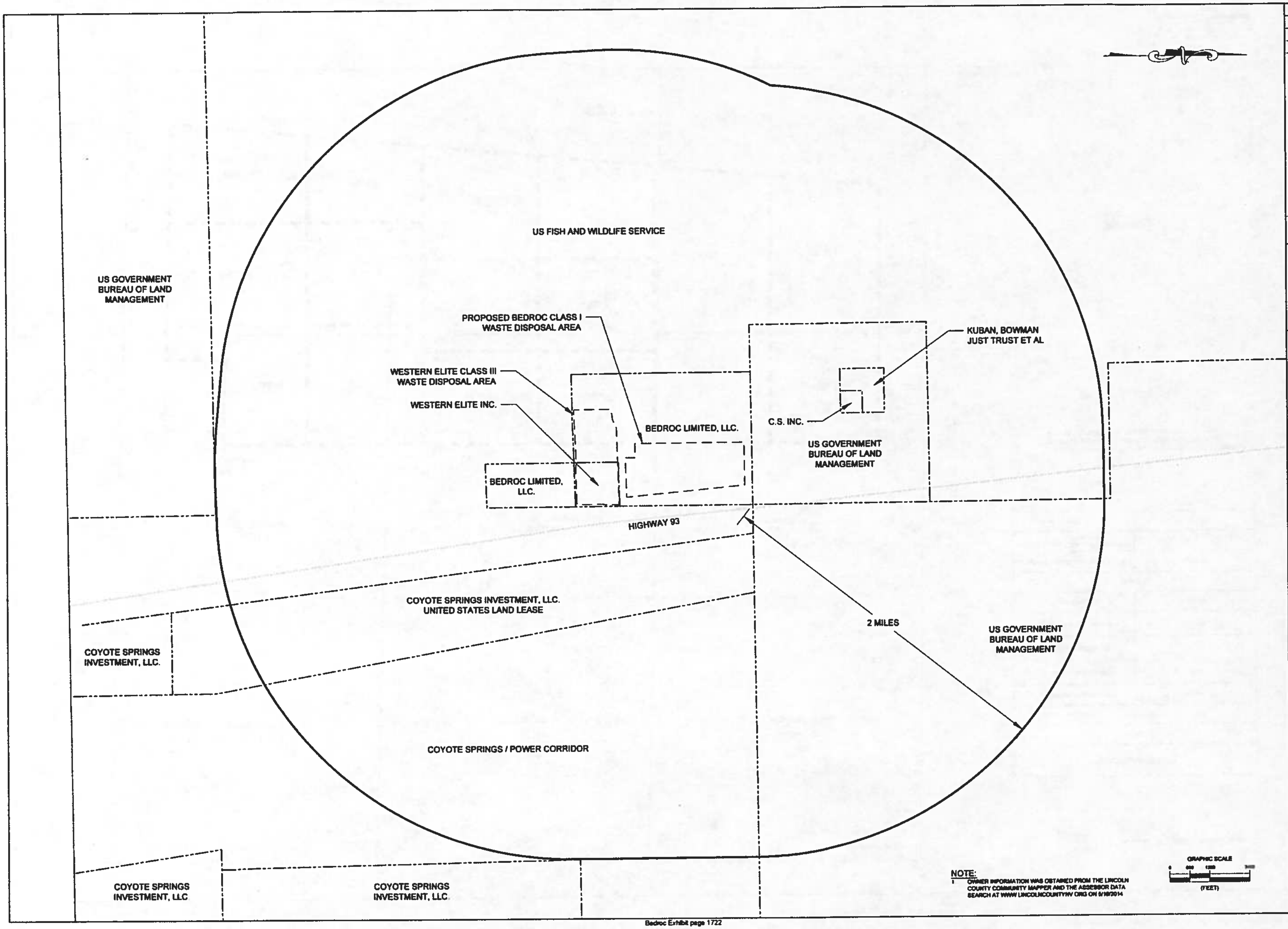

NOTE:
1 OWNER INFORMATION WAS OBTAINED FROM THE LINCOLN COUNTY COMMUNITY MAPPER AND THE ASSESSOR DATA SEARCH AT WWW.LINCOLNCOUNTYNV.ORG ON 8/18/2014

BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

ADJACENT PROPERTY OWNERS
WITHIN 2 MILE RADIUS

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DESIGNED LEB
DRAWN DAS
CHECKED LEB
APPROVED LEJ
DATE 8/19/2014

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8/19/14

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PROJECT NO.
383.1401.01

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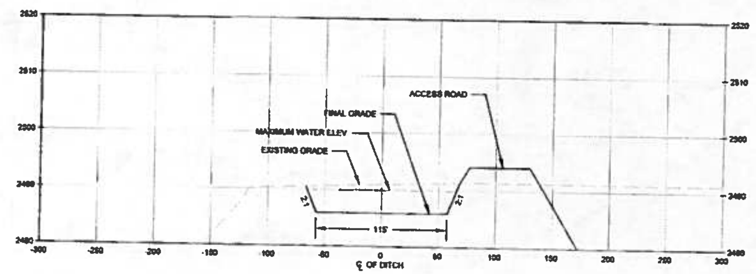

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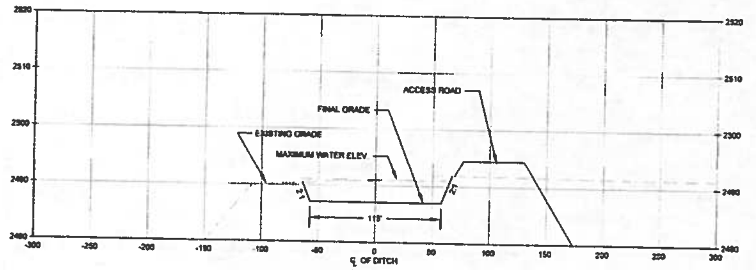

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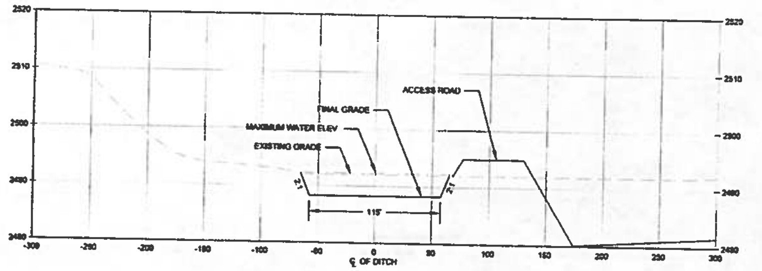

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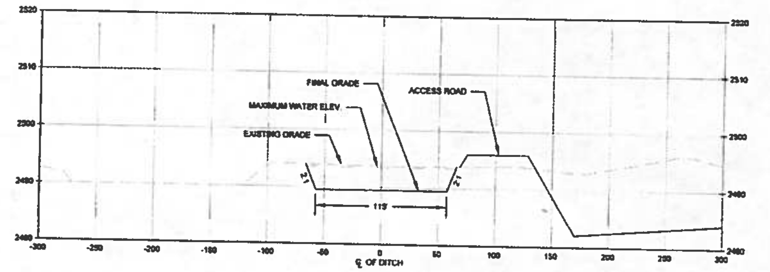

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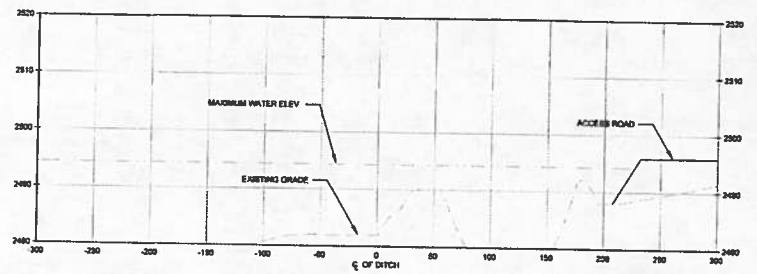

