Appendix 8 – Recycling Containment Construction Specifications

1909 West Wall Street, Suite K • Midland, Texas79701
P.O. Box 6040 • Midland, Texas 79704 (Mailing Address)
Office 432.262.0999 • Fax 432.262.0989
www.maverick-eng.com

MAVERICK ENGINEERING

HAYHURST HYDRAULIC FRACTURING PONDS

HHSO 8 P2 PAD, SECTIONS 8,9,17 & 18, T26S-R27E
&
HHSO 10 P3 PAD, SECTIONS 2,3,10 & 11, T26S-R27
EDDY COUNTY, NEW MEXICO

CHEVRON MCBU

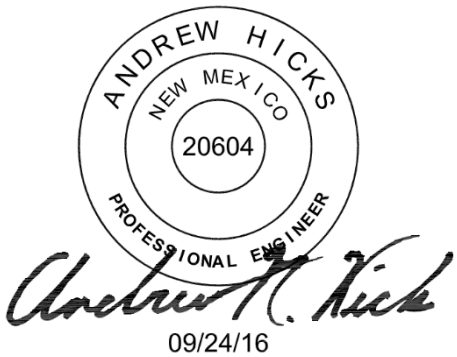
TECHNICAL AND REFERENCE SPECIFICATIONS

ENGINEER: ANDREW M. HICKS, P.E.

LICENSE # 20604

MAVERICK ENGINEERING

FIRM # F-15089



09/24/16

THESE SPECIFICATIONS FORM AN INTEGRAL PART OF THE PLAN SET OF THE SAME TITLE, BID SET DATE 09-24-16 AND ALL ADDENDA THERETO. THIS PACKET COVERS THE TECHNICAL ASPECTS OF THE PROJECT. BID STRUCTURE WILL BE AS DEFINED BY CHEVRON MCBU.

TECHNICAL SPECIFICATIONS

Hayhurst Hydraulic Fracturing Ponds

All construction for this project shall conform to the Chevron MCBU Standards issued by Chevron MCBU which are herein made a part of these specifications by reference, and included in the appendix of these specifications. All liner specifications are included in the MCBU standards.

The bidder/contractor shall conform to the following specifications for this project.

1) Item 001 - Definitions
2) Item 100 – Clearing and Grubbing
3) Item 110 - Excavation
4) Item 210 - Rolling
5) Item 216 - Proof Rolling
6) Item 800 - HDPE Pipe
7) Item 900 – Liner Installation
8) Chevron MCBU Standards Draft

GEOTECH REPORT

Hayhurst Hydraulic Fracturing Ponds

All construction for this project shall conform to the Geotech Report issued by LOI which are herein made a part of these specifications by reference and included herein.

1) Geotech Report performed by LOI and Additional Testing for soil Mixture

Item 1
Abbreviations and Definitions

1. APPLICABILITY

Wherever the following terms are used in these SPECIFICATIONS or other CONTRACT documents, the intent and meaning will be interpreted as shown below.

2. ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMRL	AASHTO Materials Reference Laboratory
ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gage
AWWA	American Water Works Association
BMP	Best Management Practices
CFR	Code of Federal Regulations
CMP	Corrugated Metal Pipe
COE	U.S. Army Corps of Engineers
CRSI	Concrete Reinforcing Steel Institute
DMS	Departmental Material Specification
EPA	United States Environmental Protection Agency
FHWA	Federal Highway Administration, U.S. Department of Transportation
FSS	Federal Specifications and Standards (General Services Administration)
GSA	General Services Administration
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
LRFD	Load and Resistance Factor Design
MPL	Material Producer List
NEC	National Electrical Code (Published by NFPA)
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NRMCA	National Ready Mixed Concrete Association
NTP	Notice to Proceed
OSHA	Occupational Safety & Health Administration, U.S. Department of Labor
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PPI	Plastics Pipe Institute
PS&E	Plans, Specifications, and Estimates
PSL	Project-Specific Location
PTI	Post-Tension Institute
QA	Quality Assurance

QC	Quality Control
RCP	Reinforced Concrete Pipe
RPLS	Registered Public Land Surveyor
SI	International System of Units
SPIB	Southern Pine Inspection Bureau
SSPC	The Society for Protective Coatings
UL	Underwriters Laboratory, Inc.
USC	United States Code
WRI	Wire Reinforcement Institute

3. DEFINITIONS

3.1. **OWNER**. The Owner is defined as Chevron North America Exploration and Production. Items that need Owner approval are to be approved by Chevron or their Appointed Representative.

3.2. **Appointed Representative**. This term will be used throughout the Plans, Contract documents and Specifications. The term will in all cases refer to the appointed Engineer, Lab, or Construction Administrator that has been directly empowered by Chevron to act on their behalf.

3.3. **Contractor**. The Contractor will be the Awarded bidding Construction entity that will build the project. The Contractor refers to the General Contractor in overall charge of all sub-Contractors.

3.4. **Air Temperature**. The temperature measured in degrees Fahrenheit (°F) in the shade, not in the direct rays of the sun, and away from artificial heat.

3.5. **Award**. The Commission's acceptance of a Contractor's bid for a proposed Contract that authorizes the Department to enter into a Contract.

3.6. **Bid**. The offer from the Bidder for performing the work described in the proposal.

3.7. **Bidder**. An individual, partnership, limited liability company, corporation, or joint venture submitting a bid for a proposed Contract.

3.8. **Bidders Qualifications**. A bidder will be required to submit paperwork detailing past work and experience to the Owner's satisfaction.

3.9. **Certificate of Insurance**. A bidder will be required to submit proof of insurance meeting the Owner's requirements.

3.10. **Change Order**. Written order to the Contractor detailing changes to the specified work, item quantities or any other modification to the Contract.

3.11. **Contract**. The agreement between the Owner and the Contractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents. The Plans and Specifications are to be considered an integral part of the Contract Documents.

3.12. **Contract Documents**. Elements of the Contract including, but not limited to the plans, specifications incorporated by reference, special provisions, special specifications, Contract bonds, change orders, and supplemental agreements.

3.13. **Contract Time**. The number of working days specified for completion of the work, including authorized additional working days.

3.14. **Contractor**. The individual, partnership, limited liability company, corporation, or joint venture and all principals and representatives with which the Contract is made by the Owner.

3.15. **Easement**. A real property right acquired by one party to use land belonging to another party for a specified purpose.

3.16. **Engineer**. The Engineer refers to the Professional Engineer that prepared the Plans and Specifications.

3.17. **Hazardous Materials or Waste**. Hazardous materials or waste include but are not limited to explosives, compressed gas, flammable liquids, flammable solids, combustible liquids, oxidizers, poisons, radioactive materials, corrosives, etiologic agents, and other material classified as hazardous by 40 CFR 261, or applicable state and federal regulations.

3.18. **Inspector**. This term is generally avoided. Any references to an Inspector will instead refer to the Appointed Representative.

3.19. **Licensed Professional Engineer**. A person who has been duly licensed by the Board of Professional Engineers in the appropriate state to engage in the practice of engineering. Also referred to as a Professional Engineer.

3.20. **Major Item**. An item of work included in the Contract that has a total cost equal to or greater than 5% of the original Contract or $100,000 whichever is less. A major item at the time of bid will remain a major item. An item not originally a major item does not become one through the course of the Contract.

3.20.1. **Surface Course**. Pavement structure layers designed to accommodate the loading. This can also refer to the material just below the liner layer, or berm surfaces.

3.20.2. **Base Course**. One or more layers of specified material thickness placed on a subgrade to support a surface course.

3.20.3. **Subgrade**. The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.

3.20.4. **Subgrade Treatment**. Modifying or stabilizing material in the subgrade.

3.21. **Plans**. The drawings approved by the Engineer, including true reproductions of the drawings that show the location, character, dimensions, and details of the work and are a part of the Contract.

3.22. **Proposal**. The offer from the Bidder submitted on the prescribed form, including addenda issued, giving unit bid prices for performing the work described in the plans and Specifications.

3.23. **Quality Control**. Sampling, testing, and other process control activities conducted by the Contractor to monitor production and placement operations.

3.24. **Replacement Alternate**. A bid item identified the proposal form that a Bidder may substitute for a specific regular item of work.

3.25. **Special Provisions**. Additions or revisions to these standard specifications or special specifications.

3.26. **Specifications**. Directives or requirements issued or made pertaining to the method and manner of performing the work or to quantities and qualities of materials to be furnished under the Contract. References to DMSs, ASTM or AASHTO specifications, or Industry bulletins and manuals, imply the latest standard or tentative standard in effect on the date of the proposal.

3.27. **Station**. A unit of measurement consisting of 100 horizontal feet.

3.28. **Subcontract**. The agreement between the Contractor and subcontractor establishing the obligations of the parties for furnishing of materials and performance of the work prescribed in the Contract documents.

3.29. **Subcontractor**. A Subcontractor is defined as an individual, partnership, limited liability company, corporation, or any combination thereof that the Contractor sublets, or proposes to sublet, any portion of a Contract, excluding a material supplier, a hauling firm hauling only from a commercial source to the project, truck owner-operator, wholly-owned subsidiary, or specialty-type businesses such as security companies and rental companies.

3.30. **Superintendent**. The representative of the Contractor who is available at all times and able to receive instructions from the Engineer or authorized Owner Representatives and to act for the Contractor.

3.31. **Utility**. Privately, publicly, or cooperatively owned lines, facilities, and systems for producing, transmitting, or distributing communications, power, heat, gas, oil, water, waste, or storm water.

3.32. **Verification Tests**. Tests used to verify accuracy of QC and QA and mixture design testing.

3.33. **Work**. The furnishing of all labor, materials, equipment, and other incidentals necessary for the successful completion of the Contract.

3.34. **Notice to Proceed**. Written notice to the Contractor to begin the work. The NTP may include the date when work and time charges will begin, the allowable number of working days, and plan sheets providing details specific to a location or to an item of work for non-site-specific work. A work order is part of the Contract.

3.35. **Written Notice**. Written notice is considered to have been duly given if delivered in person to the individual or member to whom it is intended or if sent by regular, registered, or certified mail and delivered to the last known business address; sent by facsimile to the last known phone number; or sent by e-mail to the last known address. The date of the letter will serve as the beginning day of notice. Unclaimed mail or failure to provide current contact information will not be considered a failure to provide written notice.

Item 100
Clearing and Grubbing

1. DESCRIPTION

Prepare the construction site and designated easements for construction operations by removing and disposing of all obstructions, primarily due to vegetation, roots, and other deleterious matter.

2. CONSTRUCTION

Clear areas shown on the plans of all obstructions, except those landscape features that are to be preserved. Such obstructions include remains of structures, foundations, septic tank drain fields, abandoned utility pipes or conduits, equipment, fences, and other items as specified on the plans. Remove vegetation and other landscape features not designated for preservation, whether above or below ground.

Notify the Owner in writing when items not shown on the plans and not reasonably detectable (buried with no obvious indication of presence) are encountered and required to be removed.

Remove obstructions not designated for preservation to 2 ft. below natural ground in areas receiving embankment. Remove obstructions to 2 ft. below the excavation level in areas to be excavated. Remove obstructions to 1 ft. below natural ground in all other areas. Cut trees and stumps off to ground level when allowed by the plans or directed. Plug the remaining ends of abandoned underground structures over 3 in. in diameter with concrete to form a tight closure. Backfill, compact, and restore areas where obstructions have been removed unless otherwise directed. Use approved material for backfilling.

Accept ownership, unless otherwise directed, and dispose of removed materials and debris at locations off the project site in accordance with local, state, and federal requirements.

Material that is set aside in stockpiles for mixing / processing is to be free of all vegetable and deleterious matter.

Item 110
Excavation

1. DESCRIPTION

Excavate areas as shown on the plans or as directed. Remove materials encountered to the lines, grades, and typical sections shown on the plans and cross-sections.

2. CONSTRUCTION

The excavation on this project will be considered unclassified excavation. No distinction will be made between the various materials encountered. The Contractor will stockpile excess material as directed by the Owner's Representative.

The Contractor will maintain drainage in the excavated area to avoid damage to the subgrade section. Any damage to the subgrade caused by weather shall be repaired at no additional cost to the Owner.

The Contractor will shape slopes to avoid loosening material below or outside the proposed grades. Remove and dispose of slides as directed.

2.1. **Rock Cuts**. Excavate to finish subgrade. Manipulate and compact subgrade as directed below in., "Compaction Methods," unless excavation is to clean homogenous rock at finish subgrade elevation. Use approved backfill materials to replace undercut material at no additional cost to the Owner if excavation extends below finish subgrade. Compact as directed below. Rock Cut shall be considered unclassified excavation.

2.2. **Earth Cuts**. Excavate to finish subgrade. Scarify subgrade to a uniform depth at least 6 in. below finish subgrade elevation in areas where base or pavement structure will be placed on subgrade **in a test section**. **Per the Geotech report, this subgrade material has naturally cementitious properties in place, but the material may not re-compact well once disturbed. The Owner's Representative and the Contractor will have to decide in field if scarifying is appropriate.** It may prove that it is better to excavate to the subgrade elevation shown, but leave the subgrade below undisturbed. Manipulate and compact subgrade as directed below.

Take corrective measures as directed if unsuitable material is encountered below subgrade elevations.

2.3. **Subgrade Tolerances**. The Contractor shall excavate to within 2 in. in cross-section and 2 in. in 16 ft. measured longitudinally. Work that is found to be out of tolerance shall be corrected by the Contractor at no additional expense to the Owner.

2.4. **Compaction Methods**. Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller. Begin rolling at the lower side and progress toward the high side on super elevated curves or embankments. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with Section 132.3.2.2., "Density Control," as shown on the plans. "Ordinary Compaction" will only be used on the in situ subgrade if it is determined to be superior to scarifying and re-compacting per Density Control.

2.4.1. **Ordinary Compaction**. **Ordinary compaction will only be used if it is deemed in field that scarifying the existing ground will be detrimental to the subgrade. See above in Earth Cuts.** If the Owner (or appointed representative) determines that the subgrade will retain better strength if left in place, the ordinary compaction efforts will be used. Use approved rolling equipment complying with Item 210, "Rolling," to

compact each layer. Compact the subgrade until there is no evidence of further consolidation. Monitor for ground “pumping”.

2.4.2. **Density Control**. Compact each layer to the required density using equipment complying with Item 210, “Rolling.” Do not exceed layer thickness of 8 in. loose material. Maintain a level layer to ensure uniform compaction.

