TETRA TECH

C-147 Registration Application Package

3Bear Energy, LLC
Cottonwood Site Water Recycling Facility
Eddy County, New Mexico

January 10, 2018

complex world

CLEAR SOLUTIONS™

C-147 Registration Application Package

3Bear Energy, LLC
Cottonwood Site Water Recycling Facility
Eddy County, New Mexico

Prepared for:

3BEAR ENERGY, LLC

1512 Larimer St., Suite 540
Denver, Colorado 80202

Prepared by:

Tetra Tech, INC.

4000 N. Big Spring St., Suite 401
Midland, Texas 79705

Tetra Tech Project No. 212C-MD-00981.601

January 10, 2018

TABLE OF CONTENTS

FIGURES:

APPENDICIES:

(this page is intentionally left blank)

PROFESSIONAL GEOSCIENTIST'S CERTIFICATION

I hereby certify that the geoscience components of this application for the Cottonwood Water Recycling Facility in Section 20, Township 26 South, Range 26 East in Eddy County, New Mexico, are prepared by review of published data as described here within and have been prepared under my direction and responsible supervision.

_____ _____

Ike Tavarez, P.G. Date

PG License No.

The following attachments include geoscience components for the C-147 application:

- Section 3.2 – Distance to Groundwater
- Section 3.3 – Distance to Surface Water
- Section 3.4 – Distance to Permanent Residence and Institutions
- Section 3.5 – Distance to Domestic and Stock Water Supplies
- Section 3.6 – Distance to Municipal Boundaries and Freshwater Fields
- Section 3.8 – Site Geology
- Section 3.9 – Distance to Subsurface Mines
- Section 3.10 – Distance to Cave Karst Features

PROFESSIONAL ENGINEER'S CERTIFICATION

I hereby certify that the engineering components of this application for the Cottonwood Water Recycling Facility in Section 20, Township 26 South, Range 26 East in Eddy County, New Mexico, are prepared by review of published data as described here within and have been prepared under my direction and responsible supervision. Please note, engineering drawings and specifications prepared are for permit application only and are not issued for bid or construction.

_____ _____

Nathan Langford, P.E. Date

PE License No. 24339, New Mexico

The following attachments include engineering components for the C-147 application:

- Section 4.0 – Design and Construction Plan
- Section 7.0 – Financial Assurance Requirements
- Appendix B - Cottonwood Water Recycling Facility Layout and engineering details and specifications, prepared by Tetra Tech, Inc.

1.0 INTRODUCTION

3Bear Energy, LLC (3Bear) requests registration under 19.15.34 NMAC for a Produced Water Recycling and Containment Facility and associated storage containments in the Hayhurst New Mexico development area, located in Section 20, Township 26 South, Range 26 East in Eddy County, New Mexico. The Cottonwood Water Recycling Facility will receive produced waters from other New Mexico Oil Conservation Division (NMOCD) authorized oil and gas exploration and production operators. 3Bear will collect, treat, and store the treated waters for purpose of delivery to other NMOCD authorized oil and gas exploration and production operators for use in well drilling and completion operations.

The Cottonwood Water Recycling facility is located on the northwest end of a 20-acre property, which is private land owned by 3Bear Energy, LLC. The facility will be operated by 3Bear Energy, LLC and 3 Bear Field Services (OGRID# 372603). The Cottonwood Water Recycling facility utilizes approximately 6.2 acres of the 20-acre property. The facility includes the following:

1) A produced water recycle tank system with five storage tanks (with options for future expansion) and a gun barrel separator for the separation of hydrocarbons;
2) Transfer pumps, skid mounted;
3) Five (5 ea.), 60,000 bbl (44,448 bbl including three feet freeboard) above-ground storage lined containment (tanks), (i.e. lined containment tanks);
4) Truck unloading area (future);
5) In line filtration units (future);

The operator's and Cottonwood Water Recycling Facility's compliance with the requirements of 19.15.34.9 through 19.15.34.15 is described in this application.

Figures 1 and 2 attached to this application are maps identifying the location of the Cottonwood Water Recycling Facility in proximity to municipalities and State and Federal properties.

A copy of Form C-147, in Section 2, is provided to the surface land owner, 3Bear Energy, LLC, as required under 19.15.34.10.A.

2.0 NMOCD FORM C-147

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: 3Bear Field Services, LLC (For multiple operators attach page with information) OGRID #: 372603

Address: 1512 Larimer Street, Suite 540; Denver CO. 80202

Facility or well name (include API# if associated with a well): _____

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

U/L or Qtr/Qtr SW/4 Section 20 Township 26 South Range 26 East County: Eddy

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

2.

☒ **Recycling Facility:** (Section 26, T20S, R34E)

Location of recycling facility (if applicable): Latitude 32.021682 ºN Longitude -104.318203 ºW WGS84

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:** (Section 20, T26S, R26E; "TANK 3")

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

Center of Recycling Containment (if applicable): Latitude 32.021682 ºN Longitude -104.318203 ºW WGS84

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

☒ Lined ☐ Liner type: Thickness 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☐ Other _____ Volume: 44,448 bbl Dimensions: L 190' x W N/A x D 12' (height)

☐ Recycling Containment Closure Completion Date:_____

3.

☒ **Recycling Containment:** (Section 20, T26S, R26E; "TANK 1") **NOTE: ADDITIONAL 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 32.021338 ºN Longitude -104.318868 ºW WGS84

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

☒ Lined ☐ Liner type: Thickness 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☐ Other _____ Volume: 44,448 bbl Dimensions: L 190' x W N/A x D 12' (height)

☐ Recycling Containment Closure Completion Date:_____

3.

☒ **Recycling Containment:** (Section 20, T26S, R26E; "TANK 2") **NOTE: ADDITIONAL 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 32.021993 ºN Longitude -104.318881 ºW WGS84

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

☒ Lined ☐ Liner type: Thickness 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☐ Other _____ Volume: 44,448 bbl Dimensions: L 190' x W N/A x D 12' (height)

☐ Recycling Containment Closure Completion Date:_____

3.

☒ **Recycling Containment:** (Section 20, T26S, R26E; "TANK 4") **NOTE: ADDITIONAL 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 32.021989 ºN Longitude -104.317677 ºW WGS84

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

☒ Lined ☐ Liner type: Thickness 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☐ Other _____ Volume: 44,448 bbl Dimensions: L 190' x W N/A x D 12' (height)

☐ Recycling Containment Closure Completion Date:_____

3.

☒ **Recycling Containment:** (Section 20, T26S, R26E; "TANK 5") **NOTE: ADDITIONAL 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 32.021334 ºN Longitude -104.317703 ºW WGS84

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

☒ Lined ☐ Liner type: Thickness 40 mil ☒ LLDPE ☐ HDPE ☐ PVC ☐ Other _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☒ Factory ☐ Other _____ Volume: 44,448 bbl Dimensions: L 190' x W N/A x D 12' (height)

☐ 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 $ 2,979,302 **(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 Six-foot high, chain-link fencing, with 3-strand barb-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 (FEMA MAP DATA NOT AVAILABLE FOR PROPERTY)	☐ 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): Scott Spicher Title: Vice President

Signature: _____ Date: _____

e-mail address: scott@3bearllc.com Telephone: 303-862-3960

11.

OCD Representative Signature: _____ Approval Date: _____

Title: _____ OCD Permit Number: _____

☐ OCD Conditions _____

☐ Additional OCD Conditions on Attachment

3.0 SITING REQUIREMENTS – SECTION 20 CONTAINMENTS

3.1 Location

The proposed 3Bear, Cottonwood Water Recycling and Containment Facility is located in Section 20, Township 26 South, Range 26 East in Eddy County, New Mexico on private property, owned by 3Bear Energy LLC. See Figures 1 and 2 attached to this application.

3.2 Distance to Groundwater

Nine water wells are listed in Section 20 in the New Mexico Office of the State Engineers (OSE) database. Of the nine wells, seven had records of logs with the OSE. The nearest water well to the site, with a reported depth to groundwater, is located in Section 20, approximately 0.3 miles to the northwest of the site and has a reported depth to groundwater of 15 feet below ground surface. Of the seven wells noted, two reported water depths of 15 feet below ground surface and three wells in the Section 20 reported water depths of 60, 80, and 100 feet below ground surface. Two of the seven wells did not report water depths. In addition, two water wells were noted in the southeast quadrant of Section 19, one additional well was noted in the northeast quadrant of Section 21, and one well (without logs) was noted in the center of Section 29. Copies of the well summaries from the Office of the State Engineer are attached. See Figure 5B, showing well locations.