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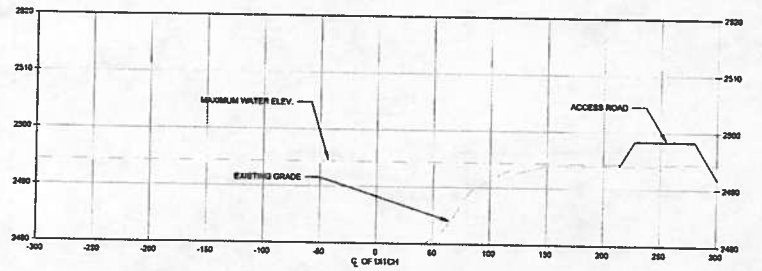

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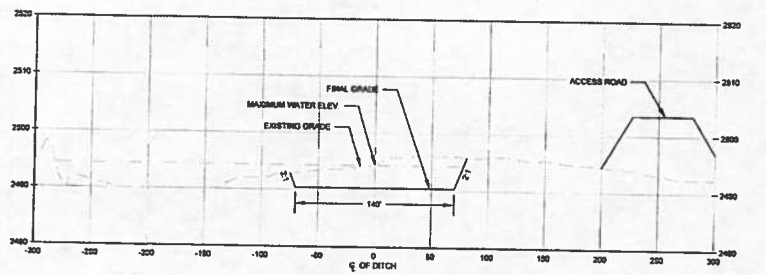

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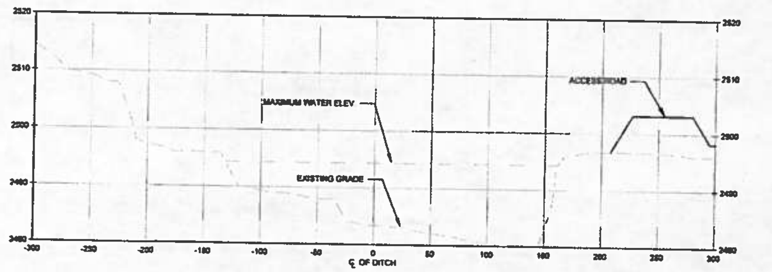

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

STORMWATER CHANNEL SECTIONS

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DESIGNED LBS
DRAWN DAS
CHECKED LBS
APPROVED LEJ
DATE 5/19/14

LEONARD E. JOYCE, JR.
CIVIL
5/19/14

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SCALE
H: 1" = 50'
V: 1" = 10'

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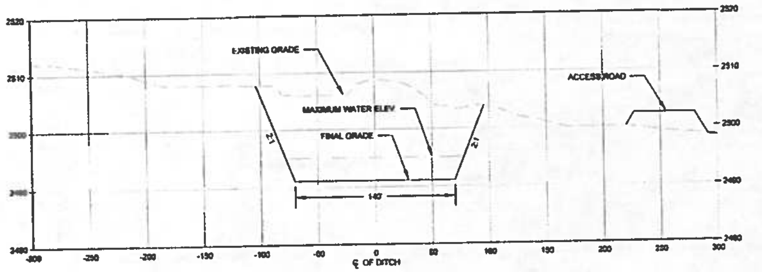

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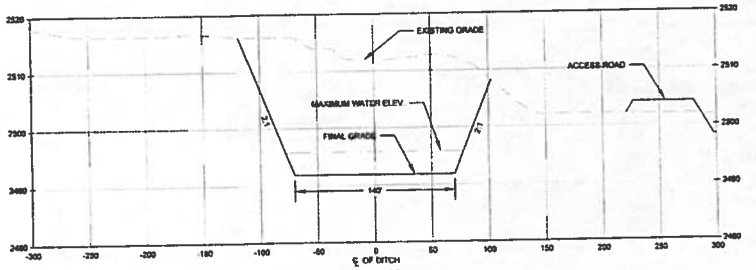