Each layer is subject to testing by the Owner’s representative for density and moisture content. During compaction, the moisture content of the soil should be with +/- 3% of the optimum moisture content determined in the Geotech Report. Each layer should be compacted to 95% density per ASTM D 1557 with the above moisture content restrictions.

Remove small areas of the layer to allow for density tests as required. Replace the removed material and recompact at no additional expense to the Owner. Proof-roll in accordance with Item 216, “Proof Rolling,” when shown on the plans or as directed. Correct soft spots as directed.

Item 132
Embankment

1. DESCRIPTION

Furnish, place, and compact materials for construction of roadways, embankments, levees, dikes, or any designated section of the roadway where additional material is required.

2. MATERIALS

Furnish approved material capable of forming a stable embankment from required excavation in the areas shown on the plans or from sources outside the right of way. Provide one or more of the following types as shown on the plans and in accordance with the geotech report:

- **Berm Material**. Berm material is to be constructed from the native material with on-site mixing/processing as indicated in the geotech report. Consult the geotech report for more details on the embankment materials and properties. In general, berm material is to be a mixture of 30% Sandy Clay from the top stratum A with 70% Silty Sands in the lower stratum B. Stratum A will generally be encountered in the top 1-3 feet of existing ground.
- **Drainage Aggregate**. Material for drainage aggregate is to be clean washed sand and gravel with the gradation below from MCBU standards. Drainage rock is to be free of all organic or deleterious materials, ice snow, frozen or excess moisture. Drainage rock is to be less than 5% carbonate.

Gradation:

Sieve Size	Percent by Weight
1.5 inch	100%
1 inch	95-100%
0.5 inch	25-60%
No. 4	0-10%
No. 8	0-5%

3. CONSTRUCTION

Backfill tree-stump holes or other minor excavations with approved material and tamp. Restore the ground surface, including any material disked loose or washed out, to its original slope. Compact the ground surface by sprinkling and by rolling using equipment complying with Item 210, “Rolling,” when directed.

Scarify and loosen the unpaved surface areas, except rock, to a depth of at least 6 in. unless otherwise shown on the plans. **See the note on scarifying under Item 110 Excavation, 2.2.** Bench slopes before placing material. Begin placement of material at the toe of slopes. Do not place trees, stumps, roots, vegetation, or other objectionable material in the embankment. Simultaneously recompact scarified material with the placed embankment material. Do not exceed 8” maximum lift thickness.

Construct embankments to the grade and sections shown on the plans. Construct the embankment in layers approximately parallel to the finished grade for the full width of the individual roadway cross-sections unless otherwise shown on the plans. Ensure that each section of the embankment conforms to the detailed sections or slopes. Maintain the finished section, density, and grade until the project is accepted.

3.1. **Earth Embankments**. Earth embankment is mainly composed of material other than rock. Construct embankments in successive layers, evenly distributing materials in lengths suited for sprinkling and rolling.

Move the material dumped in piles or windrows by blading or by similar methods and incorporate it into uniform layers. Featheredge or mix abutting layers of dissimilar material for at least 100 ft. to ensure there are no abrupt changes in the material. Break down clods or lumps of material and mix embankment until a uniform material is attained.

Apply water free of industrial wastes and other objectionable matter to achieve the uniform moisture content specified for compaction.

Roll and sprinkle each embankment layer in accordance with Section 132.3.4.2., “Density Control,”.

3.2. **Compaction Methods**. Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller. Begin rolling at the lower side and progress toward the high side on super elevated curves. Alternate roller trips to attain slightly different lengths. Compact embankments in accordance with Section 132.3.2.2., “Density Control,” as shown on the plans.

3.2.1. **Ordinary Compaction**. Ordinary compaction can only be used on the subgrade in limited circumstances. See Item 110 Excavation.

3.2.2. **Density Control**. Compact each layer to the required density using equipment complying with Item 210, “Rolling.” Determine the maximum lift thickness based on the ability of the compacting operation and equipment to meet the required density. Do not exceed layer thickness of 8 in. loose material unless otherwise approved. Maintain a level layer to ensure uniform compaction.

Each layer is subject to testing by the Owner’s representative for density and moisture content. During compaction, the moisture content of the soil should be within 3 percent of optimum moisture content as listed in the geotech report. Each layer is to be compacted to 95% density per ASTM D 1557.

Remove small areas of the layer to allow for density tests as required. Replace the removed material and recompact at no additional expense to the Owner. Proof-roll in accordance with Item 216, “Proof Rolling,” when shown on the plans or as directed. Correct soft spots as directed.

3.3. **Maintenance of Moisture and Reworking**. Maintain the density and moisture content once all requirements in Table 2 are met. Maintain the moisture content no lower than 4% below optimum for soils with a PI greater than 15. Rework the material to obtain the specified compaction when the material loses the required stability, density, moisture, or finish. Alter the compaction methods and procedures on subsequent work to obtain specified density as directed.

3.4. **Acceptance Criteria**.

3.4.1. **Grade Tolerances**.

3.4.1.1. **Staged Construction**. Grade to within 0.1 ft. in the cross-section and 0.1 ft. in 16 ft. measured longitudinally.

3.4.1.2. **Turnkey Construction**. Grade to within 1/2 in. in the cross-section and 1/2 in. in 16 ft. measured longitudinally.

3.4.2. **Gradation Tolerances**. Ensure no more than 1 of the 5 most recent gradation tests is outside the specified limits on any individual sieve by more than 5% when gradation requirements are shown on the plans.

3.4.3. **Density Tolerances**. Ensure no more than 1 of the 5 most recent density tests for compaction work is outside the specified density limits, and no test is outside the limits by more than 3 pcf.

3.4.4. **Plasticity Tolerances**. Ensure no more than 1 of the 5 most recent PI tests for material is outside the specified limit by more than 2 points.

Item 210
Rolling

1. DESCRIPTION

Compact embankment, subgrade, base, surface treatments, broken concrete pavement, or asphalt pavement using rollers. Break up asphalt mats, pit run material, or base materials.

2. EQUIPMENT

Use any type of roller to meet the production rates and quality requirements of the Contract unless otherwise shown on the plans or directed. Use equipment that meets the requirements of this Item when specific types of equipment are required. The Engineer may allow the use of rollers that operate in one direction only when turning does not affect the quality of work or encroach on traffic.

Table 1
Roller Requirements[1]

Roller Type	Materials to be Compacted	Load (tons)	Contact Pressure	Roller Speed (mph)
Steel wheel	Embankment, subgrade, base, asphalt concrete	≥ 10	≥ 325 lb. per inch of wheel width	2–3
Tamping	Embankment, subgrade	–	125–550 psi per tamping foot	2–3
Heavy tamping	Embankment, subgrade	–	≥ 550 psi per tamping foot	2–3
Vibratory	Embankment, subgrade, base, asphalt concrete	Type A < 6 Type B > 6 Type C as shown on the plans	Per equipment specification and as approved	As approved
Light pneumatic	Embankment, subgrade, surface treatment	4.5–9.0	≥ 45 psi	2–6
	Asphalt Concrete			4–12
Medium pneumatic	Embankment, subgrade, base, surface treatment	12–25	≥ 80 psi, as directed	2–6
	Asphalt Concrete			4–12
Heavy pneumatic	Embankment, subgrade, base, previously broken concrete pavement, other pavements	≥ 25	≤ 150 psi	2–6
Grid	Embankment, breaking up existing asphalt mats or base	5–13	–	2–3

1. Unless otherwise specified in the Contract.

2.1. **Static Steel Wheel Rollers**. Furnish single, double, or triple steel wheel, self-propelled power rollers weighing at least 10 tons capable of operating in a forward and backward motion. Ensure all wheels are flat. The Contractor may use vibratory rollers in the static mode when static steel wheel rollers are required.

For single steel wheel rollers, pneumatic rear wheels are allowed for embankment, subgrade, and base. Provide rear wheels for triple steel wheel rollers with a minimum diameter of 48 in., a minimum width of 20 in., and a minimum compression of 325 lb. per inch of wheel width.

2.2. **Tamping Rollers**. Furnish self-propelled rollers with at least one self-cleaning metal tamping drum capable of operating in a forward or backward motion with a minimum effective rolling width of 5 ft. Mount drums in a frame so that each drum moves independently of the other for rollers with more than one drum. Operate rollers in static or vibratory mode.

2.2.1. **Tamping Roller (Minimum Requirement)**. Provide tamping feet that exert a static load of 125 to 550 psi and project at least 3 in. from the surface of the drum for all tamping rollers except for heavy tamping rollers.

2.2.2. **Heavy Tamping Roller**. Provide tamping rollers that have:

- 2 metal tamping drums, rolls, or shells, each with a 60-in. minimum diameter and a 5-ft. minimum width, or
- 1 rear and 2 forward drums, each with a 60-in. minimum diameter. Arrange drums so that the rear drum compacts the space between the 2 forward drums and the minimum overall rolling width is 10 ft.

Equip drums with tamping feet that:

- project at least 7 in. from the drum surface,
- have an area of 7 to 21 sq. in.,
- are self-cleaning,
- exert a static load of at least 550 psi, and
- are spaced at 1 tamping foot per 0.65 to 0.70 square feet of drum area.

2.3. **Vibratory Rollers**. Furnish self-propelled rollers with at least one drum equipped to vibrate. Select and maintain amplitude and frequency settings per manufacturer's specifications to deliver maximum compaction without material displacement or shoving, as approved. Furnish the equipment manufacturer's specifications concerning settings and controls for amplitude and frequency. Operate rollers at speeds that will produce at least 10 blows per foot unless otherwise shown on the plans or approved. Pneumatic rear wheels are allowed for embankment, subgrade, and base. Equip each vibrating drum with:

- separate frequency and amplitude controls,
- controls to manually start and stop vibration, and
- a mechanism to continuously clean the face of the drum.

For asphalt-stabilized base and asphalt concrete pavement, furnish a roller that also has the ability to:

- automatically reverse the direction of the rotating eccentric weight,
- stop vibration before the motion of the roller stops, and
- thoroughly moisten the drum with water or approved asphalt release agent.

2.3.1. **Drum (Type A)**. Furnish a roller with a static weight less than 6 tons and a vibratory drum.

2.3.2. **Drum (Type B)**. Furnish a roller with a minimum static weight of 6 tons and a vibratory drum.

2.3.3. **Drum (Type C)**. Furnish a roller as shown on the plans.

2.4. **Pneumatic Tire Rollers**. Pneumatic tire rollers consist of rubber tire wheels on axles mounted in a frame with either a loading platform or body suitable for ballast loading. Arrange the rear tires to cover the gaps between adjacent tires of the forward group. Furnish rollers capable of forward and backward motion.

Compact asphalt pavements and surface treatments with a roller equipped with smooth-tread tires. Compact without damaging the surface. Moisten the wheels with water or an approved asphalt release agent when necessary.

Select and maintain the operating load and tire air pressure within the range of the manufacturer's charts or tabulations to attain maximum compaction throughout the lift, as approved. Furnish the manufacturer's chart or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the particular tires furnished. Maintain individual tire inflation pressures within 5 psi of each other. Provide uniform compression under all tires.

2.4.1. **Light Pneumatic Tire**. Furnish a unit:

- with at least 9 pneumatic tires,
- with an effective rolling width of approximately 5 ft.,
- capable of providing a total uniform load of 4.5 to 9 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 45 psi.

2.4.2. **Medium Pneumatic Tire**. Furnish a unit:

- with at least 7 pneumatic tires,
- with an effective rolling width of approximately 7 ft.,
- capable of providing a total uniform load of 12 to 25 tons, and
- with tires capable of maintaining a minimum ground contact pressure of 80 psi or 90 psi as directed.

2.4.3. **Heavy Pneumatic Tire**. Furnish a unit:

- with at least 4 pneumatic-tired wheels mounted on axles carrying no more than 2 wheels,
- with wheels arranged to carry approximately equal loads on uneven surfaces,
- with a width between 8 and 10 ft. that can turn 180° in the crown width,
- capable of providing a total uniform load of at least 25 tons,
- with tires capable of maintaining a maximum ground contact pressure of 150 psi, and
- with liquid-filled tires inflated to such a level that liquid will flow from the valve stem when the stem is in the uppermost position.

2.5. **Grid Rollers**. Furnish rollers that have 2 cylindrical cages with a minimum diameter of 66 in. and a minimum width of 32 in. Mount cages in a rigid frame with weight boxes. Use a cage surface of cast or welded steel fabric grid with bars 1-1/2 in. wide, spaced on 5-in. centers in each direction, that undulate approximately 1 in. between the high and low points.

Furnish rollers capable of providing a total load of 5 to 13 tons and capable of being operated in a forward or backward motion.

2.6. **Alternate Equipment**. The Contractor may use alternate compaction equipment that produces results equivalent to the specified equipment as approved. Discontinue the use of the alternate equipment and furnish the specified equipment if the desired results are not achieved.

3. CONSTRUCTION

Perform this work in accordance with the applicable Items using equipment and roller speeds specified in Table 1. Use only rubber-tired equipment to push or pull compaction equipment on base courses. Use equipment that does not damage material being rolled.

4. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly but will be subsidiary to pertinent Items.

Item 216
Proof Rolling

1. DESCRIPTION

Proof-roll earthwork, base, or both to locate unstable areas.

2. EQUIPMENT

2.1. **Specified Equipment**. Furnish rollers that weigh at least 25 tons when loaded. The maximum acceptable load is 50 tons. Provide rollers that meet the requirements of Section 210.2.4., "Pneumatic Tire Rollers."

2.2. **Alternative Equipment**. The Contractor may use alternate compaction equipment that produces results equivalent to the specified equipment in the same period of time as approved. Discontinue the use of the alternative equipment and furnish the specified equipment if the desired results are not achieved.

3. CONSTRUCTION

Perform proof rolling as directed. Adjust the load and tire inflation pressures within the range of the manufacturer's charts or tabulations, as directed. Make at least 2 coverages with the proof roller. Offset each trip of the roller by at most one tire width. Operate rollers at a speed between 2 and 6 mph, as directed. Correct unstable or nonuniform areas, if found, in accordance with the applicable Item.

