District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources
Department
Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-147
Revised April 3, 2017

Recycling Facility and/or Recycling Containment

Type of Facility: ☒ Recycling Facility ☒ Recycling Containment*****

Type of action: ☒ Permit ☒ Registration
☐ Modification ☐ Extension
☐ Closure ☐ Other (explain) _____

*** At the time C-147 is submitted to the division for a Recycling Containment, a copy shall be provided to the surface owner.**

Be advised that approval of this request does not relieve the operator of liability should operations result in pollution of surface water, ground water or the environment. Nor does approval relieve the operator of its responsibility to comply with any other applicable governmental authority's rules, regulations or ordinances.

1.

Operator: Percussion Petroleum, LLC (For multiple operators attach page with information) OGRID #: _____

Address: 919 Milam Street Suite 2475, Houston, TX 77002

Facility or well name (include API# if associated with a well): Welch Recycling Containment A (settling)

OCD Permit Number: _____ (For new facilities the permit number will be assigned by the district office)

U/L or Qtr/Qtr _____ Section 27 Township 17 South Range 28 East County: Eddy

Surface Owner: ☐ Federal ☒ State ☐ Private ☐ Tribal Trust or Indian Allotment

2.

☒ **Recycling Facility:**

Location of recycling facility (if applicable): Latitude 32.804126° Longitude -104.168845° NAD83

Proposed Use: ☒ Drilling* ☒ Completion* ☒ Production* ☒ Plugging *

****The re-use of produced water may NOT be used until fresh water zones are cased and cemented***

☐ Other, ***requires permit for other uses. Describe use, process, testing, volume of produced water and ensure there will be no adverse impact on groundwater or surface water.***

☒ Fluid Storage

☐ Above ground tanks ☒ Recycling containment ☐ Activity permitted under 19.15.17 NMAC explain type_____

☐ Activity permitted under 19.15.36 NMAC explain type:_____ ☐ Other explain _____

☐ For multiple or additional recycling containments, attach design and location information of each containment

☐ **Closure Report (required within 60 days of closure completion):** ☐ Recycling Facility Closure Completion Date:_____

3.

☒ **Recycling Containment:**

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable): Latitude 32.803874° Longitude -104.168230° NAD83

☐ For multiple or additional recycling containments, attach design and location information of each containment

☒ Lined ☒ Liner type: Thickness 40 mil (secondary) 60-mil (primary) ☒ LLDPE ☒ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☒ Other Field Welds Volume: 50,000 bbl Dimensions: L 200 x W 200 x D 16

☐ Recycling Containment Closure Completion Date:_____

4.

Bonding:

☒ Covered under bonding pursuant to 19.15.8 NMAC per 19.15.34.15(A)(2) NMAC **(These containments are limited to only the wells owned or operated by the owners of the containment.)**

☐ Bonding in accordance with 19.15.34.15(A)(1). Amount of bond $_____ **(work on these facilities cannot commence until bonding amounts are approved)**

☐ Attach closure cost estimate and documentation on how the closure cost was calculated.

5.

Fencing:

☐ Four foot height, four strands of barbed wire evenly spaced between one and four feet

☒ Alternate. Please specify: chain Link Game Fence with barbed wire

6.

Signs:

☒ 12"x 24", 2" lettering, providing Operator's name, site location, and emergency telephone numbers

☐ Signed in compliance with 19.15.16.8 NMAC

7.

Variances:

Justifications and/or demonstrations that the proposed variance will afford reasonable protection against contamination of fresh water, human health, and the environment.

Check the below box only if a variance is requested:

☒ Variance(s): Requests must be submitted to the appropriate division district for consideration of approval. If a Variance is requested, include the variance information on a separate page and attach it to the C-147 as part of the application.

If a Variance is requested, it must be approved prior to implementation.

8.

Siting Criteria for Recycling Containment

Instructions: The applicant must provide attachments that demonstrate compliance for each siting criteria below as part of the application. Potential examples of the siting attachment source material are provided below under each criteria.

General siting

Ground water is less than 50 feet below the bottom of the Recycling Containment. NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells	☐ Yes ☒ No ☐ NA
Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended. - Written confirmation or verification from the municipality; written approval obtained from the municipality	☐ Yes ☒ No ☐ NA
Within the area overlying a subsurface mine. - Written confirmation or verification or map from the NM EMNRD-Mining and Minerals Division	☐ Yes ☒ No
Within an unstable area. - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; topographic map	☐ Yes ☒ No
Within a 100-year floodplain. FEMA map	☐ Yes ☒ No
Within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 1000 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; aerial photo; satellite image	☐ Yes ☒ No
Within 500 horizontal feet of a spring or a fresh water well used for domestic or stock watering purposes, in existence at the time of initial application. - NM Office of the State Engineer - iWATERS database search; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 500 feet of a wetland. - US Fish and Wildlife Wetland Identification map; topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No

9.
Recycling Facility and/or Containment Checklist:
Instructions: Each of the following items must be attached to the application. Indicate, by a check mark in the box, that the documents are attached.

- ☒ Design Plan - based upon the appropriate requirements.
- ☒ Operating and Maintenance Plan - based upon the appropriate requirements.
- ☒ Closure Plan - based upon the appropriate requirements.
- ☒ Site Specific Groundwater Data -
- ☒ Siting Criteria Compliance Demonstrations –
- ☒ **Certify that notice of the C-147 (only) has been sent to the surface owner(s)**

10.
Operator Application Certification:
I hereby certify that the information and attachments submitted with this application are true, accurate and complete to the best of my knowledge and belief.

Name (Print): Luye Carrillo Title: CO

Signature: Date: 2-28-19

e-mail address: luye@percussivepetroleum.com Telephone: 713-589-9509

11.
OCD Representative Signature: Bradford Billings **Approval Date:** 3/27/2019

Title: Hydrologist **OCD Permit Number:** 2RF-136

☐ OCD Conditions

☐ Additional OCD Conditions on Attachment

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Type of Facility: ☒ Recycling Facility ☒ Recycling Containment*****

Type of action: ☒ Permit ☒ Registration
☐ Modification ☐ Extension
☐ Closure ☐ Other (explain) _____

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1.

Operator: Percussion Petroleum, LLC (For multiple operators attach page with information) OGRID #: _____

Address: 919 Milam Street Suite 2475, Houston, TX 77002

Facility or well name (include API# if associated with a well): Welch Recycling Containment B (Aeration)

OCD Permit Number: _____ (For new facilities the permit number will be assigned by the district office)

U/L or Qtr/Qtr _____ Section 27 Township 17 South Range 28 East County: Eddy

Surface Owner: ☐ Federal ☒ State ☐ Private ☐ Tribal Trust or Indian Allotment

2.

☒ **Recycling Facility:**

Location of recycling facility (if applicable): Latitude 32.804126° Longitude -104.168845° NAD83

Proposed Use: ☒ Drilling* ☒ Completion* ☒ Production* ☒ Plugging *

****The re-use of produced water may NOT be used until fresh water zones are cased and cemented***

☐ Other, ***requires permit for other uses. Describe use, process, testing, volume of produced water and ensure there will be no adverse impact on groundwater or surface water.***

☒ Fluid Storage

☐ Above ground tanks ☒ Recycling containment ☐ Activity permitted under 19.15.17 NMAC explain type_____

☐ Activity permitted under 19.15.36 NMAC explain type:_____ ☐ Other explain _____

☐ For multiple or additional recycling containments, attach design and location information of each containment

☐ **Closure Report (required within 60 days of closure completion):** ☐ Recycling Facility Closure Completion Date:_____

3.

☒ **Recycling Containment:**

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable): Latitude 32.804583° Longitude -104.168066° NAD83

☐ For multiple or additional recycling containments, attach design and location information of each containment

☒ Lined ☒ Liner type: Thickness 40 mil (secondary) 60-mil (primary) ☒ LLDPE ☒ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☒ Other Field Welds Volume: 150,000 bbl Dimensions: L 300 x W 325 x D 16

☐ Recycling Containment Closure Completion Date:_____

4.

Bonding:

☒ Covered under bonding pursuant to 19.15.8 NMAC per 19.15.34.15(A)(2) NMAC **(These containments are limited to only the wells owned or operated by the owners of the containment.)**

☐ Bonding in accordance with 19.15.34.15(A)(1). Amount of bond $_____ **(work on these facilities cannot commence until bonding amounts are approved)**

☐ Attach closure cost estimate and documentation on how the closure cost was calculated.

5.

Fencing:

☐ Four foot height, four strands of barbed wire evenly spaced between one and four feet

☒ Alternate. Please specify: chain Link Game Fence with barbed wire

6.

Signs:

☒ 12"x 24", 2" lettering, providing Operator's name, site location, and emergency telephone numbers

☐ Signed in compliance with 19.15.16.8 NMAC

7.

Variances:

Justifications and/or demonstrations that the proposed variance will afford reasonable protection against contamination of fresh water, human health, and the environment.

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8.

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Instructions: The applicant must provide attachments that demonstrate compliance for each siting criteria below as part of the application. Potential examples of the siting attachment source material are provided below under each criteria.

General siting

Ground water is less than 50 feet below the bottom of the Recycling Containment. NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells	☐ Yes ☒ No ☐ NA
Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended. - Written confirmation or verification from the municipality; written approval obtained from the municipality	☐ Yes ☒ No ☐ NA
Within the area overlying a subsurface mine. - Written confirmation or verification or map from the NM EMNRD-Mining and Minerals Division	☐ Yes ☒ No
Within an unstable area. - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; topographic map	☐ Yes ☒ No
Within a 100-year floodplain. FEMA map	☐ Yes ☒ No
Within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 1000 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; aerial photo; satellite image	☐ Yes ☒ No
Within 500 horizontal feet of a spring or a fresh water well used for domestic or stock watering purposes, in existence at the time of initial application. - NM Office of the State Engineer - iWATERS database search; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 500 feet of a wetland. - US Fish and Wildlife Wetland Identification map; topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No

9.
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- ☒ Site Specific Groundwater Data -
- ☒ Siting Criteria Compliance Demonstrations –
- ☒ **Certify that notice of the C-147 (only) has been sent to the surface owner(s)**

10.
Operator Application Certification:
I hereby certify that the information and attachments submitted with this application are true, accurate and complete to the best of my knowledge and belief.

Name (Print): Jupe Carrillo Title: CCO

Signature: Date: 2-28-19

e-mail address: jupe@percussionpetroleum.com Telephone: 713-589-9509

11.
OCD Representative Signature: Bradford Billings **Approval Date:** 3/27/2019

Title: Hydrologist **OCD Permit Number:** 2RF-136

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☐ Additional OCD Conditions on Attachment

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1.

Operator: Percussion Petroleum, LLC (For multiple operators attach page with information) OGRID #: _____

Address: 919 Milam Street Suite 2475, Houston, TX 77002

Facility or well name (include API# if associated with a well): Welch Recycling Containment C (Storage)

OCD Permit Number: _____ (For new facilities the permit number will be assigned by the district office)

U/L or Qtr/Qtr _____ Section 27 Township 17 South Range 28 East County: Eddy

Surface Owner: ☐ Federal ☒ State ☐ Private ☐ Tribal Trust or Indian Allotment

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Location of recycling facility (if applicable): Latitude 32.804126° Longitude -104.168845° NAD83

Proposed Use: ☒ Drilling* ☒ Completion* ☒ Production* ☒ Plugging *

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☐ Above ground tanks ☒ Recycling containment ☐ Activity permitted under 19.15.17 NMAC explain type_____

☐ Activity permitted under 19.15.36 NMAC explain type:_____ ☐ Other explain _____

☐ For multiple or additional recycling containments, attach design and location information of each containment

☐ **Closure Report (required within 60 days of closure completion):** ☐ Recycling Facility Closure Completion Date:_____

3.

☒ **Recycling Containment:**

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable): Latitude 32.804355° Longitude -104.166636° NAD83

☐ For multiple or additional recycling containments, attach design and location information of each containment

☒ Lined ☒ Liner type: Thickness 40 mil (secondary) 60-mil (primary) ☒ LLDPE ☒ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☒ Other Field Welds Volume: 564,000 bbl Dimensions: L 550 x W 550 x D 16

☐ Recycling Containment Closure Completion Date:_____

4.

Bonding:

☒ Covered under bonding pursuant to 19.15.8 NMAC per 19.15.34.15(A)(2) NMAC **(These containments are limited to only the wells owned or operated by the owners of the containment.)**

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Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended. - Written confirmation or verification from the municipality; written approval obtained from the municipality	☐ Yes ☒ No ☐ NA
Within the area overlying a subsurface mine. - Written confirmation or verification or map from the NM EMNRD-Mining and Minerals Division	☐ Yes ☒ No
Within an unstable area. - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; topographic map	☐ Yes ☒ No
Within a 100-year floodplain. FEMA map	☐ Yes ☒ No
Within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 1000 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; aerial photo; satellite image	☐ Yes ☒ No
Within 500 horizontal feet of a spring or a fresh water well used for domestic or stock watering purposes, in existence at the time of initial application. - NM Office of the State Engineer - iWATERS database search; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 500 feet of a wetland. - US Fish and Wildlife Wetland Identification map; topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No

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10.
Operator Application Certification:
I hereby certify that the information and attachments submitted with this application are true, accurate and complete to the best of my knowledge and belief.

Name (Print): Lupe Carrillo Title: CO

Signature: Date: 2-28-19

e-mail address: lupe@percussionpetroleum.com Telephone: 713-599-9509

11.
OCD Representative Signature: Bradford Billings **Approval Date:** 3/27/2019

Title: Hydrologist **OCD Permit Number:** 2RF-136

☐ OCD Conditions

☐ Additional OCD Conditions on Attachment

C-147 Registration Package
Welch Recycling Facility
Section 27, T17S, R28E
Eddy County, New Mexico

Prepared For

PERCUSSION PETROLEUM LLC

Prepared By

ENVIROTECH ENGINEERING & CONSULTING, INC.

JAMES R. STALLINGS
NEW MEXICO
21034
PROFESSIONAL ENGINEER

3/1/19

February 2019

CONTENTS

1. SITE CRITERIA FOR RECYCLING CONTAINMENT

1.1 LOCATION

The Welch Recycle Facility, collectively referred to as Containment, is proposed to be located in Section 27, Township 17 South, Range 28 East of Eddy County, New Mexico.

1.2 DISTANCE TO GROUNDWATER

1.2.1 HYDROLOGY

According to information reviewed from the Bureau of Land Management (BLM) Carlsbad Field Office, the proposed Containment location is not located within a mapped aquifer system. Major aquifers in the area include the Roswell Basin System, located approximately 6.8-miles west, and the Capitan Reef Complex, located approximately 8.8-miles south. The Roswell Basin system is composed of two interconnected aquifers including an alluvial system, recharged by the Pecos River, and a carbonate rock system composed primarily of limestone and dolomite.

Available groundwater within the area of the proposed Containment is noted to be within the Roswell Artesian declared Groundwater Basin, by the New Mexico Office of the State Engineer (OSE). The Roswell Artesian basin contains two major water-bearing features including shallower alluvial aquifer systems and a deeper "artesian" carbonate system.

Groundwater wells in the area of the Containment are completed at an average depth of 198-ft below ground surface. Of these wells, the closest well to the site with a recorded groundwater depth, had a reported groundwater depth of approximately 95-ft below ground surface. This well, RA-11857, is located approximately 2.39-miles south of the site. Please see to *Figure 1*. Groundwater depths for wells drilled within the 4-mile radius of the Containment pit averaged a depth of 198-ft below ground surface. This data was obtained from measured water levels or logged borings for hydrogeologic information contained in the OSE database. Available groundwater data, total depth of water wells and depth to groundwater, is presented in *Figure 1*, and an Aquifer Map presenting the area of mapped aquifer systems from the BLM Carlsbad Field Office is presented as *Figure 1A*.

The New Mexico Oil and Gas Division (NMOCD) requires that groundwater (freshwater as defined by NMOCD rules) at the location be greater than 50-ft

below the containment bottom. *Figure 1* is an aerial map that demonstrates the following to meet these criteria:

1. The location of the proposed containment shown on an aerial photograph with surface elevation, taken from the United States Geologic Survey (USGS) Dayton 7.5 Minute Series Topographic Map.

2. Location of area water wells as plotted in the Office of the State Engineers (OSE) WATERS database. It should be noted that OSE wells can be miss located as older wells are plotted in the center of the quarter, quarter, quarter section, township, and range.

3. Total depth of the wells and/or depth to water, where provided, from the most recent available data is plotted adjacent to each located water well.

From the available data, groundwater in the vicinity of the Containment pit was recorded at an average approximate depth of 81-ft below ground surface, and at 95-ft below ground surface in the closest groundwater well to the site. In addition, three test borings were drilled onsite to a depth of approximately 75-ft below ground surface; groundwater was not encountered in these borings. Since groundwater to a depth of 75-ft was not encountered during the onsite borings, the area of the proposed pit achieves the required 50-ft of separation between the bottom of the containment and groundwater.

1.2.2 GEOLOGY

A geological map for the vicinity of the site was obtained from the New Mexico Bureau of Land Management, Carlsbad Field Office and was used to review the geologic setting for the proposed containment location. Based on the review of the geologic map, the containment location lies within the Halocene to Pleistocene age Piedmont alluvial deposits, consisting of interbedded wind-deposited sands and alluvium.

Area stratigraphy to a maximum depth of 75-ft below ground surface (bgs) was obtained from multiple geotechnical borings conducted on the site by Terracon Consultants on January 14th and 15th, 2019. Three borings were advanced to an approximate depth of 75-ft below ground surface. Lithology encountered consisted mainly of tan to brown silty sand with gravel. Groundwater was not encountered in any borings performed onsite both before or immediately after drilling. The Geotechnical Engineering Report can be found in *Appendix A*.

Figure 2 is a reproduction of the New Mexico Bureau of Geology and Mineral Resources geologic map. *Figure 2* shows the following:

1. Location of the proposed Containment
2. Geologic setting of the Containment

1.3 DISTANCE TO MUNICIPAL BOUNDARIES AND FRESH WATER FIELDS

Figure 3 demonstrates that the location is not located within incorporated municipal boundaries or within a defined municipal fresh water field covered under a municipal ordinance, adopted pursuant to NMSA 1978, Section 3-27-3. *Figure 3* illustrates the following:

1. The closest municipality to the site is Artesia, New Mexico located approximately 12-miles west of the containment location, and Carlsbad New Mexico, located approximately 25.2-miles south of the containment location.
2. The closest municipal well field is located approximately 20.5-miles south of the containment location, City of Carlsbad Wellhead Protection Area, serving the community of Carlsbad, New Mexico.

1.4 DISTANCE TO SUBSURFACE MINES

According to the New Mexico Mining and Minerals Division the nearest mines to the containment location are surface stone aggregate mines (caliche) and potash mines. The site location is not within an area overlying a subsurface mine. *Figure 4* illustrates the following.

1. The nearest mapped mines are surface stone aggregate, located approximately 5.24-miles north and 13.9-miles southeast of the containment area.

1.5 DISTNACE TO HIGH OR CRITIAL KARST AREAS (UNSTABLE AREAS)

Figure 5 shows the location of the proposed contaminant area with respect to BLM mapped Karst areas.

1. The proposed Containment is located within a “low” potential karst area.
2. The nearest “high” karst area is located approximately 2.22-miles west of the proposed containment area.

1.6 DISTANCE TO 100-YEAR FLOODPLAIN

The Federal Emergency Management Agency (FEMA) Flood Insurance maps were reviewed for the location of the site. The site is located on FEMA map panel number 35015C0375D and classified as "Zone X." Zone X represents locations that are defined as outside the 0.2% annual chance floodplain. *Figure 6* demonstrates the area of the site is not located within a 100-year Floodplain.

1. The site is located within "Zone X." Zone X is described as areas outside the 0.2% annual chance floodplain. No flood hazard analysis has been conducted for this area.

1.7 DISTANCE TO SURFACE WATER

Figure 7 is reproduction of the USGS Red Lake 7.5-Minute Series topographic map that demonstrate the site location is not within 300-ft of a continuously flowing watercourse or other significant watercourse, or within 200-ft of a lakebed, sinkhole, or playa lake as measured from the ordinary high-water mark. The site is located approximately 0.8-miles southeast of an unnamed intermittent tributary and 9-miles east of the Pecos River. *Figure 7* demonstrates the following:

1. No continuously flowing watercourses or other water bodies defined by NMOCD.
2. No surfaces waters are located within 300-ft of the proposed containment location.

1.8 DISTANCE TO PERMANENT RESIDENCES OR STRUCTURES

Figure 7 is reproduction of the USGS Red Lake 7.5-Minute Series topographic map that demonstrates the site location is not within 1,000-ft of an occupied permanent residence, school, hospital, institution, church, or other permanent structure in existence at the time of initial application. The nearest manmade structures to the site location appear to be oil field tank batteries.

1.9 DISTANCE TO NON-PUBLIC WATER SUPPLY

The site is not located within 500-horizontal feet of a private, domestic fresh water well or spring that less than five households use for domestic or stock watering purposes. In addition, the site is not located within 1,000-ft of any other freshwater well or spring, as documented at the time of this application. *Figure 1* illustrates the following.

1. *Figure 1* shows the location of area water wells, active or plugged, relative to the proposed site location.

2. There are no known domestic water wells located within 1,000-ft of the proposed site location.
3. No springs were identified within the mapping area (refer to *Figure 7*).

1.10 DISTANCE TO WETLANDS

The U.S Fish and Wildlife National Wetlands Inventory maps were reviewed for the area of the site. *Figure 8* demonstrates the site is not located within an area of a mapped wetland.

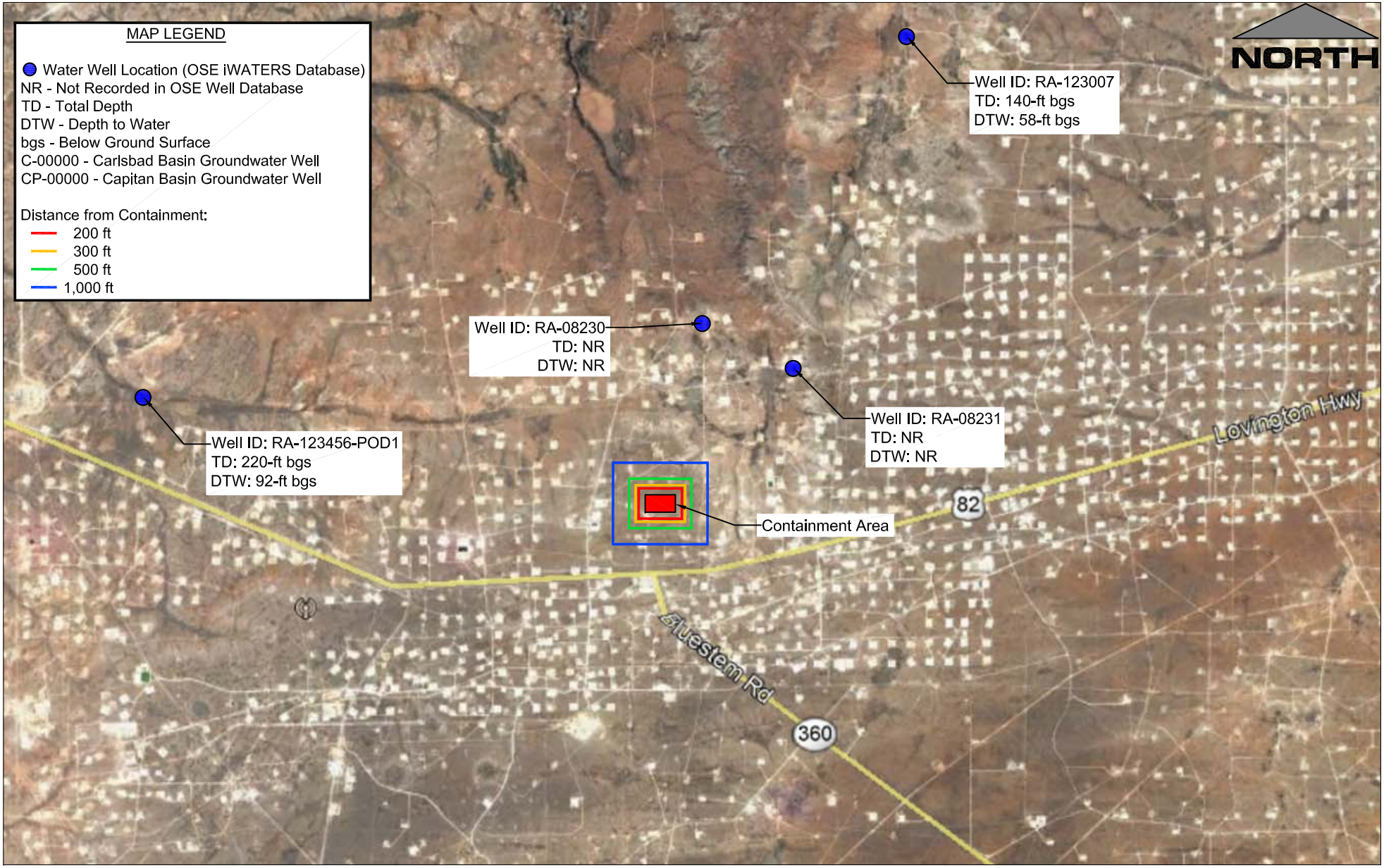
1. The nearest designated wetland to the site is a freshwater emergent wetland with a wetland code PEM1A (Palustrine, Emergent, Persistent, Temporarily Flooded). The mapped wetland is located approximately 1.3-miles northeast of the site.

1.11 FIGURES

Site criteria compliance demonstrations to support the above information are included herein as *Figures 1 through 8*, which are described as follows:

Figure 1 – OSE Groundwater Well Location Map
Figure 1A – BLM Aquifer Map
Figure 2 – USGS Geologic Map
Figure 3 – Municipality and Freshwater Field Map
Figure 4 – New Mexico Mining and Mineral Division Active Mine
Figure 5 – BLM Karst Potential Map
Figure 6 – FEMA Floodplains Map
Figure 7 – Distance from Municipalities, Structures, and Wells
Figure 8 – Wetlands Location Map

Additionally, the location maps and logs for above-referenced geotechnical borings performed by Terracon are enclosed.