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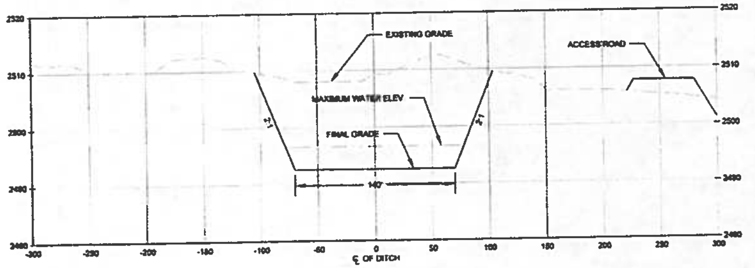

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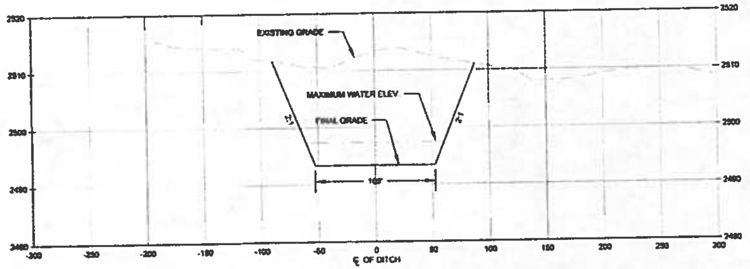

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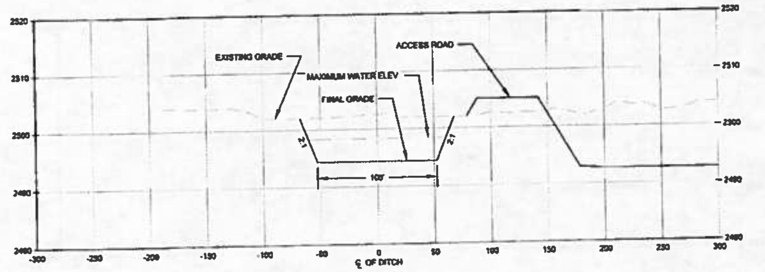

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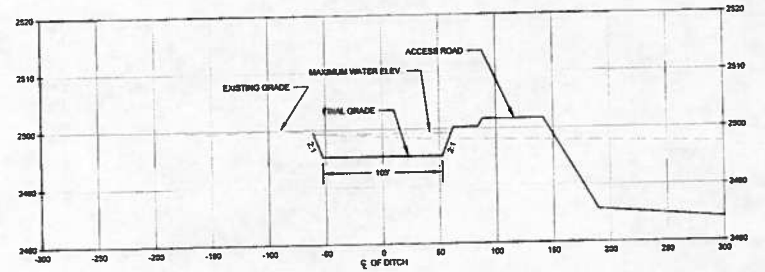

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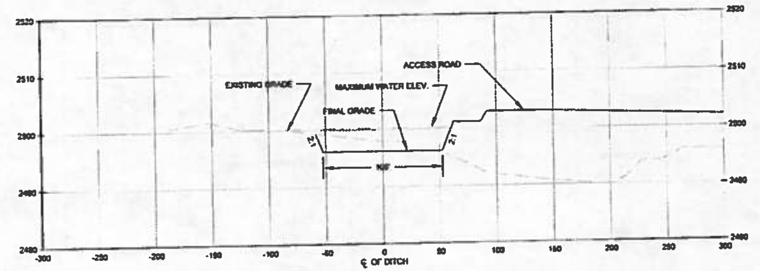

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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