Item 800
HDPE Pipe

1. DESCRIPTION

Contractor shall furnish, install and test HDPE pipe in accordance with this specification and Chevron MCBU Standards. Work under this specification will include, but not necessarily be limited to the following; leakage collection lateral and riser, transfer lines to the designated manifolds. Contractor is to include all piping, fittings, labor, material, tools, equipment, and services for a complete installation as determined by the Owner and the Engineer. Although such work may not be specifically indicated, Contractor is to include all miscellaneous items, appurtenances and incidental items necessary for the complete installation.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Owner of the proposed material sources and of changes to material sources. The Owner's representative may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance. Provided materials are to comply with the following industry standards;

ANSI/AWWA C906 Polyethylene Pressure Pipe and Fittings

ASTM F 714 Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter

ASTM F 2164 Standard Practice for Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure

ASTM F2206 Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene Plastic Pipe, Fittings, Sheet Stock, Plate Stock or Block Stock

ASTM D 2683 Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

ASTM D 2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping

ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene Plastic Fittings for Polyethylene Plastic Pipe and Tubing

ASTM D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

PPI Handbook of Plyethylene Pipe 2nd Edition

2.1. **Pipe**. Polyethylene pipe shall be made from HDPE material having a material designation code of PE3608 or higher. The material shall meet the requirements of ASTM D 3350 and shall have a minimum cell classification of PE345464C. In addition, the material shall be listed as meeting NSF-61. Pipe is to conform to AWWA C906. Pipe is to have a pressure class rating of DR9.

2.2. **Fittings**. Butt Fusion Fittings - Fittings shall be made of either PE 3608. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Molded fittings shall comply with the requirements of ASTM D 3261, AWWA C906, and have the same pressure class rating as the connecting pipe. Fabricated fittings shall be

marked in accordance with ASTM F 2206. Socket fittings shall meet ASTM D 2683. For butt fusion joints, the pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.

Flanges and Mechanical Joint Adapters - Flanges and Mechanical Joint Adapters shall have a material designation code of PE3608 or higher. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans. Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261. Fabricated (including machined) flange adapters shall be per ASTM F 2206.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work. Handle pipe in accordance with PPI Handbook of Polyethylene Pipe Chapter 2 recommendations. Do not use chains, wire rope, forklifts or other equipment that may gouge or damage the pipe.

Fusion equipment is to be provided by, leased by, or approved by the pipe manufacturer.

4. CONSTRUCTION

4.1. **Installation.** Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7. Plug pipe ends when possible during construction, when pipe is to be left exposed.

4.2. **Embedment.** Embedment material should be Class I, Class II, or Class III materials as defined by ASTM D-2321 Section 6.

4.3. **Bedding**. Pipe bedding shall be in conformance with ASTM D2321 Section 8. Compaction rates should be as specified in ASTM D2321. Haunching and backfill shall be as specified in ASTM D 2321 Section 9 with Class I, II, or III materials.

4.4. **Compaction**. Compact material below pipes to 95% density per ASTM D 1557 within +- 3% of optimum moisture as stated in the geotech report.

4.5. **Qualifications**. Any operator conducting butt or fusion welding must be manufacturer certified to perform such work. Names of certified operators will be supplied to the Owner.

Item 900
Liner Installation

1. DESCRIPTION

Contractor shall furnish, install and test geosynthetics and geotextile liners in accordance with this specification and Chevron MCBU Standards. Work under this specification will include, but not necessarily be limited to the following; 60 mil HDPE liner, 8 oz non-woven geotextiles, 200 mil geonet, primary liner, leak detection liner, labor, material, tools, equipment, and services for a complete installation as determined by the Owner and the Engineer. Although such work may not be specifically indicated, Contractor is to include all miscellaneous items, appurtenances and incidental items necessary for the complete installation.

2. MATERIALS

Furnish materials in compliance with the Chevron MCBU standards contained in these specifications.

2.1. **Submittals**. Provide the Owner's representative with submittals to attest compliance with the Chevron MCBU standards. These submittals should include but are not necessarily limited to the following;

- Manufacturer's name and contact information
- Manufacturer's qualifications
- Contractor qualifications
- A list of 10 similar projects that have used the manufacturer's materials
- Product type with representative samples
- Materials Properties (cut sheets)
- Written recommendations for storage, handling, & installation of the product
- Contractor certifications for the installation of the product
- Equipment to be used (welders, fusers, etc.)
- Contractor certifications on equipment to be used
- Material Warranty
- Installation Warranty
- Quality Control Program
- Shop Drawings
- Certificate of installation

2.2. **Contractor Qualifications.** The Contractor is to have installed a minimum of 1 million square yards of the specified material during the last three year period. The Contractor is to have worked on three or more similar sized (400,000 square feet plus) projects within the last 5 years.

2.3. **Manufacturer Qualifications.** The manufacturer is to have produced a minimum of 1 million square yards of the specified material during the last year. The manufacturer is to have a GAI-LAP accredited laboratory at the manufacturing facility. Manufacturer is to be ISO 9001; 2008 certified.

2.4. **Equipment**. Contractor is to submit data sheets for the equipment to be used on the project. Welders are to include a temperature gauge. Equipment is to be available in sufficient quantity to prevent work delays. Provide a constant voltage power source for such equipment.

2.5. **Quality Control Program.** Detail the key personnel that will be on site to administer the Quality Control Program. Define the recording structure used, daily and weekly summary reports. Detail repair methods for damaged liner sections and the methods for determining objectionable installations.

2.6. **Shop Drawings.** Shop drawings are to include the Contractor's proposed panel layout plan and seams, testing locations, anchor locations and details. All test results will be shared with the Owner's representative.

2.7. **Certificate of Installation.** Upon project completion the Contractor will furnish the Owner with a Certificate of Installation, attesting that the installation was performed in accordance with the plans and Chevron MCBU standards. The date of this completion certificate will serve as the start date for the two warranties that the Contractor is to provide. The Contractor is to provide a 5 year warranty vs. manufacturer's defects and a 1 year warranty vs. workmanship defects.

2.8. **Storage and Handling**. The Contractor is to immediately flag any material rolls that appear to be damaged during shipping. Damaged materials are not to be used in construction. Materials are to be store on site in accordance with manufacturer recommendations. It will be the Contractor's responsibility to prevent any damage to stored / handled materials.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work.

Fusion equipment / welders are to be provided by, leased by, or approved by the liner manufacturer.

4. CONSTRUCTION

4.1. **Preparation.** The Contractor is to inspect and attest that the earth surface immediately below the liner is free of any surface irregularities, rocks, clods, sticks, roots, or other debris that could endanger the integrity of the liner.

4.2. **Installation.** Contractor is to comply with all manufacturer recommended practices for installation of the liner material. In addition to the regular manufacturer recommendations, perform the following;

- Prevent a roll from ending on a side slope by using newer or full length rolls for side slope runs.
- Do not walk on the liner in a way that will damage it.
- Do not smoke or discard cigarettes on the liner
- Limit vehicular traffic to ATV's or smaller with 6 psi wheel load per each max.
- Allow sufficient slack in the material to allow for thermal expansion and contraction of the liner.
- Don't allow any anchor trench compaction equipment to directly contact the liners.

4.3. **Field Seams and Welds.** Contractor is to comply will all manufacturer recommended practices for the installation of field seams and welds in the material. In addition to the regular manufacturer recommendations, perform the following;

- Conduct trial seams and welds to demonstrate that he material and equipment is bonding satisfactorily. Repeat trial welds until the desired testing results are obtained.
- Conduct quality control tests on the trial seams and welds for peel adhesion, shear strength
- Set seams parallel to the slope where possible.
- Minimize field seams where possible.
- Sloped panels are to extend a minimum of 5 feet beyond the point of grade change to prevent seams from resting on the grade break.
- Avoid placing seams in corners and producing odd shaped sections of liner.
- Lap seams sufficiently for welding requirements, a minimum of six inches.
- Lap upper material over the top of lower material at seams.
- Do not perform seam work at below freezing or above 170 degrees Fahrenheit surface temperature.
- Field welds are to achieve minimum peel strength values of 98 for fusion, 78 for extrusion, and 121 for shear strength per ASTM D 6392.
- When peel testing the break should occur in the liner material and not the weld.

4.4. **Testing.** Each field seam and weld will be subjected to non-destructive field testing. All extrusion welds are to be tested per ASTM D 5641. The vacuum testing rig is to contain the following;

- Rigid, durable housing w/ viewing window
- Soft rubber gasket bottom
- Valve assembly for vacuum release
- Vacuum gauge and pump (27 psi vacuum minimum)
- Soapy solution to apply to the liner

Observed soap bubbles will be marked for repair and retesting by the installer. All vacuum testing is to be documented as part of the Quality control program.

All hot wedge welds are to receive air pressure testing in accordance with ASTM D 5820. The air pressure test rig is to include a pump capable of supplying a sustained 30 psi and pressure feed devices approved by the manufacturer and the Owner.

In some locations it may not be possible to perform non-destructive testing. In such cases, the Contractor is to apply cap strip seams with the same liner material.

Every 500 linear feet of seam is to be destructively tested in accordance with GRI GM-14. Destructive samples are typically one foot by 3 feet, with a 12 inch square section to be kept by the Contractor. Test samples will be pulled from these by the testing lab with results delivered to the Contractor and the Owner. The Contractor is to repair any holes resulting from destructive testing. Repair sections are to adhere to the same requirements as other repair sections.

Failed Seams are to be reconstructed between any two passed test locations. Alternatively the weld may be traced to intermediate locations at least 10 ft. away or where the seam ends in both directions form the location of the failed test. If necessary the failed seam is to be traced to previous days of seaming for the same machine / operator. An additional test is to be performed for the next seam produced by the same machine that produced the failed seam.

Visible “trampolines” or areas subjected to excess tension are to be removed and replaced.

4.5. **Repairs.** Damaged or failed material is to be removed and repaired. The Contractor is responsible for the integrity of all repairs. Patches are to have rounded corners and will be applied to areas 12 inches or larger in all directions. Short seam sections may be abraded and re-welded. Spot welding may be used to seal pinholes or other small tears. Long failed seams are to be capped with like material. All repairs to are to be documented by the Contractor. No additional compensation is to be made for repair materials or labor.

7.1 MINIMUM VALUES FOR 60-MIL SMOOTH HDPE GEOMEMBRANES

TESTED PROPERTY	TEST METHOD	FREQUENCY	MINIMUM VALUE
Thickness, (minimum average) mil Lowest individual value	ASTM D5994 / D5199	Every roll	57 54
Asperity Height (mil)	ASTM D7466	Every second roll	18
Density, g/cm3	ASTM D792	200,000 lb	0.940
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break,	ASTM D 6693, Type IV Dumbbell, 2 in/min	20,000 lb	228 700
Tear Resistance, lb	ASTM D1004	45,000 lb	42
Puncture Resistance, lb	ASTM D4833	45,000 lb	108
Carbon Black Content, %	ASTM D1603*/4218	20,000 lb	2.0 – 3.0
Carbon Black Dispersion	ASTM D5596	45,000 lb	+Note 1
REFERENCE PROPERTY	**TEST METHOD**	**FREQUENCY**	**NOMINAL VALUE**
Oxidative Induction Time, min (Standard OIT)	ASTM D3895, 200° C; 02, 1 atm	200,000 lb	≥ 100
Melt Flow, g/10 min.	ASTM D1238, 190° C; 2.16kg	200,000 lb	≤1.0
Oven Aging With HP OIT, (% retained after 90 hours)	ASTM D5721 ASTM D5885, 150° C; 500 psi O2	Per resin formulation	80
UV Resistance With HP OIT, (% retained after 1600 hours)	ASTM D5885, 150° C; 500 psi O2	Per resin formulation	50 (+Note 2)

+NOTE 1: DISPERSION ONLY APPLIES TO NEAR SPHERICAL AGGLOMERATES. 9 OF 10 VIEWS SHALL BE CATEGORY 1 OR 2. NO MORE THAN 1 VIEW FROM CATEGORY 3.
+NOTE 2: 20-HOUR CYCLE AT 75° C/4 HR DARK CONDENSATION @ 60° C.
*MODIFIED.

Associated ASTM Standards:

- ASTM D5994 – Test Method for Measuring Core Thickness of Textured Geomembrane
- ASTM D5199 – Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- ASTM D7466 – Standard Test Method for Measuring the Asperity Height of Textured Geomembrane
- ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- ASTM D6693 – Test Method for Determining Tensile Properties of Non-reinforced Polyethylene and Non-reinforced Flexible Polypropylene Geomembranes
- ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting
- ASTM D4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- ASTM D1603 – Standard Test Method for Carbon Black in Olefin Plastics
- ASTM D4218 – Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- ASTM D5596 – Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- ASTM D1238 – Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- ASTM D5721 – Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- ASTM D5885 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry

7.2 8 OZ GEOTEXTILE REQUIREMENTS

Property	Test Method	Units	Value
Mass per unit Area	ASTM D5261	oz/yd^2	8
Grab Tensile Strength	ASTM D4632	Lbs	220
Grab Tensile Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	Lbs	90
CBR Puncture Strength	ASTM D4833	Lbs	575
Permittivity	ASTM D4491	sec^{-1}	1.3
Apparent Opening Size	ASTM D4751	U.S. Sieve	80
Water Flow Rate	ASTM D4491	gpm/ft^2	95
UV Resistance[1]	ASTM D4355	%	70

[1]After 500 hrs.

Associated ASTM Standards:

- ASTM D5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- ASTM D4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
- ASTM D4533 – Test Method for Index Trapezoid Tearing Strength of Geotextiles
- ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
- ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- ASTM D4751 – Test Method for Determining Apparent Opening Size of a Geotextile
- ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- ASTM D4355 – Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)

7.3 200-MIL GEONET PROPERTIES

Property	Test Method	Frequency	Value
Geonet (prior to lamination)			
Geonet Core Thickness, mil	ASTM D 5199	$1/50{,}000\ ft^2$	200
Transmissivity[1], gal/min/ft	ASTM D 4716	$1/540{,}000\ ft^2$	9.6
Density, g/cm^3	ASTM D 1505	$1/50{,}000\ ft^2$	0.94
Creep Reduction Factor	ASTM D 7406/7361	Per formulation	Maximum of 1.2 at 15,000 lb/ft^2
Tensile Strength (MD), lb/in	ASTM D 5035/7179	$1/50{,}000\ ft^2$	45
Carbon Black Content, %	ASTM D 1603[2]/4218	$1/50{,}000\ ft^2$	2.0

[1]Gradient of 0.1, normal load of 25,000 lb/ft^2, water at 70° F, between steel plates for 15 minutes.
[2]Modified.