Percussion Petroleum

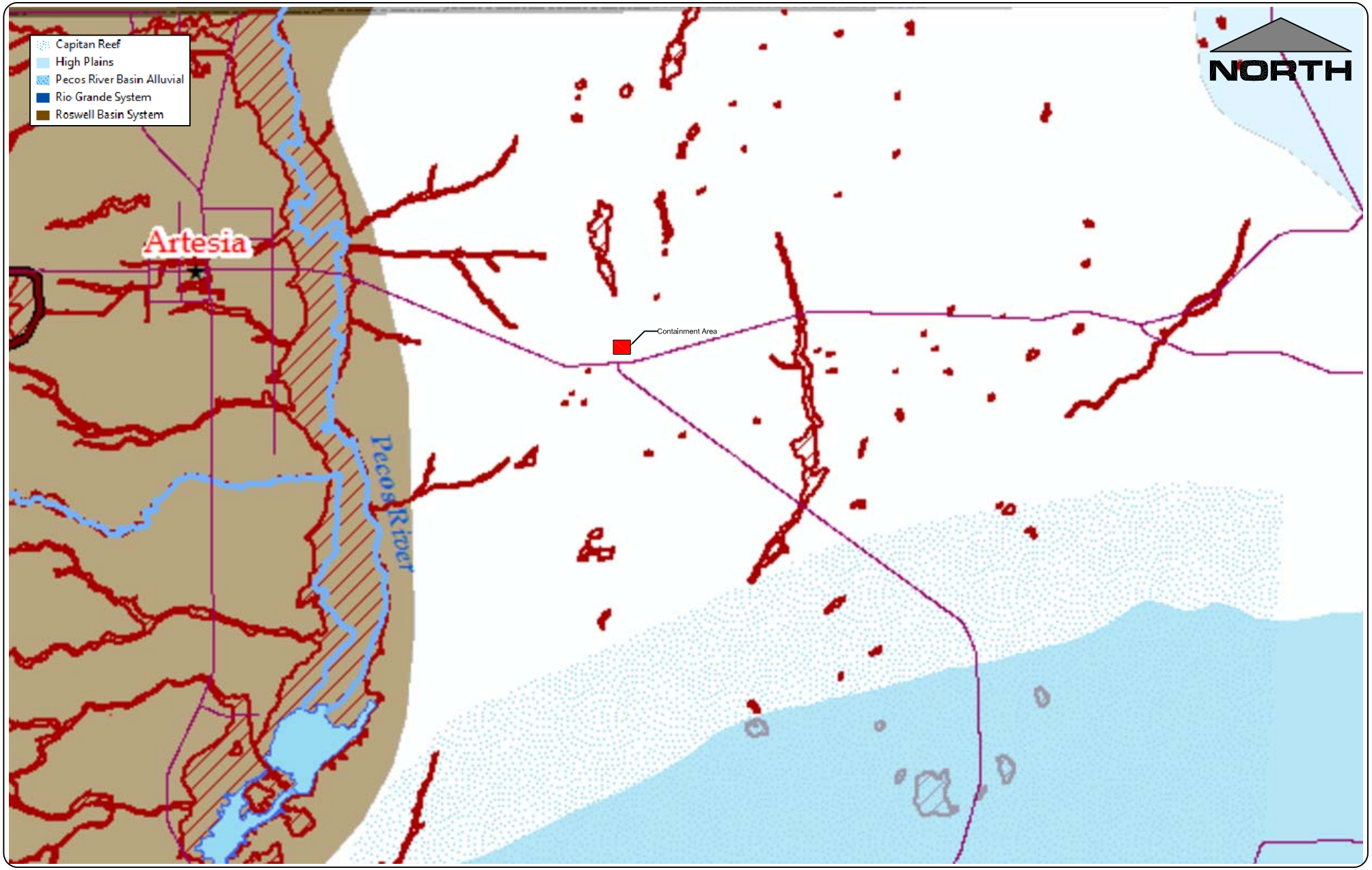
Figure 1 - OSE Groundwater Well Location Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, Township 17 South, Range 28 East, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

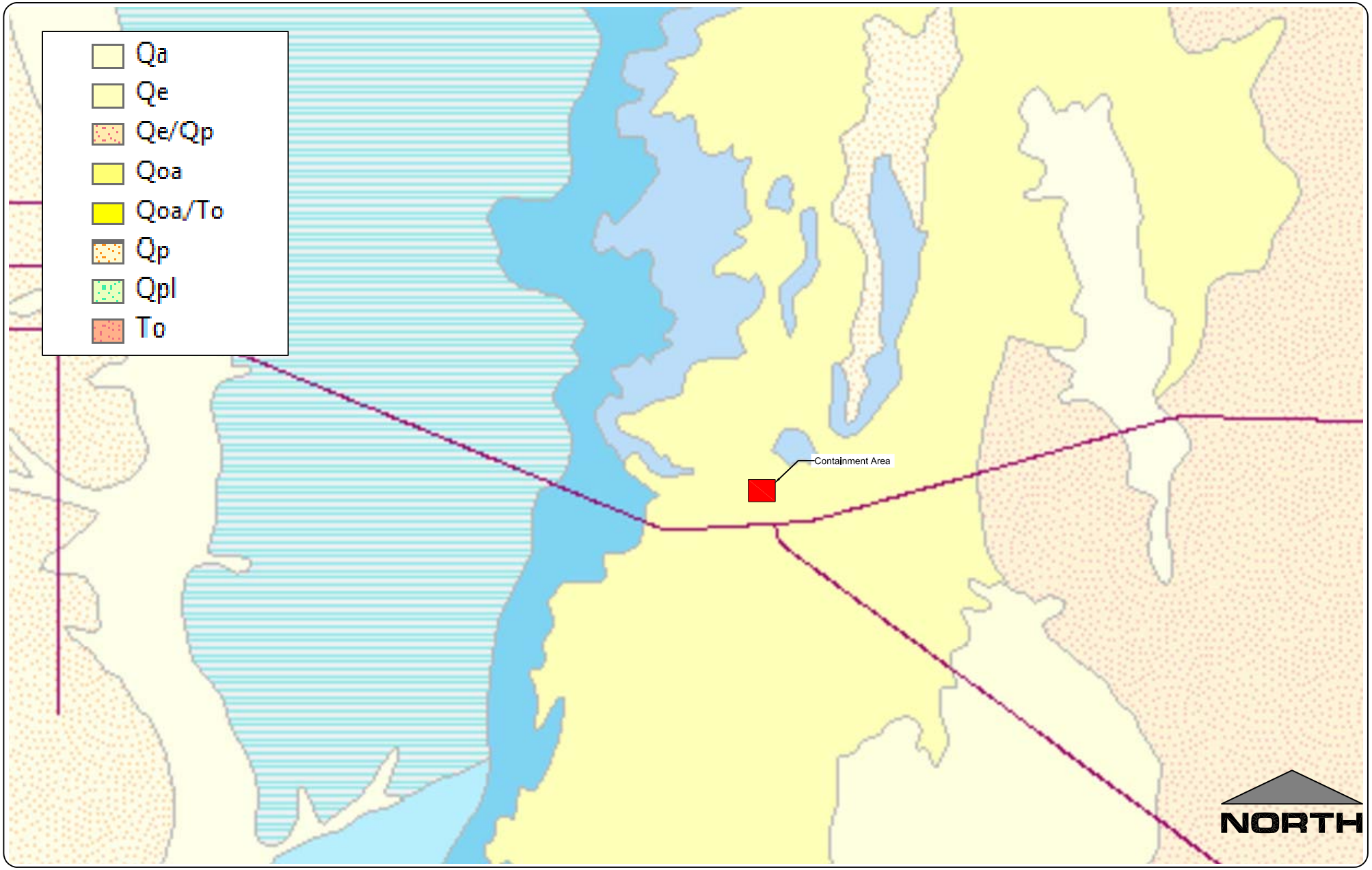
Figure 1A - BLM Aquifer Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

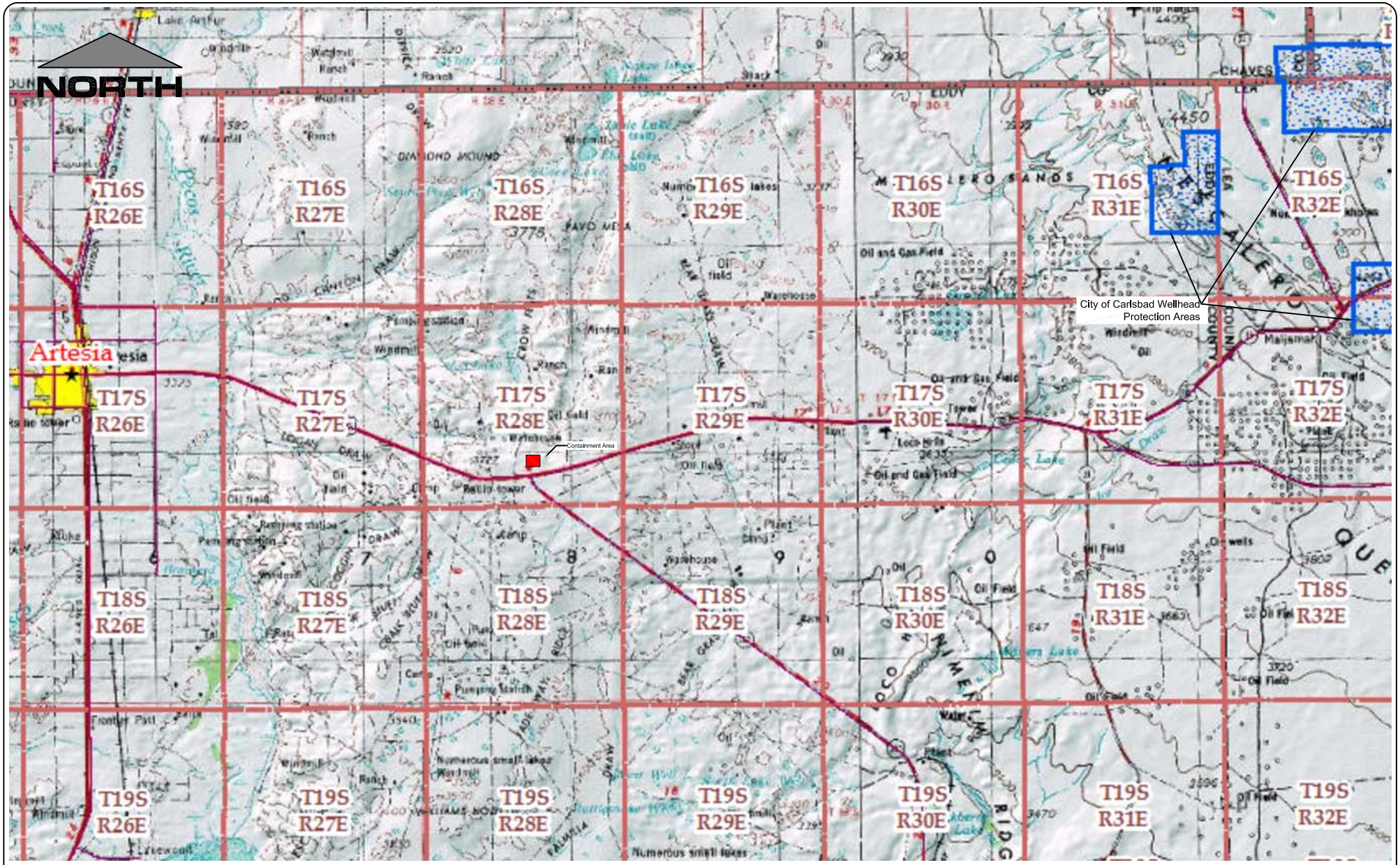
Figure 2 - USGS Geologic Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

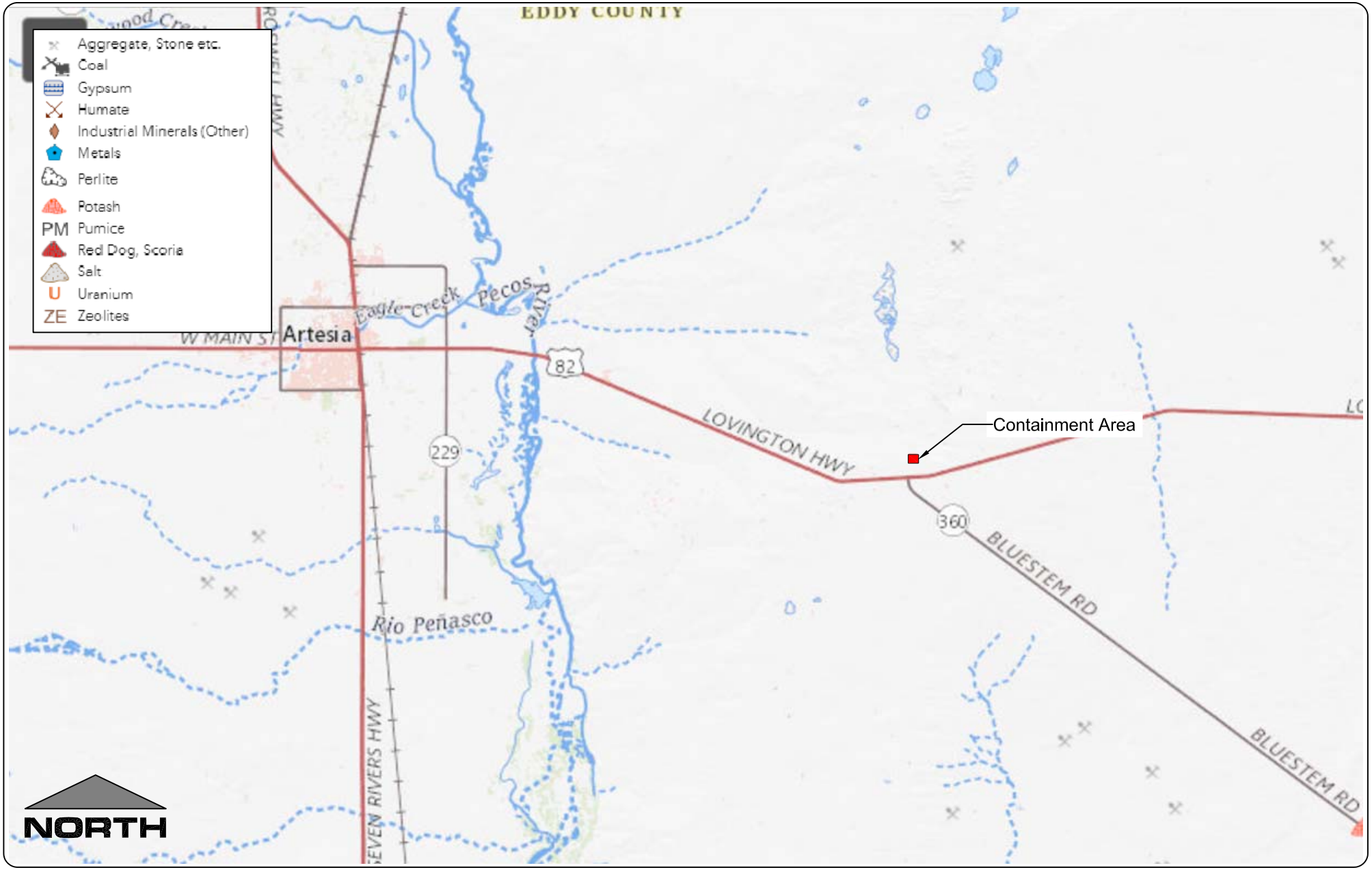
Figure 3 - Municipality and Freshwater Fields Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

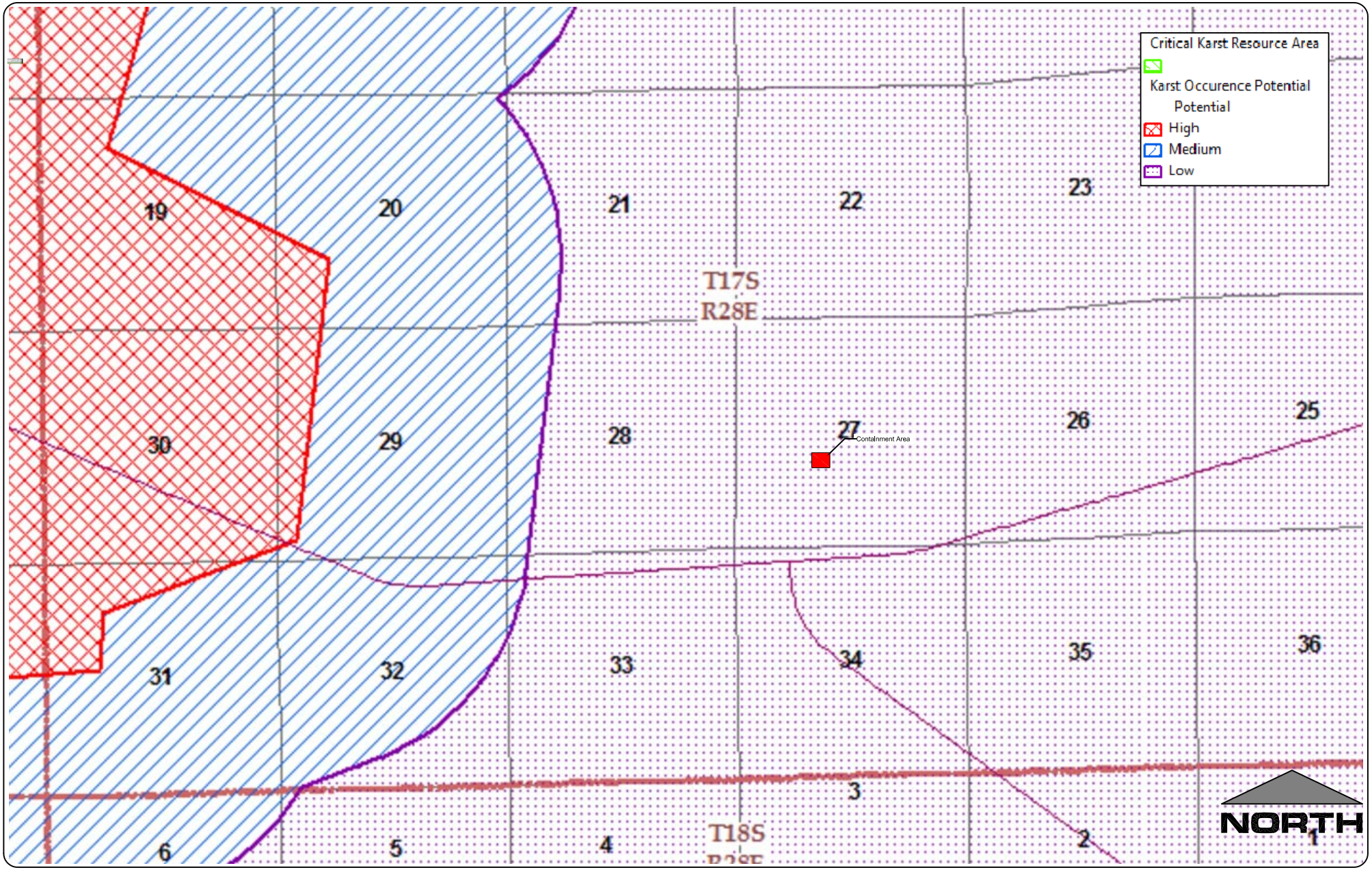
Figure 4 - NM Mining and Minerals Division- Active Mines

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

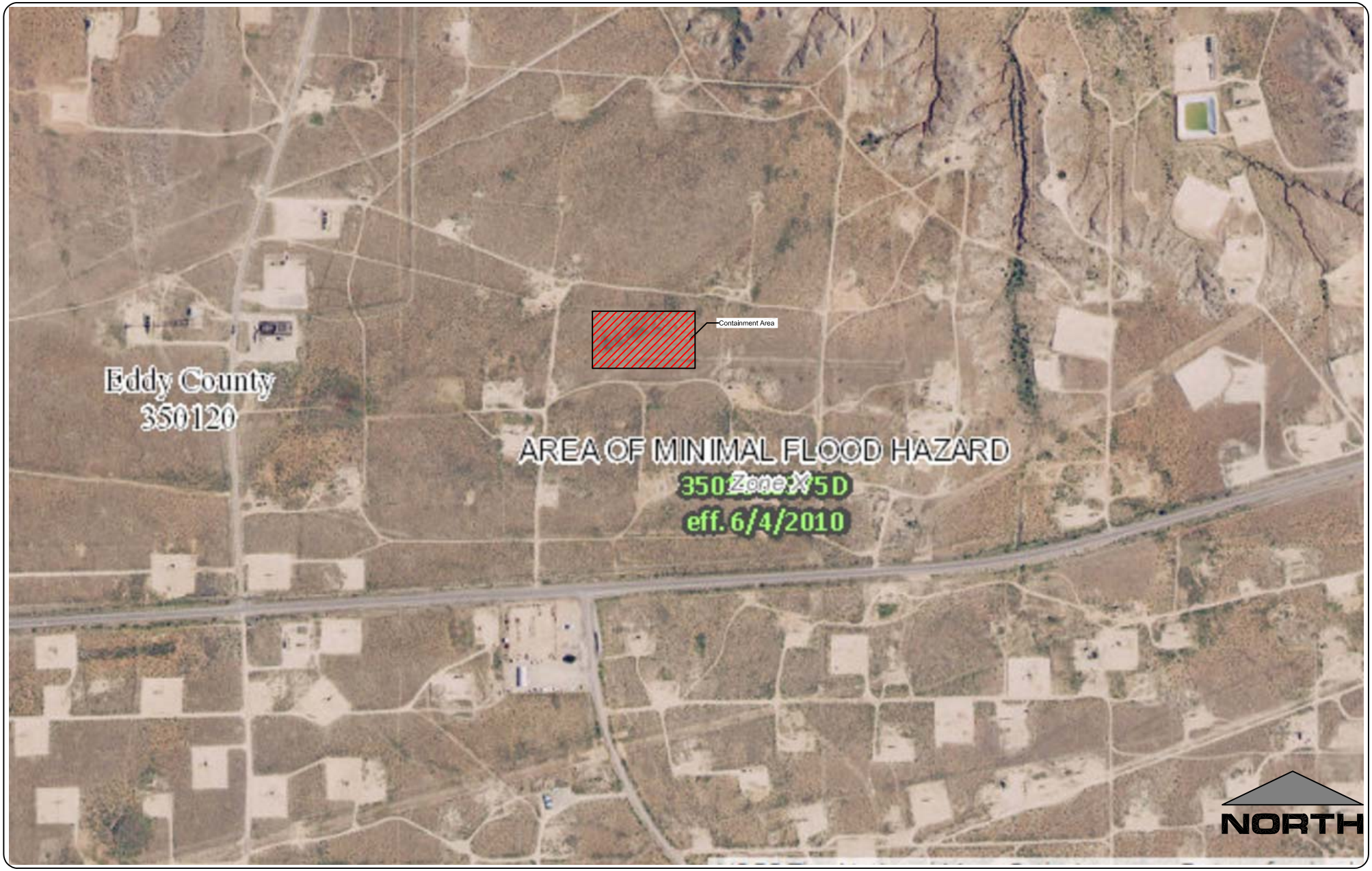
Figure 5 - BLM Karst Potential Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

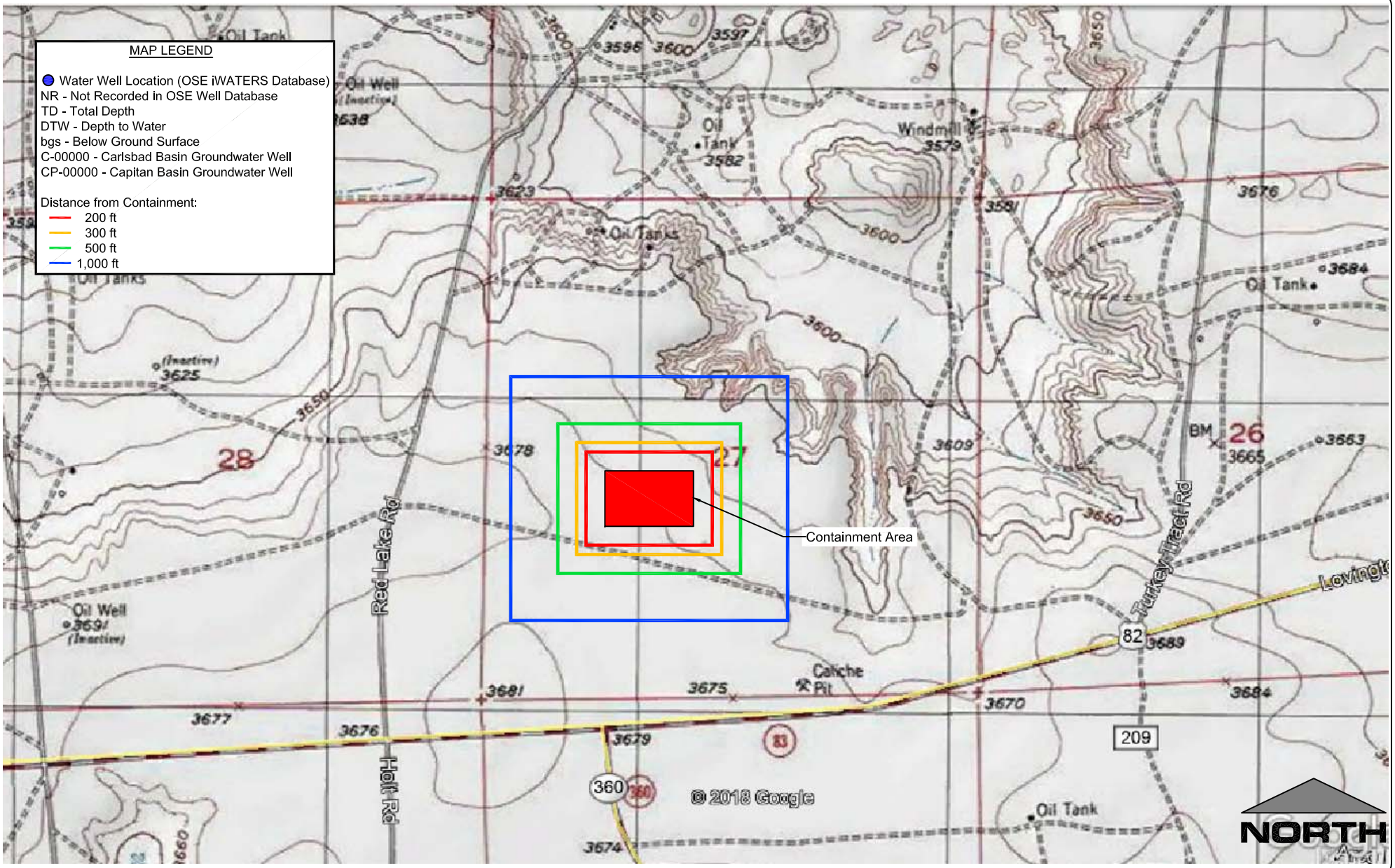
Figure 6 - FEMA Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.



Percussion Petroleum

Figure 7 - Distance From Municipalities, Structures, and Surface Waters

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.

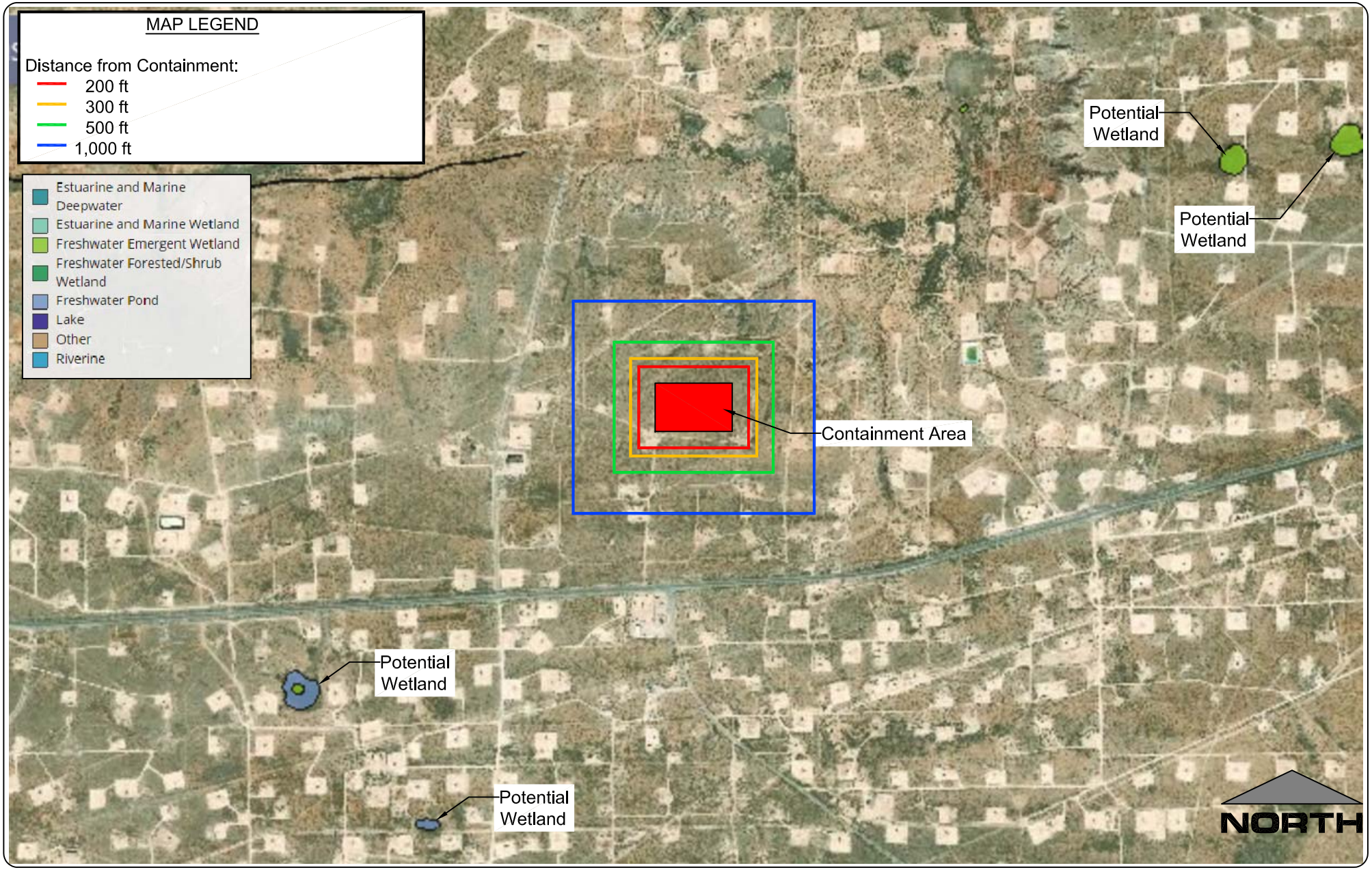


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Figure 8 - Wetlands Location Map

Project No. 018450-00

Welch Containment Permit Application

Section 27, T-17-S, R-28-E, Eddy County, New Mexico

ENVIROTECH ENGINEERING & CONSULTING, INC.

APPENDIX A

GEOTECHNICAL ENGINEERING REPORT

Geotechnical Engineering Report

Welch Water Impoundment Facility
Latitude: 32.8040, Longitude: -104.1667
North of US 82 and NM 360
Eddy County, New Mexico
February 4, 2019
Terracon Project No. 68195007

Prepared for:
Envirotech Engineering & Consulting, Inc.
Enid, Oklahoma

Prepared by:
Terracon Consultants, Inc.
Las Cruces, New Mexico

Offices Nationwide
Employee-Owned
Established in 1965
terracon.com

Terracon

Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

EXECUTIVE SUMMARY

A geotechnical exploration has been performed for the proposed Welch Water Impoundment Facility (consisting of a recycling pit, settling pit and aeriation pit) to be located approximately 10 miles east of Artesia, New Mexico. Terracon's geotechnical scope of work included the advancement of fifteen (15) test borings (Borings B-11 thru B-25) to approximate depths of 21-1/2 and 75 feet below the ground surface (bgs). Borings B-15, B-20, and B-25 were advanced to a termination depth of 75 feet bgs.

The following geotechnical considerations were identified:

- The site soils generally consisted of silty sand with varying amounts of gravel from the surface to the total explored depths of about 21-1/2 and 75 feet bgs. Groundwater was not encountered in the borings during or immediately after drilling operations.

- Approved on-site soils or approved imported materials can be used for construction of embankments. Maximum slopes for unprotected embankments having configurations of 3:1 (horizontal to vertical) are acceptable when using approved on-site soils or approved imported materials.

- The 2015 International Building Code, Table 1613.5.2 IBC seismic site classification for this site is C.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support.

This geotechnical executive summary should be used in conjunction with the entire report for design and/or construction purposes. It should be recognized that specific details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

TABLE OF CONTENTS

Terracon

February 4, 2019

Envirotech Engineering & Consulting, Inc.
2500 North Eleventh Street
Enid, OK 73701

Attn. Tyler Williams, PE
P: 580.234.8780
E: twilliams@envirotechconsulting.com

Re: Geotechnical Engineering Report
Welch Water Impoundment Facility
Latitude: 32.8040, Longitude: -104.1667
North of US 82 and NM 360
Eddy County, New Mexico
Terracon Project No. 68195007

Dear Mr. Williams;

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. These services were performed in general accordance with our proposal number P68185159 dated December 20, 2018. This geotechnical engineering report presents the results of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of the ponds, embankments and other site development elements.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

JAMES D. COSPER, II NEW MEXICO 14477 REGISTERED PROFESSIONAL ENGINEER 2-4-19

for Debbie Daniels
Ron M. Johnson
Staff Professional

J. Dan Cosper, P.E.
Senior Associate

Copies to: Addressee (1 via email)

GEOTECHNICAL ENGINEERING REPORT
WELCH WATER IMPOUNDMENT FACILITY
LATITUDE: 32.8040, LONGITUDE: -104.1667
NORTH OF US 82 AND NM 360
EDDY COUNTY, NEW MEXICO

Terracon Project No. 68195007
February 4, 2019

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed Welch Water Impoundment Facility (consisting of a recycling pit, settling pit and aeriation pit) to be located approximately 10 miles east of Artesia, New Mexico. Terracon's geotechnical scope of work included the advancement of fifteen (15) test borings (Borings B-11 thru B-25) to approximate depths of 21-1/2 and 75 feet below the ground surface (bgs). Logs of the borings along with a site location plan and boring location plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- earthwork
- liner and anchor trench construction
- embankment design and construction

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	Refer to the Site Location Plan and Boring Location Plan (Exhibits A-1 and A-2)
Structures	The proposed 3 ponds will be about 600 feet by 500 feet (recycling pit), 300 feet by 300 feet (settling pit) and 400 by 400 feet (aeriation pit) in ground contact area, respectively.
Building construction	The ponds will be excavated with dirt embankments and assumed to be lined with a 60 mil HDPE liner.