As part of the geotechnical investigation at the Cottonwood facility, nineteen (19) geotechnical borings were installed at the facility location on the site for purposes of a geotechnical investigation of subsurface conditions at the proposed site location and observation of potential groundwater depths. Of these 19 borings, eight (8) borings were deep borings, installed to depths between 50 feet and 67 feet bgs. Groundwater was observed in the four (4) of the eight (8) deep borings. The groundwater depths observed ranged from 30 feet to 43.5 feet bgs. The Cottonwood Site, Report of Geotechnical Investigation for the Proposed Water Recycling Facility and Recycled Water Storage Tanks, dated December 2017, is included in Appendix D.

3.3 Distance to Surface Water

No continuously flowing watercourses or other significant water features, as defined by NMOCD rules, are located with the prescribed setbacks. The site is not located within 300 feet of a continuously flowing watercourse or 200 feet of any other significant watercourse, lakebed, sinkhole, or playa lake. The nearest watercourse is a riverine feature (Hay Hollow Draw), which is located approximately 1,450 feet to the north of the site. See Figure 4. *Note: Surface sinkholes were noted on the 20-acre property, however the proposed containments are located such that they are at least 200 feet from the surface sinkholes. See Section 3.10.*

3.4 Distance to Permanent Residence and Institutions

No permanent residences, schools, hospitals, institutions, or churches are located within 1,000 feet of the site, at the time of registration. The only development and structures in the area are associated with oil and gas production.

3.5 Distance to Domestic and Stock Water Supplies

No springs or fresh water wells used for domestic or stock water purposes are located within 500 feet of the site at the time of registration. Seven wells, stock wells or oil field water supply

wells are located within a 1 mile radius of the site. The nearest potential fresh water well is located approximately 1,200 feet north of the site. See Figure 5B, attached to this application.

3.6 Distance to Municipal Boundaries and Fresh Water Fields

The site is not located within an incorporated municipal boundary or within the defined municipal fresh water fields. The nearest communities to the site are:

- Whites City, which is not incorporated and is located approximately 11 miles northwest of the site.
- Black River Village; which is not incorporated and is located approximately 13 miles northeast of the site.
- City of Carlsbad, which is incorporated and is located approximately 27 miles north of the site. The City of Carlsbad operates a well field, Sheep's Draw. The well field is approximately 7 miles southwest of the city and approximately 21 miles northwest of the site. See Figure 5A.

3.7 Distance to Wetlands

The site is not located within 500 feet of an identified wetland. The nearest mapped feature according to the U.S. Fish and Wildlife Service's National Wetlands inventory is approximately 1,450 ft. north of the site location and associated with Hay Hollow Draw. See Figure 5.

3.8 Site Geology

Aquifer

According to the Geology and Groundwater Resources of Eddy County, New Mexico (Report 3), the Rustler, Castile and Salado formation (Ochoa Series) is present west and east of the Pecos River. The Salado formation, which consists of halite and small amounts of anhydrite, polyhalite and other potassium salts and red sandy shale, overlies the Castile formation in the area east of the Pecos River. West of the river, most of the formation has been removed by solution. Underlying the Salado formation is the Castile formation which consists of 1,300 to 2,000 feet of anhydrite, gypsum, and small amounts of halite, dolomite, and sandstone. As originally deposited, most of the gypsum probably was anhydrite, but it has since been altered by groundwater. The Rustler formation overlies the Salado formation east of the Pecos River, and the Castile formation west of the Pecos River. The Rustler formation ranges in thickness from about 200 feet in northern Eddy County to about 500 feet southeast of Carlsbad, New Mexico. It consists of anhydrite, gypsum, interbedded red and green sandy clay, and some beds of dolomite.

The Cottonwood site is located on surficial sand deposits overlying the Permian Castile Formation, (USGS, 1957). The total original thickness of the Castile Formation is approximately 1,825 feet in the vicinity of the McBride No. 1 Well drilled in the Delaware Basin, which reports the following stratigraphy (from the bottom up): 200 feet of interlaminated white anhydrite and gray to brown limestone, above which is a saline section of 515 feet of halite and limestone, an overlying section of 560 feet of anhydrite with limestone laminae, and 305 feet of overlying white anhydrite (USGS, 1957). In the vicinity of the McBride No. 1 well, approximately 125 ft. of gypsum has been eroded from the top of the formation. The thickness of the Castile Formation at the Cottonwood site has not been confirmed at this time, but typically the upper originally anhydrite facies have weathered into gypsum.

In the region around Eddy County, NM, anhydrite facies of the Castile Formation near the ground surface that have been exposed to water and weathering processes have weathered to gypsum. Locally, residual gypsum and clastics of the formerly overlying Solado Halite are intact; The Salado deposits mostly weathered away before the Pleistocene, and where still present are collapsed and typically look like breccia.

Where present at the site, surficial Quaternary (Pleistocene-Holocene) sands should be 70% quartz / 30% carbonate. More recent geologic mapping in nearby 7.5 minute quadrangles (e.g., Otis, Loving) show these sands vary in thickness from a few feet to ~200 feet (Pederson and Dehler, 2004). Regionally, anhydrite is characterized by regular planar bedding, and gypsum bedding is convoluted and irregular.

3.9 Distance to Subsurface Mines

Search of the New Mexico Mining and Minerals Division database indicates there are no subsurface mines in the proximity of the facility. One potash mine is located approximately 26 miles northeast of the site. A copy of the Active Mines Map from the New Mexico Mining and Minerals Division (November 2014), which shows the approximate proximity of the facility to active mines is provided as a figure attached to this application. The only other identified facilities in the general area are surface caliche and aggregate pits. See Figure 7 for Active Mines locations.

3.10 Distance to Cave/Karst Features

The facility is located within a BLM-identified high karst potential zone area. In addition, three small surface sinkholes were noted onsite. Figure 8 depicts the BLM karst potential for the general area and Figure 3 and the Cottonwood Produced Water Recycling Facility Containment Area in Appendix B indicates locations of the surface sinkholes relative to the facility's containments. The facility containments and water recycle area is located within the 20-acre property, such that the containments and facility equipment are at least 200 feet from the surface sinkholes. 3Bear performed a ground survey of the area to identify these sinkholes in August of 2017. A copy of the report is provided in Appendix C.
In addition, due to the high-karst potential and identification of sink-holes on the site, 3Bear contracted Tetra Tech to perform a geophysical survey of the entire 20-acre property to identify potential localized areas of subsurface karst features. The geophysical survey scope consisted of performing a vibroseis sweep of the property by installation of probes on a 25-foot by 50-foot lineal spacing and utilizing surface-wave attenuation mapping of the subsurface to approximately 120 feet. The interpretation of the data and results indicated that the northwest area of the 20-acre tract (within yellow and green areas as shown in the geophysics report, see Appendix C) have the highest potential (within the 20-acre property) for optimal foundations for installation of the water recycle facility and containments. Based on the results of the geophysical survey, Tetra Tech was able to propose and execute an extensive geotechnical program by installing nineteen geotechnical investigative borings at the northwest area of the site with the purpose of avoiding potential karst areas at the site. See Appendix C for "3-Bear Cottonwood Site, Recycled Water Facility – Eddy County, NM 3D Seismic Imaging and Geologic Karst Characterization" prepared by Tetra Tech, dated October 26, 2017.

In addition, no cave karst features or significant voids were encountered during the performance of the geotechnical investigation. This investigation appeared to verify results of the geophysical survey. A copy of the Report of Geotechnical Investigation for the Proposed Water Recycling Facility and Recycled Water Storage Tanks, dated December 2017, is included in Appendix D.

3.11 Distance to 100-Year Floodplains

The facility and containments are not located within a designated Federal Emergency Management Agency 100-year floodplain and is subject to minimal flood hazard. The nearest FEMA 100-year floodplain is located approximately 1,120-1,200 ft. to the north of the site. See Figure 9 showing the limits of the FEMA 100-year floodplain.

4.0 DESIGN AND CONSTRUCTION PLAN

The proposed 3Bear Cottonwood Water Recycling Facility will include five (5) above ground, water storage containments (tanks), each equipped with an independent liquid leak detection system. The five containments have a storage capacity of 60,000 barrels (bbls) each and approximately 44,448 bbls of operational capacity each, including three feet of freeboard. The total operational water storage capacity at the site will be approximately 222,240 bbls. A water recycle system equipped with five, 750 bbl tanks (4 skim oil and one condensate), one, 1,000 bbl, gun barrel tank, filtration system, and two skid-mounted transfer pumps will be installed at the facility. The proposed, five (5) storage containments and the water recycle system equipment will be installed within a bermed, lined secondary containment system. The secondary containment system will collect contact storm waters from the facility and operate as a secondary barrier to capture and convey, liquids in the event of a breach of a primary storage containment or failure of a primary storage containment's independent liquid leak detection system. The secondary containment will be constructed to contain at least 1.3 times the volume of the largest tank within or 78,000 bbls. The containment will drain any fluids which infiltrate through the containments' subgrade to one of four external collection sumps. Fluids will be evacuated from the collection sump via a submersible sump pump. The secondary containment berm will function to retain waters within the containment and will also function as a run-on control berm to prevent storm waters from entering the facility.