Associated ASTM Standards:

- ASTM D5199 – Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- ASTM D4716 – Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- ASTM D1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique
- ASTM D7406 – Standard Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products
- ASTM D7361 – Standard Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method
- ASTM D5035 – Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
- ASTM D7179 – Standard Test Method for Determining Geonet Breaking Force
- ASTM D1603 – Standard Test Method for Carbon Black in Olefin Plastics
- ASTM D4218 – Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

Appendix 9 – Recycling Containment Geotechnical Engineering Report

File No. 16-141
September 6, 2016

Mr. Jim Daniels
Western Slope Oil Services
10201 West Highway 158
Midland, Texas 79707

Re: Geotechnical Engineering Study for Frac Ponds at Two Sites
Package 1 Frac Pond 1 - Section 10 (Lat.: 32.061648, Long.:-104.170242)
Package 2 Frac Pond 2 - Section 8 (Lat.: 32.053280, Long.: -104.201103)
Near Hayhurst, Eddy County, New Mexico

Dear Mr. Daniels:

LOI ENGINEERS thanks you for the opportunity to present the enclosed geotechnical engineering report for the above referenced project. This engineering report was prepared in accordance with the authorized scope of services as presented in our proposal No. LOIP16-208, dated August 5, 2016, and authorized on August 10, 2016. The information we are presenting herein describes the procedures utilized for field and laboratory investigation, along with the results of our study. This report includes our evaluation of the field and lab data obtained, and geotechnical engineering recommendations for design and construction of two sets of frac ponds near Hayhurst, New Mexico.

It was a pleasure to work with you on this phase of your project, and we look forward to assist you further during construction activities. If you have any questions regarding the information we present herein, please call us.

Respectfully submitted,

LOI ENGINEERS

BERNARDINO OLAGUE NEW MEXICO 13301 REGISTERED PROFESSIONAL ENGINEER

Bernardino Olague, P.E.
Principal Engineer

9/6/2016

Copies: Above (1) Via Email (1, via e-mail)
Mr. Ralph Truszkowski, P.E. (1, via e-mail)
File (1)

Table of Contents

APPENDIX A

APPENDIX B

1.0 INTRODUCTION

We have completed the geotechnical engineering study for two sets of frac ponds for Chevron U.S.A. Inc., near Hayhurst, Eddy County, New Mexico. We were authorized to conduct this study on August 10, 2016, by Mr. Jim Daniels, representing Western Slope Oil Services, LLC (Client).

2.0 PROJECT DESCRIPTION

The project consists of the design and construction of two sets of frac ponds, following the Chevron U.S.A. Inc. (Owner) general guidelines for this type of project. The locations of the well pads are as follows:

- Package 1 Frac Pond 1 - Section 10 (Lat.: 32.061648, Long.:-104.170242)
- Package 2 Frac Pond 2 - Section 8 (Lat.: 32.053280, Long.: -104.201103)

The sites are located near Hayhurst, Eddy County, New Mexico. Access to Frac Pon 1 Site will be provided through Whites City Road via Road Runner Road, traversing Section 10 and Section 11 of the State of New Mexico. Access to Frac Pond 2 will be provided via a utility road traversing Section 16 and Section 17 of the State of New Mexico.

According to project information provided by Client, each frac pond will be 650 feet long and 650 feet wide. In addition, each frac pond will have a capacity to store and hold 1,000,000 barrels. Furthermore, the slopes of the ponds, which will have an interior height of 24 feet (toe to shoulder) and an exterior height of 12 feet (exterior toe to crest) above the lowest adjacent finish grade, may be protected against erosion thru the installation of a 30-mil High Density Polyethylene liner and associated drainage layers. Conceptual data indicates that the maximum side slopes will not exceed 3H:1V (Horizontal:Vertical). The crest of the berm will be 12 feet wide.

3.0 ENGINEERING INVESTIGATION

3.1 Field Exploration

During the field exploration, we drilled a total of ten (10) soil borings, five (5) borings per well pad. The borings were advanced to depths ranging from 9 feet to 17 feet below ground surface at representative locations throughout the project sites. Drilling and sampling activities were performed in accordance with ASTM D-6151 and D-1586 procedures, respectively, with a truck-mounted CME-75 drill rig.

The soil boring locations are shown in the Boring Plan included in the Appendix of this report in Sheet A-1.

A log of each soil boring was prepared to delineate the soil strata studied at the site. The soil boring logs (B-1 through B-10) are included in the Appendix as Sheets A-2 through A-11. A key to the soil terminology used in the borings is included as Sheets A-12 and A-12.

Standard Penetration Tests (SPT) were conducted at each representative soil strata in the soil borings to determine the relative density or consistency of the resident soils. The SPT is a widely recognized procedure that provides a numerical value of the soil strata being tested, indicating the number of blows that it takes for a standard 140-pound weight hammer with a standard 30-inch free fall drop to penetrate 12 inches into the soil. The SPT values for the soil strata in the borings are included in the soil boring logs.

As part of the field exploration, representative soil samples from the soil borings were collected at regular depth intervals using a standard 2-inch diameter split spoon sampler. The samples were identified and visually classified according to ASTM D-2488, and placed in moisture-proof containers for transportation to the laboratory for further evaluation and testing.

The samples collected from the field investigation will be stored at LOI's soil mechanics laboratory for a period of 90 days from the date of this report, after which time LOI will discard the samples, unless prompt notification is received from

the client.

3.2 Geotechnical Laboratory Testing

In the laboratory, we determined the moisture content, particle size analysis, percent passing the No. 200 sieve, and Atterberg Limits of selected samples. We conducted these tests to determine the physical and engineering properties of representative soils at the site. These tests also allowed us to properly classify the resident soils in accordance with the Unified Soil Classification System (USCS). The results of our tests are included in the soil boring logs, adjacent to the depth at which the sample was recovered.

The results of our tests are included in the soil boring logs, adjacent to the depth at which the sample was recovered. Our laboratory testing schedule is summarized in the table below.

Type of Test	Number of Tests
Moisture Content (ASTM D-2216)	40
Percent Passing No. 200 Sieve (ASTM D-6913)	40
Grain Size Distribution Analysis (ASTM D-422)	20
Atterberg Limits (ASTM D-4318)	20

3.3 Environmental Testing

During our field exploration, we collected representative composite soil samples from the borings at select intervals. We identified and labeled the samples according to sampling point and depth, visually classified them according to ASTM D-2488, and placed them in moisture-proof containers and ice for transportation to the laboratory for further testing, including but not limited to Total Petroleum Hydrocarbons (TPH). The results of the environmental testing are attached in Appendix B of this report.

4.0 GENERAL SITE CONDITIONS

4.1 Area Geology

The project site is located within the Permian Basin geological formation, and more specifically the Delaware Basin, which is characterized by Paleozoic sedimentary deposits underlain by igneous materials, consisting of anhydrite with interbedded strata of shale, dolomite, siltstone and sandstone.

4.2 Site Topography and Conditions

The site exhibits an undulating topography with high and low points throughout

4.3 Site Vegetation

Natural vegetation includes creosote, mesquite trees, shrubs, and perennial grasses.

4.4 Soil Stratigraphy

Frac Pond 1 – Package 1

The soils we encountered in the soil borings (B-1 thru B-5) can be can be grouped into two generalized soil strata as follows:

Stratum A, consisting of brown sandy lean clays intermixed with traces of organic matter (roots), was encountered in borings B-1 through B-5, from ground surface elevation and extended to depths ranging from 1½ to 3 feet below ground surface. These soils were encountered at a dry to moist condition, with moisture contents ranging from 6 to 13 percent, and at a soft to stiff consistency, with SPT values ranging from 4 to 35 blows per foot of penetration. These plastic soils exhibited a percent passing the No. 200 sieve of 74.9 percent, and a liquid limit of 26 and yielded a plasticity index of 10. The soils in this stratum may be classified as CL in accordance with the USCS.

Stratum B, consisting of brown sandy silts intermixed with medium gravels and calcium carbonate (calcareous material) was encountered in borings B-1 through B-5, underlying the Stratum A soils described above. These soils were encountered at

a slightly cemented at a dry to moist condition, with moisture contents ranging from 7 to 18 percent, and at a stiff to very hard consistency, with SPT values ranging from 30 to more than 50 blows per foot of penetration. These non-plastic soils exhibited percent passing the No. 200 sieve ranging from 74.2 to 93.5 percent. The soils in this stratum may be classified as ML in accordance with the USCS.

Frac Pond 2 – Package 2

The soils we encountered in the soil borings (B-6 thru B-10) can be can be divided into two (2) generalized soils strata as follows:

Stratum A, consisting of brown sandy lean clays intermixed with particles of silt, was encountered from ground surface elevation and extended to depths ranging from about 2 feet to 3 feet. This stratum was encountered again in boring B-8. These plastic soils exhibited a tested liquid limit of 33 and yielded a plasticity index of 18. The soils in this stratum may be classified as CL in accordance with the USCS.

Stratum B, consisting of silts blended with various amounts of fine grained sands, medium gravels and traces of calcium carbonate (calcareous material), was encountered underlying the Stratum A soils and extended to the total explored depth, which ranged from 11 to 16 feet below ground surface. These slightly cemented soils were encountered at a dry to moist condition, with moisture content test results ranging from 18 to 24 percent, and at a very dense relative density, with SPT values exceeding 50 blows per foot of penetration. These slightly plastic soils exhibited percent passing the No. 200 sieve ranging from 76.3 to 96.4 percent. The soils in this stratum may be classified as ML in accordance with the USCS.

4.5 Groundwater

Groundwater was not present in the borings drilled during the time of our field exploration. The groundwater table at the site is believed to be at depths well below the planned depth of foundations and related excavations at the project site.

5.0 ENGINEERING EVALUATION

5.1 Project Technical Information

Based on information provided by Client, the frac ponds will have a capacity of 1,000,000 barrels. The geometry of the ponds indicates the following:

- Interior height (invert of pond to shoulder): 24 feet
- Exterior height (toe of berm to shoulder): 12 feet
- Width of crest: 12 feet

Each pond will be lined with a 30-mil HDPE liner. Installation of the liner shall be in strict adherence to the manufacturer's recommendations and shall take place under the supervision of a competent person.

5.2 Site Preparation

Pond 1 Package 1

The native soils encountered at the Pond 1 site, although were encountered at a hard condition, their remolded shear strength (i.e., recompacted) characteristics are marginally acceptable to be used as embankment material without any type of improvement as indicated below.

- Blend the Stratum B silty soils (ML classification) with clayey or sandy soils to a minimum 50:50 ratio.

Pond 2 Package 2

It is our opinion that the resident soils encountered in the upper 10 feet may not

provide adequate slope stability if used in their presented conditions to build the pond embankment (berm). Therefore, we recommend the following soil improvements:

- Blend the Stratum B silty soils (ML classification) with clayey or sandy soils to a minimum 50:50 ratio.

It is important to note that the cemented will represent some degree of difficulty, thus the contractor shall consider the use of a rock ripper during earthwork operations or other means.

5.3 Vertical Movements

We calculated the Potential Vertical Rise (PVR) of a theoretically dry soil mass, in accordance with Texas Department of Transportation (TXDOT) method Tex 124-E. The PVR value is less than 1-inch under dry moisture conditions for soils and conditions encountered in samples obtained from the soil borings. This refers to the potential expansion of clayey soils, not to consolidation or settlement due to loads exceeding the ultimate soil bearing capacity.

5.4 Foundation Recommendations

The proposed embankments shall have a soil foundation bearing at least at 2 feet below existing grade elevation on the outside of the berm (exterior side of frac pond). This foundation shall consist of select fill material compacted in 8-inch loose layers to a minimum of 95 percent compaction, as determined by ASTM D-1557, and moisture conditioned to within 3 points of the optimum moisture content.

5.5 Slope Stability

We performed a slope stability analysis using the Simplified Bishop Analysis. This method takes into account gradual water withdrawal, no significant surcharge loads, and controlled inflows and properly designed inlets. We conducted two analysis, using a 2:1 slope and a 3:1 slope (H:V) for each Frac Pond. The respective factors of safety are presented in the table below.

The calculation summary for each slope is attached in Appendix A (Sheets A-14 through A-17).

Pond 1 Package 1	
Slope (H:V)	**Calculated Safety Factor**
2 : 1	1.54
3 : 1	2.30

Pond 2 Package 2	
Slope (H:V)	**Calculated Safety Factor**
2 : 1	1.61
3 : 1	2.41

5.7 Trench Safety Guidelines

The recommendations provided below are based on the requirements of the United States Department of Labor, Occupational Safety & Health Administration (OSHA) Standards – 29 CFR, and more specifically, part number 1926, standards numbers 1926.651 and 1926.652. All parts of these standards should be followed by the contractor in performing the required work.

Soil Sloping (for trenches)

In accordance with OSHA guidelines, the soils near the surface included in soils report are classified as Type C soils. The maximum allowable slopes (horizontal to vertical) for excavations shall be 1½:1 for Type C soils.

The actual slope should not be steeper than the maximum allowable slope as recommended above. However, if there are signs of distress in the soil structure, such as fissures, subsidence, spalling, raveling, evidence of sloughing, groundwater seepage and other similar signs, the slope should be cut back to an actual slope which is at least ½ horizontal to one vertical less steep than the maximum allowable slope.

5.8 Structural Fill

The structural fill or native subgrade soils used to support the foundation system

and pavements should be granular, preferably cohesion-less, and free of deleterious material and particles over 4 inches in greatest dimension. Soils proposed for use as fill materials should be classified in accordance with ASTM D-2487. The following soils classified in accordance with the Unified Soil Classification System (USCS) can be considered satisfactory for use as structural fill:

GM, GC, GW-GM, GW-GC, GP, GP-GM and GP-GC, SM, SC, SW-SM, SW-SC, SP-SM, SW-SC and SC-SM.

The following USCS-classified soils are not considered satisfactory for use as structural fill:

CH, CL, MH, ML, OH, OL and PT, or soils that exceed a liquid limit of 40 and a plasticity index of 18.

The resident soils in our borings are not considered suitable for use as select structural fill or embankment material. The table below presents a gradation of a material suitable for use as select fill.

Sieve Size	Percent Passing by Weight
3-inch	100
¾-inch	85-100
No. 4	35-85
No. 200	5-35

Structural fill or subgrade soils should be placed in uniform layers not exceeding 6 inches in compacted thickness, moisture-conditioned to add the amount of moisture required for optimum compaction and compacted to a minimum of 95 percent of maximum density in accordance with ASTM D-1557 (modified Proctor) procedures. The moisture content should be at plus or minus 3 percent of optimum moisture content in accordance with ASTM D-1557. This compaction requirement also applies to the subgrade soils that will receive structural fill.