Item	Description
Finished elevation	Assumed invert elevation of the ponds will be about 15 to 20 feet below existing grade. Top of the embankments will be about 6 feet above existing grade.
Cut and fill slopes	Cuts and fills will be at 3:1 (horizontal to vertical)

2.2 Site Location and Description

Item	Description
Location	N/2 of the SW/4 of Sec. 27, TS 17 S, R 28 E., New Mexico. Approx. 10 miles E of Artesia, NM.
Existing improvements	Undeveloped.
Surrounding developments	North: Undeveloped West: Undeveloped East: Undeveloped South: Undeveloped
Current ground cover	Exposed subgrade and sparse to dense vegetation.
Existing topography	Relatively level.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Subsurface Profile

Specific conditions encountered at the boring locations are indicated on the individual boring logs included in Appendix A of this report. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Consistency/Density
Stratum 1	21-1/2 and 75	Silty Sand with varying amounts of gravel	Loose to Very Dense

1. Borings B-15, B-20, and B-25 had a total explored depth of 75 feet bgs.

3.2 Groundwater

The borings were observed while drilling and after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling, or for the short duration that the borings were allowed to remain open.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings. Based on the geotechnical engineering analyses, subsurface exploration, and laboratory test results, it is our opinion that the fill embankments can be constructed using approved on-site soils or approved imported fill materials with a maximum slope configuration of 3:1 (horizontal to vertical). Other recommendations for pond construction are presented in the following sections of this report.

Approved on-site soils or approved imported fill materials should be tested prior to fill embankment construction to verify compliance with the recommended engineered fill specification provided in the Earthwork section of this report has been achieved.

Geotechnical engineering recommendations for foundation systems and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (which are presented in Appendices A and B), engineering analyses, and our current understanding of the proposed project.

4.2 Earthwork

The following presents recommendations for site preparation, subgrade preparation, excavation and fill placement on the project. The recommendations presented for design and construction of earth supported elements including embankments are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of embankments soils, subgrade preparation, and other geotechnical conditions exposed during the construction of the project.

4.2.1 Site Preparation

Prior to construction and placing any fill, all vegetation, and any otherwise unsuitable material should be removed from the construction areas. Wet or dry material should either be removed or moisture conditioned and compacted. Exposed areas which will receive fill or be constructed

upon, once properly cleared, should be scarified to a minimum depth of 10 inches, conditioned to near optimum moisture content, and compacted.

The site should be initially graded to create a relatively level surface to receive fill or be constructed upon.

Although evidence of underground facilities such as utilities was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

4.2.2 Fill Material Types

Engineered fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Near Surface On-Site Soils	SM	The on-site soils appear suitable for use as engineered fill.
Import	SC or SM[2]	All locations and elevations

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. A sample of each material type should be submitted to the geotechnical engineer for evaluation.
2. Imported clayey sand or silty sand.

4.2.3 Fill Material Placement and Compaction Requirements

Item	Description
Fill Lift Thickness	10 inches or less in loose thickness, 8 inches or less in compacted thickness
Minimum Compaction Requirements [1]	95% of the materials maximum standard Proctor dry density (ASTM D 698) for embankment construction
Moisture Content	Within +/-2% of optimum moisture content value as determined by the standard Proctor test at the time of placement and compaction

1. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

4.2.4 Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the project. Infiltration of water into utility trenches (if applicable) should be prevented during construction. Surface features which could retain water in areas adjacent to the embankments should be sealed or eliminated. Backfill in utility line trenches (if applicable) should be well compacted and free of construction debris to reduce the possibility of moisture infiltration.

4.2.5 Earthwork Construction Considerations

Difficult excavations are anticipated at the site due to the dense and very dense cemented soils encountered below depths of about 5 to 10 feet bgs. Extra effort, heavy duty or specialized equipment may be required to advance excavations to the invert depths of about 15 to 20 feet bgs.

Although the exposed subgrade is anticipated to be relatively stable upon initial exposure, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. The use of light construction equipment would aid in reducing subgrade disturbance. The use of remotely operated equipment, such as a backhoe, would be beneficial to perform cuts and reduce subgrade disturbance. Should unstable subgrade conditions develop, stabilization measures will need to be employed.

Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of embankments. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to embankment construction.

Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; moisture conditioning; re-compaction; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of embankments.

4.3 Water Impoundment Ponds

New storage ponds are planned for construction. Recommendations concerning the design and construction of the storage ponds are presented in the following sections.

4.3.1 Pond Embankment Slopes

In general accordance with New Mexico Dam Safety Design Criteria, the earth embankment slopes for earthen storage dams should be designed to meet the minimum requirements for embankment dams. The interior constructed slopes, lined with a geo-synthetic liner, should be no steeper than 2:1 (horizontal to vertical) and exterior constructed slopes should be no steeper than 3:1. In addition, the crest width should be at least 12 feet. The embankments should be designed with the freeboard above high water line of at least 2 feet.

4.3.2 Preparation of Embankment Areas

The soils below the new embankments should be scarified ten inches, moisture conditioned and compacted. The interior/exterior width of subgrade preparation, as described above, should extend to the intersection of the slopes of the embankment fill. Once the subgrade preparation has been observed and approved by the geotechnical engineer, embankment fill operations can commence.

4.3.3 Embankment Placement and Compaction

Once the prepared embankment bearing area has been approved by Terracon, on-site embankment material stockpiles should be moisture conditioned in preparation for lift placement. The embankments should be constructed as a unit from the bottom of the embankment elevation to the rim elevation.

All materials should be moisture conditioned to within 2 percent of optimum moisture content, placed in horizontal lifts not to exceed 10-inches loose, and compacted to a minimum of 95 percent of the standard laboratory dry density as evaluated by ASTM D698 (standard proctor).

The distal slopes of the pond embankments should be overbuilt and cut to final grade to provide compaction to these edges of the embankments. Consideration should be given to providing erosion control for unprotected embankment slopes. The embankments should be constructed in strict accordance with the project plans and specifications.

4.3.4 Excavation of Pond Bottom Area

The soils below the pond bottom area should be compacted below the bottom-of-pond elevation. Once the site grades have been achieved and have been observed and approved by the geotechnical engineer, the surface should be moistened and compacted to the satisfaction of the geotechnical engineer. The over-excavated material should then be replaced in compacted lifts (moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of ASTM D698, standard Proctor) to bring the bottom of the pond to final grade. The finished pond subgrade surface should be smooth graded and free of rocks, roots, gravel, or debris that may puncture the geomembrane liner.

4.3.5 Embankment Anchor Trenches

The geomembrane liner should be affixed to the embankments using anchor trenches. Trench dimensions should be (at a minimum) 2 feet wide and 1-1/2 feet in depth. The centerline of the trench should be a minimum of 3 feet from the interior embankment crest. The liner should cover the interior of the anchor trench. Once this is accomplished, fill material (consisting of native soil or engineered fill) or lean concrete can then be placed over the liner until the trench is completely filled. Liner should be placed in accordance with manufacturer's specifications and recommendations.

4.4 Seismic Considerations

Description	Value
2015 International Building Code Site Classification (IBC) [1]	C[2]
Site Latitude	32.8040
Site Longitude	-104.1667
Spectral Response Accelerations SMs and SM1 SMs = FaSs and SM1 = FvS1 Site Class C - Fa = 1.21, Fv = 1.68	
SM_S Spectral Acceleration for a Short Period (0.2 sec)	0.140g
SM1 Spectral Acceleration for a 1-Second Period	0.067g
SDs = 2/3 x SMs and SD1 = 2/3 x SM1	
SD_S Spectral Acceleration for a Short Period (0.2 sec)	0.093g
SD1 Spectral Acceleration for a 1-Second Period	0.045g

[1] Note: In general accordance with the *2015 International Building Code,* Table 1613.5.2.

[2] Note: The 2015 International Building Code (IBC) requires a site soil profile determination extending to a depth of 100 feet for seismic site classification. The current scope does not include the required 100 foot soil profile determination. The borings extending to a maximum depth of 75 feet, and this seismic site class definition considers that dense or denser soil may be encountered below the maximum depth of the subsurface exploration. Additional exploration to deeper depth would be required to confirm the conditions below the current depth of exploration.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation construction and other earth-related construction phases of the project.

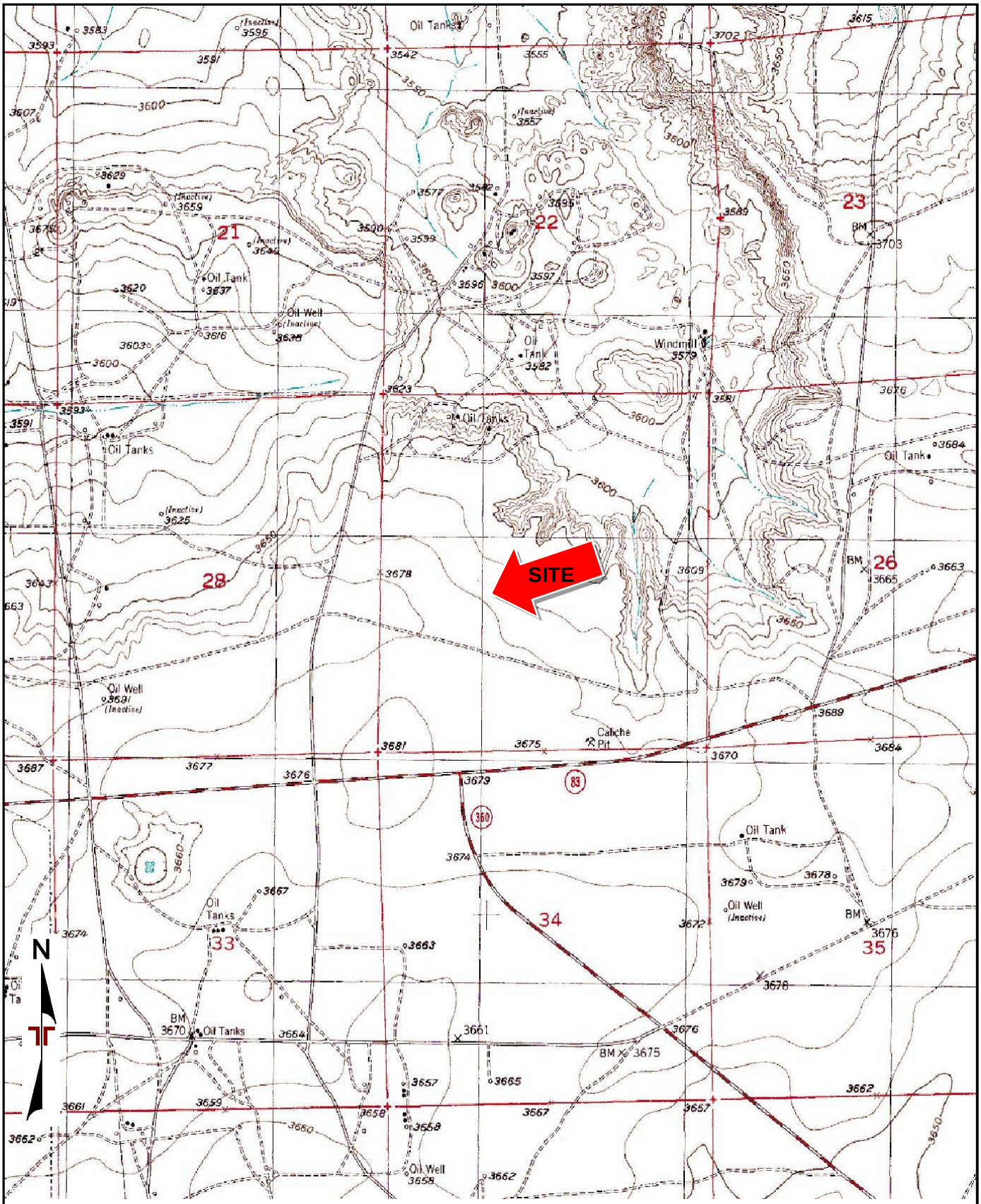
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A

FIELD EXPLORATION



TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: RED LAKE, NM (1/1/1975).

Project Manager: JDC	Project No. 68195007	Terracon 4450 Bataan Memorial E Las Cruces, NM 88011-6000	SITE LOCATION PLAN	Exhibit
Drawn by: DC	Scale: 1"=2,000'		Welch Water Impoundment Facility North of US 82 and NM 360 Eddy County, NM	A-1
Checked by: JDC	File Name: FIGURES			
Approved by: JDC	Date: 1/28/2019			

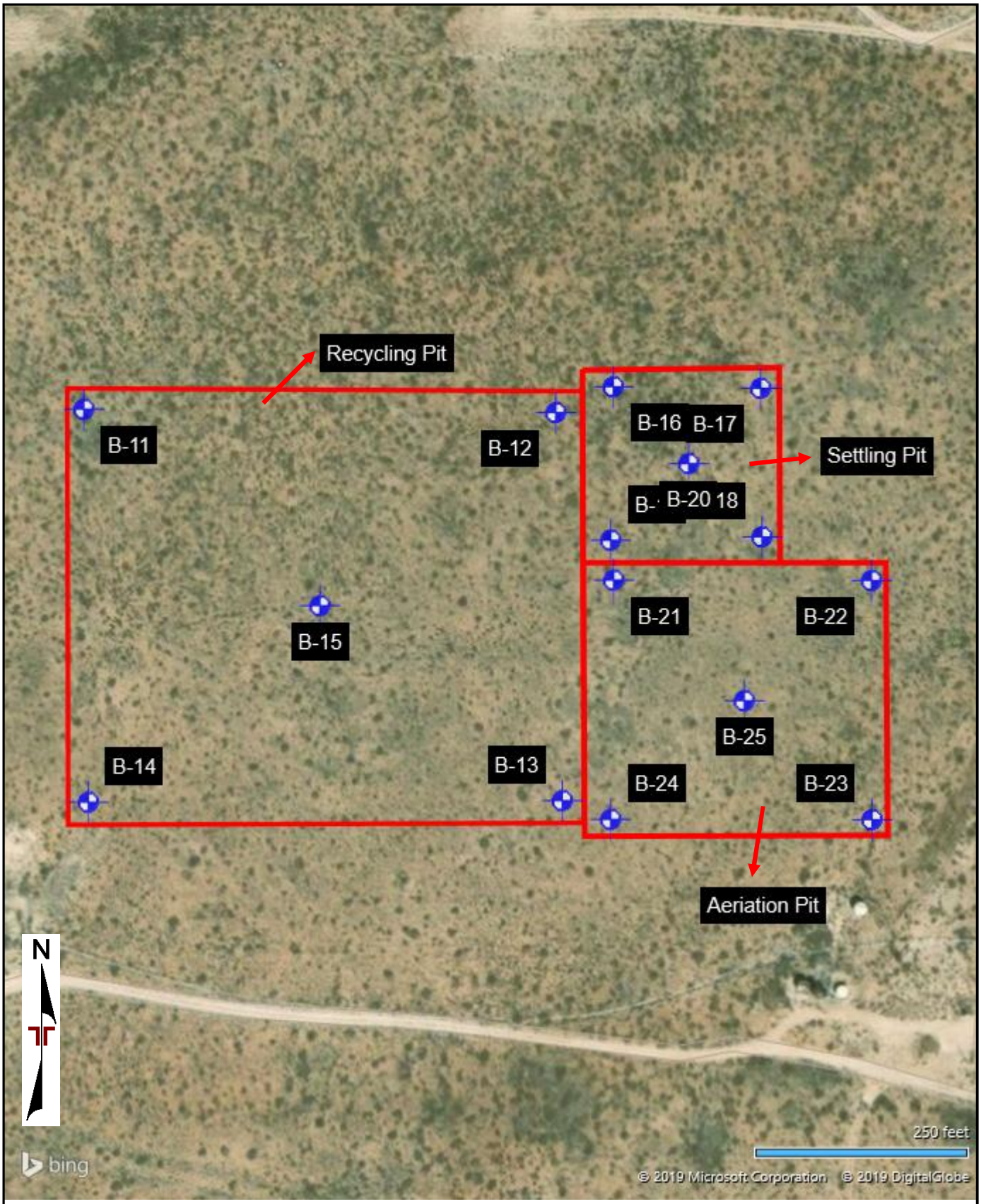


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

Project Manager: JDC	Project No. 68195007	Terracon 4450 Bataan Memorial E Las Cruces, NM 88011-6000	BORING LOCATION PLAN Welch Water Impoundment Facility North of US 82 and NM 360 Eddy County, NM
Drawn by: DC	Scale: AS SHOWN		
Checked by: JDC	File Name: FIGURES		
Approved by: JDC	Date: 1/28/2019		Exhibit A-2

Field Exploration Description

A total of fifteen (15) test borings were drilled at the site on January 14 and 15, 2019. The borings were drilled to depths of approximately 21-1/2 and 75 feet below the ground surface at the approximate locations shown on the attached Boring Location Plan, Exhibit A-2. The test borings were located as follows:

Borings	Location	Depth (feet)
B-11 to B-14	Approximate Edges of Recycling Pit Footprint	21-1/2
B-15	Approximate Center of Recycling Pit Footprint	75
B-16 to B-19	Approximate Edges of Settling Pit Footprint	21-1/2
B-20	Approximate Center of Settling Pit Footprint	75
B-21 to B-24	Approximate Edges of Aeration Pit Footprint	21-1/2
B-25	Approximate Center of Aeration Pit Footprint	75

The test borings were advanced with a truck-mounted CME-75 drill rig utilizing 8-inch diameter hollow-stem augers.

The borings were located in the field by using the proposed site plan and an aerial photograph of the site, measuring from existing property lines and using a hand-held GPS unit. The accuracy of boring locations should only be assumed to the level implied by the method used.

Lithologic logs of each boring were recorded by the field engineer during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon or ring-barrel samplers. Bulk samples of subsurface materials were also obtained.

Penetration resistance measurements were obtained by driving the split-spoon and ring-barrel samplers into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The penetration resistance value is a useful index in estimating the consistency or relative density of materials encountered.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

Groundwater conditions were evaluated in the borings at the time of site exploration. For safety purposes, we backfilled the borings with auger cuttings immediately after drilling operations.

BORING LOG NO. B-11

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804978° Longitude: -104.168538°

Approximate Surface Elev.: 3680 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), tan								
		trace gravel, loose	5			5-5-4 N=9	5		NP	28
		dense	10			11-18-21 N=39				
		very dense	15			15-25-50 N=75				
			20			22-28-38 N=66				
21.5	3658.5+/-									
		Boring Terminated at 21.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Recycling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-14-2019 | Boring Completed: 01-14-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-4

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-12

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804967° Longitude: -104.166735°

Approximate Surface Elev.: 3673 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), tan								
		medium dense	5			13-10-15 N=25				
		trace gravel, dense	10			12-19-18 N=37	5		NP	26
			15			21-18-22 N=40				
		very dense	20			23-24-28 N=52				
21.5	3651.5+/-									
		Boring Terminated at 21.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Recycling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-14-2019 | Boring Completed: 01-14-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-5

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-13

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.803721° Longitude: -104.166710°

Approximate Surface Elev.: 3681 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND WITH GRAVEL (SM), tan								
		very dense	5			12-26-43 N=69	8		NP	20
		medium dense	10			7-9-11 N=20				
		very dense	15			15-28-50/3"				
			20			20-50/5"				
21.5	3659.5+/-	***Boring Terminated at 21.5 Feet***								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Recycling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-14-2019 | Boring Completed: 01-14-2019
Drill Rig: CME 75 | Driller: Envirodril
Project No.: 68195007 | Exhibit: A-6

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-14

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.803716° Longitude: -104.168521°

Approximate Surface Elev.: 3687 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), white, carbonate indurated									
		5							
medium dense					8-10-9 N=19				
		10							
trace gravel, tan, very dense					22-37-50/3"	6		NP	32
		15			45-50				
		20			24-50/5"				
21.5	3665.5+/-								
Boring Terminated at 21.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Recycling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-14-2019 | Boring Completed: 01-14-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-15

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804362° Longitude: -104.167574°

Approximate Surface Elev.: 3679 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND WITH GRAVEL (SM), tan					
medium dense		17-14-13 N=27	9	NP	18
		10-8-8 N=16			
very dense		2-4-11 N=15			
		29-40-50/5"			
brown		19-34-36 N=70			
		18-50/5"			
		13-50			
		15-26-30 N=56			
75.0	3604+/-				
Boring Terminated at 75 Feet					

DEPTH (Ft.): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75

GRAPHIC LOG | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | DRY UNIT WEIGHT (pcf)

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Recycling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019
Drill Rig: CME 75 | Driller: Envirodril
Project No.: 68195007 | Exhibit: A-8

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/28/19

BORING LOG NO. B-16

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.805050° Longitude: -104.166515°

Approximate Surface Elev.: 3673 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), tan				
5		loose	5-4-5 N=9			
10		trace gravel, medium dense	5-6-18 N=24	8	NP	21
15		very dense	12-26-27 N=53			
20		medium dense	11-7-10 N=17			
21.5	3651.5+/-	***Boring Terminated at 21.5 Feet***				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Settling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019
Drill Rig: CME 75 | Driller: Envirodril
Project No.: 68195007 | Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-17

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.805045° Longitude: -104.165952°

Approximate Surface Elev.: 3671 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), tan									
trace gravel, medium dense		5		X	11-10-11 N=21	5		NP	22
very dense		10		X	30-50				
brown, dense		15		X	16-16-21 N=37				
very dense		20		X	50				
21.5	3649.5+/-								
Boring Terminated at 21.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Settling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-18

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804568° Longitude: -104.165947°

Approximate Surface Elev.: 3673 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), tan										
medium dense			5			9-9-9 N=18				
trace gravel			10			11-9-10 N=19	8		NP	19
brown, very dense			15			17-20-50/5"				
dense			20			22-18-29 N=47				
21.5	3651.5+/-									
Boring Terminated at 21.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Settling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-11

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-19

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804557° Longitude: -104.166525°

Approximate Surface Elev.: 3674 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND WITH GRAVEL (SM), tan								
		medium dense	5			10-6-11 N=17	9		NP	22
		very dense	10			20-50/4"				
		dense	15			12-16-17 N=33				
21.5	3652.5+/-		20			12-20-27 N=47				
		Boring Terminated at 21.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Settling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019
Drill Rig: CME 75 | Driller: Envirodril
Project No.: 68195007 | Exhibit: A-12

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-20

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804803° Longitude: -104.166227°

Approximate Surface Elev.: 3672 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0	3672+/-	**SILTY SAND WITH GRAVEL (SM)**, tan				
5		medium dense	8-9-20 N=29	8	NP	18
10		loose	8-5-4 N=9			
15		medium dense	4-5-6 N=11			
20		dense	4-5-5 N=10			
25		brown	13-26-23 N=49			
30		very dense	13-17-20 N=37			
35			50/4"			
40			21-26-33 N=59			
45						
50						
55						
60						
65						
70						
75						
75.0	3597+/-	***Boring Terminated at 75 Feet***				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Settling Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019
Drill Rig: CME 75 | Driller: Envirodril
Project No.: 68195007 | Exhibit: A-13

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/28/19

BORING LOG NO. B-21

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804429° Longitude: -104.166514°

Approximate Surface Elev.: 3675 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), tan								
		trace gravel, medium dense	5			15-14-11 N=25	5		NP	33
		dense	10			15-20-26 N=46				
		brown, very dense	15			10-50				
			20			29-31-50/3"				
21.5	3653.5+/-	***Boring Terminated at 21.5 Feet***								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Aeriation Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019
Drill Rig: CME 75 | Driller: Envirodril
Project No.: 68195007 | Exhibit: A-14

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-22

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804428° Longitude: -104.165529°

Approximate Surface Elev.: 3673 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND WITH GRAVEL (SM), tan								
		medium dense	5			8-8-8 N=16				
		very dense	10			13-34-50 N=84	5		NP	16
			15			38-30-50/5"				
			20			30-50/1"				
21.5	3651.5+/-									
		Boring Terminated at 21.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Aeriation Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-15

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-23

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.803660° Longitude: -104.165527°

Approximate Surface Elev.: 3676 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), tan										
trace gravel, medium dense			5			8-10-8 N=18	6		NP	22
dense			10			10-18-17 N=35				
very dense			15			35-50				
			20			50/3"				
21.5	3654.5+/-									
Boring Terminated at 21.5 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Aeriation Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-16

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-24

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.803661° Longitude: -104.166525°

Approximate Surface Elev.: 3681 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), tan								
		very dense	5			21-26-29 N=55				
		trace gravel, medium dense	10			8-8-13 N=21	7		NP	14
		brown, dense	15			11-14-24 N=38				
		very dense	20			29-50/5"				
21.5	3659.5+/-									
		Boring Terminated at 21.5 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Aeriation Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-17

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/30/19

BORING LOG NO. B-25

PROJECT: Welch Water Impoundment Facility

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

SITE: North of US 82 and NM 360
Eddy County, NM

LOCATION See Exhibit A-2

Latitude: 32.804042° Longitude: -104.166015°

Approximate Surface Elev.: 3676 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), tan					
very dense		9-29-38 N=67	7	NP	31
trace gravel		20-35-38 N=73			
dense		5-12-30 N=42			
very dense		28-50			
brown		20-50/5"			
		18-38-50/1"			
		15-50/1"			
		20-36-50/5"			
75.0	3601+/-				
Boring Terminated at 75 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes: **Aeriation Pit**

WATER LEVEL OBSERVATIONS

Terracon
4450 Bataan Memorial E
Las Cruces, NM

Boring Started: 01-15-2019 | Boring Completed: 01-15-2019

Drill Rig: CME 75 | Driller: Envirodril

Project No.: 68195007 | Exhibit: A-18

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 68195007 WELCH WATER IMPOU.GPJ MODELLAYER.GPJ 1/28/19

APPENDIX B

LABORATORY TESTING

Laboratory Testing

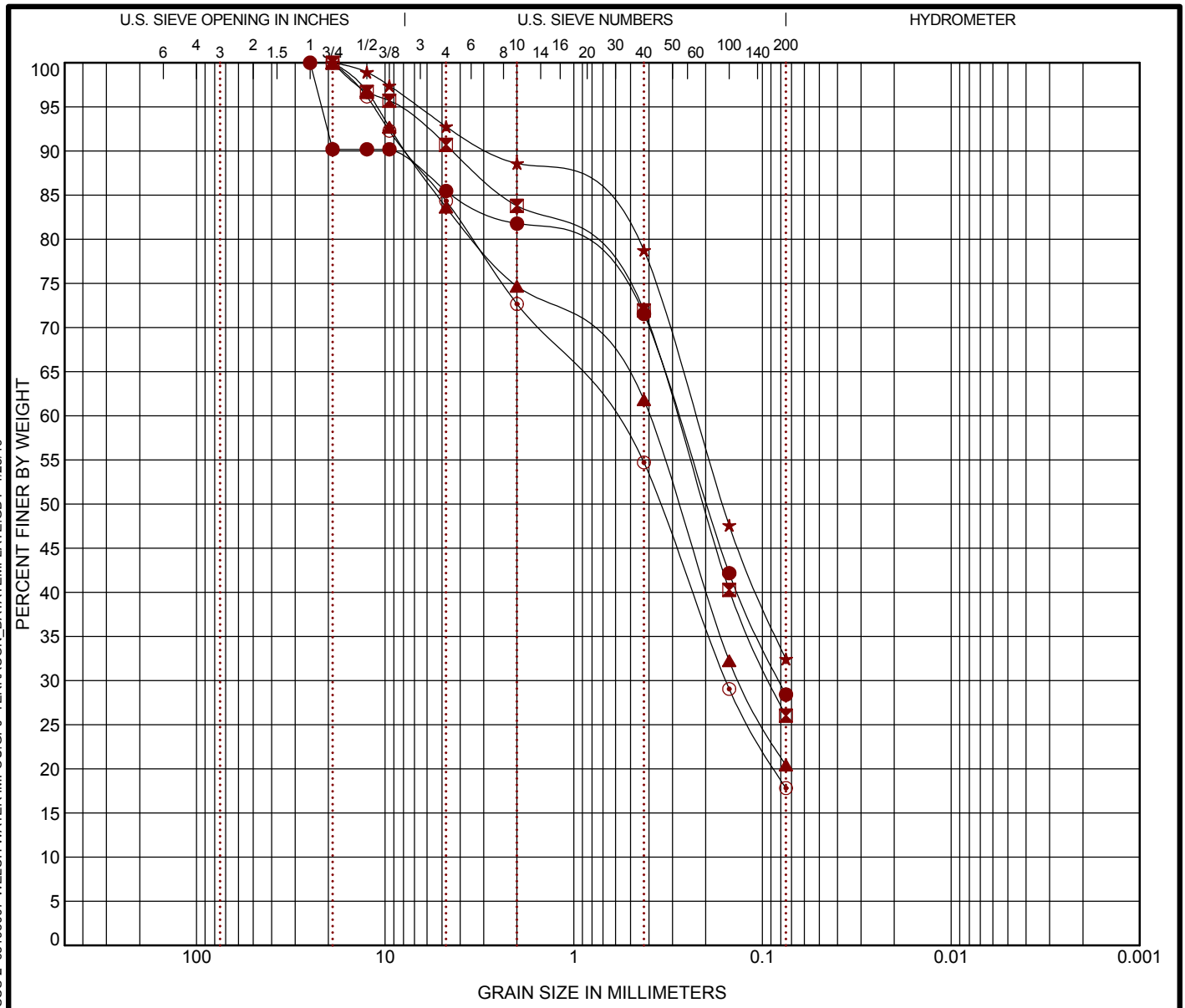
Soil samples were tested in the laboratory to measure their natural water content. Grain size analyses (ASTM D422), and maximum dry density-optimum moisture relationship (ASTM D698) were also performed on selected samples. The test results are provided on the boring logs and presented in Appendix B.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report in Appendix C. All classification was by visual/manual procedures, (ASTM D2487). Selected samples were further classified using the results of Atterberg limit testing, (ASTM D4318). The Atterberg limit test results are also provided on the boring logs.