Each 60,000 bbl containment tank is constructed of a dual 40-mil low-density polyethylene (LDPE) liner system. Each of the containments is erected by installing 28 steel panels or side walls supporting the LDPE dual lined containment system. Each 60,000 bbl containment is approximately 190 feet in diameter by 12 feet in height. The containments will be operated with three-feet of additional freeboard and will be constructed and installed such that materials are compatible with the fluids contained within.

Each containments' dual liner system is fabricated in the manufacturer's shop to fit the standard 60,000 bbl tank size. The liner is shop-fabricated in effort to maximize quality control during the liner fabrication process (versus field welding). The containments will be erected on site with the pre-fabricated LDPE liner and leak detection system installed within the erected steel panels on the site location. As described, each of the containments are equipped with a dual geosynthethic liner and leak detection system. The leak detection system will be equipped with a 200-mil geonet and lateral underdrain, which drains to a collection sump near one end of the containment as recommended by the manufacturer.

The containments' liner and leak detection system, materials and installation methods are described below. A copy of the civil engineering drawings and specifications for the Cottonwood Water Recycling Facility by Tetra Tech, Inc. is provided in Appendix B.

Above-ground Storage Containments

The proposed above-ground storage containment will be lined with a double-layer synthetic 40-mil LDPE membrane liner. The LDPE allows for conformity and installation of a continuous liner system to conform to the structure of vertical tank walls. The secondary FML will control potential leakage of affected liquid through the primary FML.

A copy of the containment tank's manufacturer's design specifications and site civil engineering drawings and specifications for the Cottonwood Water Recycling Facility by Tetra Tech, Inc. is

provided in Appendix B. A brief list of structural components, from top to bottom for the containment tank and secondary containment system is as follows:

- 60,000 bbl. Containment Tank;
  - primary flexible membrane liner (FML) barrier
  - liner leak detection system and leak collection sump, geonet drain on tank bottom only
  - secondary FML barrier
- Containment Tank Subgrade and Secondary Containment Structure;
  - two feet, minimum, of compacted, stable, engineered fill soils material (using on-site native subgrade soils or imported soils meeting specifications)
  - geocomposite, synthetic drainage net
  - flexible membrane liner (FML) barrier
  - synthetic geotextile cushion layer
  - secondary containment berms
  - prepared subgrade

The containment tanks and secondary containment liner components will be protected and supported by other associated materials as described by the engineering drawings, specifications, and recommended by the manufacturer to maintain the integrity of the liner systems. See Appendix B for engineering design recommendations and details.

60,000 bbl. Containment Tank (Liner System)

Primary FML

The primary FML will be a 40-mil nominal thickness LDPE geomembrane. The parts of the primary FML covering the bottom of the containment tanks, including the parts in the leachate collection lateral and leachate removal sump will be smooth-surface FML.

The primary FML panels will be a continuous membrane barrier pre-manufactured in a controlled environment.

The primary FML product used within the containment is specified by the manufacturer.

Liquid Leak Detection System

The liquid leak detection (LLD) system will be an open three-dimensional HDPE synthetic drainage net installed in between the primary and secondary containment LDPE liners.

The liquid leak detection drain will be supported by the secondary FML. The entire liner, including the leak detection drainage net, will be graded to drain to a leak detection drain sump that is filled with graded fine gravel supported by the secondary FML.

A leak detection drainage net is located in the gravel-filled sump and in the adjacent surface runout between the primary FML and the secondary FML. The LLD and associated gravel-filled underdrain will be graded to an associated leak detection sump beneath the containment tank. A geotextile cushion or additional geocomposite will be placed over the top of the gravel filling the gravel-filled leak detection trench to reduce the potential for damage to the overlying primary FML. A leachate collection underdrain lateral will be installed beneath the geonet drainage layer, and will extend from the center of each containment to the leachate detection sump. This will increase

the total capacity of the leak detection drainage system to convey the necessary leachate flow along the primary flow path to the sump.

The LLD product used within the containment is specified by the manufacturer for use as an equivalent or better product and is compatible with the containment system.

Liquids collected in each individual LLD sump will be evacuated with an onsite centrifugal pump or vacuum truck and will be transferred back into the Recycle Water System for treatment and recirculation to the containments.

Secondary FML

The secondary FML will be a 40-mil nominal thickness LDPE geomembrane. The parts of the secondary FML covering the bottom of the containment, including the parts in the liquid leak detection drain underdrain and sump will be smooth-surface FML.

The secondary FML product used within the containment is specified by the manufacturer.

Containment Tank Subgrade and Secondary Containment Structure

Compacted Engineered Fill

A minimum of two feet of engineered fill material will be prepared using native, on-site soil materials (primarily consisting of silty-sand) or borrow soil materials meeting the engineering specifications and gradation for engineered fill materials used for the tank subgrade. The final surface will be graded to promote positive drainage to small surface drainage channels on the site and to one of four storm water collection sumps at pre-determined locations at the site. The sumps will be evacuated by small submersible pumps or vacuum trucks. Specifications for engineered fill are shown in Appendix B.

Geocomposite Synthetic Drainage Net

A geocomposite synthetic drainage net (SDN) will be installed beneath the minimum two-foot engineered fill layer. The SDN will overlay a geomembrane liner. The SDN is installed to promote drainage from storm waters or waters which have infiltrated beneath the engineered fill layer to the underlying secondary containment liner. The SDN consists of a non-woven geotextile, which is installed above a HDPE SDN to minimize potential for clogging of the SDN layer. The geocomposite SDN product used within the secondary containment is single-sided, non-woven geotextile with HDPE geonet core, GSE Lining Technology or equal. Specifications for that product are shown in Appendix E.

Secondary Containment Flexible Membrane Liner (FML)

The secondary containment FML will be a 40-mil nominal thick HDPE geomembrane. The parts of the secondary containment FML covering the bottom of the secondary containment, including the drainage trenches and the side slopes of the containment berm will be smooth-surface FML.

The secondary FML product used within the secondary containment will be 40-mil GSE Lining Technology “HD Smooth Geomembrane” or equal. Specifications for that product are shown in Appendix E.

Synthetic Geotextile Cushion Layer

The synthetic geotextile cushion layer will be a 10-oz nominal thickness, non-woven geotextile. The geotextile will be installed beneath the secondary containment FML to support the FML layer and provide additional protection.

The geotextile component will be made of nonwoven synthetic resin fiber. The geotextile will reduce potential for puncture of the secondary liner by protruding smaller rock aggregates or any potential voids, if they exist. Given the gradation of the subgrade, this layer adds an additional component of separation of direct contact of the liner with the subgrade materials.

The synthetic geotextile cushion layer product used within the secondary containment will be 10-oz, non-woven geotextile, GSE Lining Technology or equal. Specifications for that product are shown in Appendix E.

Secondary Containment Berms

The secondary containment will be surrounded by a perimeter berm on all sides of the containment. The berm will be approximately 3.5 feet high and 15 feet wide at the base. The purpose of the containment berm is to prevent uncontrolled contact storm waters or leaking waters from leaving the facility site and to prohibit storm water run-on to the facility. The perimeter berm crest will be constructed at a constant elevation set at least 2 feet above the immediate adjacent design grade surface elevation of the secondary containment. Also where required diversionary trenches (primarily on the west and north ends of the site) will be installed on the exterior of the containment berm to divert storm water drainage around the property. The interior of the secondary containment berm will be lined with the secondary FML layer to prevent release of waters and vertical migration of waters from the secondary containment.

Prepared Subgrade

The liner subgrade will support the secondary containment FML. The liner subgrade will be supported by stable native soil engineered as described in the specifications.

The upper part of the liner subgrade will be a 6-inch nominal compacted thickness layer of compacted, stable native soil. The use of native soil in the upper part of the subgrade will reduce the potential for damage to the overlying secondary containment FML. The material used for the compacted fill will be native soil free of aggregates larger than one-inch, sharp objects, protrusions, organic matter, wastes, and unstable materials.

The surface of the compacted layer will be graded and compacted to produce a smooth surface, free of depressions and sharp changes in elevation. It will be suitable for effective support, placement, and installation of the secondary containment FML, overlying liner components, and the related construction and operating loads.

Liner Interior Grades

The secondary containment FML (and associated subgrade) will be graded to produce positive drainage at slope of approximately 0.5% to 1% to the location of a proximate underdrain. The underdrains and the SDN components will be graded at 0.5% to 1% to drain a concrete collection sump at the southeast end of the site. Consequently, storm waters or leaking waters (from the primary storage containments) will be conveyed to the collection sump, where fluids will be

pumped from the containment using a submersible sump pump and will be transferred and introduced into the water recycle system.