Compaction of the fill material and subgrade soils should be conducted with approved types of pneumatic, power or tamping equipment. Determination of

density in the field should be conducted in accordance with ASTM D-2922 or D-1556.

5.9 Site Drainage

Positive surface drainage should be provided during and after construction by sloping the ground surface a minimum of two percent graded away from the toe of the exterior side of the pond embankment for a minimum distance of 10 feet. Underground water and sewer lines should be properly installed underneath the structures to reduce the possibility of moisture infiltration in the event of plumbing leaks.

6.0 ADDITIONAL CONSIDERATIONS

6.1 Construction Monitoring

We recommend that the client retain the geotechnical engineer (LOI Engineers) during the construction phase of this project to verify the findings of our study, and to provide supplemental recommendations to this study in the event that site conditions vary from those described in this report.

The geotechnical engineer should also conduct testing of fill materials at the rate of one field density per each lift of fill or one per 3,000 square feet of, in accordance with ASTM D-2922 or D-1556. Additionally, one moisture-density curve should be obtained for each type of material used in accordance with ASTM D-1557, and one sieve analysis and one plasticity index for each type of imported material used, according to ASTM C-136, and D-4318.

6.2 Limitations

We have performed our professional services, have obtained the data presented in this report, and have prepared our recommendations in accordance with generally accepted engineering principles and practices. Our conclusions and recommendations are based on the data obtained from ten (10) test borings and laboratory testing conducted on representative samples, and on our knowledge of

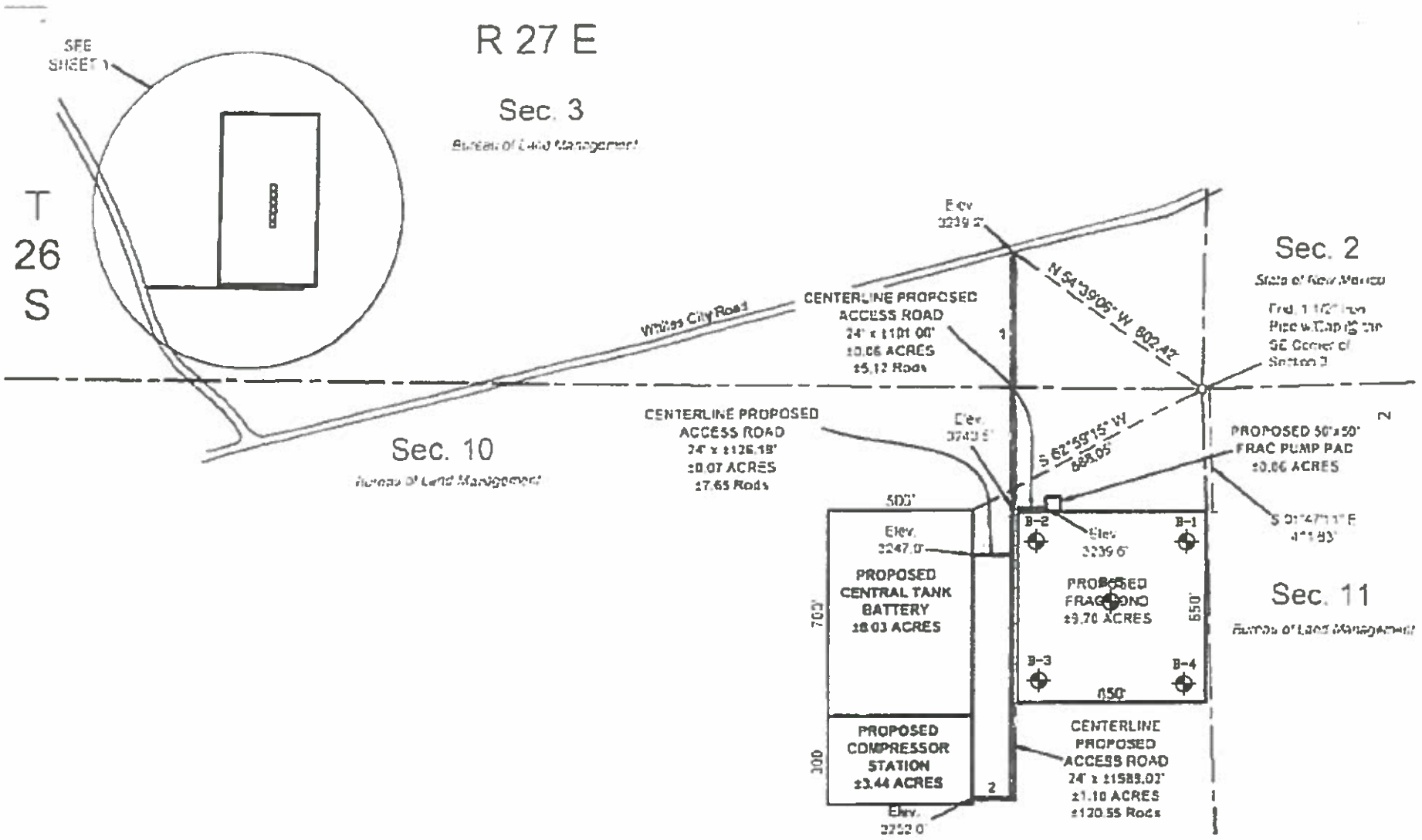
the project conditions at the time of our geotechnical engineering study.

The data in this report reflects subsurface soil conditions only at the specific sampling location, time of sampling, and to the depths indicated in our report. This report is not intended to identify or address any potential environmental concerns associated with the project site.

We recommend that the client notify LOI Engineers of any changes to the project conditions considered in this report, so that we may provide pertinent modifications to our recommendations if deemed necessary.

Additionally, once construction commences, we should be notified of any unusual site conditions that appear to vary from those reported herein, so that we may conduct further investigations and prepare supplemental recommendations if deemed necessary.

We conducted this investigation for the purpose of defining the subsurface soil conditions for design of Frac Ponds 1 and 2 Packages, near Hayhurst, Eddy County, New Mexico. Use of this information for projects other than the one described herein will not be adequate.



LEGEND:

B-1 APPROXIMATE LOCATION, AND BORING NUMBER

DRAWN BY	D.G.
REVIEWED BY	B.O.
APPROVED BY	B.O.
PROJECT MGR.	B.O.
PROJECT NO.	L0116-140
FILE NAME	SITE PLAN
DATE	08/17/16
SCALE	N.T.S

PROJECT ENGR.

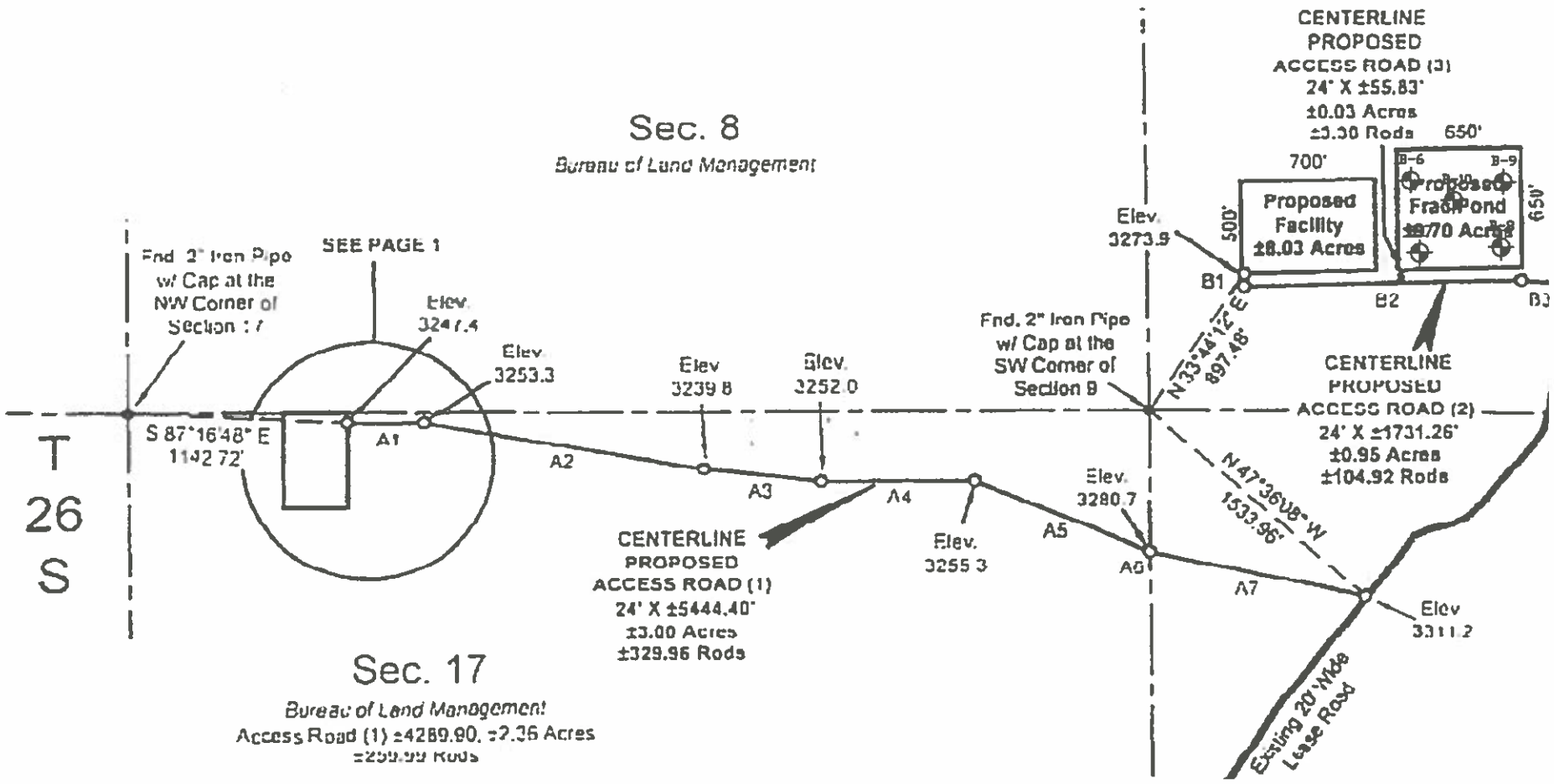
GEOTECHNICAL CONSULTANT

918-781-1532
2101 E. MISSOURI AVE.
SUITE B
EL PASO, TEXAS 79903

DRAWING TITLE: BORING LOCATION PLAN

PROJECT NAME: PROPOSED OIL WELL PADS NEAR ORLA, TEXAS

SHEET NUMBER: A-1.1



LEGEND:

B-1 APPROXIMATE LOCATION, AND BORING NUMBER

DRAWN BY: D.G.
REVIEWED BY: B.O.
APPROVED BY: B.O.
PROJECT MGR: B.O.
PROJECT NO.: L0116-140
FILE NAME: SITE PLAN
DATE: 08/17/16
SCALE: N.T.S.

PROJECT ASCE

GEOTECHNICAL CONSULTANT

815-781-1532
2101 E. MISSOURI AVE.
SUITE B
EL PASO, TEXAS 79903

DRAWING TITLE: BORING LOCATION PLAN

PROJECT NAME: PROPOSED OIL WELL PADS
NEAR ORLA, TEXAS

SHEET NUMBER: A-1.2

LOG OF TEST BORING No. 1

Project name: Chevron Fracking Pond 1 Section 10
File No.: LOI16-141 Section 10
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-19-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			CLAY, sandy, brown, soft, moist, with traces of organic matter roots	CL	13					6	
			SILT, light brown-whitish, firm, moist, with traces of fine grained sand and some gypsum particles	ML	16	93.5	NV	NV	NP	33	
5			- sandy, light brown-whitish, firm, moist, with traces of fine grained sand and some gypsum particles							50	
			- sandy, light brown, very hard, moist, with silt, and traces of calcareous material		15					40	
10			- fine grained, to medium gravel below 11 feet		16	74.2	NV	NV	NP	38	
			Termination depth at 11 feet Auger refusal								
15											
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-2

LOG OF TEST BORING No. 2

Project name: Chevron Fracking Pond 1 Section 10
File No.: LOI16-141 Section 10
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-19-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value: CURVE (10 30 50)
0			CLAY, sandy, brown, loose, dry, with silt	CL	9	74.9	26	16	10	4	
			SILT, sandy, light brown, tan, hard, dense, dry, with calcium carbonate							30	
5			- sandy, light brown, tan, hard, dense, dry, with traces of calcium carbonate	ML	7					38	
			- sandy, brown, moist, with gravel		9	61.7	NV	NV	NP		
10				ML							
			Termination depth at 11 feet Auger refusal								
15											
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-3

LOG OF TEST BORING No. 3

Project name: Chevron Fracking Pond 1 Section 10
File No.: LOI16-141 Section 10
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-19-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			CLAY, fine grained, silty, light brown, tan, hard, dry, with traces of organis matter (roots) and particales of cemented calcium carbonate	CL	9					35	
			SILT, sandy, light brown, tan, hard, dry	ML	14	88.4	NV	NV	NP	48	
5			- sandy, with interbedded lenses of whitish calcium carbonate and calcareous material							50	
			- sandy, light brown, very hard, moist		16	81.9	NV	NV	NP	50	
10					15					50	
			Termination depth at 11 feet Auger refusal								
15											
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-4

LOG OF TEST BORING No. 4

Project name: Chevron Fracking Pond 1 Section 10
File No.: LOI16-141 Section 10
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-19-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value: CURVE (10 30 50)
0			CLAY, sandy, lean, brown, soft, dry	CL	6					6	
			SILT, sandy, whitish light brown, with traces of calcium carbonate		14	86.3	NV	NV	NP	50	
5										50	
			- whitish nodules of calcareous material with rust pigmentation	ML	18					50	
10			- sandy, light brown to whitish, very dense, dry with gypsum and some medium gravel		18	88.2	NV	NV	NP	50	
			Termination depth at 13.5 feet Auger refusal								
15											
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-5

LOG OF TEST BORING No. 5

Project name: Chevron Fracking Pond 1 Section 10
File No.: LOI16-141 Section 10
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-19-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			CLAY, sandy, lean, brown, soft, dry	CL	19					22	
			SILT, sandy, light brown, stiff to very hard, dry to moist		8	60.3	NV	NV	NP	34	
5										50	
					11					50	
10										50	
				ML							
15			- sandy, light brown, stiff to very hard, dry to moist, with medium gravel		8	64.1	NV	NV	NP	50	
20					7					50	
			Termination depth at 21.5 feet Auger refusal								
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-6