Procedural standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	B-11	5 - 6.5	SILTY SAND (SM)	5	NP	NP	NP		
⊠	B-12	10 - 11.5	SILTY SAND (SM)	5	NP	NP	NP		
▲	B-13	5 - 6.5	SILTY SAND with GRAVEL (SM)	8	NP	NP	NP		
★	B-14	10 - 11.3	SILTY SAND (SM)	6	NP	NP	NP		
⊙	B-15	2.5 - 4	SILTY SAND with GRAVEL (SM)	9	NP	NP	NP		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	B-11	5 - 6.5	25	0.282	0.081		14.5	57.0		28.4	
⊠	B-12	10 - 11.5	19	0.287	0.091		9.3	64.7		26.0	
▲	B-13	5 - 6.5	19	0.399	0.132		16.4	63.2		20.4	
★	B-14	10 - 11.3	19	0.227			7.2	60.3		32.4	
⊙	B-15	2.5 - 4	19	0.671	0.156		15.7	66.5		17.8	

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360
Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

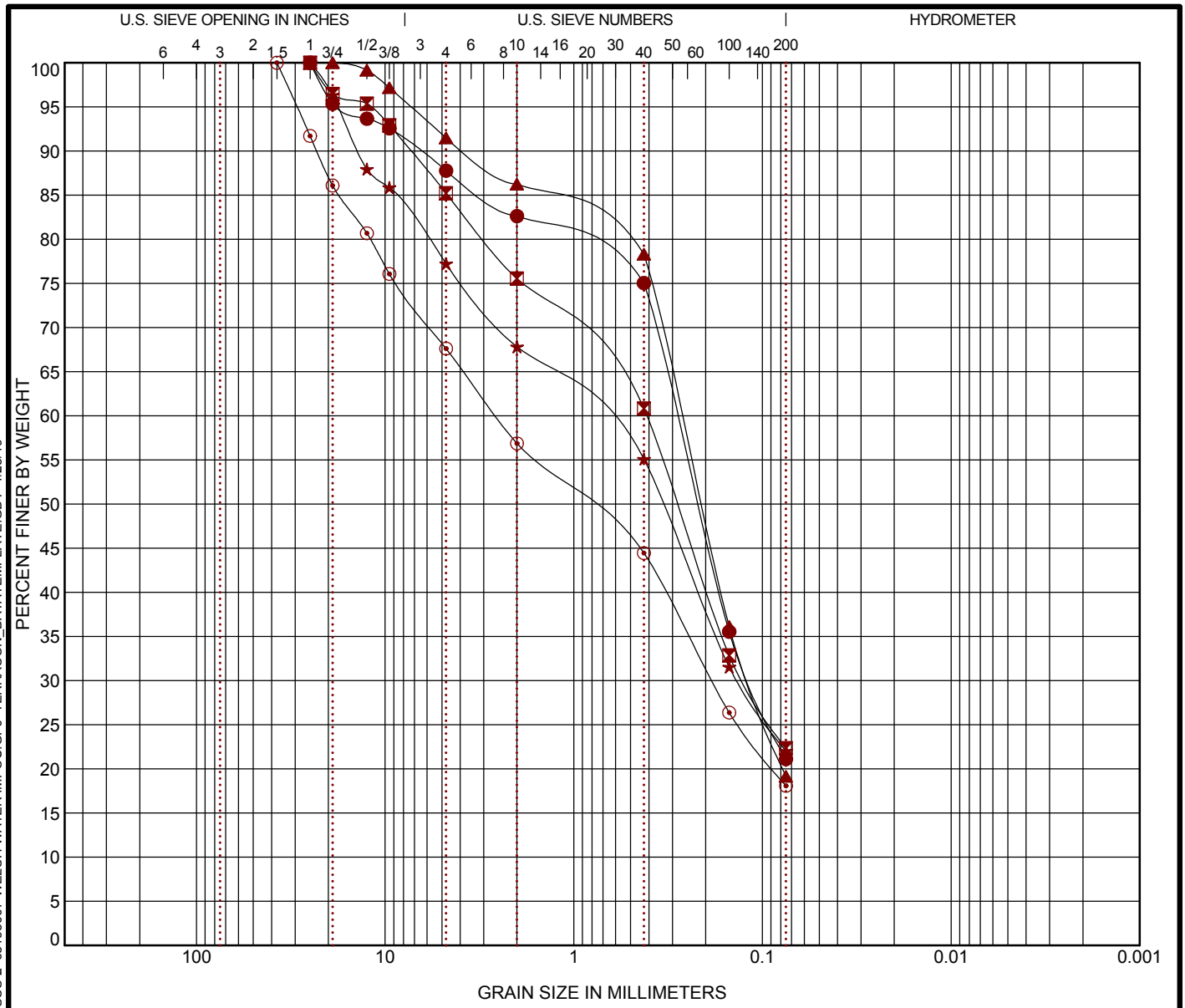
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
B-16	10 - 11.5	SILTY SAND (SM)	8	NP	NP	NP		
B-17	5 - 6.5	SILTY SAND (SM)	5	NP	NP	NP		
B-18	10 - 11.5	SILTY SAND (SM)	8	NP	NP	NP		
B-19	5 - 6.5	SILTY SAND with GRAVEL (SM)	9	NP	NP	NP		
B-20	5.1 - 6.6	SILTY SAND with GRAVEL (SM)	8	NP	NP	NP		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
B-16	10 - 11.5	25	0.286	0.115		12.2	66.7		21.1	
B-17	5 - 6.5	25	0.412	0.124		14.8	62.9		22.3	
B-18	10 - 11.5	19	0.27	0.117		8.5	72.3		19.2	
B-19	5 - 6.5	25	0.772	0.134		22.8	55.2		22.0	
B-20	5.1 - 6.6	37.5	2.573	0.185		32.4	49.5		18.1	

PROJECT: Welch Water Impoundment Facility

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4450 Bataan Memorial E
Las Cruces, NM

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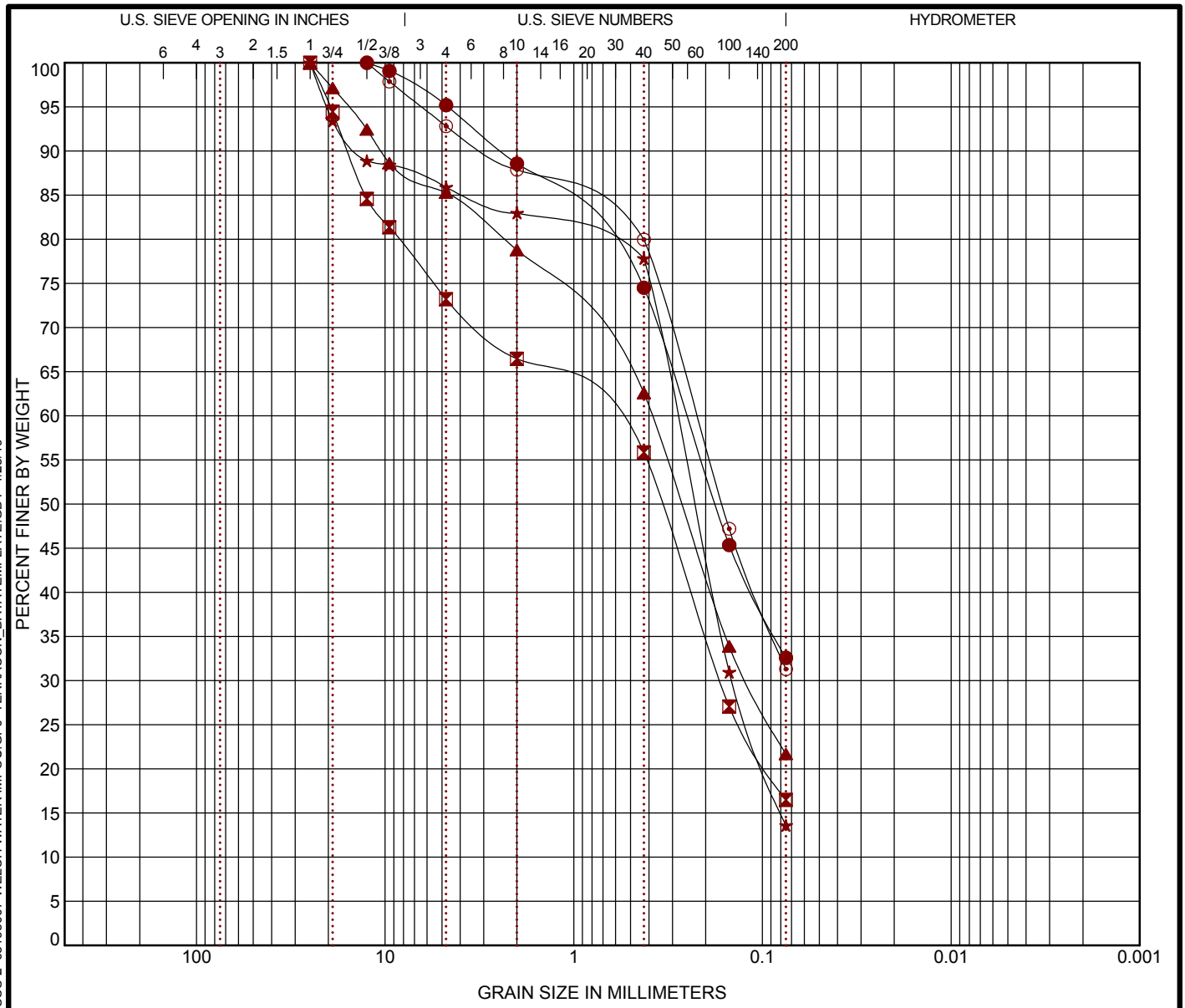
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
B-21	5 - 6.5	SILTY SAND (SM)	5	NP	NP	NP		
B-22	10 - 11.5	SILTY SAND with GRAVEL (SM)	5	NP	NP	NP		
B-23	5 - 6.5	SILTY SAND (SM)	6	NP	NP	NP		
B-24	10 - 11.5	SILTY SAND (SM)	7	NP	NP	NP		
B-25	5.1 - 6.6	SILTY SAND (SM)	7	NP	NP	NP		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
B-21	5 - 6.5	12.5	0.253			4.8	62.6		32.6	
B-22	10 - 11.5	25	0.779	0.167		26.8	56.7		16.5	
B-23	5 - 6.5	25	0.387	0.12		14.7	63.6		21.7	
B-24	10 - 11.5	25	0.286	0.144		14.1	72.3		13.6	
B-25	5.1 - 6.6	12.5	0.225			7.2	61.5		31.3	

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360
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Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

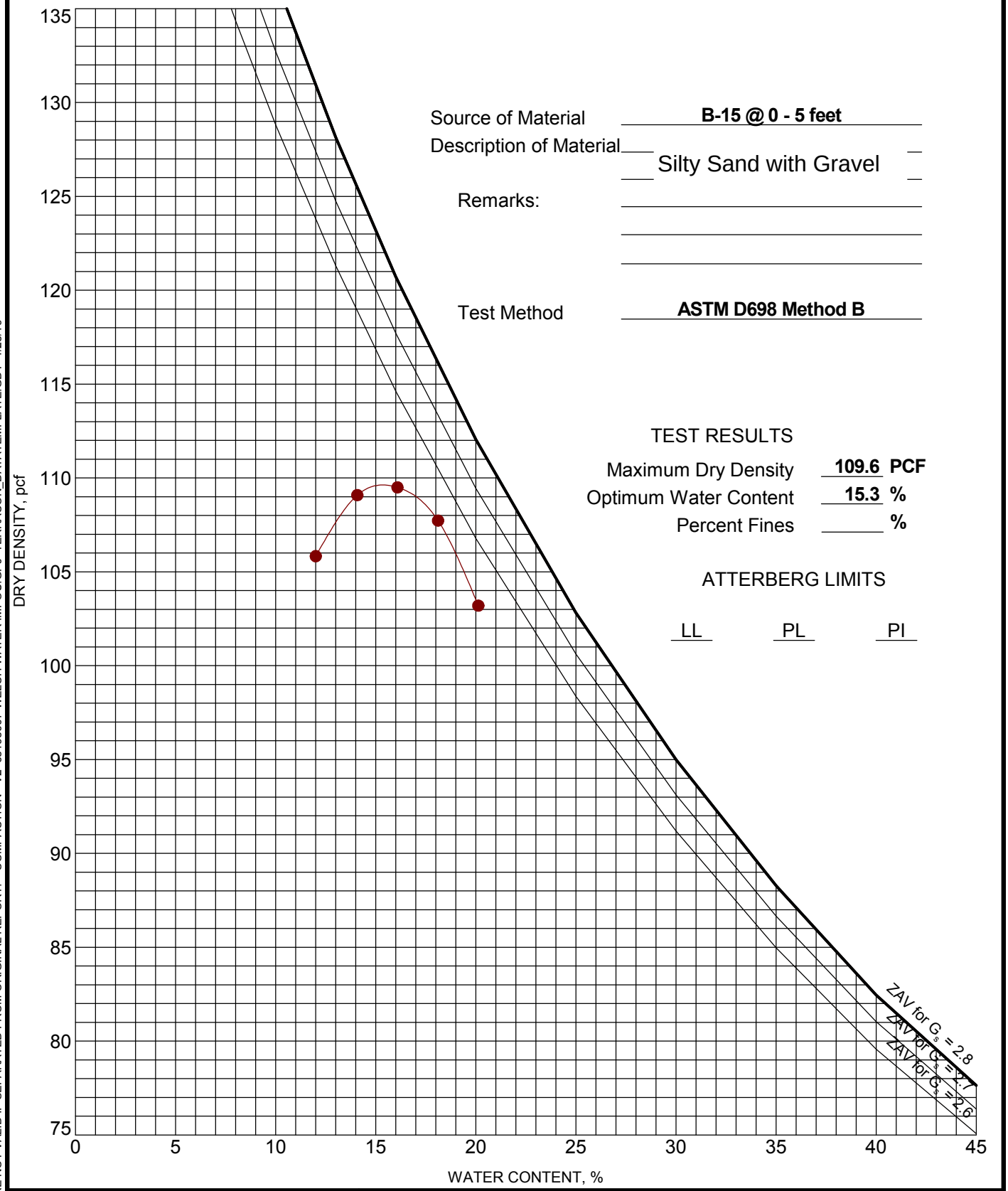
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-15 @ 0 - 5 feet**

Description of Material: Silty Sand with Gravel

Remarks:

Test Method: **ASTM D698 Method B**

TEST RESULTS

Maximum Dry Density	**109.6**	**PCF**
Optimum Water Content	**15.3**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360
Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

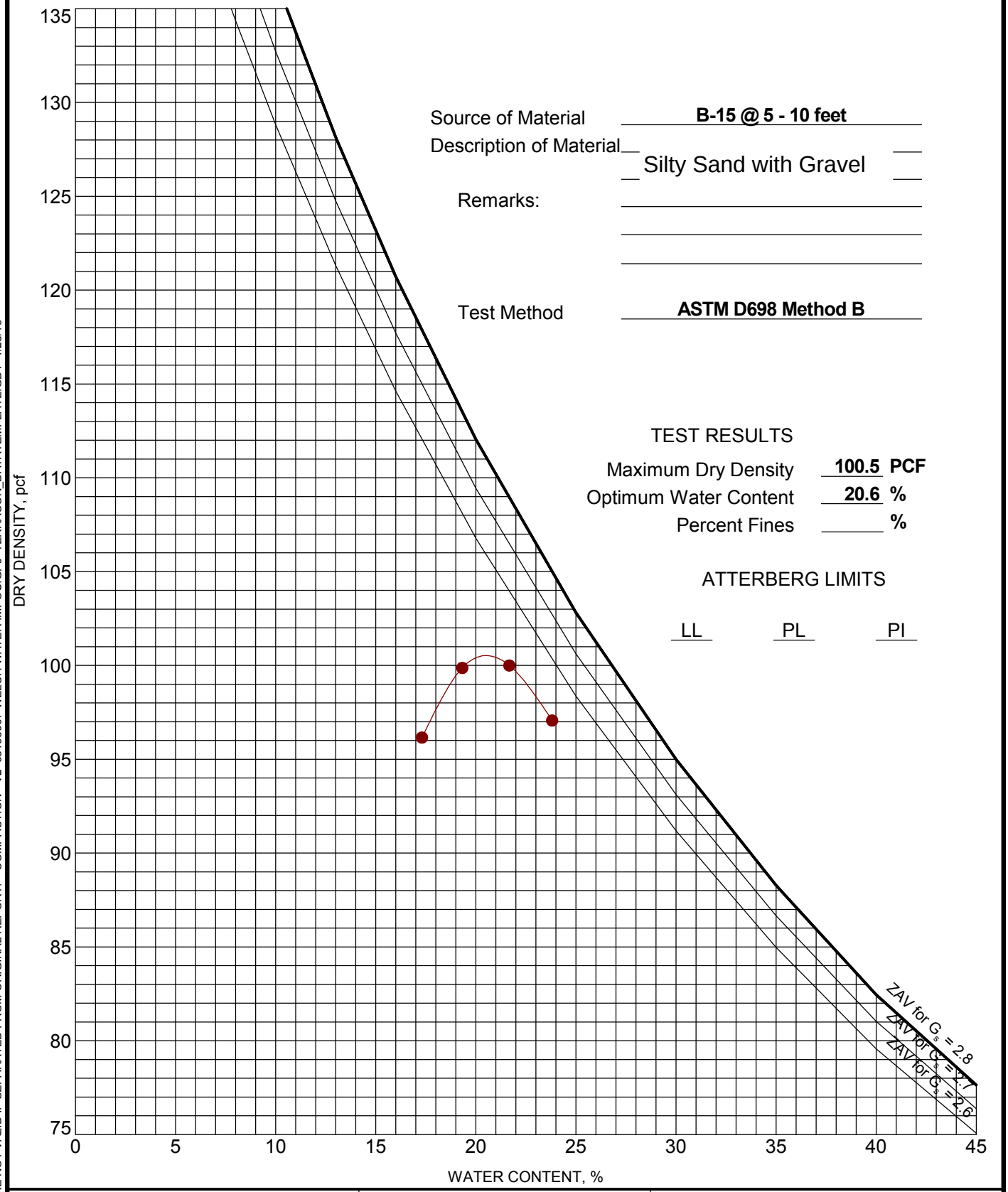
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-5

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-15 @ 5 - 10 feet**

Description of Material: Silty Sand with Gravel

Remarks:

Test Method: **ASTM D698 Method B**

TEST RESULTS

Maximum Dry Density	**100.5**	**PCF**
Optimum Water Content	**20.6**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360
Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

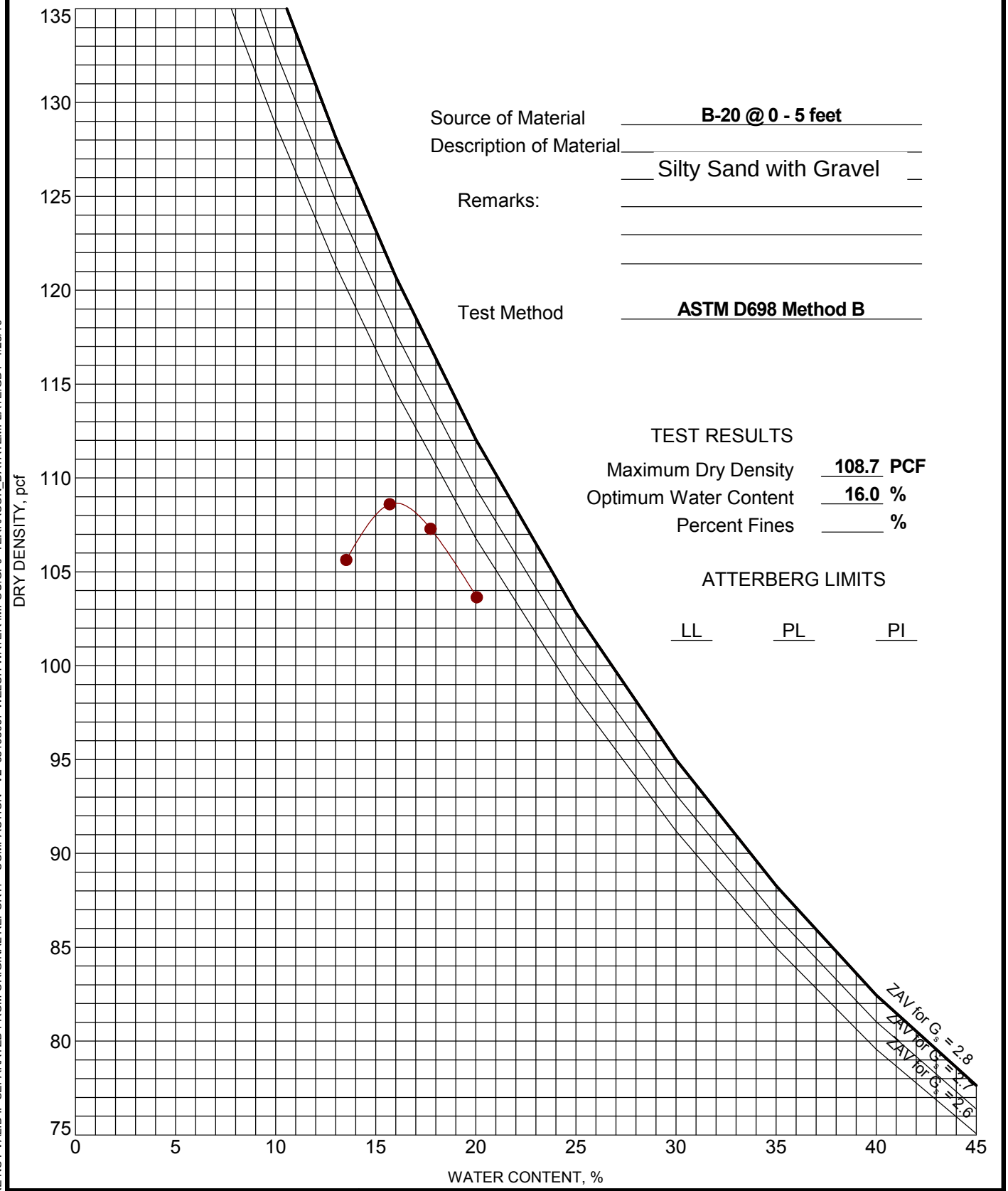
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-6

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-20 @ 0 - 5 feet**

Description of Material: Silty Sand with Gravel

Remarks:

Test Method: **ASTM D698 Method B**

TEST RESULTS

Maximum Dry Density	**108.7**	**PCF**
Optimum Water Content	**16.0**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360 Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

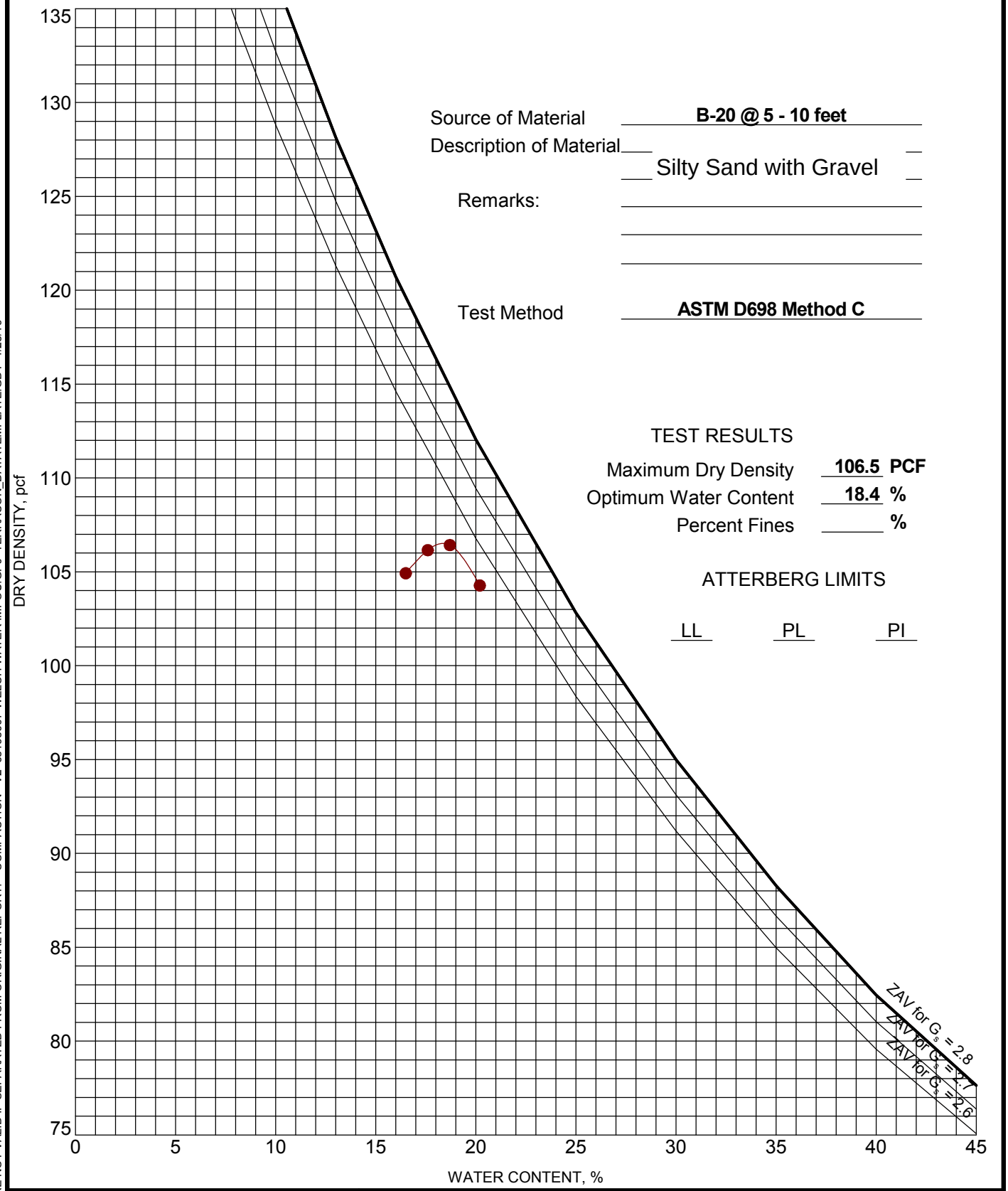
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-7

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-20 @ 5 - 10 feet**

Description of Material: Silty Sand with Gravel

Remarks:

Test Method: **ASTM D698 Method C**

TEST RESULTS

Maximum Dry Density	**106.5**	**PCF**
Optimum Water Content	**18.4**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360
Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

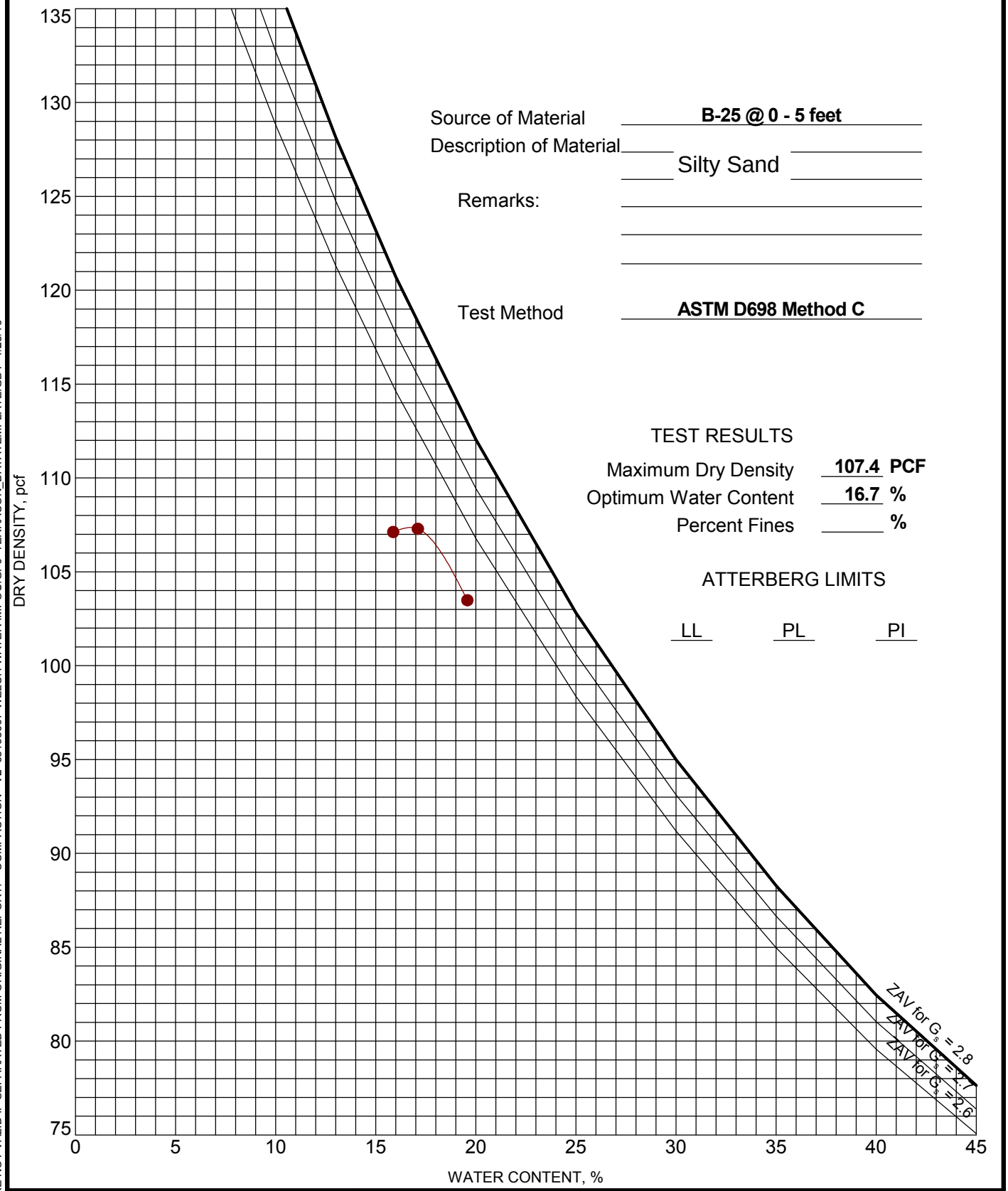
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-8

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-25 @ 0 - 5 feet**

Description of Material: Silty Sand

Remarks:

Test Method: **ASTM D698 Method C**

TEST RESULTS

Maximum Dry Density	**107.4**	**PCF**
Optimum Water Content	**16.7**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360
Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