Geosynthetic Anchor Trenches

Anchor trenches will be excavated in the crest of the perimeter secondary containment berms to anchor the liner geosynthetics (i.e. the secondary containment FML). Anchor trenches will be 24" X 24" deep and will be constructed per the engineering drawings and technical specifications.

Liner Borrow Sources

Native soil or suitable imported soil are suitable for use as engineered fill and will be used to construct the liner earthwork. See the Report of Geotechnical Investigation for the Proposed Water Recycling Facility and Recycled Water Storage Tanks, dated December 2017 in Appendix D.

Liner Construction Sequence

The containment liner will be constructed in stages and in accordance with the engineering specifications for the system. A copy of the specifications is provided in Appendix B.

4.1 General Specifications

The containment construction and liner system installation will be performed in accordance with the manufacturer's specifications and recommendation for the 60,000 bbl, above ground storage containment tanks installation, site preparation, engineering drawings and specifications as provided in Appendix B. The civil engineering drawings and specifications for the Cottonwood Facility site grading and secondary containment by Tetra Tech, Inc. is provided in Appendix B.

4.2 Stockpiling of Topsoil

Where topsoil is present, it will be stripped and stockpiled against the southeast, east, and northeast sides (only) of the secondary containment berms and will be used as final cover or fill material for the site at time of closure. Topsoil may be stockpiled in other designated areas downgradient and away from the facility, if needed. Unused soils or top soils stockpiles may not exceed four feet in height and must be graded with a side slopes no steeper than 10H:1V.

4.3 Signs

A sign with no less than 12 inches by 24 inches to include lettering with no less than two inches in height, will be installed in a visible area on the perimeter fencing of the facility and in immediate proximity of the containment. The sign will include the following:

- The operator's name;
- The location of the site by quarter or unit letter, section, township, and range; and
- Emergency Phone numbers.

4.4 Fencing

Fencing will be constructed at the facility and will consist of six-foot tall chain-link fencing, with 3-strand barb-wire, installed along the extent of the perimeter of the 6.2-acre site to include the Cottonwood Water Recycle facility containment and tanks. The facility will be gated to provide

access to operations personnel and will be locked when the facility is not is operation. This will prevent unauthorized personnel access and access from animals. This fencing system is a variance from the minimum four-foot fence with barbed-wire strands required by the NMOCD. The system will provide an equivalent or greater deterrent from unauthorized access. The proposed truck unloading area will not be fenced to allow for authorized access to unloading stations, however the stations will be monitored for unauthorized access.

4.5 Netting and Wildlife Protection

The fencing as described in Section 4.4 will provide protection to wildlife by preventing access to the facility grounds and the containments. 3Bear will also implement a system designed to prevent access to the containment system by migratory birds. Due to the size of the facility and containments (approximately 620 feet by 440 feet, 190 feet in diameter, respectively), 3Bear has determined that it is not feasible to construct or install a netting system on these types of containments. Due to the infeasibility of installation of the netting system, 3Bear proposes to install an audible bird deterrence system as an alternative. This type of system has been used by other operators in the southeast New Mexico as effective protection for birds and migratory birds. The audible system will be installed in proximity of each of the five, 60,000 bbl containment tanks and will be installed as designed to provide adequate audible coverage for the entire facility. A copy of the specifications for the Bird-X Mega Blaster PRO system is provided in Appendix E. This proposed system or equivalent will be utilized and is included as a variance from the specified netting systems described in NMAC 19.15.34. However, this system is designed to provide equal protection by deterrence of avian species.

As part of the operations described in Section 5.0 below, inspections of the containments will be conducted at least once per week. Inspections will include visual observations and monitoring to be performed during normal operations. The visual observations will include observations of any adverse impacts to wildlife. If any dead migratory birds or other wildlife is detected, 3Bear will notify the New Mexico Department of Game and Fish and the NMOCD District Office as reasonably possible and within 30 days of discovery.

5.0 OPERATING AND MAINTENANCE PLAN

The Cottonwood Water Recycling and Containment Facility will consist of the following:

1) A produced water recycle tank system with five storage tanks (with options for future expansion) and a gun barrel separator for the separation of hydrocarbons;
2) Transfer pumps, skid mounted;
3) Five, 60,000 barrel (44,448 bbl operational capacity), above-ground containment (tanks) (i.e. lined containment tanks) for recycled water storage;
4) Truck unloading area (future);
5) In line filtration units (future);

Waters will be delivered to the facility from authorized exploration and production operator's primarily via pipeline and trucks (future). Waters at the facility will be accepted from only NMOCD approved operators. The expected throughput of the system will start at 15,000 bbls per day and range from 25,000 bbls/day to 50,000 bbls/day with future contracts. Waters will be treated by hydrocarbon separation in an in-line gun barrel tank. The treated waters will then flow through buffering tanks before being processed through an in-line Pall filtration system and will then be delivered from the filtration system to one of the five above-ground containments (tanks) for storage.

This facility/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.

The water recycling containments will be operated to contain the liquids and any solids stored within. The integrity of the liner and liquid leak detection system will be monitored to maintain integrity of the system to prevent contamination of fresh waters and protect public health and the environment. The water recycling containments will be operated to recycle field-generated produced waters and will not be used for disposal of oilfield wastes. Introduction or extraction of fluids into the containment are accomplished through hardware and equipment that will prevent damage to the liner system as shown in the Appendix B.

Each of the five, 60,000 bbl water recycling containments will be designed to be independently operated and are not passively manifolded for storage. Each of the containments will be monitored with a liquid level indicator, which will be monitored to ensure three-foot freeboard is maintained and to prevent overfilling of the containments.

In addition, each of the five containments is equipped with an independent leak detection system with an independent leachate collection sump to allow for detection of any leaks through the primary liner. Each containment's associated liner, leak detection system and collection sump will be inspected at least once per week, while in use. The results of the inspection, including the monitoring of the liquid leak detection sump, will be documented on an inspection checklist and these records will be maintained by the facility owner. The inspection records will be maintained and available for review upon request.

When the recycling containment is not in use, ballast will be maintained in the containments, to prevent wear and liner deterioration due to potential liner uplift from winds. The facility will be enclosed by fencing and the fencing will be closed and secured by a locked gate when not in operation to prevent unauthorized access. Fencing at the facility will be installed as described in Section 4.4 and shall be maintained in good repair.

All containments and equipment for the water recycle system will be installed within a lined, secondary containment at the facility to prevent release or migration of any leaks from the containments or contact storm waters. The secondary containment will function as a secondary barrier to prevent releases from surface run off and vertical migration of fluids through the subsurface. The secondary containment will be graded to a localized in-ground collection sump at the southeast end of the facility and is equipped with a synthetic drainage system to covey fluids to the collection sump. The site is graded to drain any storm water runoff to one of four localized storm water collection sumps.

The following inspection, maintenance, and monitoring procedures will be implemented weekly unless otherwise noted.

1. Dike Integrity: The perimeter of the facility secondary containment dikes will be inspected for evidence of storm water run-on, significant erosion, and/or leakage out of the perimeter dikes. The liner system will be inspected for signs of wear or degradation which would result in reducing the integrity of the structure or overall system.

2. Oil Removal: Crude oils will not be stored in the water recycling containments. The above-ground containments (tanks) will be inspected on a weekly basis for visual indication of oil on the liquid surface. Any visible layer of oils will be removed from the liquid surface. Collected oils will be transferred and will be stored within the skim oil tank on-site.

3. Liner Integrity: The water recycling containments' liners will be inspected from the perimeter dikes to confirm liner interior coverage and perimeter anchor integrity (to ensure liner is intact within the containment structural wall as designed). Additionally, assuming there is no indication in the leak detection system of a leak, the liner within each of the containments will be visually inspected on a monthly basis or as the containments are emptied or drained for indications of potential wear or deterioration of the primary liner system.

   LDPE liner systems in the containments will be inspected for signs of UV degradation and will be replaced in the tanks every five years (minimum) or as recommended by the manufacturer.

4. Adequate Freeboard: A surface water level indicator will be installed in each of the containments to allow for water surface level monitoring. The level of water in the water recycling containment will be monitored on a daily basis during normal operations to verify that there is at least three (3) feet of freeboard from the top of the containment wall to the adjacent top of the water surface to ensure the required freeboard level of three feet is maintained during operation and overtopping is prevented. The operational level of the containment will be documented weekly.

5. Containments' Sump Riser Integrity: The exposed parts of each containments' liner leak detection (LLD) sump riser and will be inspected for integrity and presence of leaks.

6. Containments' Sump Levels: An LLD sump liquid monitor will be installed in the LLD sump for each containment. The LLD sump liquid monitor will be observed to confirm the presence of leachate and determine if a failure in the primary tank liner exists. If detected, leachate will be evacuated from the LLD sump (via vacuum truck). The volume of fluids removed from the sump will be recorded. The LLD sump monitors will be inspected and recorded weekly or as the leachate is evacuated from the LLD sump.