LOG OF TEST BORING No. 6

Project name: Chevron Fracking Pond 2 Section 9
File No.: LOI16-141 Section 9
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-18-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			CLAY, lean, sandy, brown, firm, dry	CL	7					20	
			SAND, fine grained, silty, brown, medium dense, dry, with some fine gravel	SM	9					20	
5					9	48.6	NV	NV	NP	21	
			SILT, sandy, light brown, very hard, moist, with sand, silt and traces of gravel	ML						50	
10			- sandy, light brown, very hard, moist, with sand, silt and traces of gravel		18	80.5	NV	NV	NP	50	
15			- with gravel below 12 feet		20					50	
			Termination depth at 17 feet Auger refusal								
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-7

LOG OF TEST BORING No. 7

Project name: Chevron Fracking Pond 2 Section 9
File No.: LOI16-141 Section 9
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-18-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value: CURVE (10 30 50)
0			CLAY, lean, silty, brown, soft, dry	CL						5	
			SILT, tan to whitish-brown, very stiff, moist, with sand and traces of fine gravel	ML	23	96.7	NV	NV	NP	30	
5			- with sand							50	
			- with traces of fine gravel		24					50	
10										50	
15					22	96.4	NV	NV	NP	50	
			Termination depth at 16 feet Auger refusal								
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-8

LOG OF TEST BORING No. 8

Project name: Chevron Fracking Pond 2 Section 9
File No.: LOI16-141 Section 9
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-18-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value: CURVE (10 30 50)
0			CLAY, lean, light brown, moist, with sand, silt and traces of gravel	CL	9					4	
			SILT, sandy, tan, firm, dry							18	
5					11	67.1	NV	NV	NP	32	
			SILT, sandy, tan, firm, dry, with some clay nodules at 8 feet	ML						12	
10					10	60.6	NV	NV	NP	17	
15			CLAY, sandy, lean, brown, moist	CL	15	82.1	33	15	18	19	
20			SAND, fine grained, silty, reddish-brown, very dense, moist	SM							
			Termination depth at 21.5 feet Auger refusal								
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-9

LOG OF TEST BORING No. 9

Project name: Chevron Fracking Pond 2 Section 9
File No.: LOI16-141 Section 9
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-18-16

LOI ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE (10 30 50)
0			CLAY, sandy, lean, brown, soft, dry							6	
			- sandy, lean, light brown, stiff, moist, with traces of calcareous material		18					16	
5				CL	21					29	
					23	76.3	NV	NV	NP	29	
10			SILT, sandy, light brown, stiff, moist		22					29	
				ML							
15			- with some medium gravel		24	78.2	NV	NV	NP		
			Termination depth at 16.5 feet Auger refusal								
20											
25											
30											

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-10

LOG OF TEST BORING No. 10

Project name: Chevron Fracking Pond 2 Section 9
File No.: LOI16-141 Section 9
Boring location: See Sheet A-1
Surface elevation: N/A
Date drilled: 08-18-16

ENGINEERS

Elevation and Depth (ft.)	Samples	Soil symbols	Soil Description	USCS symbol	Moisture content, %	Minus #200 sieve, %	Liquid limit	Plastic limit	Plasticity index	SPT N-Value: Blows per foot (N)	SPT N-Value CURVE
0			SILT, light brown-whitish, sstiff, dry	ML	21					32	
			- tan-light brown at 3 feet		21					39	
5			- with medium gravel at 6 feet							50	
					23	91.3	NV	NV	NP	50	
10			Termination depth at 10 feet Auger refusal								
15											
20											
25											
30											

SPT N-Value CURVE: 10 30 50

Groundwater Table Data

Depth	Date	Time
N/A	N/A	N/A

Sample Type
- Auger cutting
- 2" O.D. split spoon
- 3" O.D. split tube
- Thin-walled Shelby tube

Rig type: CME-75
Boring type: HSA
Logger: OGC

Sheet No. A-11

Soil Terminology

COARSE GRAINED SOILS: More than 50 percent retained on No. 200 sieve. Includes fine, medium, or coarse grained (depending on grain size) gravel and sand, and silty and/or clayey gravel and sand. Density is described according to relative density measured in the laboratory, or sampler resistance in the field as follows:

Penetration Resistance* (Blows per Foot)	Descriptive Term	Relative Density** (Percent)
0 - 10	Loose	0 - 40
10 - 30	Medium Dense	40 - 70
30 - 50	Dense	70 - 90
More than 50	Very Dense	90 - 100

* From Standard Penetration Test with 140-pound hammer, 30 inch drop.
** From relative density tests on undisturbed sand sample.

FINE GRAINED SOILS: More than 50 percent passing through the No. 200 sieve. Includes organic and inorganic silt and clay, gravelly and/or sandy silt and clay, silty clay, and clayey silt. Consistency is described according to shear strength, from unconfined compression tests in the laboratory, penetrometer tests in the field or laboratory, or sampler resistance in the field as follows:

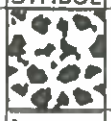
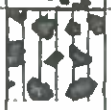
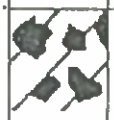
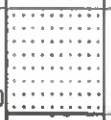
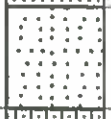
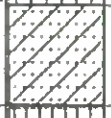
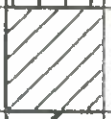
Compressive Strength* (Tons per Square Foot)	Descriptive Term	Penetration Resistance** (Blows per Foot)
Less than 0.25	Very Soft	Less than 2
0.25 - 0.50	Soft	2 - 4
0.50 - 1.00	Firm	5 - 8
1.00 - 2.00	Stiff	9 - 15
2.00 - 4.00	Very Stiff	16 - 50
4.00 and higher	Hard	50 and higher

* From unconfined compression strength test.
** From Standard Penetration Test with 140-pound hammer, 30 inch drop.

Slickensided: With inclined planes of weakness of slick and glassy appearance.
Fissured: With shrinkage cracks that are frequently filled with fine sand.
Laminated: With thin layers of varying colors and texture.
Interbedded: With alternate layers of different soil types.
Calcareous: With noticeable quantities of calcium carbonate.
Sensitive: Applies to cohesive soils that are subject to loss of strength when remolded.
Well graded: With wide range in grain sizes and good distribution of intermediate particle sizes.
Poorly graded: With one predominant grain size, or a poor distribution with intermediate sizes missing.

SOIL SYMBOLS

Identification of the major soil divisions used to distinguish the change of a different stratum. For their combinations and a more detailed description, see UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487-00)

MAJOR SOIL DIVISIONS			SOIL SYMBOL	USCS SYMBOL	TYPICAL NAME
Coarse-Grained Soils (< 50% pass No. 200 sieve)	GRAVELS (<50% pass No. 4 sieve)	Clean Gravels (< 5% pass No. 200 sieve)		GW	Well-Graded Gravels
				GP	Poorly-Graded Gravels
		Gravels with fines (> 12% pass No. 200 sieve)		GM	Silty Gravels
				GC	Clayey Gravels
	SANDS (> 50% pass No. 4 sieve)	Clean Sands (< 5% pass No. 200 sieve)		SW	Well-Graded Sands
				SP	Poorly-Graded Sands
		Sands with fines (> 12% pass No. 200 sieve)		SM	Silty Sands
				SC	Clayey Sands
Fine-Grained Soils (> 50% pass No. 200 sieve)	SILTS	Silts of Low Plasticity (*LL < 50)		ML	Inorganic Silts (slightly plastic)
		Silts of High Plasticity (*LL > 50)		MH	Inorganic Silts (elastic)
	CLAYS	Clays of Low Plasticity (*LL < 50)		CL	Inorganic Clays (lean clays)
		Clays of High Plasticity (*LL > 50)		CH	Inorganic Clays (Fat clays)

*Liquid Limit of the soil
NV: No value obtained; NP: Non-plastic

Sheet No. A-13

Project Name: Frac Pond No. 1 Package 1

LEO File No. LOI16-14

Simplified Bishop Method **2:1 Slope**

Slice	Horizontal Width (b), ft.	Avg. Slice Ht., Ft.	Slice area, sf	Total unit weight (γ), pcf	Partial weight, kips	Total weight (W), kips	Base inclination (α), deg.	W x Sin(α)	Ht. of Surface Water, ft.	Avg. Surface Press., ksf	Surface load (P), kips	Horizontal moment Arm (dh), ft.	Vertical momemnt Arm (dy), ft.	Moment (MP), kip-ft.	Piezometric ht.,ft.	Pore Water pressure (u) ksf	Cohesion (c'), ksf	Friction angle (Φ), deg.	c'b+W+Pcos$^{\beta}$-ub)tan$^{\Phi}$
1	3.5	3	11	108	0.11	1134	65	1027.8	0	0	0	0	0	0	0	0	0	28	603.0
2	4	6	24	108	0.11	2592	48	1926.2	0	0	0	0	0	0	0	0	0	28	1378.2
3	4	6	24	108	0.11	2592	35	1486.7	0	0	0	0	0	0	0	0	0	28	1378.2
4	4	6	24	119	0.12	2856	31	1470.9	0	0	0	0	0	0	0	0	0	32	1784.6
5	4	4	16	119	0.12	1904	24	774.4	0	0	0	0	0	0	0	0	0	34	1284.3
6	3	3	9	119	0.12	1071	22	401.2	0	0	0	0	0	0	0	0	0	34	722.4
6B	3	3	9	119	0.12	1071	12	222.7	0	0	0	0	0	0	0	0.5	0	34	721.4
7	3	3	9	124	0.12	1116	2	38.9	0	0	0	0	0	0	0	0	50	34	902.8
7B	3	3	9	124	0.12	1116	-10	-193.8	0	0	0	0	0	0	0	0.3	0	34	752.2
8	3	3	9	124	0.12	1116	-20	-381.7	0	0	0	0	0	0	0	0	50	34	902.8
	35	40						6773.4											10429.8

Soil Properties

	Unit Weigth (pcf)		Shear Strength	
USCS	Moist	Sat	c'ksf	Φ, deg.
ML	119	0	0	32
ML	108	0	0	28
ML	124	0	0	34

F (B/A)= 1.540

Project Name: Frac Pond No. 2 Package 2

LEO File No. LOI16-14

Simplified Bishop Method **3:1 Slope**

Slice	Horizontal Width (b), ft.	Avg. Slice Ht., Ft.	Slice area, sf	Total unit weight (γ), pcf	Partial weight, kips	Total weight (W), kips	Base inclination (α), deg.	W x Sin(α)	Ht. of Surface Water, ft.	Avg. Surface Press., ksf	Surface load (P), kips	Horizontal moment Arm (dh), ft.	Vertical momemnt Arm (dy), ft.	Moment (MP), kip-ft.	Piezometric ht.,ft.	Pore Water pressure (u) ksf	Cohesion (c'), ksf	Friction angle (Φ), deg.	c'b+W+Pcos$^{\beta}$-ub)tan$^{\Phi}$
1	6	6	36	108	0.11	3888	48	2889.3	0	0	0	0	0	0	0	0	0	28	2067.3
2	8	8	64	119	0.12	7616	41	4996.5	0	0	0	0	0	0	0	0	0	31	4576.2
3	10	14	140	119	0.12	16660	32	8828.5	0	0	0	0	0	0	0	0	0	31	10010.3
4	10	14	140	119	0.12	16660	26	7303.3	0	0	0	0	0	0	0	0	0	31	10010.3
5	10	14	140	124	0.12	17360	18	5364.5	0	0	0	0	0	0	0	0	0	34	11709.5
6	6	14	84	124	0.12	10416	10	1808.7	0	0	0	0	0	0	0	0	0	34	7026.9
7	4	13	52	124	0.12	6448	3	337.5	0	0	0	0	0	0	0	0	0	34	4350.0
8	4	9	36	124	0.12	4464	1	77.9	0	0	0	0	0	0	0	0	0	34	3011.0
8A	4	7	28	124	0.12	3472	-1	-60.6	0	0	0	0	0	0	0	0	0	34	2341.9
9	4	6	24	124	0.12	2976	-3	-155.8	0	0	0	0	0	0	0	0	0	34	2007.3
9A	4	6	24	124	0.12	2976	-15	-770.2	0	0	0	0	0	0	0	0	0	34	2007.3
10	6	8	48	124	0.12	5952	-32	-3154.1	0	0	0	0	0	0	0	0	0	34	4014.7
	76	119						27465.6											63132.7

Soil Properties

	Unit Weigth (pcf)		Shear Strength	
USCS	Moist	Sat	c'ksf	Φ, deg.
ML	119	0	0	31
ML	108	0	0	28
ML	124	0	0	34

F (B/A)= 2.299

Project Name: Frac Pond No. 2 Package 2

LEO File No. LOI16-14

Simplified Bishop Method **2:1 Slope**

Slice	Horizontal Width (b), ft.	Avg. Slice Ht., Ft.	Slice area, sf	Total unit weight (γ), pcf	Partial weight, kips	Total weight (W), kips	Base inclination (α), deg.	W x Sin(α)	Ht. of Surface Water, ft.	Avg. Surface Press., ksf	Surface load (P), kips	Horizontal moment Arm (dh), ft.	Vertical momemnt Arm (dy), ft.	Moment (MP), kip-ft.	Piezometric ht.,ft.	Pore Water pressure (u) ksf	Cohesion (c'), ksf	Friction angle (Φ), deg.	c'b+W+Pcos$^{\beta}$-ub)tan$^{\Phi}$
1	3	3	10	119	0.12	1190	65	1078.5	0	0	0	0	0	0	0	0	0	28	632.7
2	3.5	7	24	119	0.12	2856	48	2122.4	0	0	0	0	0	0	0	0	0	28	1518.6
3	3.5	7	24	119	0.12	2856	35	1638.1	0	0	0	0	0	0	0	0	0	28	1518.6
4	4	7	24	119	0.12	2856	31	1470.9	0	0	0	0	0	0	0	0	0	32	1784.6
5	4	4	12	119	0.12	1428	24	580.8	0	0	0	0	0	0	0	0	0	34	963.2
6	3.5	4	10	119	0.12	1190	22	445.8	0	0	0	0	0	0	0	0	0	34	802.7
6B	3.5	4	12	119	0.12	1428	12	296.9	0	0	0	0	0	0	0	0.5	0	34	962.0
7	3	4	12	123	0.12	1476	2	51.5	0	0	0	0	0	0	0	0	50	34	1145.6
7B	3	4	12	123	0.12	1476	-10	-256.3	0	0	0	0	0	0	0	0.3	0	34	995.1
8	3	3	10	123	0.12	1230	-20	-420.7	0	0	0	0	0	0	0	0	50	34	979.6
	34	47						7008.0											11302.7