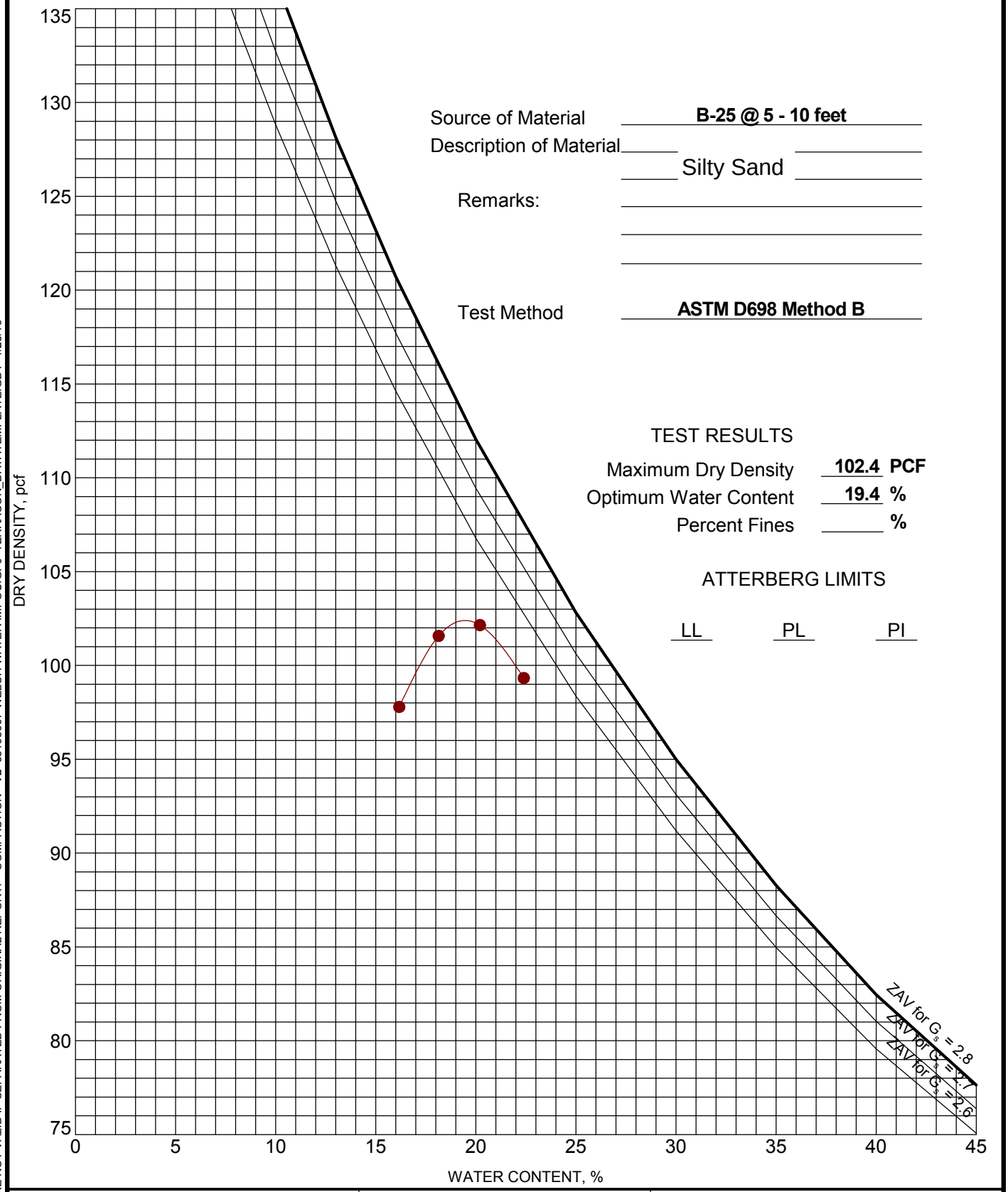
CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-9

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-25 @ 5 - 10 feet**

Description of Material: Silty Sand

Remarks:

Test Method: **ASTM D698 Method B**

TEST RESULTS

Maximum Dry Density	**102.4**	**PCF**
Optimum Water Content	**19.4**	**%**
Percent Fines		**%**

ATTERBERG LIMITS

LL	PL	PI

PROJECT: Welch Water Impoundment Facility

SITE: North of US 82 and NM 360 Eddy County, NM

Terracon
4450 Bataan Memorial E
Las Cruces, NM

PROJECT NUMBER: 68195007

CLIENT: EnviroTech Engineering & Consulting Inc
Enid, OK

EXHIBIT: B-10

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 68195007 WELCH WATER IMPOU.GPJ TERRACON_DATATEMPLATE.GDT 1/28/19

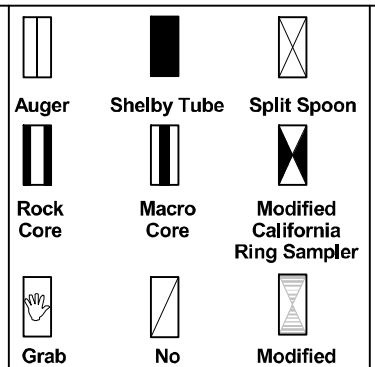
APPENDIX C

SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



WATER LEVEL

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
N	N value
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, tsf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

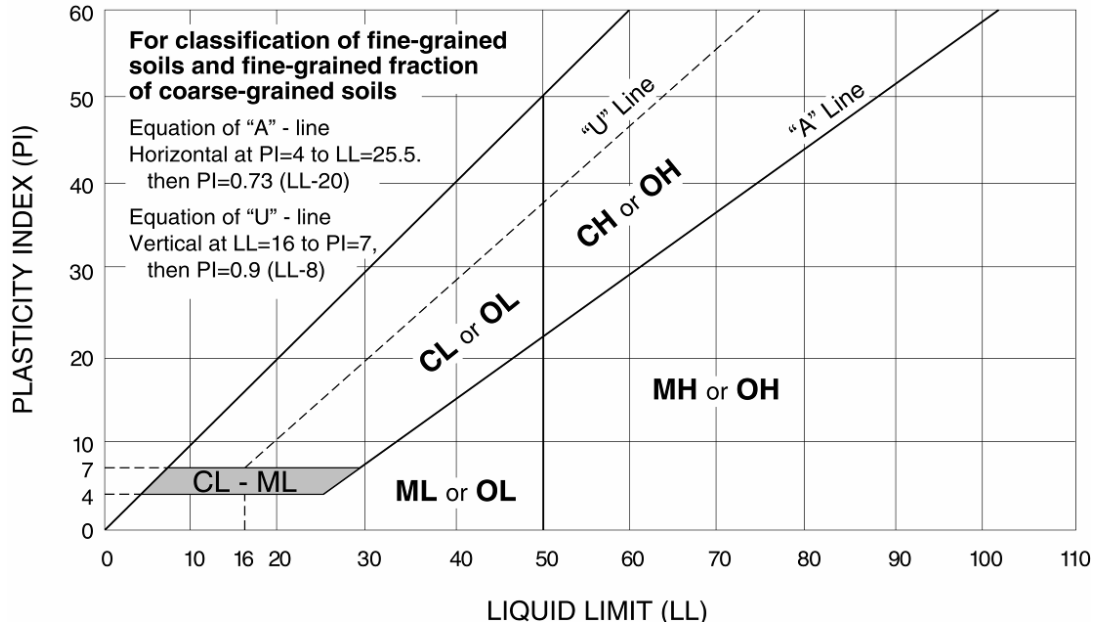
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



APPENDIX B

ENGINEER DRAWINGS

WELCH WATER RECYCLING FACILITY

Section 27 - Township 17 South, Range 28 East,
N.M.P.M. Eddy County, New Mexico

PERCUSSION PETROLEUM LLC

32.8056491, -104.1639504

Know what's below. Call before you dig.

Index to Drawings

Sheet No.	Description
1.	Cover Sheet
2.	Project Location Plan
3.	Site Plan
4.	Site Prep / Staking Plan
5.	Cross Sections
6.	Cross Sections
7.	Sump Plan & Details
8.	Miscellaneous Details
9.	Miscellaneous Details

Contacts

Percussion Petroleum -

Envirotech Engineering - Jimmy Stallings 580-234-8780
(Design Engineer)

ENVIROTECH ENGINEERING & CONSULTING, INC.

Owner	Percussion Petroleum
Site Name	Welch Recycle Facility - Storage Pit

Lagoon Feature	Top FB	Bottom	Max Liq. Level
Sideslope Ratio	3		3
Maximum Depth (ft)	16.0		13.0
Lagoon Top Width (ft)	550	454	526
Lagoon Top Length (ft)	550	454	526
Maximum Total Vol (ft^3)	4,044,352		3,166,228
Maximum Total Vol (bbls)	720,280		563,890

Lagoon Liq Depth ft	Storage ft	Surface Area ac	Remaining Stor Vol ft3	Gallons Storage gal	Percent of Total Volume %	Vol in lagoon ft^3	Vol in Lagoon Gallons	Vol in Lagoon BBLS	Percent Total Vol %
16.0	0.0	6.94	-	-	0.0%	4,044,352	30,251,753	720,280	100%
15.0	1.0	6.79	208,852	1,562,213	5.2%	3,745,140	28,013,647	666,992	93%
14.0	2.0	6.64	423,224	3,165,716	10.5%	3,452,456	25,824,371	614,866	85%
13.0	3.0	6.50	643,188	4,811,046	15.9%	3,166,228	23,683,385	563,890	78%
12.0	4.0	6.35	868,816	6,498,744	21.5%	2,886,384	21,590,152	514,051	71%
11.0	5.0	6.21	1,100,180	8,229,346	27.2%	2,612,852	19,544,133	465,336	65%
10.0	6.0	6.07	1,337,352	10,003,393	33.1%	2,345,560	17,544,789	417,733	58%
9.0	7.0	5.92	1,580,404	11,821,422	39.1%	2,084,436	15,591,581	371,228	52%
8.0	8.0	5.79	1,829,408	13,683,972	45.2%	1,829,408	13,683,972	325,809	45%
7.0	9.0	5.65	2,084,436	15,591,581	51.5%	1,580,404	11,821,422	281,462	39%
6.0	10.0	5.51	2,345,560	17,544,789	58.0%	1,337,352	10,003,393	238,176	33%
5.0	11.0	5.38	2,612,852	19,544,133	64.6%	1,100,180	8,229,346	195,937	27%
4.0	12.0	5.25	2,886,384	21,590,152	71.4%	868,816	6,498,744	154,732	21%
3.0	13.0	5.11	3,166,228	23,683,385	78.3%	643,188	4,811,046	114,549	16%
2.0	14.0	4.99	3,452,456	25,824,371	85.4%	423,224	3,165,716	75,374	10%
1.0	15.0	4.86	3,745,140	28,013,647	92.6%	208,852	1,562,213	37,196	5%
0.0	16.0	4.73	4,044,352	30,251,753	100.0%	-	-	-	0%

Owner	Percussion Petroleum
Site Name	Welch Recycle Facility - Aeration Pit

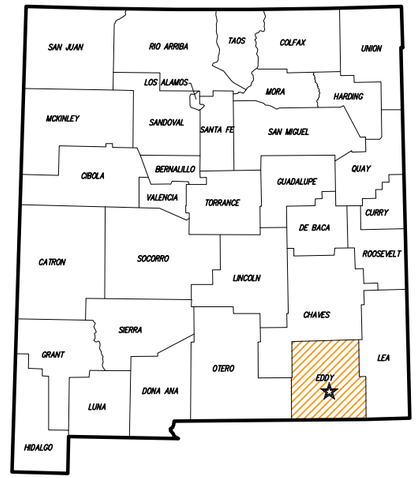
Lagoon Feature	Top FB	Bottom	Max Liq. Level
Sideslope Ratio	3		3
Maximum Depth (ft)	16.0		13.0
Lagoon Top Width (ft)	300	204	276
Lagoon Top Length (ft)	325	229	301
Maximum Total Vol (ft^3)	1,129,152		853,203
Maximum Total Vol (bbls)	201,097		151,951

Lagoon Liq Depth ft	Storage ft	Surface Area ac	Remaining Stor Vol ft3	Gallons Storage gal	Percent of Total Volume %	Vol in lagoon ft^3	Vol in Lagoon Gallons	Vol in Lagoon BBLS	Percent Total Vol %
16.0	0.0	2.24	-	-	0.0%	1,129,152	8,446,057	201,097	100%
15.0	1.0	2.15	48,027	359,242	4.3%	1,033,515	7,730,692	184,064	92%
14.0	2.0	2.07	98,724	738,456	8.7%	941,556	7,042,839	167,687	83%
13.0	3.0	1.99	152,163	1,138,179	13.5%	853,203	6,381,958	151,951	76%
12.0	4.0	1.91	208,416	1,558,952	18.5%	768,384	5,747,512	136,846	68%
11.0	5.0	1.83	267,555	2,001,311	23.7%	687,027	5,138,962	122,356	61%
10.0	6.0	1.75	329,652	2,465,797	29.2%	609,060	4,555,769	108,471	54%
9.0	7.0	1.68	394,779	2,952,947	35.0%	534,411	3,997,394	95,176	47%
8.0	8.0	1.60	463,008	3,463,300	41.0%	463,008	3,463,300	82,460	41%
7.0	9.0	1.53	534,411	3,997,394	47.3%	394,779	2,952,947	70,308	35%
6.0	10.0	1.46	609,060	4,555,769	53.9%	329,652	2,465,797	58,709	29%
5.0	11.0	1.39	687,027	5,138,962	60.8%	267,555	2,001,311	47,650	24%
4.0	12.0	1.32	768,384	5,747,512	68.0%	208,416	1,558,952	37,118	18%
3.0	13.0	1.26	853,203	6,381,958	75.6%	152,163	1,138,179	27,100	13%
2.0	14.0	1.20	941,556	7,042,839	83.4%	98,724	738,456	17,582	9%
1.0	15.0	1.13	1,033,515	7,730,692	91.5%	48,027	359,242	8,553	4%
0.0	16.0	1.07	1,129,152	8,446,057	100.0%	-	-	-	0%

Owner	Percussion Petroleum
Site Name	Welch Recycle Facility - Aeration Pit

Lagoon Feature	Top FB	Bottom	Max Liq. Level
Sideslope Ratio	3		3
Maximum Depth (ft)	16.0		13.0
Lagoon Top Width (ft)	200	104	176
Lagoon Top Length (ft)	200	104	176
Maximum Total Vol (ft^3)	381,952		272,428
Maximum Total Vol (bbls)	68,024		48,518

Lagoon Liq Depth ft	Storage ft	Surface Area ac	Remaining Stor Vol ft3	Gallons Storage gal	Percent of Total Volume %	Vol in lagoon ft^3	Vol in Lagoon Gallons	Vol in Lagoon BBLS	Percent Total Vol %
16.0	0.0	0.92	-	-	0.0%	381,952	2,857,001	68,024	100%
15.0	1.0	0.86	11,452	85,661	3.0%	343,140	2,566,687	61,112	90%
14.0	2.0	0.81	24,224	181,196	6.3%	306,656	2,293,787	54,614	80%
13.0	3.0	0.76	38,388	287,142	10.1%	272,428	2,037,761	48,518	71%
12.0	4.0	0.71	54,016	404,040	14.1%	240,384	1,798,072	42,811	63%
11.0	5.0	0.66	71,180	532,426	18.6%	210,452	1,574,181	37,480	55%
10.0	6.0	0.62	89,952	672,841	23.6%	182,560	1,365,549	32,513	48%
9.0	7.0	0.57	110,404	825,822	28.9%	156,636	1,171,637	27,896	41%
8.0	8.0	0.53	132,608	991,908	34.7%	132,608	991,908	23,617	35%
7.0	9.0	0.49	156,636	1,171,637	41.0%	110,404	825,822	19,662	29%
6.0	10.0	0.45	182,560	1,365,549	47.8%	89,952	672,841	16,020	24%
5.0	11.0	0.41	210,452	1,574,181	55.1%	71,180	532,426	12,677	19%
4.0	12.0	0.38	240,384	1,798,072	62.9%	54,016	404,040	9,620	14%
3.0	13.0	0.34	272,428	2,037,761	71.3%	38,388	287,142	6,837	10%
2.0	14.0	0.31	306,656	2,293,787	80.3%	24,224	181,196	4,314	6%
1.0	15.0	0.28	343,140	2,566,687	89.8%	11,452	85,661	2,040	3%
0.0	16.0	0.25	381,952	2,857,001	100.0%	-	-	-	0%



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PERCUSSION PETROLEUM LLC

PROJECT LOCATION

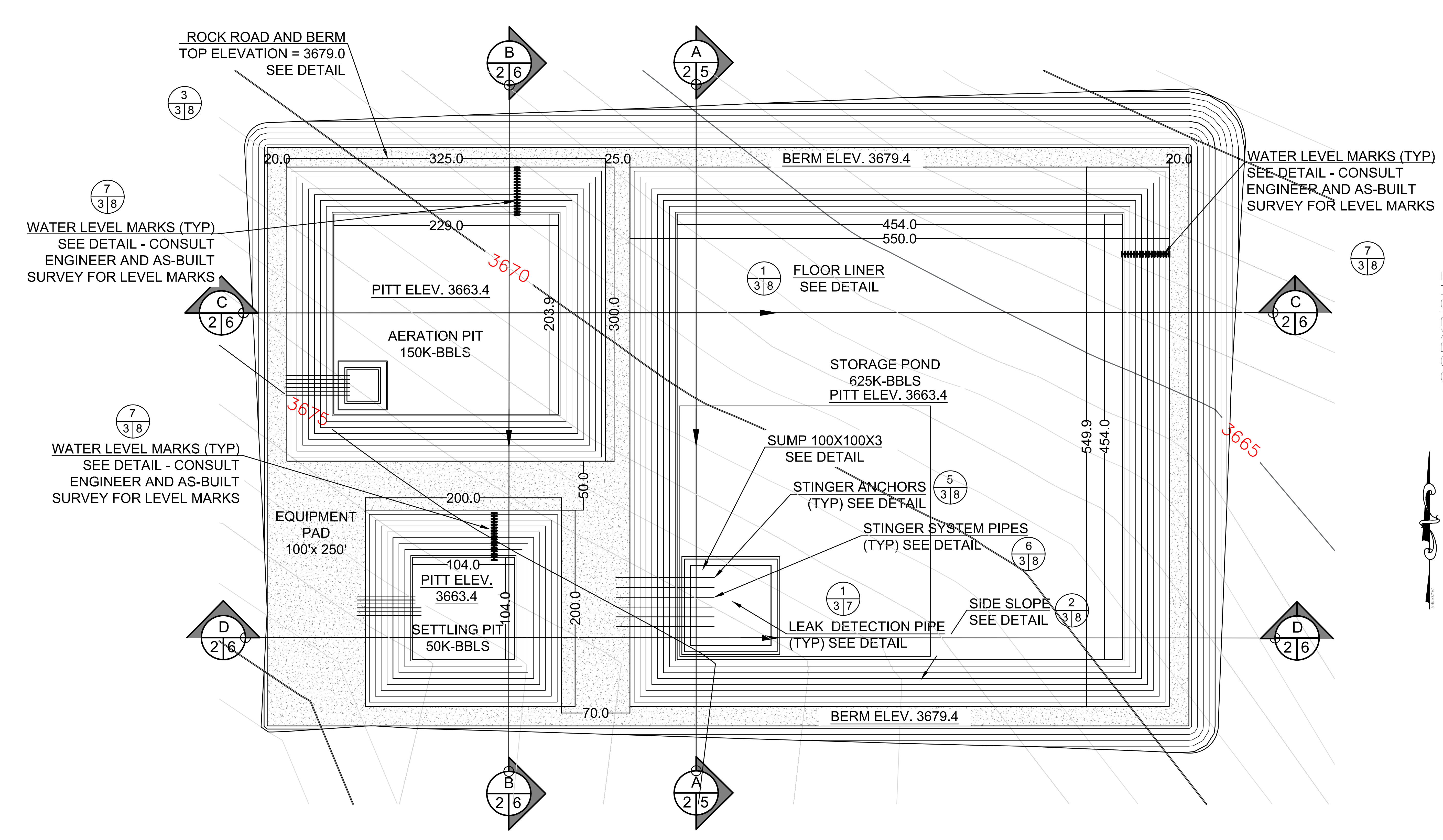
WELCH WATER RECYCLING

SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST

EDDY, NEW MEXICO

Date:	JANUARY, 2019
Scale:	—
Designed By:	T. WILLIAMS
Drawn By:	R. STOUT
Checked By:	J. STALLINGS
Project No.	18450-00

Sheet No.



Preliminary Site Volume Table: Adjusted

					Cut	Fill	NET	
Site	Stratum	Surface 1	Surface 2	Fill Factor	cubic yard	cubic yard	cubic yard	Method
Percussion		Existing	Proposed	20%	82,993	82872	121 (C)	Grid
WELCH PIT	GRADING						121 (C)	
		Rock surfacing area 12,778 (CY)						

NO.	DATE	REVISION	DRAWN BY	CHECKED BY

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SITE PLAN

WELCH WATER RECYCLING

SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST
EDDY, NEW MEXICO

Date: JANUARY 2019
Scale: — 1" = 100'
Designed by: T. WILLIAMS
Drawn by: R. STOUT
Checked By: J. STALLINGS
Project No. 18450-00

Sheet No.

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SITE PREP/STAKING PLAN

WELCH WATER RECYCLING

SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST
EDDY, NEW MEXICO

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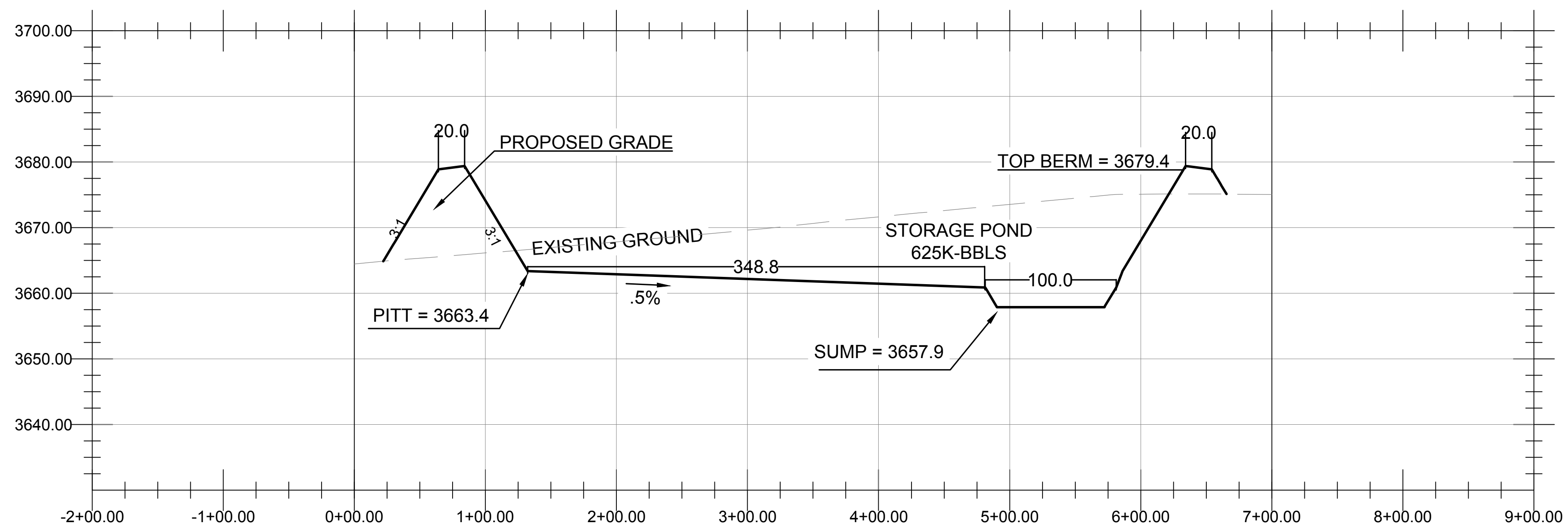
Date: JANUARY 2019	Drawn By: R. STOUT
Scale: —	Checked By: J. STALLINGS
Surveyed By: T. WILLIAMS	Project No. 18450-00

Elevation



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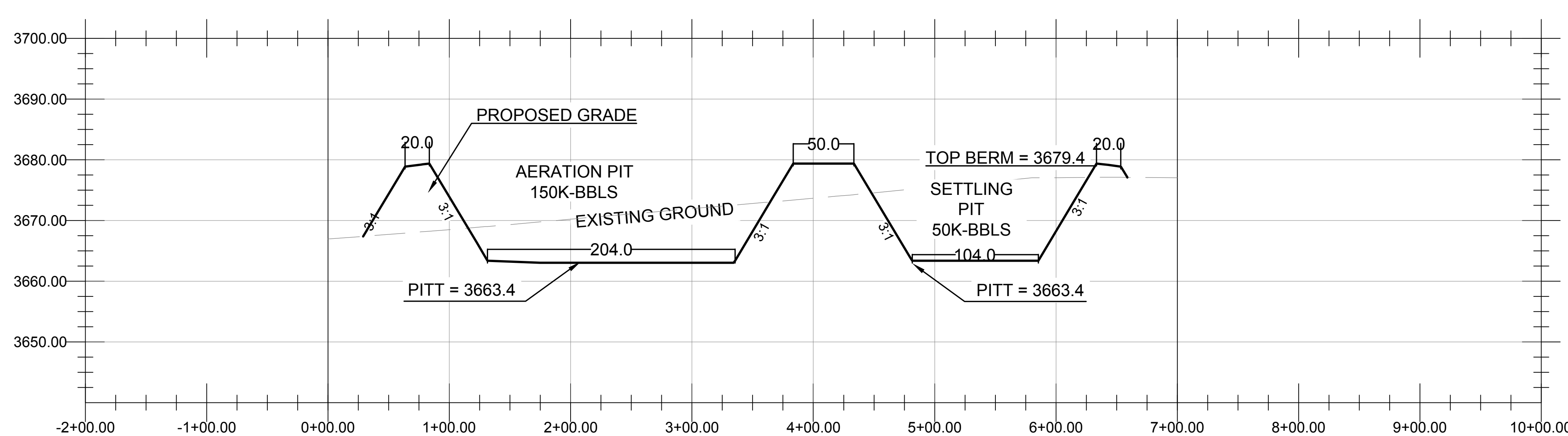

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PERCUSSION PETROLEUM LLC

CROSS SECTION

WELCH WATER RECYCLING

SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST

EDDY, NEW MEXICO

Date: JANUARY 2019
Scale: —
Designed by: T. WILLIAMS
Drawn by: R. STOUT
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Project No. 18450-00

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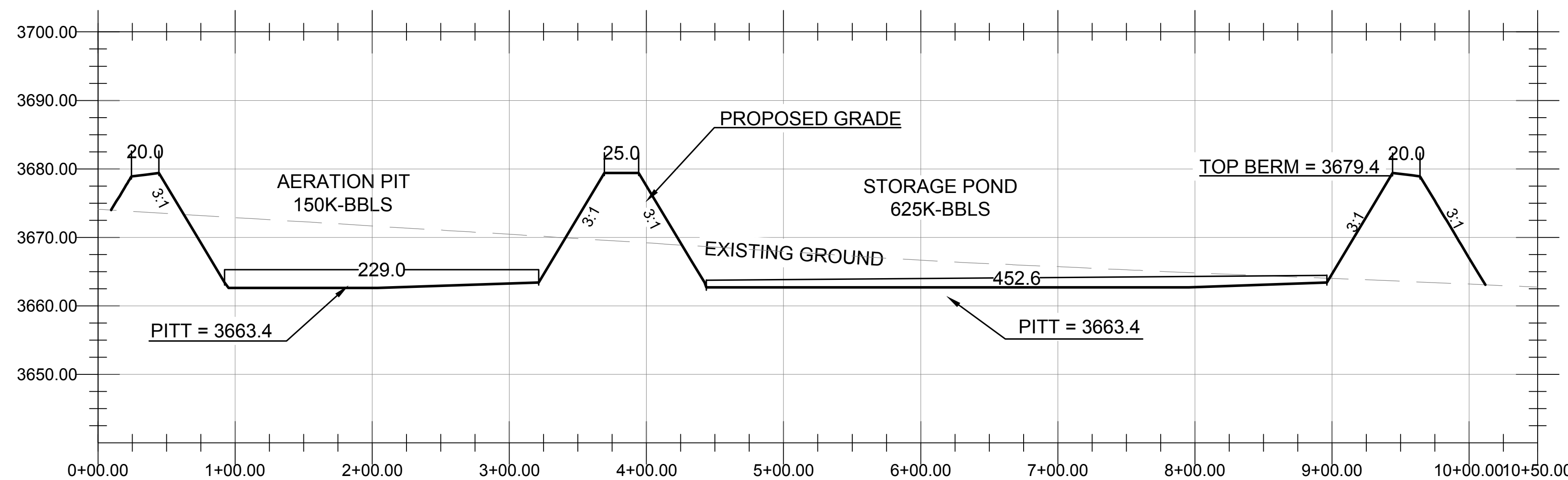

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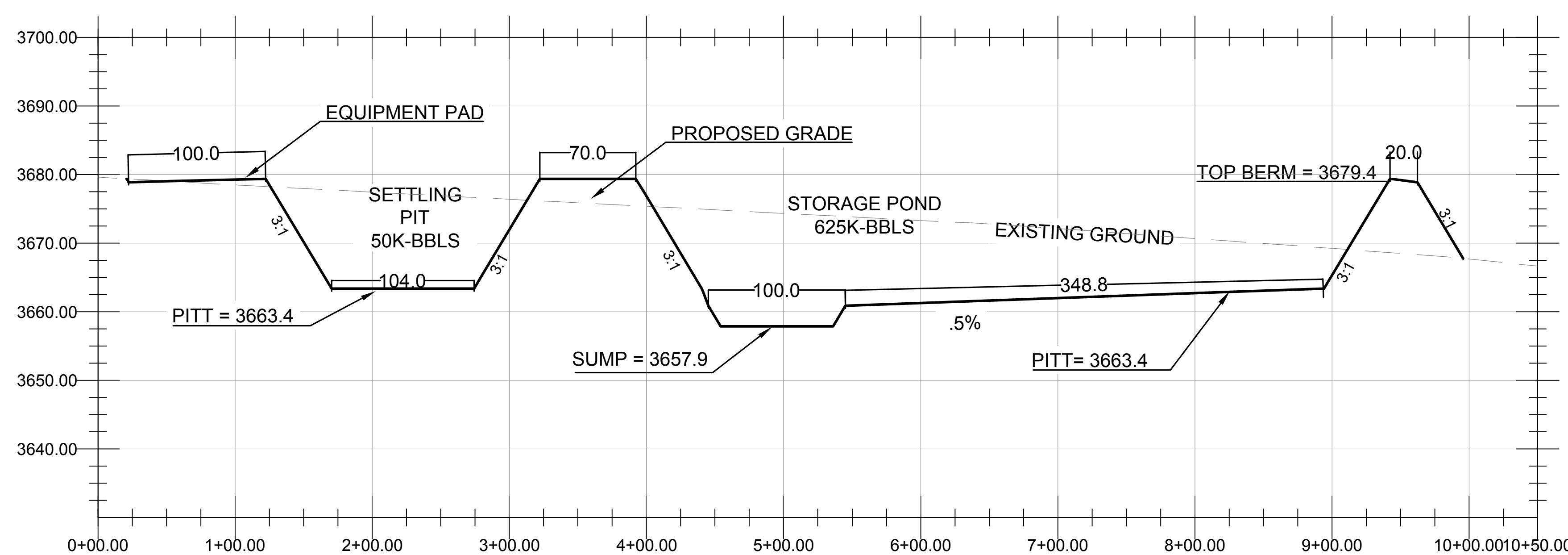