7. Containments' Sump Control Operability: A LLD sump level controls and alarms will be installed adjacent to the containments. The controls and associated alarms will be inspected and tested for control panel device functionality.

8. Exposed Geocomposite Liquid Collection Integrity: As applicable, any exposed liner or composite synthetic drainage net will be inspected for rips, tears or other damage. Damaged geotextile components and the composite drainage net will be repaired or replaced as needed.

9. Leak Detection Flow Volume: Each containments' LLD sump increment flow volume will be recorded when encountered during the inspection. The total LLD increment flow volume will be compared to the capacity of the sump. If the total volume is greater than half the sump volume, then the system will be considered to have a significant failure and require repairs. See number 11, below.

10. Recordkeeping for Inspections: The date, time, and observations made during each inspection will be recorded for each containment. The records will be maintained by 3Bear while the water recycling containments are open, and if requested by the NMOCD, the records will be filed with the NMOCD after closure. Logs of the inspections and inspection records will be made available to the NMOCD upon request.

11. Containments' Liner System Integrity Inspections and Repair: In the event that leakage from the containments into the leak detection LLD sump is suspected by positive fluid level measurements, the operator will evacuate the contents of the sump and monitor the sump on a daily basis for a week to determine the leakage rate into the sump.

    If the leakage rate is exceeding the action leakage rate (i.e. half of the available capacity of the sump) or if a visible defect or breach in the liner is detected (below the water surface):
    a) The effected containment(s) will then be emptied and placed out-of-service immediately and the liner will be inspected for system integrity. Any breach of the liner or associated liner leak detection system will be repaired prior to the containment(s) being placed back into service.
    b) The NMOCD district office will be notified within 48 hours of the breach and the positive leakage and any repairs of the liner system will be initiated within 48 hours of detection. The NMOCD will be contacted to request an extension for liner system repair as needed. Liner repairs will be tested for integrity via vacuum box or seam weld testing (as applicable) or other equivalent method prior to being placed back into service. Geosynthetics repairs and integrity testing will be performed in accordance with the engineering specifications and the manufacturer's requirements.
    c) Any liquids evacuated from the sump associated with the leakage will be recorded.
    d) The operator will provide the NMOCD with a report describing the inspection and/or repair within 20 days of the initial notification.

12. Secondary Containment System Integrity and Monitoring: As described above, the facility, secondary containment system is equipped with a synthetic drainage system and a containment collection sump. The purpose of the collection sump is to collect and retain storm water infiltration and any leachate in the event that a containment(s) have a breech or failure of its own independent leak detection system. The facility's secondary containment collection sump will be monitored on a weekly basis for indications of fluids.

The secondary containment sump will be equipped with a riser, a liquid level indicator, and an automated submersible sump pump. In the event, waters collect in the secondary containment sump, they will be evacuated from the sump area. Samples of the collected waters in each sump will be visually observed for indications of a sheen or production waters. As samples are collected, each containments' LLD sump will also be inspected for indications of fluid and evacuated as required.
Samples collected from the secondary containment will be sent to a laboratory and analyzed for TPH, Chlorides, BTEX, and Benzene. Comparison of the laboratory results with the recycled waters analysis and Table 1 of NMAC 19.15.34.14 (for 51-100 feet) will be performed to aid in characterization of the recovered fluids. If the samples are clean and determined to be storm waters or possibly contact storm waters, and thresholds identified in the Table 1 mentioned above is not exceeded, then the waters will be placed back into the recycle system and operations will resume.
If contaminated fluids, exceeding the thresholds identified in Table 1 of NMAC 19.15.34.14 (for 51-100 feet) are discovered in the operations will be suspended and an investigation of the potential release point (containment failure) will be performed.
The NMOCD will be notified of the potential failure within 48 hours and will be informed of the investigation, results of any analysis and any repairs performed for the system. 3Bear will work with the NMOCD during the investigation and will not continue operations until the facility's systems integrity is restored and approval to continue with operations is received from the NMOCD.

13. Spill Response: The operator will have spill response equipment, such as an oil absorbent boom or other device, and response personnel available within a reasonable time necessary to contain and unanticipated release from the containment system. Drainage systems at the site and in proximity of the containments and water recycle area will be inspected on a weekly basis for indications of a leak or release.
A Spill Response, Control and Countermeasures (SPCC) Plan will be implemented for the facility.

The operator will report releases of fluids in a manner consistent with and as required by NMAC 19.15.29 and any local or federal requirements, as applicable.

Groundwater Monitoring: To further aid in ensuring that protection of groundwaters from facility operations is maintained, 3Bear will initiate and maintain a groundwater monitoring program for the facility. 3Bear proposes to install up to four (4) groundwater monitoring wells at the facility. One-two of the monitoring wells will be installed up-gradient and at least two wells would be installed downgradient of the facility. The wells will be installed into a depth of at least 10 feet below the water surface. The exact proposed location, design, construction, and installation of the monitoring wells will be provided to the NMOCD and approved by the NMOCD and the Office of the State Engineer, as required, prior to implementation at the site. The proposed design and location of the monitoring wells are not included in this application at this time, however, they will be provided as supplementary submittals for approval prior to operations at the facility.
Note: Due to the fact that there are other oil and gas operators, which have exploration and production activities immediately upgradient of the proposed Cottonwood site, 3Bear will propose two upgradient monitoring wells, likely to be located to south of the facility in addition to two monitoring wells immediately downgradient of the facility.

3Bear intends to collect water samples from all wells once installed for purposes of establishing a baseline characterization of the groundwater.
3Bear will work with the NMOCD to propose a groundwater monitoring program which is suitable for the type of operation and will meet the NMOCD requirements for protection of groundwater including monitoring, sampling, reporting, and response actions. Proposal of a groundwater monitoring program is not included in this application and will be proposed in a supplementary submittal upon further consultation with the NMOCD.

14. Wildlife Inspections: The operator will inspect the containment and surrounding areas for dead migratory birds and other wildlife. The operator will report the discovery within 30 days of discovery and will 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.

15. Site-Generated Wastes: Site generated wastes will be collected on site and transported off-site to an approved and NMOCD permitted disposal facility. Solid wastes may be transported to a permanent disposal facility. Liquid wastes may either be disposed of at a permitted off-site SWD, operated by 3Bear, (for permitted RCRA exempt wastes) or may be transported off-site for disposal at a 3rd-Party permitted facility.

16. Operational Records: Accurate records will be maintained at the facility to include total volumes of waters received, volumes of waters for treatment and recycling, volumes of waters for disposal, volumes of waters for sale (leaving the facility), and volumes of treated waters deposited into and withdrawn from each of the containments. 3 Bear will submit a completed FORM C-148 to the NMOCD within 30 days following the end of each calendar month. The submittal will describe the operation and certify that the recycling containment operation have not ceased based on use of the 20% threshold of the containment's total operational fluid capacity, every six months until closure in compliance with NMAC 19.15.34.13.

    The operator will maintain accurate records that identify the sources and disposition of all recycled waters that shall be made available upon request.

17. Secession of Operations: 3Bear will notify the NMOCD district office and secession of operations of the water recycling facility and the associated containments. The containments will be drained of fluids and the facility closure plan, described in Section 6.0, will be initiated within 60 days.

6.0 CLOSURE PLAN

Upon secession of operations the NMOCD district office will be notified and all fluids will be removed from the tanks and containments within 60 days. The water recycling containments will be closed within six months of secession of operations. A part of the facility closure, any solids, liner materials and leak detection system components will be removed. All removed liquids, solids, and liner/leak detection materials will be transported to an off-site, NMOCD approved disposal facility within the closure period. Other above-ground storage tanks, pumps and equipment will be decommissioned and removed from the site for re-use or disposal, as applicable. The secondary containment system including liner and any contaminated soils material used for the tank subgrade (above the secondary containment liner) will be transported off-site to an approved disposal facility.

Upon removal and disposal of materials, 3Bear will initiate a sampling program for the closure at the containment site. A five-point (minimum) composite sample will be collected at a pre-determined spacing from beneath the lined, secondary containment and tested by a qualified laboratory for potential contamination. The composite sample(s) will include any stained or saturated soils or areas. The sample(s) will be analyzed for the constituents listed in the Closure Criteria for Recycling Containments Table 1 of NMAC 19.15.34.14.

In the event, any contaminant concentration exceeds the values listed for Closure Criteria for Recycling Containments (from 51 feet-100 feet), 3Bear will contact the NMOCD and request approval of a proposed approach prior to proceeding with the closure activities. Alternative proposed approach for site closure, if required, will be performed in accordance with NMOCD requirements and recommendations and will be initiated upon approval from the NMOCD.