Soil Properties

	Unit Weigth (pcf)		Shear Strength	
USCS	Moist	Sat	c'ksf	Φ, deg.
ML	119	0	0	32
ML	108	0	0	28
ML	123	0	0	34

F (B/A)= 1.613

Project Name: Frac Pond No. 2 Package 2

LEO File No. LOI16-14

Simplified Bishop Method **3:1 Slope**

Slice	Horizontal Width (b), ft.	Avg. Slice Ht., Ft.	Slice area, sf	Total unit weight (γ), pcf	Partial weight, kips	Total weight (W), kips	Base inclination (α), deg.	W x Sin(α)	Ht. of Surface Water, ft.	Avg. Surface Press., ksf	Surface load (P), kips	Horizontal moment Arm (dh), ft.	Vertical momemnt Arm (dy), ft.	Moment (MP), kip-ft.	Piezometric ht.,ft.	Pore Water pressure (u) ksf	Cohesion (c'), ksf	Friction angle (Φ), deg.	c'b+W+Pcos$^{\beta}$-ub)tan$^{\Phi}$
1	10	8	80	108	0.11	8640	46	6215.1	0	0	0	0	0	0	0	0	0	28	4594.0
2	10	8	80	119	0.12	9520	34	5323.5	0	0	0	0	0	0	0	0	0	31	5720.2
3	12	12	144	119	0.12	17136	29	8307.7	0	0	0	0	0	0	0	0	0	31	10296.3
4	12	12	144	119	0.12	17136	24	6969.8	0	0	0	0	0	0	0	0	0	31	10296.3
5	10	12	120	123	0.12	14760	16	4068.4	0	0	0	0	0	0	0	0	0	34	9955.7
6	8	12	96	123	0.12	11808	11	2253.1	0	0	0	0	0	0	0	0	0	34	7966.2
7	6	12	72	123	0.12	8856	4	617.8	0	0	0	0	0	0	0	0	0	34	5974.6
8	8	10	80	123	0.12	9840	1	171.7	0	0	0	0	0	0	0	0	0	34	6637.2
9	8	8	64	123	0.12	7872	-4	-549.1	0	0	0	0	0	0	0	0	0	34	5309.7
10	8	8	64	123	0.12	7872	-26	-3450.9	0	0	0	0	0	0	0	0	0	34	5309.7
	92	102						29927.1											72060.1

Soil Properties

	Unit Weigth (pcf)		Shear Strength	
USCS	Moist	Sat	c'ksf	Φ, deg.
ML	119	0	0	32
ML	108	0	0	28
ML	123	0	0	34

F (B/A)= 2.408

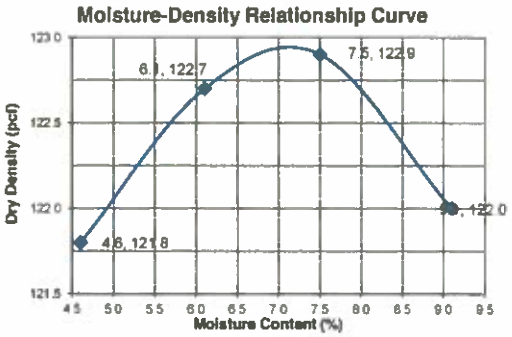
REPORT OF MOISTURE-DENSITY RELATIONSHIP, SIEVE ANALYSIS, AND PLASTICITY INDEX

ASTM D-2487, C-136, D-4318, D-1557

Project Name: Chevron Fracking Pond near Hayhurst
Project Number: LOI16-141
Client: Western Slope Oil Services, LLC.
Sample date: 8/23/16
Sample Location: Subgrade Material; Fracking Pond 1; Sec. 10; Cut from 6" to 3' depth.
Sampler: ID
Soil Classification: Lean clay (CL)
Sample Number: 082316-FP1-S10

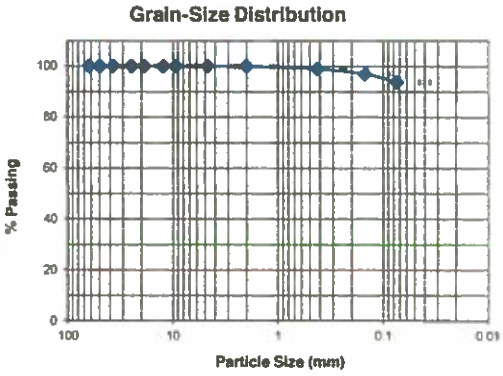
Method Used: A
Preparation: Dry
Rammer: Manual
Specific Gravity: 2.52 (estimated)
As Received Water Content: n/a

Modified Maximum Dry Unit Weight: 123.0 pcf
Modified Optimum Water Content: 10.2 %



Sieve Analysis

Sieve Opening Size		Retained		Passing	
Std.	mm	%	Specs.	%	Specs.
2-1/2"	63.00	0	-	100	-
2"	50.00	0	-	100	-
1-1/2"	37.50	0	-	100	-
1"	25.00	0	-	100	-
3/4"	19.00	0	-	100	-
1/2"	12.50	1	-	100	-
3/8"	9.50	1	-	100	-
#4	4.75	2	-	100	-
#10	2.00	3	-	100	-
#40	0.425	8	-	99	-
#100	0.150	42	-	97	-
#200	0.075	78.8	-	93.9	-



D10= 0.04 Cc= 1.46
D30= 0.09 Cu= 4.73
D60= 0.17

Plasticity Index

Process: Air-dry

Actual	**LL=**	26	**PL=**	16	**PI=**	10
Specified	**LL=**	-	**PL=**	-	**PI=**	-

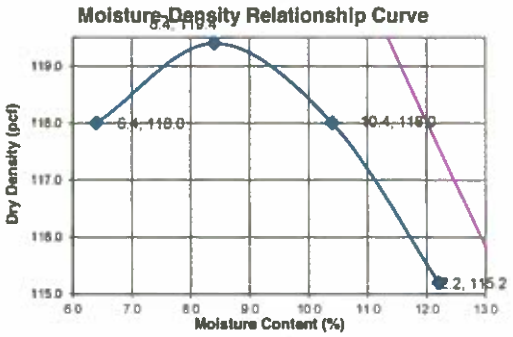
REPORT OF MOISTURE-DENSITY RELATIONSHIP, SIEVE ANALYSIS, AND PLASTICITY INDEX

ASTM D-2487, C-136, D-4318, D-1557

Project Name: Chevron Fracking Pond near Hayhurst
Project Number: LOI16-141
Client: Western Slope Oil Services, LLC.
Sample date: 8/23/16
Sample Location: Subgrade Material; Fracking Pond 2; Sec. 9; Cut from 6" to 3' depth.
Sampler: ID
Soil Classification: Lean clay (CL)
Sample Number: 082316-FP2-S9

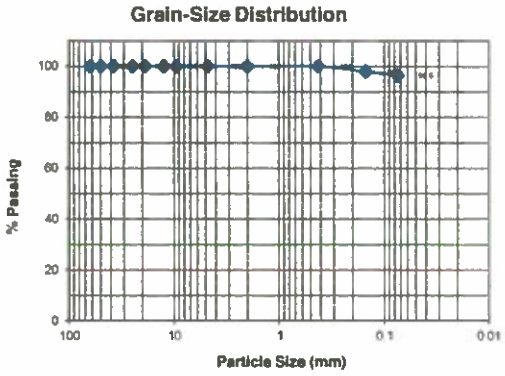
Method Used: A
Preparation: Dry
Rammer: Manual
Specific Gravity: 2.45 (estimated)
As Received Water Content: n/a

Modified Maximum Dry Unit Weight: 119.4 pcf
Modified Optimum Water Content: 8.4 %



Sieve Analysis

Sieve Opening Size		Retained		Passing	
Std.	mm	%	Specs.	%	Specs.
2-1/2"	63.00	0	-	100	-
2"	50.00	0	-	100	-
1-1/2"	37.50	0	-	100	-
1"	25.00	0	-	100	-
3/4"	19.00	0	-	100	-
1/2"	12.50	1	-	100	-
3/8"	9.50	1	-	100	-
#4	4.75	2	-	100	-
#10	2.00	3	-	100	-
#40	0.425	8	-	100	-
#100	0.150	42	-	98	-
#200	0.075	78.8	-	96.5	-



D10= 0.04 Cc= 1.46
D30= 0.09 Cu= 4.73
D60= 0.17

Plasticity Index

Process: Air-dry

Actual	**LL=**	33	**PL=**	15	**PI=**	18
Specified	**LL=**	-	**PL=**	-	**PI=**	-

APPENDIX B

TRACEANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800-378-1296 806-794-1296 FAX 806-794-1296
200 East Sunset Road, Suite E El Paso, Texas 79922 915-585-3443 FAX 915-585-4944
5002 Basin Street, Suite A1 Midland, Texas 79703 432-689-6301 FAX 432-689-6313
(BioAquatic) 2501 Mayes Rd., Suite 100 Carrollton, Texas 75006 972-242-7750
E-Mail: lab@traceanalysis.com WEB: www.traceanalysis.com

Certifications

WBE HUB NCTRCA DBE NELAP DoD LELAP Kansas Oklahoma ISO 17025

Analytical and Quality Control Report

Bernadino Olague
LOI Engineers
2101 E. Missouri Ave.
El Paso, TX, 79903

Report Date: August 30, 2016

Work Order: 16082626

Project Name: Chevron Fracking Pond
Project Number: LOI16-141

Enclosed are the Analytical Report and Quality Control Report for the following sample(s) submitted to TraceAnalysis, Inc.

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
427243	Frac Pond 1 BH4 13 1/2	soil	2016-08-23	11:00	2016-08-25
427244	Frac Pond Sec 9 BH1 0-1 1/2	soil	2016-08-23	11:30	2016-08-25
427245	Frac Pond 1 Sec 10 BH2 5-6 1/2	soil	2016-08-23	12:00	2016-08-25
427246	Frac Pond 1 Sec 10 BH5 10-11 1/2	soil	2016-08-23	12:30	2016-08-25
427247	Frac Pond 1 Sec 10 BH3 7 1/2-9	soil	2016-08-23	13:00	2016-08-25
427248	Frac Pond 2 Sec 9 BH5 5-6 1/2	soil	2016-08-23	13:30	2016-08-25
427249	Frac Pond 2 Sec 9 BH4 15-16 1/2	soil	2016-08-23	14:00	2016-08-25
427250	Frac Pond 2 Sec 9 BH3 5-6 1/2	soil	2016-08-23	14:30	2016-08-25
427251	Frac Pond 1 Sec 10 BH1 0-1 1/2	soil	2016-08-23	15:00	2016-08-25
427252	Frac Pond 2 Sec 9 BH2 2 1/2-4	soil	2016-08-23	15:30	2016-08-25

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

TraceAnalysis, Inc. uses the attached chain of custody (COC) as the laboratory check-in documentation which includes sample receipt, temperature, sample preservation method and condition, collection date and time, testing requested, company, sampler, contacts and any special remarks.

TraceAnalysis, Inc.

Dr. Blair Leftwich, Director
James Taylor, Assistant Director
Johnny Grindstaff, Operations Manager

Report Contents

Case Narrative

Samples for project Chevron Fracking Pond were received by TraceAnalysis, Inc. on 2016-08-25 and assigned to work order 16082626. Samples for work order 16082626 were received intact at a temperature of 4.3 C.

Samples were analyzed for the following tests using their respective methods.

Test	Method	Prep Batch	Prep Date	QC Batch	Analysis Date
Chloride (IC)	E 300.0	112259	2016-08-29 at 08:30	132443	2016-08-29 at 09:47
pH	S 9045C	112242	2016-08-29 at 12:00	132421	2016-08-29 at 14:30
SO4 (IC)	E 300.0	112259	2016-08-29 at 08:30	132443	2016-08-29 at 09:47
TX1005	TX1005	112255	2016-08-29 at 11:00	132445	2016-08-30 at 09:59

Results for these samples are reported on a wet weight basis unless data package indicates otherwise.

A matrix spike (MS) and matrix spike duplicate (MSD) sample is chosen at random from each preparation batch. The MS and MSD will indicate if a site specific matrix problem is occurring, however, it may not pertain to the samples for work order 16082626 since the sample was chosen at random. Therefore, the validity of the analytical data reported has been determined by the laboratory control sample (LCS) and the method blank (MB). These quality control measures are performed with each preparation batch to ensure data integrity.

All other exceptions associated with this report have been footnoted on the appropriate analytical page to assist in general data comprehension. Please contact the laboratory directly if there are any questions regarding this project.