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WELCH WATER RECYCLING

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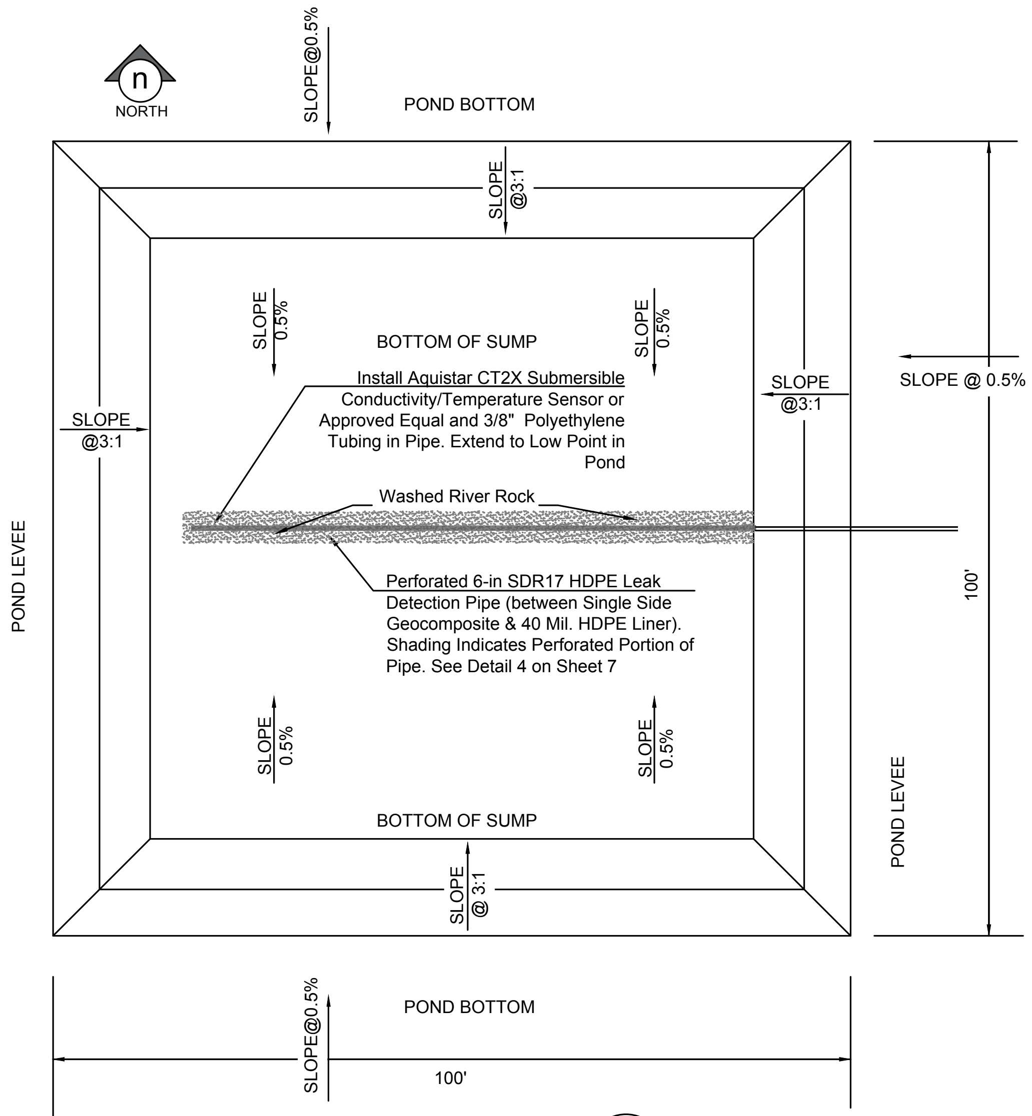

POND SUMP PLAN VIEW 1 / 3 7
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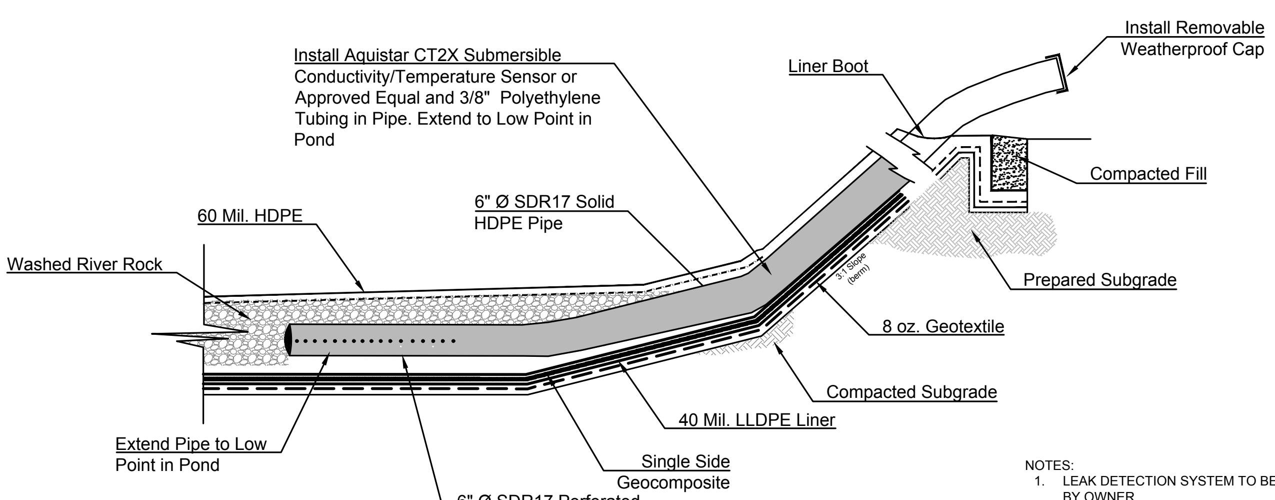
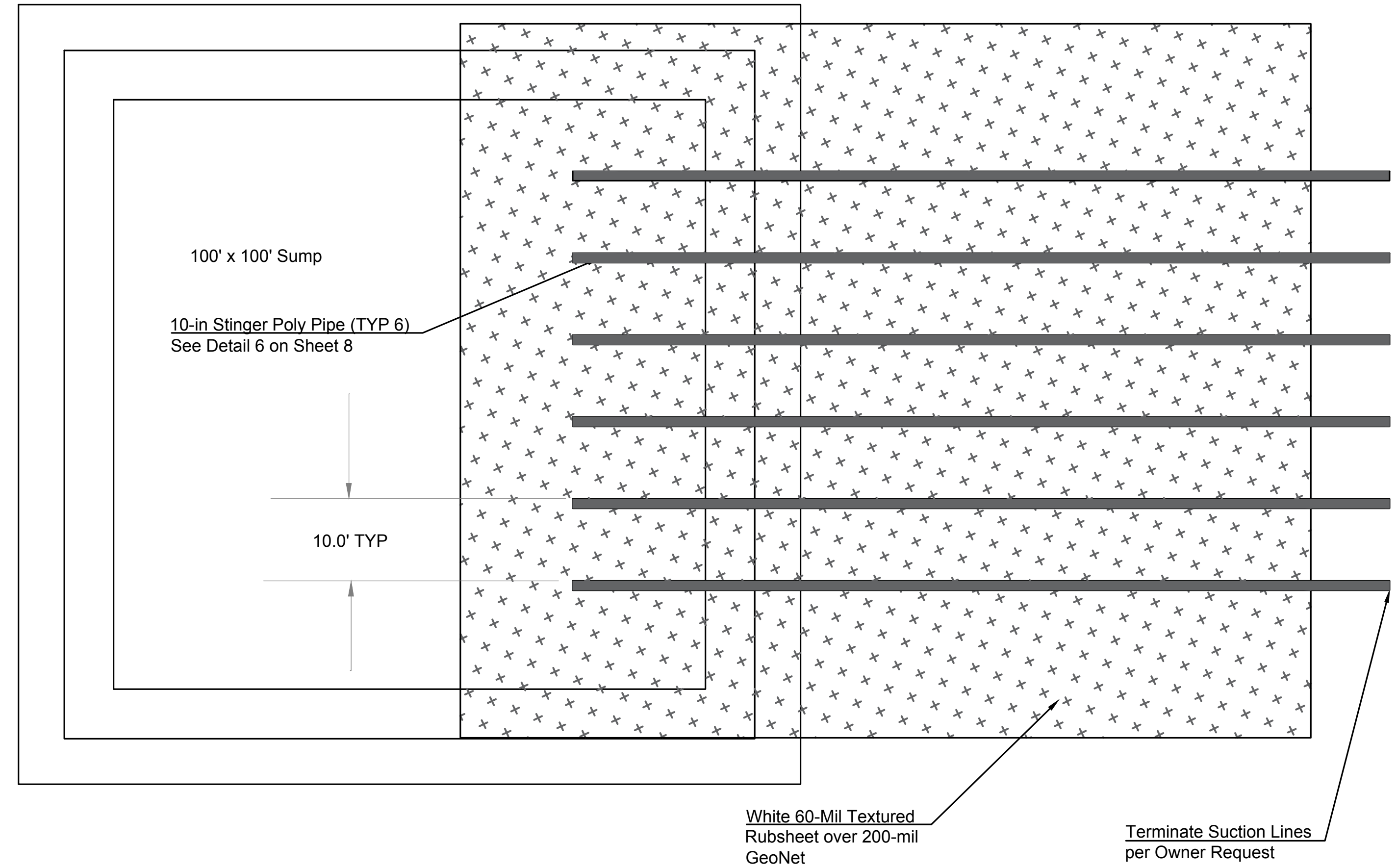
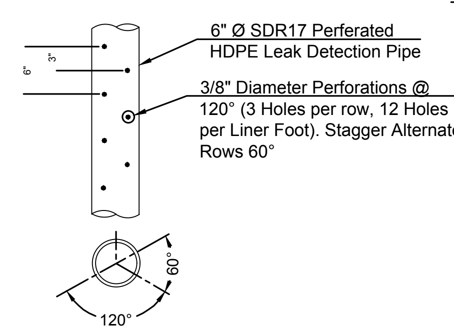


LEAK DETECTION/SAMPLING SYSTEM DETAIL 2 / 3 7
Not to Scale

NOTES:
1. LEAK DETECTION SYSTEM TO BE INSTALLED BY OWNER.
2. PERFORATED PIPE TO BE ALONG THE BOTTOM OF THE POND. SOLID PIPE ON THE SIDE SLOPE.
3. CONSTRUCT COMPACTED SUBGRADE TO 95% STANDARD PROCTOR AS PER ASTM D-698.
4. EXTEND 60 MIL. RUB SHEET 1.0-FT PAST TOP OF SHOULDER OF SUMP.
5. WASH RIVER ROCK SHALL BE 3/8" MIN. & 3/4" MAX.



PIT OUTLET PIPES 5 / 3 7
Not to Scale



PERFORATED PIPE DETAIL 4 / 3 7
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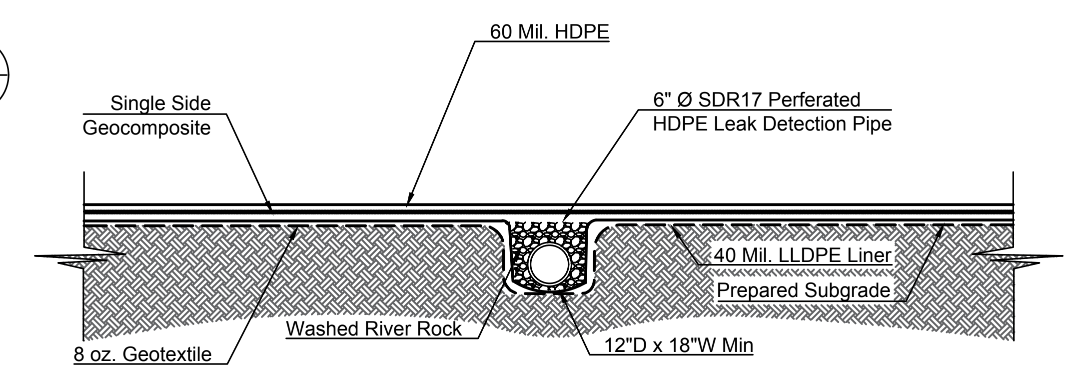

SUMP LEAK DETECTION PIPE DETAIL 3 / 3 7
Not to Scale

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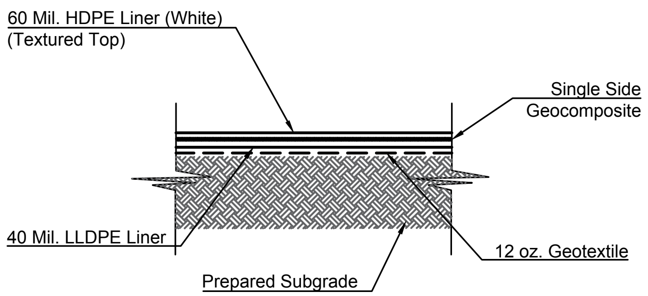
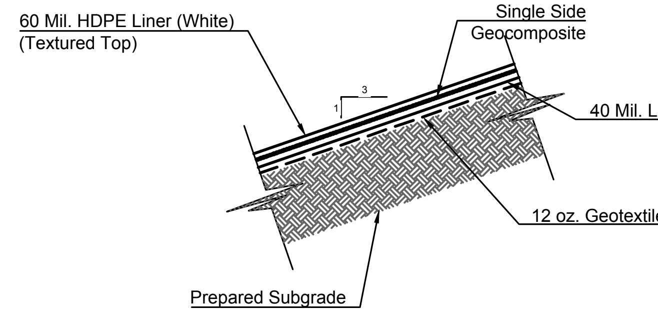
SUMP PLAN AND DETAILS
WELCH WATER RECYCLING
SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST
EDDY, NEW MEXICO

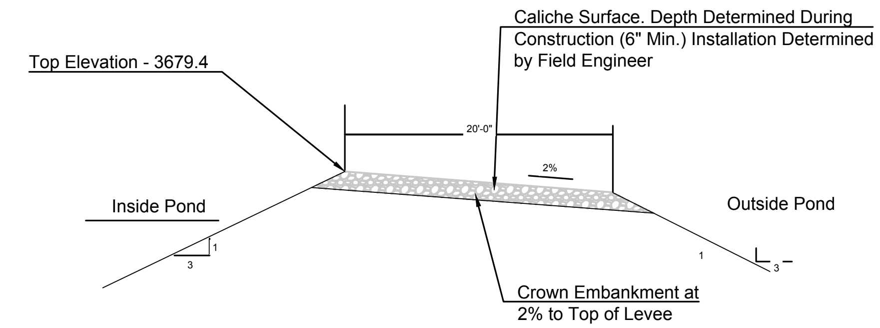
Date: JANUARY 2019
Scale: —
Designed by: T. WILLIAMS
Drawn by: R. STOUT
Checked By: J. STALLINGS
Project No. 18450-00



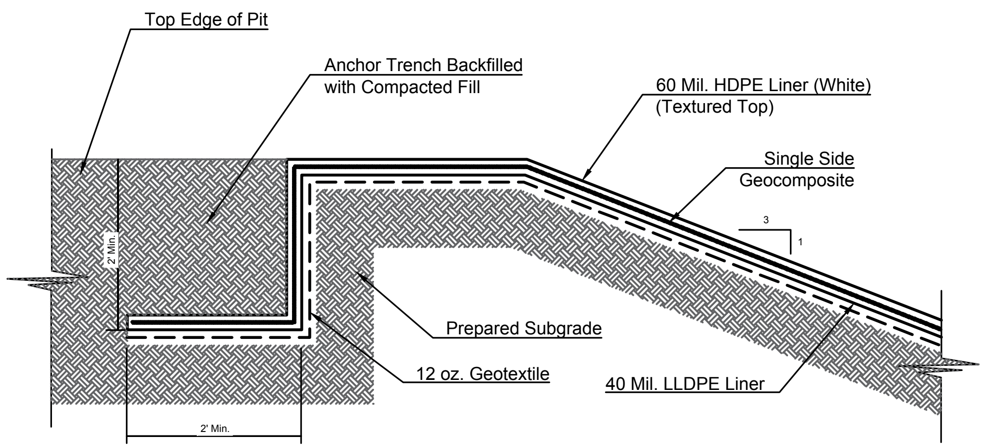
LINER SYSTEM FLOOR DETAIL 1/3 8
Not to Scale



LINER SYSTEM SIDE SLOPE DETAIL 2/3 8
Not to Scale



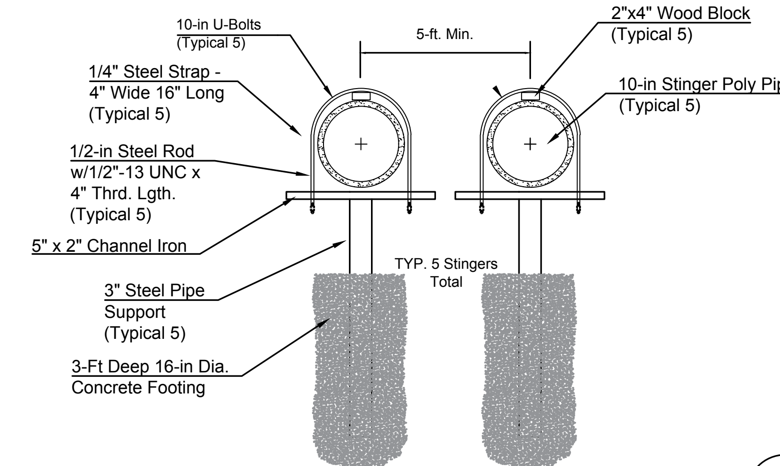
TYPICAL CREST DETAIL 3/3 8
Not to Scale



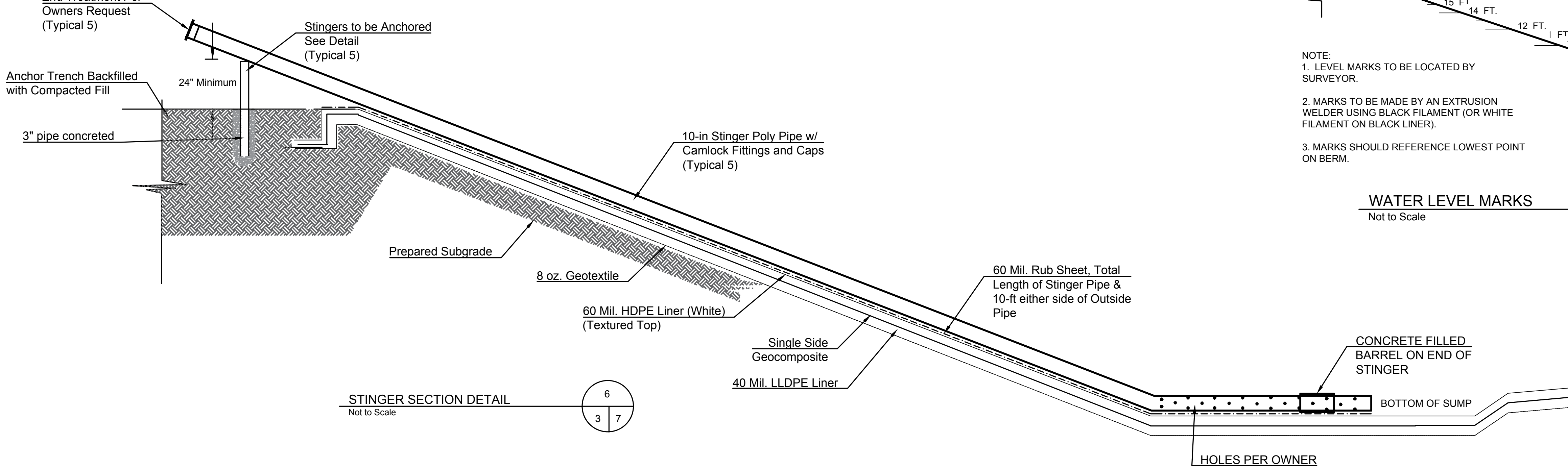
ANCHOR TRENCH DETAIL 4/3 8
Not to Scale

GENERAL NOTES:

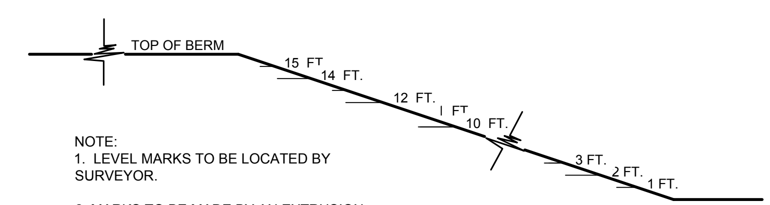
1. PREPARED SUBGRADE MEANS COMPACTED SMOOTH SUBGRADE FREE OF ROCK, ROOTS, WOOD DEBRIS, CONCRETE RUBBLE AND ANY SHARP OBJECTS THAT MIGHT PUNCTURE THE HDPE LINER.
2. ALL INTERIOR SLOPES AND TOP OF BERMS TO BE SMOOTH DRUM ROLLED.
3. ALL EMBANKMENT SLOPES SHALL HAVE A RATIO OF 3:1, COMPACTED EARTH EMBANKMENTS TO BE CONSTRUCTED WITH 12 INCH (MAXIMUM LOOSE LIFTS, COMPACTED TO 95% STANDARD PROCTOR DENSITY.
4. PERFORM GEOTECHNICAL ANALYSIS ON EXISTING SOIL TO CONFIRM SOIL IS SUITABLE FOR USE IN THE LEVEE.
5. ALL BOTTOM OF PITS SHALL SLOPE TO THE SUMP @ 0.5%.



Stinger System Anchor Detail 5/3 7
Not to Scale



STINGER SECTION DETAIL 6/3 7
Not to Scale



NOTE:
1. LEVEL MARKS TO BE LOCATED BY SURVEYOR.
2. MARKS TO BE MADE BY AN EXTRUSION WELDER USING BLACK FILAMENT (OR WHITE FILAMENT ON BLACK LINER).
3. MARKS SHOULD REFERENCE LOWEST POINT ON BERM.

WATER LEVEL MARKS 7/3 8
Not to Scale

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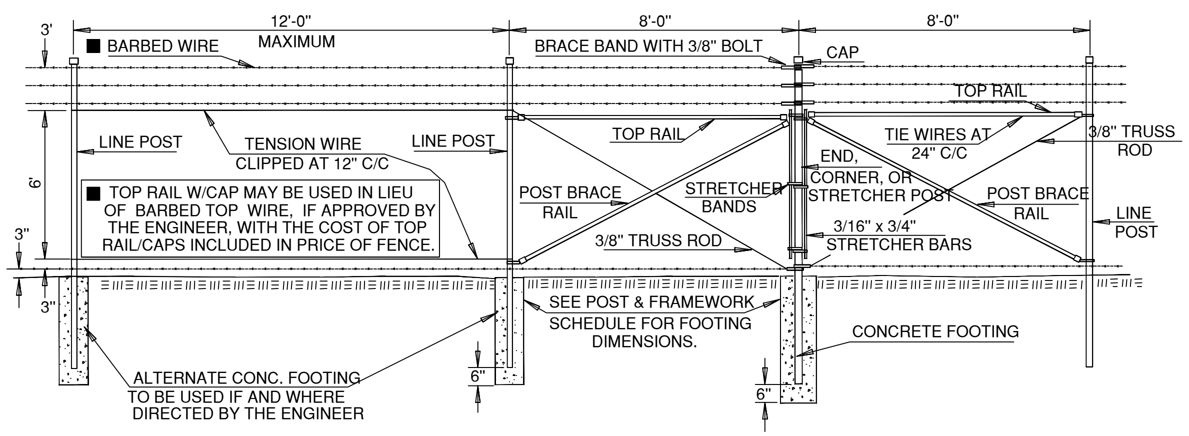
PERCUSSION PETROLEUM LLC

MISCELLANEOUS 1
WELCH WATER RECYCLING
SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST
EDDY, NEW MEXICO

8 OF 9

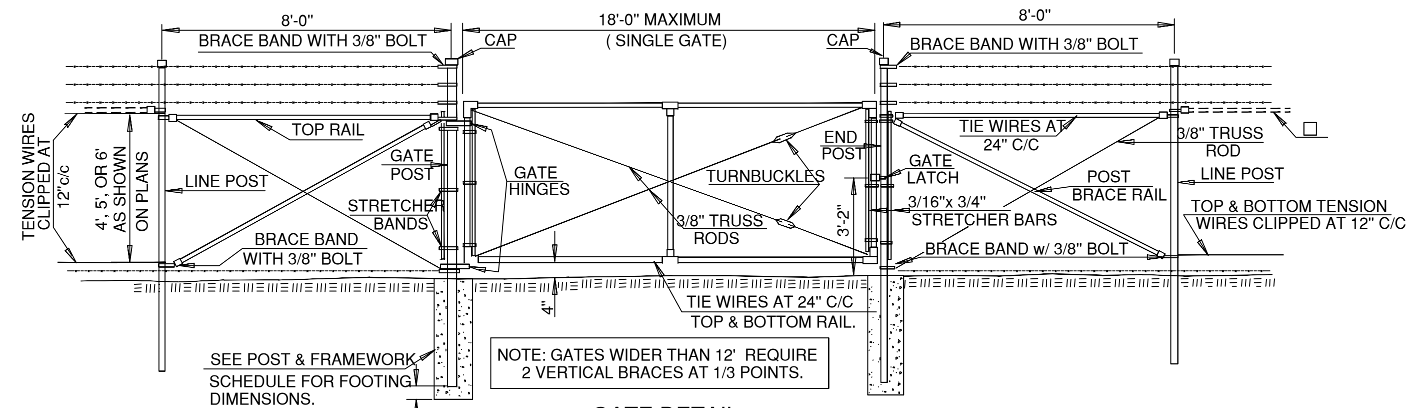


TYPICAL LINE POST DETAIL

NOTE: LINE POSTS MAY BE DRIVEN OR EARTH EMBEDED SEE SPECIFICATIONS

END, CORNER, & STRETCHER DETAILS

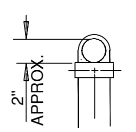
USE STRETCHER DETAILS AT ALL CORNERS, BENDS IN R/W, ON HILLTOPS, IN VALLEYS OR DEEP DEPRESSIONS, AND AT 500' MAXIMUM SPACING. (REQUIRES CONCRETE FOOTING)



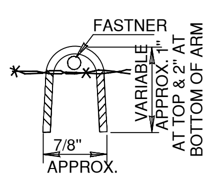
GATE DETAIL

SEE PLANS FOR SIZE AND LOCATION OF GATES. WHERE WIDTH GREATER THAN 18' IS REQUIRED, USE DOUBLE SWING GATES WITH MIDDLE LATCH.

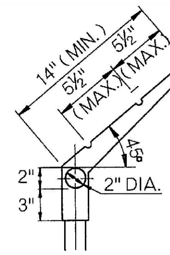
NOTE: Signage Provided by Percussion Petroleum - Installed by Contractor



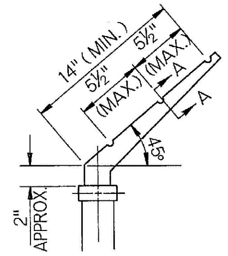
ALTERNATE POST CAP DETAIL (W/TOP RAIL)



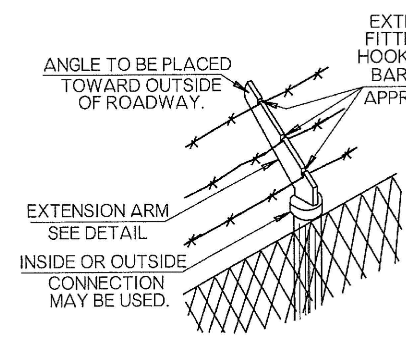
SECTION A-A



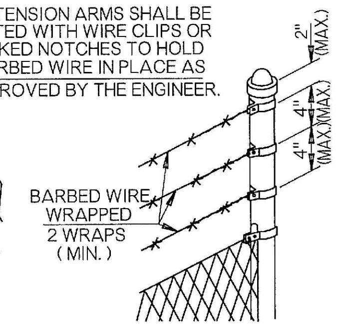
ALTERNATE EXTEN. ARM DETAIL (W/TOP RAIL)



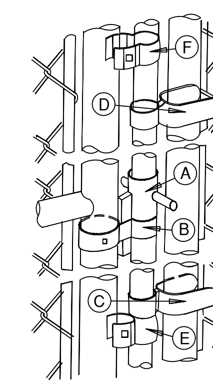
EXTENSION ARM DETAIL



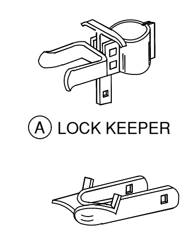
ANGULAR CLIMB BARRIER FOR LINE POSTS



VERTICAL CLIMB BARRIER FOR END & GATE POSTS



DOUBLE GATE LATCH



Ⓐ LOCK KEEPER

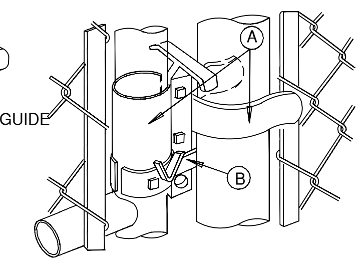
Ⓑ LOCK KEEPER GUIDE

Ⓒ LOWER FORKS

Ⓓ UPPER FORKS

Ⓔ LOWER GUIDE

Ⓕ UPPER GUIDE



SINGLE GATE LATCH

TYPICAL GATE LATCH DETAIL

ALTERNATE TYPE LATCH MAY BE USED IF APPROVED BY THE ENGINEER.