If all constituent concentrations are less than or equal to the values listed in the Closure Criteria for Recycling Containments Table 1 (from 51 feet-100 feet), 3Bear will proceed with the closure plan as described.

6.1 Razing, Grading, and Site Restoration

The site closure will be accomplished by razing the secondary containment area and leveling the site by using non-contaminated, native earthen materials at the site. If needed, additional borrow soils from a nearby borrow pit will be used as backfill. Backfill soil materials will be compacted to stabilize the subgrade and minimize future potential subsidence conditions at the site. Once razed, the site will be regraded to tie-in with the immediate surrounding grade. Grading will be accomplished such that the finished surface will blend into the surrounding grade and that grading will be contoured to allow for positive surface drainage from the property and so that contouring will be restored to original relative conditions. Top-soils, if present will be replaced and contoured to achieve stability and minimize erosion.

6.2 Reclamation and Re-Vegetation

The site will be re-seeded to promote vegetative growth and restore the site to its pre-existing conditions. The reseeding activity will consist of seeding of local native grasses to the area and surface reclamation with a goal coverage of ground disturbing areas. Surface reclamation is determined to be completed when the following are complete:

- all ground disturbing activities are completed;
- a uniform vegetative cover with a ratio of plus or minus 50% of the pre-construction surface level has been established; and

- at least 70% of a total percent plant, excluding noxious weeds, are established;

3 Bear will notify the NMOCD upon completion of re-vegetation and reclamation of the site.

6.3 Documentation of Site Closure

Upon completion of the grading activities and the site closure activities, 3Bear will submit a Closure Report with the NMOCD FORM C-147 and the required attachments. The Closure Report will document all closure activities, including waste materials disposal, construction, backfilling, and grading. The report will be provided within 60 days of closure and will include the sampling results and analysis for the closure of the site.

7.0 FINANCIAL ASSURANCE REQUIREMENTS

This section describes cost estimates for closure of the water recycling containments and facility at the 3Bear Cottonwood Water Recycling facility. The estimated costs shown are based on current prices and equipment rates for necessary closure construction. The estimated costs shown for construction materials, including borrow soils, are based on use of material purchased from an off-site commercial source. The estimated costs shown for disposal of waste and demolition debris are based on disposal in an authorized commercial disposal facility. Disposal costs assume that no naturally occurring radioactive materials (NORM) are included in the disposal costs or scope.

The estimated cost for closure of the water recycling containments and facility are based on removal of waste materials and closure as described in Section 6.0. The cost includes estimates for removal of the recycle water system tanks and associated piping and estimates for plugging the off-site SWD well. A contingency is included in each estimated cost total. A summary of the estimated costs and a breakdown of the estimated cost is shown in Tables 7.1, 7.2, and 7.3 below. The total estimated cost for closure of the Cottonwood Water Recycle facility is $2,979,302.

Financial Assurance
Pursuant to the requirements of NMAC 19.15.34.15, 3Bear Energy, LLC plans to file a Surety Bond or an Irrevocable Standby Letter of Credit from an authorized bank, payable to the State of New Mexico, for financial assurance meeting the requirements. Financial assurance will be submitted on the required NMOCD forms in the amount of $2,979,302 upon approval of this application.
3Bear requests that it be noted that a bond in the amount of $2,170,094 is being prepared to be issued for the financial assurance at the 3Bear Libby Site and Impoundment. 3Bear respectfully requests that the NMOCD provide further advisement if issuance of a single bond in the larger amount of the two estimates can be provided as financial assurance coverage for both facilities. Otherwise, 3Bear is prepared to issue separate bonds in the amounts as stated for both facilities.

NMOCD Permit to Maintain and Use a Commercial Water Recycling Facility - FORM C-147

Table 7.1 - Summary Table

Summary of Closure Cost Estimates for 3Bear Energy, LLC - Cottonwood Site	
Description	**Estimated Cost**
Secondary Containment Razing and Reclamation	$1,949,352
Water Storage Containments (5 Each)	$150,030
Water Recycle	$441,075
Off-Site SWD Plugging (if applicable)	$168,000
Contingency 10%	$270,846
Total Estimated Closure Costs:	**$2,979,302**

Note: Estimated closure costs include solid waste disposal and characterization of the site, however it assumes that the site is "clean" and does not include remediation costs or disposal costs associated with RCRA non-exempt hazardous waste materials or NORM materials. Construction disposal for piping and ancillary equipment is estimated as engineering drawings are not issued for construction at this time.

3Bear Energy, LLC - Cottonwood Site Recycle Facility, Containments and SWD Closure Cost Estimate

Table 7.2 – Secondary Containment Estimated Closure Costs

Equip	Cost $/hr
Trackhoe	$185.00
D8 Dozer	$195.00
Loader	$105.00
30 Bbl Water Truck	$98.00
Sheepsfoot	$98.00

Material Removed for Disposal for Cottonwood Site

Subgrade (CY)	Containment Berm (CY)	Net Total (CY)
25007	3400	28407

Material Moved/Re-compacted for Cottonwood Site

Excavation (CY)	Fill (CY)	Net Total (CY)
17265	4898	12367

Assumptions:

All soil materials on top of secondary containment liner will be disposed at an off-site facility.

Move material at 1,200 CY per day

Compact material at 400 CY per day

Cost Estimations:

Estimated Costs for Razing/Backfill/Grading Site:

Equip	Cost $/hr	# of Hours	Cost
Trackhoe	185	103	$19,065.79
D8 Dozer	195	103	$20,096.38
Loader	105	77	$8,118.47
30 Bbl Water Truck	98	340	$33,329.07
Sheepsfoot	98	309	$30,299.15
Grader	115	62	$7,130.00
Estimated Cost for Razing/Backfill/Grading the Cottonwood Site:			**$110,908.85**

Secondary Containment Liner Removal/Material Disposal:

Assumptions:

Move material at 1,200 CY per day

Area is ~6.2 acres or ~270,100 CF at 1 foot depth

Equip	Cost $/hr	# of Hours	Cost
Trackhoe	185	237	$43,794.13

	D8 Dozer	195	237	$46,161.38
	Loader	105	189	$19,884.90
	30 Bbl Water Truck	98	0	$0.00
	Sheepsfoot	98	0	$0.00
Estimated Cost for Material Removal:				**$109,840.40**

Estimated Cost for Hauling waste soils per CY:	$15.00	
Estimated Cost for Disposal per Ton:	$30.00	
Subtotal Estimated Cost for Disposal:		***$1,576,589***
Total Estimated Cost for Liner Removal and Disposal:		**$1,686,429**
Environmental Sampling Analysis and Engineering Support:		**$38,144**
Estimated Cost for Reseeding:		**$4,030**
Total Estimated Costs:		**$1,949,352**

Estimated Costs for Containments Removal:

Description	Cost $/unit	# of Units	Cost
Drain and Tear Down	11000	5	$55,000.00
Liner Disposal	19006	5	$95,030.00
Estimated Cost for Containments Removal at the Cottonwood Site:			**$150,030.00**

3Bear Energy, LLC - Libby Site Water Recycle Tanks and SWD Closure Cost Estimate

Table 7.3 - Water Recycle Tanks and SWD Estimated Closure Costs

Description	Cost, $/Ea	Qty	Unit	# of Units	Est. Cost, $
Material Removal/Disposal	$55	5	CY	1481	$407,275
Steel ASTs (Tanks)	$1,500	5	EA	1	$7,500
Tank Piping	$8	5	LF	200	$8,000
Pump Removal	$1,200	4	EA	1	$4,800
Sump Removal/Disposal	$2,500	4	EA	1	$10,000
Small AST Containment	$3,500	1	EA	1	$3,500
Total Estimated Cost:					**$441,075**

Note: Piping material Units are estimated and not based on construction as construction drawings are not issued.

Estimated Cost for Plugging Off-Site SWD Well	**Est. Cost, $**
Off-site SWD Well Plugging at 13,300 feet bgs	**$168,000**
SWD plugging estimated provided by 3rd party.	

8.0 VARIANCE REQUESTS

A. Siting Requirements:
Per NMAC 19.15.34.11 A(1), an operator shall not locate a recycling containment where groundwater is less than 50-feet below the containment.

Based on the observations during the geotechnical investigations as described in Section 3.2 and in Appendix C, groundwaters were observed at various depths, ranging from 33 feet bgs to 48 feet bgs, in certain deep borings beneath the facility and proposed containment locations. 3Bear respectfully proposes to construct and operate the facility as described in this application in effort to provide alternative engineering controls to aid in the protection of groundwater. As described, 3Bear intends to install and operate five, independently operated above-ground water storage containments which are synthetically lined and equipped with independent leak detection systems. The five containments are designed and will be constructed with a dual, 40-mil LDPE geomembrane supported by steel structural panels. The containments will be equipped with a liquid leak detection system. These containment systems will be installed as described in Section 4.0 and the design drawings, specifications and per the manufacturer's recommendations. The independent leak detection systems will be monitored independently, as described in Section 5.0.