Analytical Report

Sample: 427243 - Frac Pond 1 BH4 13 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12	U	2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			22.8	mg/Kg	1	25.0	91	62 - 137
n-Tricosane			23.5	mg/Kg	1	25.0	94	65.1 - 144
n-Triacontane			26.3	mg/Kg	1	25.0	105	46.4 - 152

Sample: 427244 - Frac Pond Sec 9 BH1 0-1 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			23.2	mg/Kg	1	25.0	93	62 - 137
n-Tricosane			23.1	mg/Kg	1	25.0	92	65.1 - 144
n-Triacontane			19.8	mg/Kg	1	25.0	79	46.4 - 152

Sample: 427245 - Frac Pond 1 Sec 10 BH2 5-6 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			20.6	mg/Kg	1	25.0	82	62 - 137
n-Tricosane			20.5	mg/Kg	1	25.0	82	65.1 - 144
n-Triacontane			18.4	mg/Kg	1	25.0	74	46.4 - 152

Sample: 427246 - Frac Pond 1 Sec 10 BH5 10-11 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12	U	2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			23.5	mg/Kg	1	25.0	94	62 - 137
n-Tricosane			22.9	mg/Kg	1	25.0	92	65.1 - 144
n-Triacontane			20.4	mg/Kg	1	25.0	82	46.4 - 152

Sample: 427247 - Frac Pond 1 Sec 10 BH3 7 1/2-9

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	Result	RL Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			22.8	mg/Kg	1	25.0	91	62 - 137
n-Tricosane			22.8	mg/Kg	1	25.0	91	65.1 - 144
n-Triacontane			18.2	mg/Kg	1	25.0	73	46.4 - 152

Sample: 427248 - Frac Pond 2 Sec 9 BH5 5-6 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	Result	RL Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			23.7	mg/Kg	1	25.0	95	62 - 137
n-Tricosane			22.9	mg/Kg	1	25.0	92	65.1 - 144
n-Triacontane			21.3	mg/Kg	1	25.0	85	46.4 - 152

Sample: 427249 - Frac Pond 2 Sec 9 BH4 15-16 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	Result	RL Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			23.0	mg/Kg	1	25.0	92	62 - 137
n-Tricosane			23.2	mg/Kg	1	25.0	93	65.1 - 144
n-Triacontane			20.2	mg/Kg	1	25.0	81	46.4 - 152

Sample: 427250 - Frac Pond 2 Sec 9 BH3 5-6 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			21.8	mg/Kg	1	25.0	87	62 - 137
n-Tricosane			21.5	mg/Kg	1	25.0	86	65.1 - 144
n-Triacontane			18.6	mg/Kg	1	25.0	74	46.4 - 152

Sample: 427251 - Frac Pond 1 Sec 10 BH1 0-1 1/2

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			24.4	mg/Kg	1	25.0	98	62 - 137
n-Tricosane			24.1	mg/Kg	1	25.0	96	65.1 - 144
n-Triacontane			20.7	mg/Kg	1	25.0	83	46.4 - 152

Sample: 427252 - Frac Pond 2 Sec 9 BH2 2 1/2-4

Laboratory:	Lubbock				
Analysis:	Chloride (IC)	Analytical Method:	E 300.0	Prep Method:	N/A
QC Batch:	132443	Date Analyzed:	2016-08-29	Analyzed By:	RL
Prep Batch:	112259	Sample Preparation:	2016-08-29	Prepared By:	RL

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
Chloride		5,6	<25.0	mg/Kg	1	25.0

Sample: 427252 - Frac Pond 2 Sec 9 BH2 2 1/2-4

Laboratory:	Lubbock				
Analysis:	pH	Analytical Method:	S 9045C	Prep Method:	N/A
QC Batch:	132421	Date Analyzed:	2016-08-29	Analyzed By:	RL
Prep Batch:	112242	Sample Preparation:	2016-08-29	Prepared By:	RL

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
pH		2,3,5,6	7.70	s.u.	1	2.00

Sample: 427252 - Frac Pond 2 Sec 9 BH2 2 1/2-4

Laboratory:	Lubbock				
Analysis:	SO4 (IC)	Analytical Method:	E 300.0	Prep Method:	N/A
QC Batch:	132443	Date Analyzed:	2016-08-29	Analyzed By:	RL
Prep Batch:	112259	Sample Preparation:	2016-08-29	Prepared By:	RL

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
Sulfate		5,6	13500	mg/Kg	50	25.0

Sample: 427252 - Frac Pond 2 Sec 9 BH2 2 1/2-4

Laboratory:	Lubbock				
Analysis:	TX1005	Analytical Method:	TX1005	Prep Method:	N/A
QC Batch:	132445	Date Analyzed:	2016-08-30	Analyzed By:	HJ
Prep Batch:	112255	Sample Preparation:	2016-08-29	Prepared By:	HJ

Parameter	Flag	Cert	RL Result	Units	Dilution	RL
C6-C12		2,5	<50.0	mg/Kg	1	50.0
>C12-C28	U	2,5	<50.0	mg/Kg	1	50.0

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			25.0	mg/Kg	1	25.0	100	62 - 137
n-Tricosane			25.0	mg/Kg	1	25.0	100	65.1 - 144
n-Triacontane			20.4	mg/Kg	1	25.0	82	46.4 - 152

Method Blanks

Method Blank (1) QC Batch: 132443

QC Batch: 132443 Date Analyzed: 2016-08-29 Analyzed By: RL
Prep Batch: 112259 QC Preparation: 2016-08-29 Prepared By: RL

Parameter	Flag	Cert	MDL Result	Units	RL
Chloride		5,6	<4.44	mg/Kg	25

Method Blank (1) QC Batch: 132443

QC Batch: 132443 Date Analyzed: 2016-08-29 Analyzed By: RL
Prep Batch: 112259 QC Preparation: 2016-08-29 Prepared By: RL

Parameter	Flag	Cert	MDL Result	Units	RL
Sulfate		5,6	<5.55	mg/Kg	25

Method Blank (1) QC Batch: 132445

QC Batch: 132445 Date Analyzed: 2016-08-30 Analyzed By: HJ
Prep Batch: 112255 QC Preparation: 2016-08-29 Prepared By: HJ

Parameter	Flag	Cert	MDL Result	Units	RL
C6-C12		2,5	<7.83	mg/Kg	50
>C12-C28		2,5	<7.48	mg/Kg	50

Surrogate	Flag	Cert	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
n-Octane			21.2	mg/Kg	1	25.0	85	62 - 137
n-Tricosane			18.0	mg/Kg	1	25.0	72	65.1 - 144
n-Triacontane			18.8	mg/Kg	1	25.0	75	46.4 - 152

Duplicates

Duplicates (1) Duplicated Sample: 427252

QC Batch:	132421	Date Analyzed:	2016-08-29	Analyzed By:	RL
Prep Batch:	112242	QC Preparation:	2016-08-29	Prepared By:	RL

Param		Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
pH	2,3,5,6	7.73	7.70	s.u.	1	0	20

Laboratory Control Spikes

Laboratory Control Spike (LCS-1)

QC Batch: 132443
Prep Batch: 112259

Date Analyzed: 2016-08-29
QC Preparation: 2016-08-29

Analyzed By: RL
Prepared By: RL

Param	F	C	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Chloride		5,6	241	mg/Kg	1	250	<4.44	96	90 - 110

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	F	C	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Chloride		5,6	239	mg/Kg	1	250	<4.44	96	90 - 110	1	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 132443
Prep Batch: 112259

Date Analyzed: 2016-08-29
QC Preparation: 2016-08-29

Analyzed By: RL
Prepared By: RL

Param	F	C	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Sulfate		5,6	253	mg/Kg	1	250	<5.55	101	90 - 110

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	F	C	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Sulfate		5,6	249	mg/Kg	1	250	<5.55	100	90 - 110	2	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 132445
Prep Batch: 112255

Date Analyzed: 2016-08-30
QC Preparation: 2016-08-29

Analyzed By: HJ
Prepared By: HJ

Param	F	C	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
C6-C12		2,5	450	mg/Kg	1	500	<7.83	90	66.1 - 139
>C12-C28		2,5	499	mg/Kg	1	500	<7.48	100	63 - 139

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	F	C	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
C6-C12		2,5	411	mg/Kg	1	500	<7.83	82	66.1 - 139	9	20
>C12-C28		2,5	464	mg/Kg	1	500	<7.48	93	63 - 139	7	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Surrogate	LCS Result	LCSD Result	Units	Dil.	Spike Amount	LCS Rec.	LCSD Rec.	Rec. Limit
n-Octane	18.6	17.7	mg/Kg	1	25.0	74	71	62 - 137
n-Tricosane	32.6	28.5	mg/Kg	1	25.0	130	114	65.1 - 144
n-Triacontane	25.1	22.1	mg/Kg	1	25.0	100	88	46.4 - 152

Matrix Spikes

Matrix Spike (MS-1) Spiked Sample: 426720

QC Batch: 132443
Prep Batch: 112259

Date Analyzed: 2016-08-29
QC Preparation: 2016-08-29

Analyzed By: RL
Prepared By: RL

Param	F	C	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Chloride		5,6	313	mg/Kg	2	250	80.5	93	80 - 120

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	F	C	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Chloride		5,6	312	mg/Kg	2	250	80.5	93	80 - 120	0	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 426720

QC Batch: 132443
Prep Batch: 112259

Date Analyzed: 2016-08-29
QC Preparation: 2016-08-29

Analyzed By: RL
Prepared By: RL

Param	F	C	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Sulfate		5,6	358	mg/Kg	2	250	134	90	80 - 120

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	F	C	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Sulfate		5,6	359	mg/Kg	2	250	134	90	80 - 120	0	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 427252

QC Batch: 132445
Prep Batch: 112255

Date Analyzed: 2016-08-30
QC Preparation: 2016-08-29

Analyzed By: HJ
Prepared By: HJ

Param	F	C	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
C6-C12		2,5	405	mg/Kg	1	500	12.1	78	51.1 - 135
>C12-C28		2,5	470	mg/Kg	1	500	<7.48	94	45.3 - 130

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	F	C	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
C6-C12		2,5	395	mg/Kg	1	500	12.1	76	51.1 - 135	2	20
>C12-C28		2,5	461	mg/Kg	1	500	<7.48	92	45.3 - 130	2	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Surrogate	MS Result	MSD Result	Units	Dil.	Spike Amount	MS Rec.	MSD Rec.	Rec. Limit
n-Octane	18.2	17.6	mg/Kg	1	25	73	70	62 - 137
n-Tricosane	31.3	30.3	mg/Kg	1	25	125	121	65.1 - 144
n-Triacontane	21.9	21.4	mg/Kg	1	25	88	86	46.4 - 152

Calibration Standards

Standard (CCV-1)

QC Batch: 132421 Date Analyzed: 2016-08-29 Analyzed By: RL

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
pH		2,3,5,6	s.u.	7.00	7.04	100	98.6 - 101.4	2016-08-29

Standard (CCV-1)

QC Batch: 132443 Date Analyzed: 2016-08-29 Analyzed By: RL

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Chloride		5,6	mg/Kg	25.0	24.2	97	90 - 110	2016-08-29

Standard (CCV-1)

QC Batch: 132443 Date Analyzed: 2016-08-29 Analyzed By: RL

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Sulfate		5,6	mg/Kg	25.0	25.4	102	90 - 110	2016-08-29

Standard (CCV-2)

QC Batch: 132443 Date Analyzed: 2016-08-29 Analyzed By: RL

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Chloride		5,6	mg/Kg	25.0	23.9	96	90 - 110	2016-08-29

Standard (CCV-2)

QC Batch: 132443 Date Analyzed: 2016-08-29 Analyzed By: RL

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Sulfate		5,6	mg/Kg	25.0	25.4	102	90 - 110	2016-08-29

Standard (CCV-1)

QC Batch: 132445 Date Analyzed: 2016-08-30 Analyzed By: HJ

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
C6-C12		2,5	mg/Kg	500	385	77	75 - 125	2016-08-30
>C12-C28		2,5	mg/Kg	500	432	86	75 - 125	2016-08-30

Standard (CCV-2)

QC Batch: 132445 Date Analyzed: 2016-08-30 Analyzed By: HJ

Param	Flag	Cert	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
C6-C12		2,5	mg/Kg	500	454	91	75 - 125	2016-08-30
>C12-C28		2,5	mg/Kg	500	507	101	75 - 125	2016-08-30

Appendix

Report Definitions

Name	Definition
MDL	Method Detection Limit
MQL	Minimum Quantitation Limit
SDL	Sample Detection Limit

Laboratory Certifications

C	Certifying Authority	Certification Number	Laboratory Location
-	NCTRCA	WFWB384444Y0909	TraceAnalysis
-	DBE	VN 20657	TraceAnalysis
-	HUB	1752439743100-86536	TraceAnalysis
-	WBE	237019	TraceAnalysis
1	L-A-B	L2418.01	El Paso
2	L-A-B	L2418	Lubbock
3	Kansas	Kansas E-10317	Lubbock
4	NELAP	T104704221-15-6	El Paso
5	NELAP	T104704219-16-12	Lubbock
6		2015-066	Lubbock

Standard Flags

F	Description
B	Analyte detected in the corresponding method blank above the method detection limit
H	Analyzed out of hold time
J	Estimated concentration
Jb	The analyte is positively identified and the value is approximated between the SDL and MQL. Sample contains less then ten times the concentration found in the method blank. The result should be considered non-detect to the SDL.
Je	Estimated concentration exceeding calibration range.
MI1	Split peak or shoulder peak
MI2	Instrument software did not integrate
MI3	Instrument software misidentified the peak
MI4	Instrument software integrated improperly
MI5	Baseline correction
Qc	Calibration check outside of laboratory limits.
Qr	RPD outside of laboratory limits
Qs	Spike recovery outside of laboratory limits.

F	Description
Qsr	Surrogate recovery outside of laboratory limits.
U	The analyte is not detected above the SDL

Attachments

The scanned attachments will follow this page.
Please note, each attachment may consist of more than one page.

Appendix 10 – HDPE Liner Specifications

19103 Gundle Road
Houston, TX 77073
800 435 2008 • 281 443 8564
281 230 8650 Fax
www.gseworld.com

October 27, 2016

Tony Banuelos
EC Applications-Texas
12002 E Highway 158
Gardendale, TX 79758

RE: GSE Geomembrane – Permeability for EDS-040NE and EDS-060NE

Certification of Compliance

The undersigned, being qualified and authorized to do so, hereby certifies that GSE 40 mil and 60 EDS Geomembrane will meet a permeability of $< 1 \times 10^{-12}$ cm/s when tested per ASTM E96.

Sincerely,

Miguel Garcia
GSE Technical Support

MG16-0214

PRODUCT DATA SHEET

GSE HD Smooth Geomembrane

GSE HD is a smooth high density polyethylene (HDPE) geomembrane manufactured with the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require excellent chemical resistance and endurance properties.

AT THE CORE:

An HDPE geomembrane used in applications that require excellent chemical resistance and endurance properties.

Product Specifications

These product specifications meet GRI GM 13

Tested Property	Test Method	Frequency	Minimum Average Value				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	30 27	40 36	60 54	80 72	100 90
Density, g/cm³	ASTM D 1505	200,000 lb	0.940	0.940	0.940	0.940	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width Strength at Yield, lb/in-width Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in G.L. 1.3 in	20,000 lb	 114 63 700 12	 152 84 700 12	 228 126 700 12	 304 168 700 12	 380 210 700 12
Tear Resistance, lb	ASTM D 1004	45,000 lb	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lb	54	72	108	144	180
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	500	500	500	500	500
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O_2 1 atm	200,000 lb	>100	>100	>100	>100	>100
TYPICAL ROLL DIMENSIONS							
Roll Length(2), ft			1,120	870	560	430	340
Roll Width(2), ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft²			25,200	19,575	12,600	9,675	7,650

NOTES:
- (1)Dispersion only applies to mear spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ±1%.
- GSE HD is available in rolls weighing approximately 3,900 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales ofice.