STORMWATER CHANNEL SECTIONS

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DESIGNED LRS
DRAWN DAS
CHECKED LRS
APPROVED LRJ
DATE 9/19/14

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LEONARD R. JOYCE, JR.
CIVIL
No. 15371

9/19/14

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PROJECT NO.
383.1401.01

SCALE
H: 1" = 50'
V: 1" = 10'

DRAWING NO.
22

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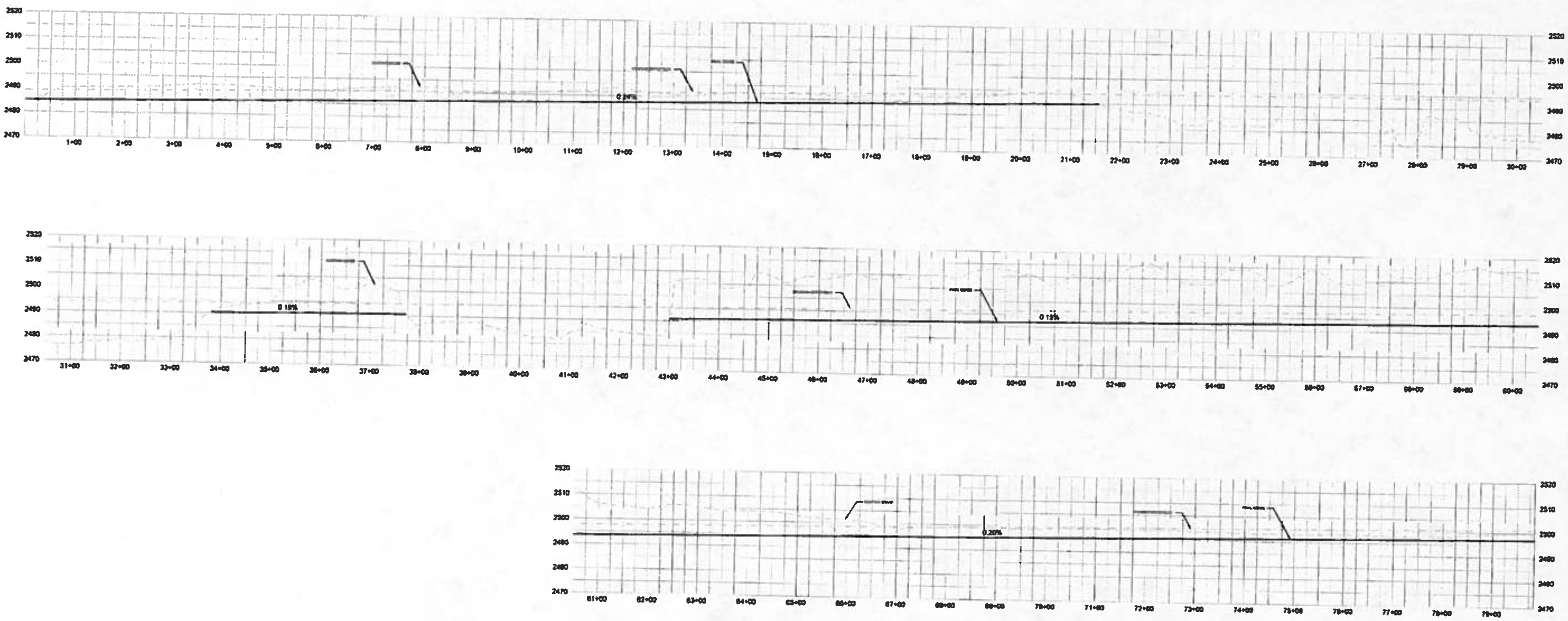

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5/19/14

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APPROVED LJU
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BEDROC LANDFILL AND WASTE MGMT. FACILITY
LINCOLN COUNTY, NEVADA

STORMWATER PROFILE

PROJECT NO.
383.1401.01

SCALE
H: 1" = 100'
V: 1" = 20'

DRAWING NO.
23

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