In addition, a bermed, and synthetically lined secondary containment will be installed utilizing earthen materials and a 40-mil HDPE flexible membrane liner barrier with a geocomposite drainage system to prevent vertical migration of leakage and prevent uncontrolled surface drainage from leaving the facility grounds.

As described in Section 5.0, the containment systems and lined secondary containment will be monitored for indications of structural failures of the containment, leaks, liner or and system degradation. LDPE liner systems in the containments will be inspected for signs of UV degradation and will be replaced in the tanks every five years (minimum) or as recommended by the manufacturer.

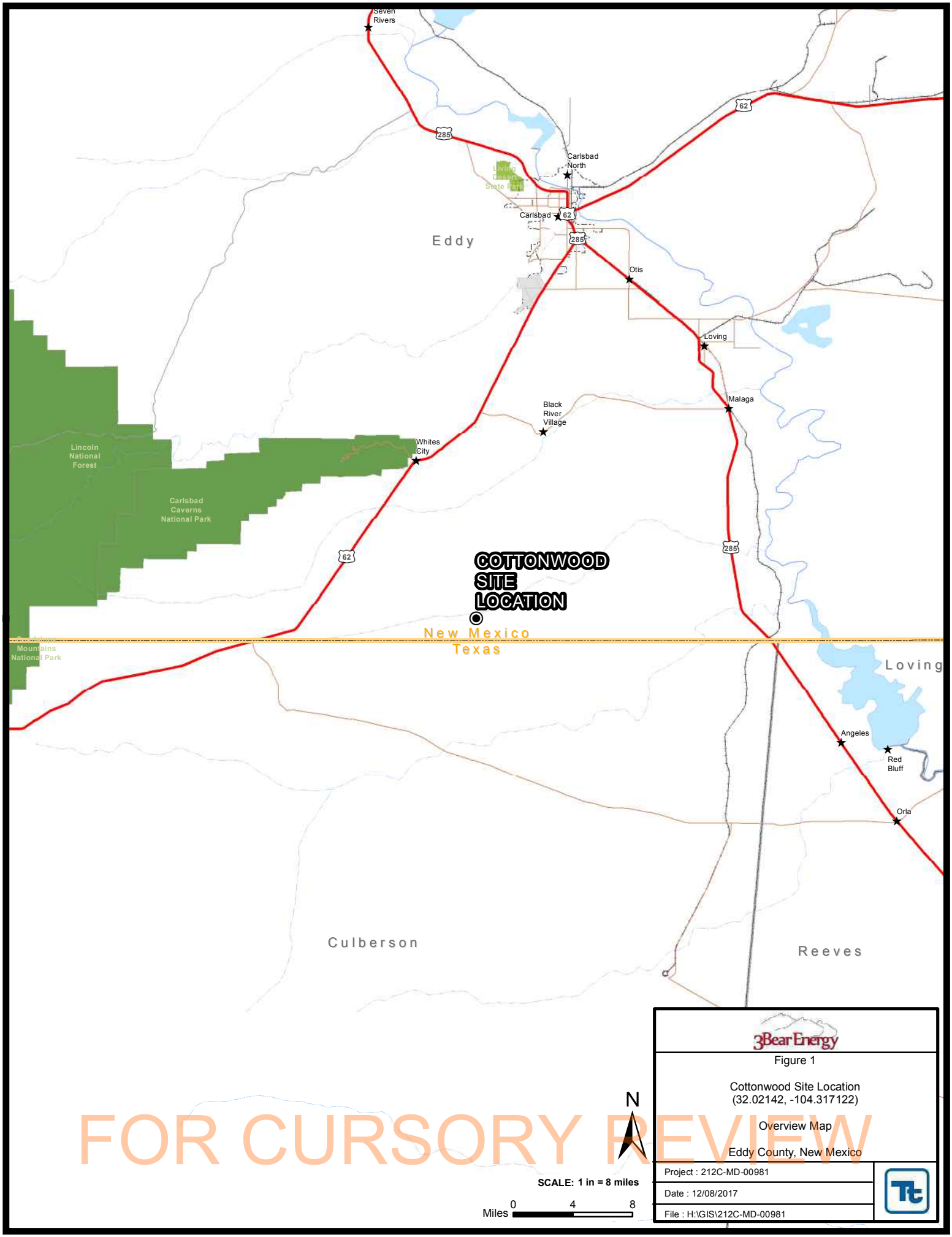
In effort to ensure the local groundwater beneath the site is protected, 3Bear proposes to initiate a groundwater monitoring program. This monitoring program will include installation of up to four monitoring wells. The monitoring program will be proposed independently of this application and will be approved by the NMOCD prior to implementation at the site and prior to operation as indicated in Section 5.0.

B. Fencing:
As described in Section 4.4, a six-foot high chain-link fencing, with 3-strand barb-wire, will be installed around the facility site instead of the four foot high, barb-wire strand fencing described in the FORM C-147 and NMAC. The proposed fencing will provide equivalent or better deterrent to animal and unauthorized personnel access to the facility and associated containment.

C. Netting:
As described in Section 4.5, the water recycle containment will be equipped with an audible bird protective system (i.e. Bird-X Mega Blaster PRO). The audible system is designed to effectively deter birds from approaching the containment area. This system has been used by other operators in southeast New Mexico and has been proven to be effective. 3Bear has determined that installation of the netting system for the types of

containments proposed is not practicable and has determined that the proposed audible system, such as the “Bird-X Mega Blaster PRO”, is a safe and reliable alternative.

FIGURES



3Bear Energy

Figure 1

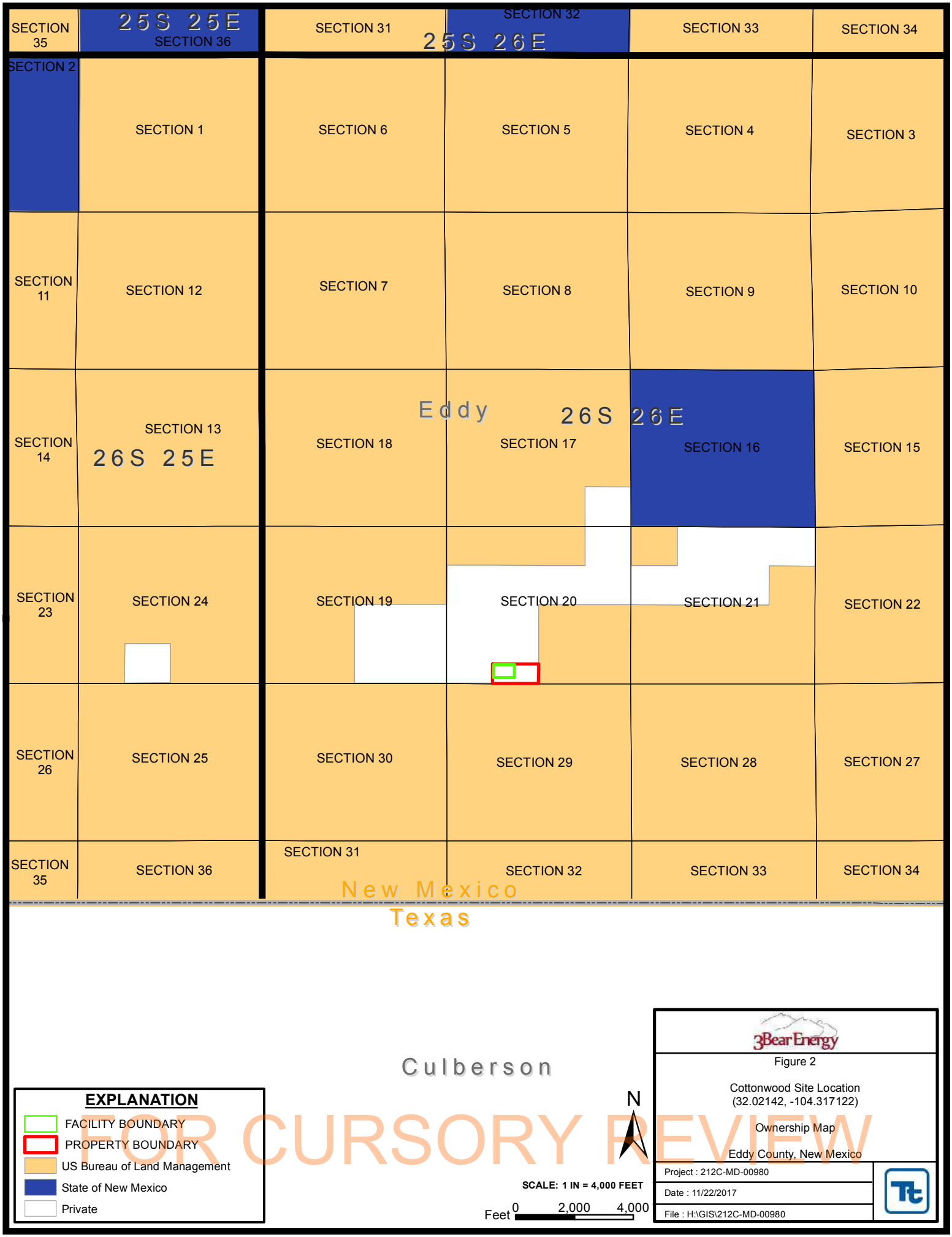
Cottonwood Site Location
(32.02142, -104.317122)