POST & FRAMEWORK SCHEDULE

	LINE POST				END, CORNER, OR STRETCHER POSTS		GATE POSTS ○			TOP RAIL OR POST BRACE RAIL		GATE FRAMES		
							6' WIDE & LESS	OVER 6' TO 12' WIDE	OVER 12' TO 18' WIDE			GATES UP TO 6' WIDE	GATES OVER 6' TO 12'	GATES OVER 12' TO 18'
SHAPE	○	C	C	I	○	▲	○	○	○	○	▯	○	○	○
NOMENCLATURE	1.5" PIPE	ROLL FORMED HEAVY "C"	ROLL FORMED STAND. "C"	"H" RAIL	2" PIPE	ROLL FORMED	2.5" PIPE	3.5" PIPE	5.0" PIPE	1 1/4" PIPE	ROLL FORMED	1 1/4" PIPE	1 1/2" PIPE	1 1/2" PIPE
DIMENSIONS	1.9" O.D. 1.6" I.D. 0.145" THK	2.25" x 1.7" 0.121" THK	1.875" x 1.625" 0.105" THK	2.25" x 1.7" 0.125" THK	2.38" O.D. 2.07" I.D. 0.154" THK	3.5" x 3.5" 0.128" THK	2.88" O.D. 2.47" I.D. 0.203" THK	4.0" O.D. 3.55" I.D. 0.226" THK	5.563" O.D. 5.047" I.D. 0.258" THK	1.66" O.D. 1.44"I.D. 0.11" THK	1.625" x 1.25" 0.075" THK	1.66" O.D. 1.44" I.D. 0.11" THK	1.9" O.D. 1.67" I.D. 0.114" THK	1.9" O.D. 1.61" I.D. 0.145" THK
CRITICAL AXIS SEC. MODULUS	.326 $IN.^3$	.506 $IN.^3$	.368 $IN.^3$	.661 $IN.^3$	.561 $IN.^3$	1.00 $IN.^3$	1.06 $IN.^3$	2.39 $IN.^3$	▼ 5.45 $IN.^3$	◐ 0.195 $IN.^3$	0.165 $IN.^3$	◐ 0.195 $IN.^3$	◐ 0.270 $IN.^3$	▼ 0.326 $IN.^3$
WEIGHT	2.72 LBS./LIN. FT.	2.64 LBS./LIN. FT.	1.85 LBS./LIN. FT.	3.26 LBS./LIN. FT.	3.65 LBS./LIN. FT.	4.85 LBS./LIN. FT.	5.79 LBS./LIN. FT.	9.11 LBS./LIN. FT.	14.62 LBS./LIN. FT.	1.81 LBS./LIN. FT.	1.35 LBS./LIN. FT.	1.81 LBS./LIN. FT.	2.17 LBS./LIN. FT.	2.72 LBS./LIN. FT.
LENGTH FOR GIVEN FENCE FAB. HT. 4	6'-10" W/CONC. FOOTING; 7'- 4" WHEN DRIVEN.				7'-4" W/CONC. FOOTING				7'-10"					
LENGTH FOR GIVEN FENCE FAB. HT. 5	8'- 1" W/CONC. FOOTING; 8'- 7" WHEN DRIVEN.				8'-7" W/CONC. FOOTING				9'- 1"					
LENGTH FOR GIVEN FENCE FAB. HT. 6	9'- 4" W/CONC. FOOTING; 9'-10" WHEN DRIVEN.				9'-10" W/CONC. FOOTING				10'- 4"					
EMBEDMENT FOR GIVEN FENCE FAB. HT. 4	24" IN CONC. FOOTING; 30" WHEN DRIVEN.				30" IN CONC. FOOTING				36"					
EMBEDMENT FOR GIVEN FENCE FAB. HT. 5	27" IN CONC. FOOTING; 33" WHEN DRIVEN.				33" IN CONC. FOOTING				39"					
EMBEDMENT FOR GIVEN FENCE FAB. HT. 6	30" IN CONC. FOOTING; 36" WHEN DRIVEN.				36" IN CONC. FOOTING				42"					
FOOTING DIM. IN EARTH	9" DIA.				9" DIA.	14" DIA.	12" DIA.	16" DIA.	18" DIA.					
	36" DEEP													
FOOTING DIM. IN ROCK	4" DIA.				4" DIA.	6" DIA.	5" DIA.	6" DIA.	8" DIA.					
	9" DEEP				9" DIA.	16" DIA.	12" DIA.	16" DIA.	24" DIA.					

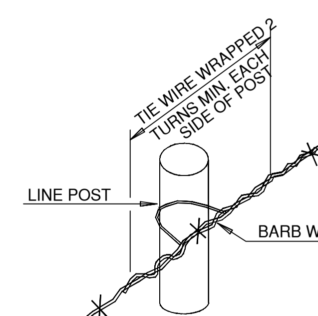
○ MAXIMUM WIDTH OF SINGLE SWING GATE TO BE 18 FT.; OPENING MAY BE UP TO 36 FT. WIDE

DIAMETERS AS SHOWN ARE MINIMUM VALUES. DEPTHS FOR ROCK ARE MINIMUMS. DEPTHS SHOWN FOR CONCRETE FOOTINGS IN EARTH ARE MINIMUM FOR 6 FT. HIGH FENCE, AND MAY BE REDUCED 3 IN. FOR EACH FOOT OF FENCE HEIGHT LESS THAN 6 FT. HIGH.

▲ WIRE FABRIC TO BE WOVEN INTO LOCK LOOPS FOR THE ENTIRE WIDTH OF THE FABRIC.

▼ SECTION MODULUS AS SHOWN IS BASED UPON ASTM A53, AND AASHTO M181. SEE SPECIFICATIONS FOR SUBSTITUTION FORMULA ON CLASS 2 COLD FORMED STEEL PIPE.

◐ SECTION MODULUS AS SHOWN IS BASED UPON ASTM A 501 AND AASHTO M 181. SEE SPECIFICATIONS FOR SUBSTITION FORMULA ON CLASS 2 COLD FORMED STEEL PIPE.



TIE WIRE DETAIL

GENERAL NOTES

1. ALL CONSTRUCTION AND MATERIAL REQUIREMENTS SHALL BE IN ACCORDANCE WITH THE 1988 STANDARD SPECIFICATIONS AND APPLICABLE SPECIAL PROVISIONS.
2. COST OF BARB WIRE AND EXTRA LENGTH POSTS FOR FAN TO BE INCLUDED IN PRICE BID FOR CHAIN LINK FENCE.
3. ALL MISCELLANEOUS HARDWARE SHALL BE FURNISHED GALVANIZED OR ALUMNINUM ALLOY.
4. CLIMB BARRIER SHOWN INTENDED ONLY TO SHOW AN ACCEPTABLE TYPE. ALTERNATE CLIMB BARRIERS APPROVED BY THE ENGINEER PRIOR TO INSTALLATION MAY BE USED. FENCE POST EXTENSION ARM SHALL BE MADE OF PRESSED STEEL OR MALLEABLE IRON AND SHALL BE GALVANIZED AFTER FABRICATION.
5. CHAIN LINK FABRIC MAY BE ACCEPTED KNUCKLED BOTH SELVAGES IN ALL WIDTHS. NO FABRIC WITH TWISTS AND BARBS ON BOTH SELVAGES WILL BE ACCEPTED.
6. NOTE: CLASS A IN THE PAY ITEM DENOTES NO CLIMB BARRIER: CLASS B DENOTES CLIMB BARRIER. (CLASS A = NOBAR; CLASS B = BARR)
7. STRETCHER POSTS TO BE USED IN GENERAL AT HILL TOPS AND AT BOTTOM OF VALLEYS AND AT A MAXIMUM OF 500 FEET APART.
8. ALL POSTS WITH THE EXCEPTION OF LINE POSTS, FAN POSTS AND HEADWALL CONNECTION STRETCHER POSTS SHALL BE EMBEDDED IN CONCRETE WHEN FENCE IS BEING ERECTED ON EARTHEN FOUNDATIONS. OTHER POSTS MAY BE EMBEDDED IN CONCRETE IF AND AS DIRECTED BY THE ENGINEER TO SATISFY SPECIFIC FOOTING REQUIREMENTS.

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ENVIROTECH ENGINEERING & CONSULTING, INC.
2500 North 11th Street - Enid, Oklahoma 73701
Phone (580) 234-8780, Fax (580) 234-4302
C.A. #1960 - Expiration Date: 6-30-2020

PERCUSSION PETROLEUM LLC

MISCELLANEOUS 2

WELCH WATER RECYCLING

SECTION 27, TOWNSHIP 17 SOUTH, RANGE 28 EAST
EDDY, NEW MEXICO

Date: JANUARY 2019
Designed by: T. WILLIAMS
Drawn by: R. STOUT
Checked by: J. STALLING
Project No. 18450-00

APPENDIX C

DESIGN AND CONSTRUCTION PLAN

OPERATION AND MAINTENANCE PROCEDURES

Applicable mandates in Rule 34 are underlined. This plan addresses construction of lined earthen containments. *Appendix B* presents Engineering Design Plans. *Appendix D* provides liner and geotextile specifications.

Field conditions may create the need for minor modification of the containment design (e.g. changing the length, width, or depth.)

Dike Protection and Structural Integrity

Design elements are addressed in the section of this submission containing the foundation recommendations. The recommendations are based on site-specific data. The operator, engineer, and selected contractor will review the recommendations prior to beginning the earthwork and adhere to the specific recommendations.

The design and operation provide for the confinement of produced water to prevent releases and to prevent overtopping due to wave action or rainfall. Additionally, the design prevents run-on of surface water as the containment is surrounded by an above-grade levee (berm) and diversion ditch to prevent run-on of surface water.

Stockpile Topsoil

Where topsoil is present, prior to constructing containment, the operator will strip and stockpile the topsoil for use as the final cover or fill at the time of closure. The topsoil will be stockpiled adjacent to perimeter fence surrounding the containment or incorporated into the levee.

Signage

The design calls for an upright sign no less than 12-in by 24-in with lettering not less than two inches in height in a conspicuous place on the fence surrounding the containment. The sign is posted in a manner and location such that a person can easily read the legend. The sign will provide the following information:

1. The operator's name,
2. The location of the site by quarter-quarter or unit letter, section, township and range, and
3. Emergency telephone numbers.

Fencing

The design provides for a fence to enclose the Recycling Containment in a manner that deters unauthorized wildlife and human access. The design calls for a 7-ft tall chain link and barbed wire fence around the containment to exclude wildlife (see detail on last page of engineering design). This fence provides greater wildlife (and human) deterrence than the minimum required barbed wire fence with four strands evenly spaced in the interval between one foot and four feet above ground level. The fence will be gated to provide access for maintenance and placement of pumps and other necessary equipment. As stated in the O&M plan, the operator will ensure that all gates associated with the fence are closed and locked when responsible personnel are not onsite.

Netting and Protection of Wildlife

The game fence on the containment levee will be effective in excluding antelope, coyotes, and most other terrestrial wildlife.

The Recycling Containment is otherwise protective of wildlife, including migratory birds. The containment will contain treated produced water that has not shown to be a material threat to birds due to hydrogen sulfide gas or floating, free-phase hydrocarbons. The O&M plan calls for the operator to inspect for and, within 30 days of discovery, report the discovery of dead migratory birds or other wildlife to the appropriate wildlife agency ad to the division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.

The containment will have a properly constructed foundation and interior slopes consisting of a firm, unyielding base, smooth and free of rocks, debris, sharp edges or irregularities to prevent the liner's rupture or tear. Geotextile may be placed under the liner when needed to reduce localized stress-strain or protuberances that otherwise may compromise the liner's integrity.

Appendix B shows:

1. The levee has an inside grade no steeper than three horizontal feet to one vertical foot (3H:1V).
2. The levee outside grade is no steeper than three horizontal feet to one vertical foot (3H:1V).

3. The top of the levee is wide enough to install an anchor trench and provide adequate room for inspection and maintenance.
4. The caliche gravel placed on the outside levee provides additional erosion control.

Field conditions may create the need for changes to the design. Any changes to the construction or grade requirements due to unforeseen conditions will be reviewed and approved prior to initiating installation of the liner system. Any design change that does not conform to the NMOCD Rule will be the subject of a variance request and will be submitted to the OCD for review and approval.

LINER AND DRAINAGE GEOTEXTILE INSTALLATION

The containment has a primary (upper) liner and a secondary (lower) liner with a leak detection system appropriate to the site's conditions.

The primary (upper) liner is a geomembrane liner composed of an impervious, synthetic material that is resistant to ultraviolet light, petroleum hydrocarbons, salts and acidic and alkaline solutions. It is 60-mil HDPE. The secondary liner is 40-mil LLDPE. Liner compatibility meets or exceeds a subsequent relevant publication to EPA SW-846 method 9090A.

The Recycling Containment design has a leak detection system between the upper and lower geomembrane liners of 200-mil geonet to facilitate drainage. The leak detection system consists of a properly designed drainage and collection and removal system placed above the lower geomembrane liner in depressions and sloped to facilitate the earliest possible leak detection. The containment floor design calls for a slope of approximately 0.5% toward the sump. This slope, combined with the highly transmissive geonet drainage layer, provides for the earliest possible leak detection.

The liners and drainage material will be installed consistent with the manufacture's specifications (See *Appendix D*). In addition to any specifications of the manufacturer, protocols for liner installation include measures to:

1. Minimize liner seams and orient them up and down, not across, a slope of the levee.
2. Use factory welded seams where possible.
3. Field seams in geosynthetic material are thermally seamed; prior to field seaming, overlap liner four to six inches.

4. Minimize the number of field seams and corners and irregularly shaped areas.
5. Provide for no horizontal seams within five feet of the slope's toe.
6. Use qualified personnel to perform field welding and testing.
7. Avoid excessive stress-strain on the liner.
8. The edges of all liners are anchored in the bottom of a compacted earth-filled trench that is at least 18-in deep.

At points of discharge into the lined earthen containment, the pipe configuration (see *Appendix B*) effectively protects the liner from excessive hydrostatic force or mechanical damage during filling. The design shows that at any point of discharge into or suction from the recycling containment, the liner is protected from excessive hydrostatic force or mechanical damage. External discharge or suction lines do not penetrate the liner.

Pumping from the containment to hydraulic fracturing operations is the responsibility of stimulation contractors. Typically, numerous lines are permanently placed in the containment with floats attached to prevent damage to the liner system. The containment may be equipped with permanent HDPE stinger (supported by a sacrificial liner or geotextile) for withdrawal of fluid during operations, if the owner deems necessary. External discharge or suction lines do not penetrate the liner.

LEAK DETECTION AND FLUID REMOVAL SYSTEM INSTALLATION

The leak detection system, contains the following design elements:

1. The 200-mil Hypernet drainage material between the primary and secondary liner is sufficiently permeable to allow the transport of fluids to the observation ports (*Appendix B*).
2. The containment floor, sloped towards the monitoring riser pipe, facilitates the earliest possible leak detection of the containment bottom. A pump may be placed in an observation port to provide for fluid removal.
3. Piping will withstand chemical attack from any seepage, structural loading from stresses and disturbances from overlying water, cover materials, equipment operation, and expansion or contraction (see *Appendix B*).
4. The slope of the interior subgrade is approximately 1%.

APPENDIX D

MATERIAL SPECIFICATIONS

GEOMEMBRANE SPECIFICATION

This specification covers the technical requirements for the Manufacturing and Installation of the geomembrane. All materials meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these project specifications

1.1 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
2. D 1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
3. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
4. D 1603 Test Method for Carbon Black in Olefin Plastics
5. D 3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
6. D 4218 Standard Test Method for Determination of Carbon Black in Polyethylene Compounds
7. D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
8. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
9. D 5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
10. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
11. D 5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes
12. D 6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

13. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

14. D 7240 Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test)

B. Geosynthetic Research Institute

1. GRI GM 13 Test Properties, Testing Frequency and Recommended Warranty for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes

2. GRI GM 17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

1.2 DEFINITIONS

A. Lot - A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.

B. Construction Quality Assurance Consultant (CONSULTANT) – The Party, independent from MANUFACTURER and INSTALLER, that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

C. ENGINEER- The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

D. Geomembrane Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geomembrane rolls.

E. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY) – The Party, independent from the OWNER, MANUFACTURER, and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the OWNER.

F. INSTALLER- The Party responsible for field handling, transporting, storing, deploying, seaming, and testing of the geomembrane seams.

G. Panel- Unit area of geomembrane that will be seamed in the field that is larger than 100-ft^2.

H. Patch - Unit area of geomembrane that will be seamed in the field that is less than 100-ft^2.

I. Subgrade Surface - Soil layer surface which immediately underlies the geosynthetic material(s).

1.3 SUBMITTALS POST-AWARD

A. Furnish the following product data, in writing, to ENGINEER prior to installation of the geomembrane material:

1. Resin Data shall include the following:
   a. Certification stating that the resin meets the specification requirements (see *Table 1.9B*).
2. Geomembrane Roll
   a. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin (product run may be recycled).

B. The INSTALLER shall furnish the following information to the ENGINEER and OWNER prior to installation:

1. Installation layout drawings
   a. Must show proposed panel layout including field seams and details
   b. Must be approved prior to installing the geomembrane
2. Approved drawings will be for concept only; actual panel placement will be determined by site conditions.
3. Installer's Geosynthetic Field Installation Quality Assurance Plan

C. The INSTALLER will submit the following to the ENGINEER upon completion of installation:

1. Certificate stating the geomembrane has been installed in accordance with the Contract Documents
2. Material and installation warranties
3. As-built drawings showing actual geomembrane placement and seams including typical anchor trench detail

1.4 QUALITY ASSURANCE

A. The OWNER will engage and pay for the services of a Geosynthetic Quality Assurance Consultant and Laboratory to monitor geomembrane installation.

1.5 QUALIFICATIONS

A. MANUFACTURER

1. Geomembrane shall be manufactured by the following:
   a. GSE Lining Technology, LLC
   b. approved equal
2. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane during the last year.

B. INSTALLER

1. Installation shall be performed by one of the following installation companies (or approved equal)
   a. GSE Lining Technology, LLC
   b. GSE Approved Installers
2. INSTALLER shall have installed a minimum of 5,000,000-ft^2 of HDPE geomembrane during the last two years.
3. INSTALLER shall have worked in a similar capacity on at least 5 projects similar in complexity to the project described in the contract documents, and with at least 500,000-ft^2 of HDPE geomembrane installation on each project.
4. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.
5. The INSTALLER shall provide a minimum of one Master Seamer for work on the project.
   a. Must have completed a minimum of 1,000,000-ft^2 of geomembrane seaming work using the type of seaming apparatus proposed for the use on this Project.

1.6 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling - Each roll of geomembrane delivered to the site shall be labeled by the MANUFACTURER. The label will identify:

   a. manufacturer's name

   b. product identification

   c. thickness

   d. length

   e. width

   f. roll number

B. Delivery- Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage- The on-site storage location for geomembrane material, provided by the CONTRACTOR to protect the geomembrane from punctures, abrasions and excessive dirt and moisture, should have the following characteristics:

   a. level (no wooden pallets)

   b. smooth

   c. dry

   d. protected from theft and vandalism

   e. adjacent to the area being lined

D. Handling- Materials are to be handled so as to prevent damage.

1.7 WARRANTY

A. Material shall be warrantied, on a pro-rata basis, against Manufacturer's defects for a period of 5 years from the date of geomembrane installation.

B. Installation shall be warrantied against defects in workmanship for a period of 1 year from the date of geomembrane completion.

1.8 GEOMEMBRANE PROPERTIES

A. Material shall be smooth/textured polyethylene geomembrane as shown on the drawings.

B. Resin

1. Resin shall be new, first quality, compounded and manufactured specifically for producing geomembrane.
2. Natural resin (without carbon black) shall meet the following requirements:

Table 1.9B RAW MATERIAL PROPERTIES			
Property	**Test Method**	**HDPE**	**LLDPE**
Density (g/cm3)	ASTM D 1505	$\geq$0.932	$\geq$0.915
Melt Flow Index (g/10 min)	ASTM D 1238 (190/2.16)	$\leq$1.0	$\leq$1.0
OIT (minutes)	ASTM D 3895 (1 atm/200^{0}C)	$\geq$100	$\geq$100

C. Geomembrane Rolls

1. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.
2. Geomembrane shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.
3. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating roll number, thickness, length, width, and MANUFACTURER.
4. All liner sheets produced at the factory shall be inspected prior to shipment for compliance with the physical property requirements listed in section 1.09 D and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

D. Smooth surfaced geomembrane shall meet the requirements shown in the following data sheets below:

1. *Table 1.1* for Black HDPE
2. *Table 1.2* for Green HDPE
3. *Table 1.3* for White HDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
4. *Table 1.4* for Smooth Leak Location Liner HDPE
   a. The geomembrane shall have a coextruded, electrically conductive layer.

b. The conductive layer is installed downward.

c. Electrical testing shall be performed after liner installation by the INSTALLER.

5. *Table 1.5* for Smooth White Leak Location Liner HDPE
   a. The geomembrane shall have a coextruded, electrically conductive layer.
   b. The conductive layer is installed downward.
   c. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   d. The white surface shall be installed upwards.
   e. Electrical testing shall be performed after liner installation by the INSTALLER.
6. *Table 1.6* for Black LLDPE
7. *Table 1.7* for White-surfaced LLDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
8. *Table 1.8* for Leak Location Liner LLDPE
   a. The geomembrane shall have a coextruded, electrically conductive layer.
   b. The conductive layer is installed downward.
   c. Electrical testing shall be performed after liner installation by the INSTALLER.
9. *Table 1.9* for White Leak Location Liner LLDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
   c. The geomembrane shall have a coextruded, electrically conductive layer.
   d. The conductive layer is installed downward.
   e. Electrical testing shall be performed after liner installation by the INSTALLER.

TABLE 1.1: GSE HD SMOOTH GEOMEMBRANE							
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**				
			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/cm^3, (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940	0.940
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 lbs	 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 lbs	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	54	72	108	144	180
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lbs	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 lbs	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Notch Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>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, ft^2			25,200	19,575	12,600	9,675	7,650

NOTES:
- (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.
- (2)Roll lengths and widths have a tolerance of ± 1%.
- GSE HD Smooth is available in rolls weighing approximately 4,000 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.

TABLE 1.2: GSE GREEN SMOOTH GEOMEMBRANE							
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**				
			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/cm^3 , (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940	0.940
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 lbs	 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 lbs	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	54	72	108	144	180
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	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 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Notch Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100	>100
Typical Roll Dimensions							
Roll Length[(3)], ft			1,120	870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft^2			25,200	19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE Green Smooth may have an overall ash content of 3.0% due to the green layer. These values apply to the black layer only.
- [(2)]Dispersion applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [(3)]Roll lengths and widths have a tolerance of ± 1%.
- GSE Green Smooth is available in rolls weighing approximately 4,000 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.

TABLE 1.3: GSE WHITE SMOOTH GEOMEMBRANE							
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**				
			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/cm^3 , (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940	0.940
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 lbs	 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 lbs	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	54	72	108	144	180
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	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 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Notch Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100	>100
Typical Roll Dimensions							
Roll Length[(3)], ft			1,120	870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft^2			25,200	19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE White Smooth may have an overall ash content of 3.0% due to the white layer. These values apply to the black layer only.
- [(2)]Dispersion applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [(3)]Roll lengths and widths have a tolerance of ± 1%.
- GSE White Smooth is available in rolls weighing approximately 4,000 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.

TABLE 4.1: GSE LEAK LOCATION SMOOTH GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 , (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940
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 lbs	 152 84 700 12	 228 126 700 12	 304 168 700 12	 380 210 700 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	72	108	144	180
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Notch Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft			870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2			19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE Leak Location Smooth may have an overall ash content of 3.0% due to the conductive layer. These values apply to the non-conductive black layer only.
- [(2)]Dispersion applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [(3)]Roll lengths and widths have a tolerance of ± 1%.
- GSE Leak Location Smooth is available in rolls weighing approximately 4,000 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.

TABLE 1.5: GSE LEAK LOCATION WHITE SMOOTH GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3, (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940
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 lbs	 152 84 700 12	 228 126 700 12	 304 168 700 12	 380 210 700 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	72	108	144	180
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Notch Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft			870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2			19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE Leak Location White Smooth may have an overall ash content of 3.0% due to the white and conductive layers. These values apply to the black layer only.
- [(2)]Dispersion applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [(3)]Roll lengths and widths have a tolerance of ± 1%.
- GSE Leak Location White Smooth is available in rolls weighing approximately 4,000 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.

TABLE 1.6: GSE ULTRAFLEX SMOOTH GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Value**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 152 800	 228 800	 304 800	 380 800
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	56	84	112	140
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note(1)	Note(1)	Note(1)	Note(1)
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length(2), ft			870	560	430	340
Roll Width(2), ft			22.5	22.5	22.5	22.5
Roll Area, ft^2			19,575	12,600	9,675	7,650

NOTES:
- (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.
- (2)Roll lengths and widths have a tolerance of ±1 %.
- GSE UltraFlex is available in rolls weighing approximately 4,000 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.

TALBE 1.7: GSE ULTRAFLEX WHITE SMOOTH GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Value**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 152 800	 228 800	 304 800	 380 800
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	56	84	112	140
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft			870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2			19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE UltraFlex White Smooth may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [(2)]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.
- [(3)]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex White Smooth is available in rolls weighing approximately 4,000 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.

TABLE 1.8: GSE ULTRAFLEX LEAK LOCATION LINER SMOOTH GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Value**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 152 800	 228 800	 304 800	 380 800
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	56	84	112	140
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft			870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2			19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE UltraFlex Leak Location Smooth may have an overall ash content greater than 3.0% due to the conductive layer. These values apply to the non-conductive black layer only.
- [(2)]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.
- [(3)]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Leak Location Smooth is available in rolls weighing approximately 4,000 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.

TABLE 1.9: GSE ULTRAFLEX LEAK LOCATION LINER WHITE SMOOTH GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Value**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 152 800	 228 800	 304 800	 380 800
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	56	84	112	140
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft			870	560	430	340
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2			19,575	12,600	9,675	7,650

NOTES:
- [(1)]GSE UltraFlex Leak Location White Smooth may have an overall ash content greater than 3.0% due to the white and conductive layers. These values apply to the non-conductive black layer only.
- [(2)]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.
- [(3)]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Leak Location White Smooth is available in rolls weighing approximately 4,000 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.

E. Textured surfaced geomembrane shall meet the requirements shown in the following data sheets below.

1. *Table 2.1* for Black coextruded textured HDPE
2. *Table 2.2* for Green coextruded textured HDPE
3. *Table 2.3* for White coextruded textured HDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
4. *Table 2.4* for Leak Location Liner coextruded textured HDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
5. *Table 2.4* for White Leak Location Liner coextruded textured HDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
6. *Table 2.6* for Black coextruded textured LLDPE
7. *Table 2.7* for White coextruded textured LLDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
8. *Table 2.8* for Leak Location Liner coextruded textured LLDPE
   a. The geomembrane shall have a coextruded, electrically conductive layer.
   b. The conductive layer is installed downward.
   c. Electrical testing shall be performed after liner installation by the INSTALLER.
9. *Table 2.9* for White Leak Location Liner coextruded textured LLDPE
   a. The geomembrane shall be a white-surfaced, coextruded geomembrane.
   b. The white surface shall be installed upwards.
   c. The geomembrane shall have a coextruded, electrically conductive layer.
   d. The conductive layer is installed downward.
   e. Electrical testing shall be performed after liner installation by the INSTALLER.

TABLE 2.1: GSE HD TEXTURED GEOMEMBRANE							
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	30 27	40 36	60 54	80 72	100 90
Density, g/cm^3, (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940	0.940
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 lbs	 45 63 100 12	 60 84 100 12	 90 126 100 12	 120 168 100 12	 150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	45	60	90	120	150
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lbs	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 lbs	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Asperity Height, mil	ASTM D 7466	second roll	16	18	18	18	18
Notch Constant Tensile Load(2), hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100	>100
Typical Roll Dimensions							
Roll Length(3), ft	Double-Sided Textured Single-Sided Textured		830 1,010	700 780	520 540	400 410	330 330
Roll Width(3), ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		18,675 22,725	15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:
- (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.
- (2)NCTL for GSE HD Textured is conducted on representative smooth geomembrane samples.
- (3)Roll lengths and widths have a tolerance of ± 1%.
- GSE HD Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.2 GSE GREEN TEXTURED GEOMEMBRANE							
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	30 27	40 36	60 54	80 72	100 90
Density, g/cm^3, (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940	0.940
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 lbs	 45 63 100 12	 60 84 100 12	 90 126 100 12	 120 168 100 12	 150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	45	60	90	120	150
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	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 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	16	18	18	18	18
Notch Constant Tensile Load[(3)], hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100	>100
Typical Roll Dimensions							
Roll Length[(4)], ft	Double-Sided Textured Single-Sided Textured		830 1,010	700 780	520 540	400 410	330 330
Roll Width[(4)], ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		18,675 22,725	15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:
- [(1)]GSE Green may have an overall ash content greater than 3.0% due to the green layer. These values apply to the black layer only.
- [(2)]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.
- [(3)]NCTL for GSE Green Textured is conducted on representative smooth geomembrane samples.
- [(4)]Roll lengths and widths have a tolerance of ±1%.
- GSE Green Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.3: GSE WHITE TEXTURED GEOMEMBRANE							
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**				
			30 mil	40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	30 27	40 36	60 54	80 72	100 90
Density, g/cm3 , (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940	0.940
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 lbs	 45 63 100 12	 60 84 100 12	 90 126 100 12	 120 168 100 12	 150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	21	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	45	60	90	120	150
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	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 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	16	18	18	18	18
Notch Constant Tensile Load[(3)], hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100	>100
Typical Roll Dimensions							
Roll Length[(4)], ft	Double-Sided Textured Single-Sided Textured		830 1,010	700 780	520 540	400 410	330 330
Roll Width[(4)], ft			22.5	22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		18,675 22,725	15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:
- [(1)]GSE White may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [(2)]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.
- [(3)]NCTL for GSE White Textured is conducted on representative smooth geomembrane samples.
- [(4)]Roll lengths and widths have a tolerance of ±1%.
- GSE White Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.4: GSE LEAK LOCATION LINER TEXTURED GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3, (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940
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 lbs	 60 84 100 12	 90 126 100 12	 120 168 100 12	 150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	60	90	120	150
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Notch Constant Tensile Load[(3)], hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(4)], ft	Double-Sided Textured Single-Sided Textured		700 780	520 540	400 410	330 330
Roll Width[(4)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:
- [(1)]GSE Leak Location may have an overall ash content greater than 3.0% due to the conductive layer. These values apply to the non-conductive layer only.
- [(2)]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.
- [(3)]NCTL for GSE Leak Location Textured is conducted on representative smooth geomembrane samples.
- [(4)]Roll lengths and widths have a tolerance of ±1%.
- GSE Leak Location Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.5: GSE LEAK LOCATION LINER WHITE TEXTURED GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5994	every roll	40 36	60 54	80 72	100 90
Density, g/cm3 , (min.)	ASTM D 1505	200,000 lbs	0.940	0.940	0.940	0.940
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 lbs	 60 84 100 12	 90 126 100 12	 120 168 100 12	 150 210 100 12
Tear Resistance, lb	ASTM D 1004	45,000 lbs	28	42	56	70
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	60	90	120	150
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Notch Constant Tensile Load[(2)], hr	ASTM D 5397, Appendix	200,000 lbs	300	300	300	300
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(4)], ft	Double-Sided Textured Single-Sided Textured		700 780	520 540	400 410	330 330
Roll Width[(4)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		15,750 17,550	11,700 12,150	9,000 9,225	7,425 7,425

NOTES:
- [(1)]GSE Leak Location White may have an overall ash content greater than 3.0% due to the conductive and white layers. These values apply to the non-conductive black layer only.
- [(2)]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.
- [(3)]NCTL for GSE Leak Location White Textured is conducted on representative smooth geomembrane samples.
- [(4)]Roll lengths and widths have a tolerance of ±1%.
- GSE Leak Location White Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.6: GSE ULTRAFLEX TEXTURED GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	60 250	90 250	120 250	150 250
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	44	66	88	110
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note(1)	Note(1)	Note(1)	Note(1)
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length(2), ft	Double-Sided Textured Single-Sided Textured		700 650	520 420	400 320	330 250
Roll Width(2), ft			22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		15,750 14,625	11,700 9,450	9,000 7,200	7,425 5,625

NOTES:
- (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.
- (2)Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.7: GSE ULTRAFLEX WHITE TEXTURED GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 60 250	 90 250	 120 250	 150 250
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	44	66	88	110
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft	Double-Sided Textured Single-Sided Textured		700 650	520 420	400 320	330 250
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		15,750 14,625	11,700 9,450	9,000 7,200	7,425 5,625

NOTES:
- [(1)]GSE UltraFlex White Textured may have an overall ash content greater than 3.0% due to the white layer. These values apply to the black layer only.
- [(2)]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.
- [(3)]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex White Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.8: GSE ULTRAFLEX LEAK LOCATION TEXTURED GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 60 250	 90 250	 120 250	 150 250
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	44	66	88	110
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft	Double-Sided Textured Single-Sided Textured		700 650	520 420	400 320	330 250
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		15,750 14,625	11,700 9,450	9,000 7,200	7,425 5,625

NOTES:
- [(1)]GSE UltraFlex Leak Location Textured may have an overall ash content greater than 3.0% due to the conductive layer. These values apply to the non-conductive black layer only.
- [(2)]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.
- [(3)]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Leak Location Textured is available in rolls weighing approximately 4,000 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.

TABLE 2.9: GSE ULTRAFLEX LEAK LOCATION WHITE TEXTURED GEOMEMBRANE						
Tested Property	**Test Method**	**Frequency**	**Minimum Average Values**			
			40 mil	60 mil	80 mil	100 mil
Thickness, mil Lowest individual reading	ASTM D 5199	every roll	40 36	60 54	80 72	100 90
Density, g/cm^3 (max.)	ASTM D 1505	200,000 lbs	0.939	0.939	0.939	0.939
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in	20,000 lbs	 60 250	 90 250	 120 250	 150 250
Tear Resistance, lb	ASTM D 1004	45,000 lbs	22	33	44	55
Puncture Resistance, lb	ASTM D 4833	45,000 lbs	44	66	88	110
Carbon Black Content[(1)], % (Range)	ASTM D 1603*/4218	20,000 lbs	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lbs	Note[(2)]	Note[(2)]	Note[(2)]	Note[(2)]
Asperity Height, mil	ASTM D 7466	second roll	18	18	18	18
Oxidative Induction Time, min	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lbs	>100	>100	>100	>100
Typical Roll Dimensions						
Roll Length[(3)], ft	Double-Sided Textured Single-Sided Textured		700 650	520 420	400 320	330 250
Roll Width[(3)], ft			22.5	22.5	22.5	22.5
Roll Area, ft^2	Double-Sided Textured Single-Sided Textured		15,750 14,625	11,700 9,450	9,000 7,200	7,425 5,625

NOTES:
- [(1)]GSE UltraFlex Leak Location White Textured may have an overall ash content greater than 3.0% due to the white and conductive layers. These values apply to the non-conductive black layer only.
- [(2)]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.
- [(3)]Roll lengths and widths have a tolerance of ±1%.
- GSE UltraFlex Leak Location White Textured is available in rolls weighing approximately 4,000 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.

F. Extrudate Rod or Bead

1. Extrudate material shall be made from same type resin as the geomembrane.
2. Additives shall be thoroughly dispersed.
3. Materials shall be free of contamination by moisture or foreign matter.

1.9 EQUIPMENT

A. Welding equipment and accessories shall meet the following requirements:

1. Gauges showing temperatures in apparatus such as extrusion welder or fusion welder shall be present.
2. An adequate number of welding apparatus shall be available to avoid delaying work.
3. Power source must be capable of providing constant voltage under combined line load.

1.10 DEPLOYMENT

A. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.

B. Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

C. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:

1. Geomembranes shall be installed according to site-specific specifications, and GSE Conductive should be installed with the Conductive layer down.

   Note: A spark tester or ohm meter can be used to determine Conductive layer.

2. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage (spreader bar, protected equipment bucket).
3. Place ballast (commonly sandbags) on geomembrane which will not damage geomembrane to prevent wind uplift.
4. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.

5. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 8 psi.
6. Protect geomembrane in areas of heavy traffic by placing protective cover over the geomembrane.

D. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

1.11 FIELD SEAMING

A. Seams shall meet the following requirements:

1. To the maximum extent possible, orient seams parallel to the line of the slope, i.e., down and not across slope.
2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.
3. Slope seams (panels) shall extend a minimum of 5-ft beyond the grade break into the flat area.
4. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the CONSULTANT and INSTALLER.
5. Align seam overlaps consistent with the requirements of the welding equipment being used. A 6-in overlap is commonly suggested.

B. During Welding Operations

1. Provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

C. Extrusion Welding

1. Hot-air tack adjacent pieces together using procedures that do not damage the geomembrane.
2. Clean geomembrane surfaces by disc grinder or equivalent.
3. Purge welding apparatus of heat-degraded extrudate before welding.

D. Hot Wedge Welding

1. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.

2. Clean seam area of dust, mud, moisture and debris immediately ahead of hot wedge welder.

3. Protect against moisture build-up between sheets.

E. Trial Welds

1. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.

2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

3. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.

4. Cut four, one-inch wide by six-inch long test strips from the trial weld.

5. Quantitatively test specimens for peel adhesion, and then for shear strength.

6. Trial weld specimens shall pass when the results shown in the following tables for HDPE and LLDPE are achieved in both peel and shear test.

TABLE 1.12.6A: MINIMUM WELD VALUES FOR HDPE GEOMEMBRANES

Property	Test Method	30	40	60	80	100	120
Peel Strength (fusion), ppi	ASTM D 6392	49	65	98	130	162	196
Peel Strength (extrusion), ppi	ASTM D 6392	39	52	78	104	130	157
Shear Strength (fusion & ext.), ppi	ASTM D 6392	61	81	121	162	203	242

TABLE 1.2.6B: MINIMUM WELD VALUES FOR LLDPE GEOMEMBRANES

Property	Test Method	30	40	60	80	100
Peel Strength (extrusion), ppi	ASTM D 6392	36	48	72	96	120
Peel Strength (fusion), ppi	ASTM D 6392	38	50	75	100	125
Shear Strength (fusion & ext.), ppi	ASTM D 6392	45	60	90	120	150

a. The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).

b. The break is ductile.

7. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.

8. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.

F. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. INSTALLER shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

G. Defects and Repairs

1. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

2. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

1.12 FIELD QUALITY ASSURANCE

A. MANUFACTURER and INSTALLER shall participate in and conform to all terms and requirements of the Owner's quality assurance program. CONTRACTOR shall be responsible for assuring this participation.

B. Quality assurance requirements are as specified in this Section and in the Field Installation Quality Assurance Manual if it is included in the contract.

C. Field Testing

1. Non-destructive testing may be carried out as the seaming progresses or at completion of all field seaming.

a. Vacuum Testing

1) Shall be performed in accordance with ASTM D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

b. Air Pressure Testing

1) Shall be performed in accordance with ASTM D 5820, Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

c. Spark Testing

1) Shall be performed accordance with ASTM D 7240 Standard Practice for Leak Location using Geomembranes with an Insulating Layer in Intimate

Contact with a Conductive Layer via Electrical Capacitance Technique (Conductive Geomembrane Spark Test).

d. Other approved methods.

2. Destructive Testing (performed by CONSULTANT with assistance from INSTALLER)

a. Location and Frequency of Testing

1) Collect destructive test samples at a frequency of one per every 500 lineal feet of seam length.

2) Test locations will be determined after seaming.

3) Exercise Method of Attributes as described by GRI GM-14 (Geosynthetic Research Institute, http://www.geosynthetic-institute.org) to minimize test samples taken.

b. Sampling Procedures are performed as follows:

1) INSTALLER shall cut samples at locations designated by the CONSULTANT as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.

2) CONSULTANT will number each sample, and the location will be noted on the installation as-built.

3) Samples shall be 12-in wide by minimal length with the seam centered lengthwise.

4) Cut a 2-in wide strip from each end of the sample for field-testing.

5) Cut the remaining sample into two parts for distribution as follows:

a) One portion for INSTALLER, 12-in by 12-in

b) One portion for the Third-Party laboratory, 12-in by 18-in

c) Additional samples may be archived if required.

6) Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determiningg the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

7) INSTALLER shall repair all holes in the geomembrane resulting from destructive sampling.

8) Repair and test the continuity of the repair in accordance with these Specifications.

3. Failed Seam Procedures

a) If the seam fails, INSTALLER shall follow one of two options:

1) Reconstruct the seam between any two passed test locations.

2) Trace the weld to intermediate location at least 10-ft minimum or where the seam ends in both directions from the location of the failed test.

b) The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10-ft long.

c) If sample passes, then the seam shall be reconstructed or capped between the test sample locations.

d) If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

1.13 REPAIR PROCEDURES

A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

B. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.

C. INSTALLER shall be responsible for repair of defective areas.

D. Agreement upon the appropriate repair method shall be decided between CONSULTANT and INSTALLER by using one of the following repair methods:

1. Patching- Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

2. Abrading and Re-welding- Used to repair short section of a seam.

3. Spot Welding- Used to repair pinholes or other minor, localized flaws or where geomembrane thickness has been reduced.

4. Capping- Used to repair long lengths of failed seams.

5. Flap Welding- Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

6. Remove the unacceptable seam and replace with new material.

E. The following procedures shall be observed when a repair method is used:

1. All geomembrane surfaces shall be clean and dry at the time of repair.
2. Surfaces of the polyethylene which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.
3. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

F. Repair Verification

1. Number and log each patch repair (performed by CONSULTANT).
2. Non-destructively test each repair using methods specified in this Specification.

2 OZ GEOTEXITLE

1.1 SCOPE

This specification covers the technical requirements for the Manufacturing and Installation of the nonwoven geotextile. All materials meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these project specifications.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. ASTM D 5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles
2. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
3. ASTM D 4533, Standard Test Method for Index Trapezoidal Tearing Strength of Geotextiles
4. ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
5. ASTM D 4491, Standard Test Method for Water Permeability of Geotextiles by Permittivity
6. ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
7. ASTM D 4354, Standard Practice for Sampling of Geosynthetics for Testing
8. ASTM D 4759, Standard Practice for Determining the Specifications Conformance of Geosynthetics

1.3 SUBMITTALS

A. Prior to material delivery to project site, the contractor shall provide the engineer with a written certification or manufacturers quality control data which displays that the geotextile meets or exceeds minimum average roll values (MARV) specified herein.

B. The contractor shall submit, if required by the engineer, manufacturer's quality control manual for the geotextile to be delivered to the site.

2. PRODUCT

2.1 GEOTEXTILE

A. The nonwoven needle-punched geotextile specified herein shall be made from staple fiber.
B. The geotextile shall be manufactured from prime quality virgin polymer.
C. The geotextile shall be able to withstand direct exposure to ultraviolet radiation from Sun for up to 30 days without any noticeable effect on index or performance properties.
D. Geotextile shall meet or exceed all material properties listed in *Table 1*.

TABLE 1: GEOTEXTILE PROPERTIES

Property	Test Method	Test Frequency	Value
Mass per Unit Area, oz/yd^2	ASTM D 5261	90,000-ft^2	12
Grab Tensile Strength, lb	ASTM D 4632	90,000-ft^2	320
CBR Puncture Strength, lb	ASTM D 6241	540,000-ft^2	925
Grab Elongation, %	ASTM D 4632	90,000-ft^2	50
Trapezoidal Tear Strength, lb	ASTM D 4533	90,000-ft^2	125
UV Resistance, % retained after 500 hours	ASTM D 4355	per formulation	70

2.2 MANUFACTURE

All rolls of the geotextile shall be identified with permanent marking on the roll or packaging, with the manufacturers name, product identification, roll number, and roll dimensions.

2.3 TRANSPORT

A. Transportation of the geotextile shall be the responsibility of the contractor.

B. During shipment, the geotextile shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, or other damaging or deleterious conditions.

C. Upon delivery at the job site, the contractor shall ensure that the geotextile rolls are handled and stored in accordance with the manufacturer's instructions as to prevent damage.

3. EXECUTION

3.1 QUALITY ASSURANCE

A. The engineer shall examine the geotextile rolls upon delivery to the site and report any deviations from project specifications to the contractor.

3.2 INSTALLATION

A. The geotextile shall be handled in such a manner as to ensure that it is not damaged in any way. Should the contractor damage the geotextile to the extent that it is no longer usable as determined by these specifications or by the engineer, the contractor shall replace the geotextile at his own cost.

B. The geotextile shall be installed to the lines and grades as shown on the contract drawings and as described herein.

C. The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self-weight. The geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods.

D. In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

E. The contractor shall take necessary precautions to prevent damage to adjacent or underlying materials during placement of the geotextile. Should damage to such material occur due to the fault of the contractor, the latter shall repair the damaged materials at his own cost and to the satisfaction of the engineer.

F. During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the engineer.

G. The geotextile shall not be exposed to precipitation prior to being installed and shall not be exposed to direct sunlight for more than 15 days after installation.

H. The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the engineer. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous. Seams shall be oriented down slopes perpendicular to grading contours unless otherwise specified. For heat-seaming, fusion welding techniques recommended by the manufacturer shall be used.

I. The contractor shall not use heavy equipment to traffic above the geotextile without approved protection.

J. The geotextile shall be covered as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.

K. Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

Single Sided Geocomposite

1.1 SCOPE

This specification covers the technical requirements for the manufacturing and installation of the geocomposite drainage layer. All materials meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these project specifications.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D 1238 Standard Test Method for Melt Flow Rates of Thermoplastics
2. by Extrusion Plastometer
3. D 1505-98 Standard Test Method for Density of Plastics by the Density-Gradient Technique
4. ASTM D 4218, Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique D 1603-94 Standard Test Method for Carbon Black in Olefin Plastics
5. D 4355-02 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
6. D 4491-99 Standard Test Method for Water Permeability of Geotextiles by Permittivity
7. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
8. D 4716-00 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
9. D 4751-99 Standard Test Method for Determining Apparent Opening Size of a Geotextile
10. D 6241 Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe D 4833-88 (1996) Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
11. D 5261-92 (1996) Standard Test Method for Measuring the Mass Per Unit Area of Geotextiles
12. D7005-03 Determining The Bond Strength (Ply-Adhesion) of Geocomposites
13. D 7179 Standard Test Method for Determining Geonet Breaking Force

B. Relevant publications from the Environmental Protection Agency (EPA):
   1. Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.3 DEFINITIONS

A. Construction Quality Assurance Consultant (CONSULTANT) – The Party, independent from MANUFACTURER and INSTALLER, that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

B. ENGINEER - The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

C. Geocomposite Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geocomposite rolls.

D. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY) - The Party, independent from the MANUFACTURER and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the OWNER.

E. INSTALLER- Party responsible for field handling, transporting, storing and deploying the geocomposite.

F. Lot- A quantity of resin (usually the capacity of one rail car) used to manufacture polyethylene geocomposite rolls. The finished rolls will be identified by a roll number traceable to the resin lot.

1.4 QUALIFICATIONS

A. MANUFACTURER
   1. Geocomposite shall be manufactured by the following:
      a. GSE Lining Technology, Inc.
      b. Approved Equal

2. MANUFACTURER shall have manufactured a minimum of 10,000,000-ft^2 of polyethylene geocomposite material during the last year.

B. INSTALLER

1. INSTALLER shall have installed a minimum of 500,000 square feet of geocomposite in the last 3 years.
2. INSTALLER shall have worked in a similar capacity on at least 5 projects similar in complexity to the project described in the contract documents, and within at least 50,000 square feet of geonet installation on each project.
3. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

1.5 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling- Each roll delivered to the site shall be wrapped and labeled by the MANUFACTURER. The label will identify:

1. Manufacturer's name
2. Product identification
3. Length
4. Width
5. Roll number

B. Delivery- Rolls will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage- The on-site storage location provided by the CONTRACTOR to protect the geonet from abrasions, excessive dirt and moisture, shall have the following characteristics:

1. Level (no wooden pallets)
2. Smooth
3. Dry
4. Protected from theft and vandalism
5. Adjacent to the area being lined

D. Handling

1. The CONTRACTOR and INSTALLER shall handle all rolls in such a manner to ensure they are not damaged in any way.
2. The INSTALLER shall take any necessary precautions to prevent damage to underlying layers during placement of the drainage material.

1.6 WARRANTY

A. Material shall be warranted, on a pro-rata basis against defects for a period of 1-year from the date of the geocomposite installation.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocomposite completion.

2. PRODUCTS

2.1 GEOCOMPOSITE PROPERTIES

A. A geocomposite shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure with a non-woven geotextile bonded to one or both sides.

B. The geocomposite specified shall have properties that meet or exceed the values listed in the following data sheets below.

TABLE 1: GEOCOMPOSITE PROPERTIES			
Property	**Test Method**	**Frequency**	**Value**
Geocomposite			
Transmissivity (1), gal/min/ft (m2/sec) Single-Sided Composite	ASTM D 4716	1/540,000-ft^2	6.2 (1.3 x 10-3)
Ply Adhesion, lb/in	ASTM D 7005	1/50,000-ft^2	0.5
Geonet			
Geonet Core Thickness, mil (1)	ASTM D 5199	1/50,000-ft^2	270
Transmissivity (2), gal/min/ft (m2/sec)	ASTM D 4716	1/540,000-ft^2	19 (4 x 10-3)
Compressive Strength, lbs/ft	ASTM D 6364	1/540,000-ft^2	40,000
Density, g/cm3	ASTM D 1505	1/50,000-ft^2	0.94
Tensile Strength (MD), lb/in	ASTM D 7179	1/50,000-ft^2	100
Carbon Black Content, %	ASTM D 4218	1/50,000-ft^2	2.0
8 oz. Geotextile (prior to lamination)			
Mass per Unit Area, oz/yd2	ASTM D 5261	1/90,000-ft^2	8
Grab Tensile Strength, lb	ASTM D 4632	1/90,000-ft^2	220
Grab Elongation	ASTM D 4632	1/90,000-ft^2	50%
CBR Puncture Strength, lb	ASTM D 6241	1/540,000-ft^2	575
Trapezoidal Tear Strength, lb	ASTM D 4533	1/90,000-ft^2	90
AOS, US Sieve (mm)	ASTM D 4751	1/540,000-ft^2	80 (0.180)
Permittivity, sec-1	ASTM D 4491	1/540,000-ft^2	1.3
Water Flow Rate, gpm/ft2	ASTM D 4491	1/540,000-ft^2	95
UV Resistance, % Retained	ASTM D 4355 (after 500 hours)	per formulation	70

Note: The design engineer shall prepare the table above based on the GSE product data sheet and then delete this note

C. Resin

1. Resin shall be new first quality, compounded polyethylene resin.
2. Natural resin (without carbon black) shall meet the following additional minimum requirements:

TABLE 2: RAW MATERIAL PROPERTIES		
Property	**Test Method(1)**	**Value**
Density (g/cm^3)	ASTM D 1505	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	$\leq$ 1.0

[1]GSE utilizes test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geosynthetics. All procedures and values are subject to change without prior notification.

2.2 MANUFACTURING QUALITY CONTROL

The geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the ENGINEER.
The geocomposite shall be tested according to the test methods and frequencies listed on *Table 1* which has been prepared based on product data sheets.

3. EXECUTION

3.1 FAMILIARIZATION

A. Inspection
1. Prior to implementing any of the work in the Section to be lined, the INSTALLER shall carefully inspect the installed work of all other Sections and verify that all Work is complete to the point where the installation of the Section may properly commence without adverse impact.
2. If the INSTALLER has any concerns regarding the installed work of other Sections, he shall notify the Project ENGINEER.

3.2 MATERIAL PLACEMENT

A. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.

B. If the project contains long, steep slopes, special care should be taken so that only full length rolls are used at the top of the slope.

C. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

D. If the project includes an anchor trench at the top of the slopes, the geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

E. In applying fill material, no equipment can drive directly across the geocomposite. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

F. The cover soil shall be placed in the geocomposite in a manner that prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

3.3 SEAMS AND OVERLAPS

A. Each component of the geocomposite will be secured or seamed to the like component at overlaps.

B. Geonet Components

1. Adjacent edges of the geonet along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other.
2. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5-ft along the roll length.
3. Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12-in across the roll width.

4. The geonet portion should be tied every 6-in in the anchor trench or as specified by the ENGINEER.

3.4 REPAIR

A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.

B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6-in with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with *Subsection 3.03*.

APPENDIX E

OPERATING AND MAINTENANCE PLAN

OPERATION AND MAINTENANCE PROCEDURES

In this plan, underlined text represents the language of the Rule.

The operator will operate and maintain the lined earthen containment to contain liquids and solids (blow sand and minimal precipitates from the treated produced water) and maintain the integrity of the liner system in a manner that prevents contamination of fresh water and protects public health and the environment as described below. The purpose of the lined earthen containment is to facilitate recycling, reuse, and reclamation of produced water derived from nearby oil and gas wells. During periods when water for E&P operations is not needed, produced water will discharge to one of the injection wells in the operator's SWD system. The containment will not be used for the disposal of produced water or other oilfield waste.

The operation of the Recycling Containment is summarized below:

1. Via pipeline, produced water generated from nearby oil and gas wells is delivered to a treatment system located as indicated in the C-147.
2. After treatment, the produced water discharges into the containment.
3. When required, treated produced water is removed from the containment for E&P operations. At this time, treated produced water will be used for drilling beneath the fresh water zones (beneath surface casing), for well stimulation (e.g. hydraulic fracturing) and other E&P uses as approved by OCD.
4. Whenever the maximum fluid capacity of the containment is reached, treatment and discharge to the containment ceases (see Freeboard and Overtopping Plan, below).
5. The operator will keep accurate records and shall report monthly to the division the total volume of water received for recycling, with the amount of fresh water received listed separately, and the total volume of water leaving the facility for disposition by use on form C-148.
6. The operator will maintain accurate records that identify the sources and disposition of all recycled water that shall be made available for review by the division upon request.
7. The containment shall be deemed to have ceased operations if less than 20 % of the total fluid capacity is used every six months following the first withdrawal of produced water for use. The operator will report cessation of operations to the appropriate division district office. The appropriate division district office may grant an extension to this determination of cessation of operations not to exceed six months.

The operation of the lined earthen containment will follow the mandates listed below:

1. The operator will not discharge into or store any hazardous waste (as defined by 40 CFR 261 and NMAC 19.15.2.7.H.3) in the containments.
2. If the containment's primary liner is compromised above the fluid's surface, the operator will repair the damage or initiate replacement of the primary liner within 48 hours of discovery or seek an extension of time from the Division District office.
3. If the primary liner is compromised below the fluid's surface, the operator will remove all fluid above the damage or leak within 48 hours of discover, notify the division district office, and repair the damage or replace the primary liner.
4. If any penetration of the containment liner is confirmed by sampling of fluid in the leak detection system (see Inspection and Monitoring Plan), the operator will:
   a. Begin and maintain fluid removal from the leak detection/pump-back system,
   b. Notify the District office within 48 hours (phone or email) of the discovery,
   c. Identify the location of the leak, and
   d. Repair the damage or, if necessary, replace the containment liner.
5. The operator will install, or maintain onsite, an oil absorbent boom or other device to contain an unanticipated release and the operator will remove any visible layer of oil from the surface of the recycling containment.
6. The operator will report releases of fluid in a manner consistent with NMAC 19.15.29.
7. The containment will be operated to prevent the collection of surface water run-on.
8. The operator will maintain the containment free of miscellaneous solid waste or debris.
9. The operator will maintain at least 3-ft of freeboard for the containment and will use a free-standing staff gauge to allow easy determination of the required 3-ft of freeboard.
10. As described in the design/construction plan, the injection or withdrawal of fluids from the containment is accomplished through hardware that prevents damage to the liner by erosion, fluid jets, or impact from installation and removal of hoses or pipes.
11. The operator shall ensure that all gates associated with the fence are closed and locked when responsible personnel are not onsite.
12. The operator will maintain the fences in good repair.

MONITORING, INSPECTION, AND REPORTING PLAN

The operator will inspect the recycling containment and associated leak detection systems weekly while it contains fluids. The operator shall maintain a current log of such inspections and make the log available for review by the division upon request.

Weekly inspections consist of:

1. Reading and recording the fluid height of staff gauges,
2. Recording any evidence that the pond surface shows visible oil,
3. Visually inspecting the containment's exposed liners, and
4. Checking the leak detection system for any evidence of a loss of integrity of the primary liner.

As stated above, if a liner's integrity is compromised, or if any penetration of the liner occurs above the water surface, then the operator will notify the District office within 48 hours (phone or email).

Monthly, the operator will:

1. Inspect diversion ditches and berms around the containment to check for erosion and collection of surface water run-on.
2. Inspect the leak detection system for evidence of damage or malfunction and monitor for leakage.
3. Inspect the containment for dead migratory birds and other wildlife. Within 30 days of discovery, report the discovery of dead migratory birds or other wildlife to the appropriate wildlife agency and to the division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.
4. Report to the division the total volume of water received for recycling, with the amount of fresh water received listed separately, and the total volume of water leaving the facility for disposition by use on form C-148.
5. Record sources and disposition of all recycled water.

The operator will maintain a log of all inspections and make the log available for the appropriate Division District office's review upon request. An example of the log is attached to this section of the permit application.

FREEBOARD AND OVERTOPPING PREVENTION PLAN

The method of operation of the containment allows for maintaining freeboard with very few potential problems. When the capacity of the containment is reached (3-ft of freeboard), the discharge of treated produced water ceases and the produced water generated by nearby oil and gas wells is managed by one of the injection wells as identified in *Appendix F*.

If rising water levels suggest that 3-ft of freeboard will not be maintained, the operator will implement one or more of the following options:

1. Cease discharging treated produced water to the containment.
2. Accelerate re-use of the treated produced water for purposes approved by the Division.
3. Transfer treated produced water from the containment to injection wells.

The reading of the staff gauge typically occurs daily when treatment operations are ongoing and weekly when discharge to the containment is not occurring.

PROTOCOL FOR LEAK DETECTION MONITORING, FLUID REMOVAL, AND REPORTING

As shown in *Appendix B*, the leak detection system includes a monitoring system. Any fluid released from the primary liner will flow to the collection sump, where fluid level monitoring is possible at the monitoring riser pipe associated with the leak detection system.

Staff may employ a portable electronic water level meter to determine if fluid exists in the monitoring riser pipe. Obtaining accurate readings of water levels in a sloped pipe beneath a containment can be a challenge. An electrician's wire snake may be required to push the probe to the bottom of the port and the probe may be fixed in a 2-in pipe "dry housing" to avoid false readings due to water condensation on the pipe. There are many techniques to determine the existence of water in the sumps, including low-flow pumps and a simple small bailer affixed to an electrician's snake. The operator will use the method that works best for this containment.

If seepage from the containment into the leak detection system is suspected by a positive fluid level measurement, the operator will:

1. Re-measure fluid levels in the monitoring riser pipe on a daily basis for one week to determine the rate of seepage.
2. Collect a water sample from the monitoring riser pipe to confirm the seepage is treated produced water from the containment via field conductivity and chloride measurements.
3. Notify NMOCD of a confirmed positive detection in the system within 48 hours of sampling (initial notification).
4. Install a pump into the monitoring riser pipe sump to continually (manually on a daily basis or via automatic timers) remove fluids from the leak detection system into the containment until the liner is repaired or replaced.
5. Dispatch a liner professional to inspect the portion of the containment suspected of leakage during a "low water" monitoring event.
6. Provide NMOCD a second report describing the inspection and/or repair within 20 days of the initial notification.

If the point of release is obvious from a low water inspection, the liner professional will repair the loss of integrity. If the point of release cannot be determined by the inspection, the liner professional will develop a more robust plan to identify the point(s) of release. The inspection plan and schedule will be submitted to OCD with the second report. The operator will implement the plan upon OCD approval.

APPENDIX F

CLOSURE PLAN

CLOSURE PLAN

In this plan, underlined text represents the language of the Rule.

After operations cease, the operator will remove all fluids within 60 days and close the containment within six months from the date the operator ceases operations from the containment for use.

The operator shall substantially restore the impacted surface area to

1. The condition that existed prior to the construction of the recycling containment or
2. To a condition imposed by federal, state trust land, or tribal agencies on lands managed by those agencies as these provisions govern the obligations of any operator subject to those provisions.

EXCAVATION AND REMOVAL CLOSURE PLAN - PROTOCOLS AND PROCEDURES

The workover pit is expected to contain a small volume of solids, the majority of which will be windblown sand and dust with some mineral precipitates from the water.

1. The operator will remove all liquids from the pits and either:
   a. Dispose of the liquids in a division-approved facility, or
   b. Recycle, reuse, or reclaim the water for reuse in drilling and stimulation
2. The operator will close the recycling containment by first removing all fluids, contents, and synthetic liners and transferring these materials to a Division approved facility.
3. After the removal of the pit contents and liners, soils beneath the workover pit will be tested by collection of a five-point (minimum) composite sample, which includes stained or wet soils, if any. That sample shall be analyzed for the constituents listed in *Table 1* of *19.15.34.14*.
4. After review of the laboratory results:
   a. If any contaminant concentration is higher than the parameters listed in *Table 1*, additional delineation may be required, and the operator must receive approval before proceeding with closure.

b. If all contaminant concentrations are less than or equal to the parameters listed in *Table 1*, then the operator will proceed to:

   i. Backfill with non-waste containing, uncontaminated earthen material or

   ii. Undertake an alternative closure process pursuant to a variance request after approval by OCD.

5. The operator will reclaim the containment's location to a safe and stable condition that blends with the surrounding undisturbed area.
6. Topsoils and subsoils shall be replaced to their original relative positions and contoured so as to achieve erosion control, long-term stability, and preservation of surface water flow patterns.
7. The disturbed area shall then be reseeded in the first favorable growing season following closure of a recycling containment.

CLOSURE DOCUMENTATION

Within 60 days of closure completion, the operator shall submit a closure report on Form C-147, including required attachments, to document all closure activities including sampling results and the details on any backfilling, capping or covering, where applicable. The closure report shall certify that all information in the report and attachments is correct and that the operator has complied with all applicable closure requirements and conditions specified in division rules or directives.

The operator shall notify the division when reclamation and re-vegetation are complete. Specifically, the notice will document that all ground surface disturbing activities at the site have been completed, and a uniform vegetative cover has been established that reflects a life-form ratio of plus or minus fifty percent (50%) of pre-disturbance levels and a total percent plant cover of at least seventy percent (70%) of pre-disturbance levels, excluding noxious weeds.