Overview Map

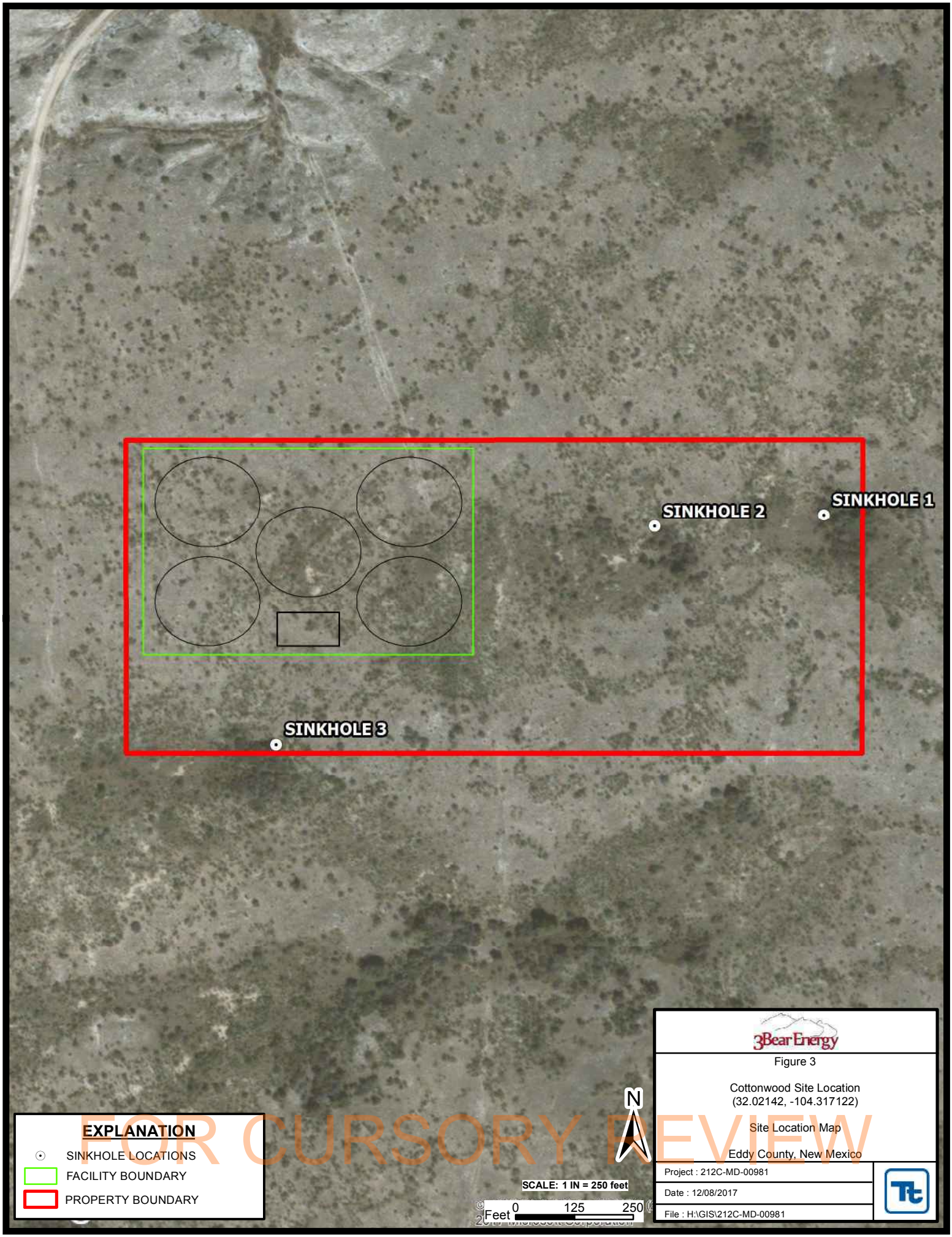
Eddy County, New Mexico

Project : 212C-MD-00981	
Date : 12/08/2017	
File : H:\GIS\212C-MD-00981	

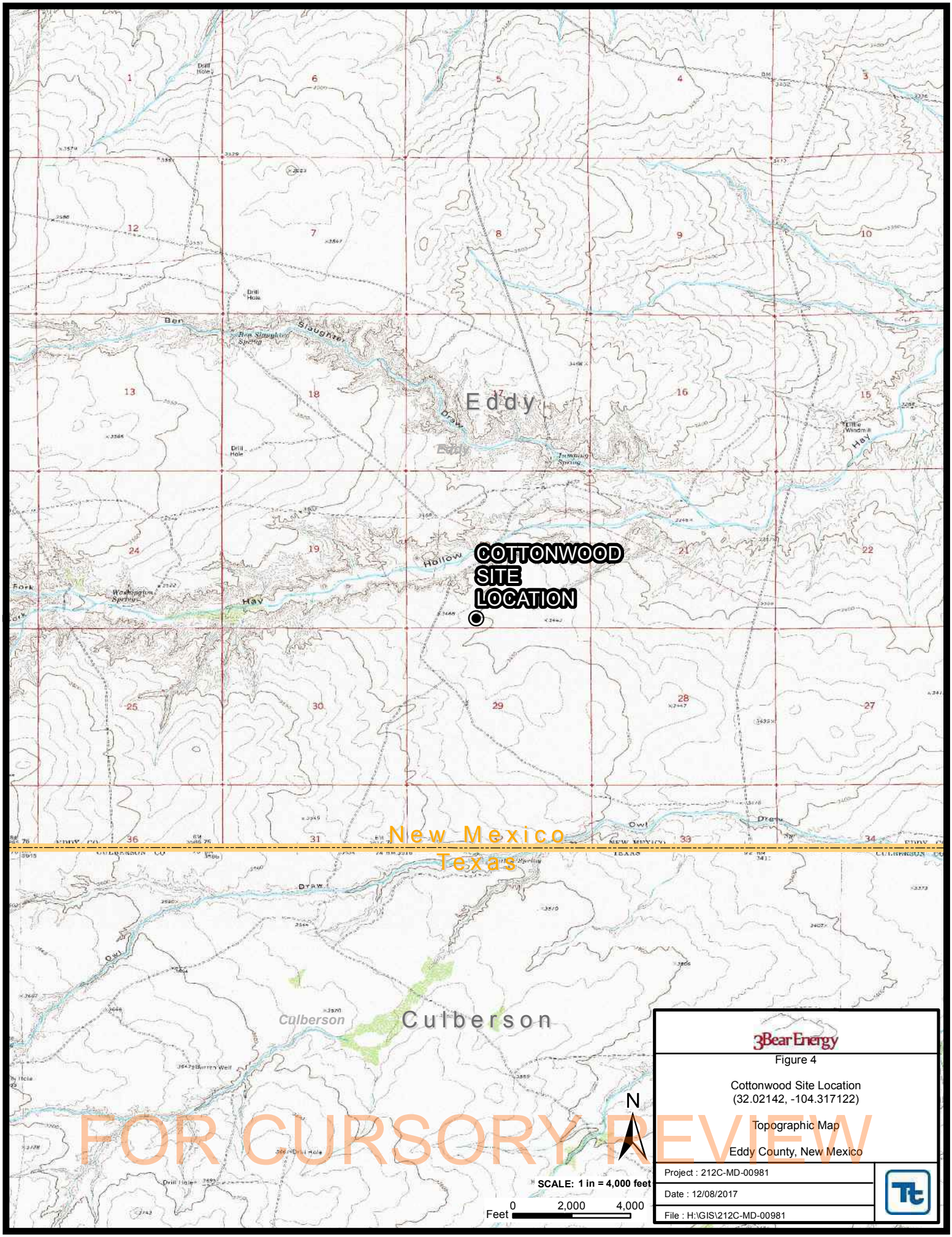
Mapped By: Isabel Marmolejo



Mapped By: Isabel Marmolejo



Mapped By: Isabel Marmolejo



3Bear Energy

Figure 4

Cottonwood Site Location
(32.02142, -104.317122)

Topographic Map

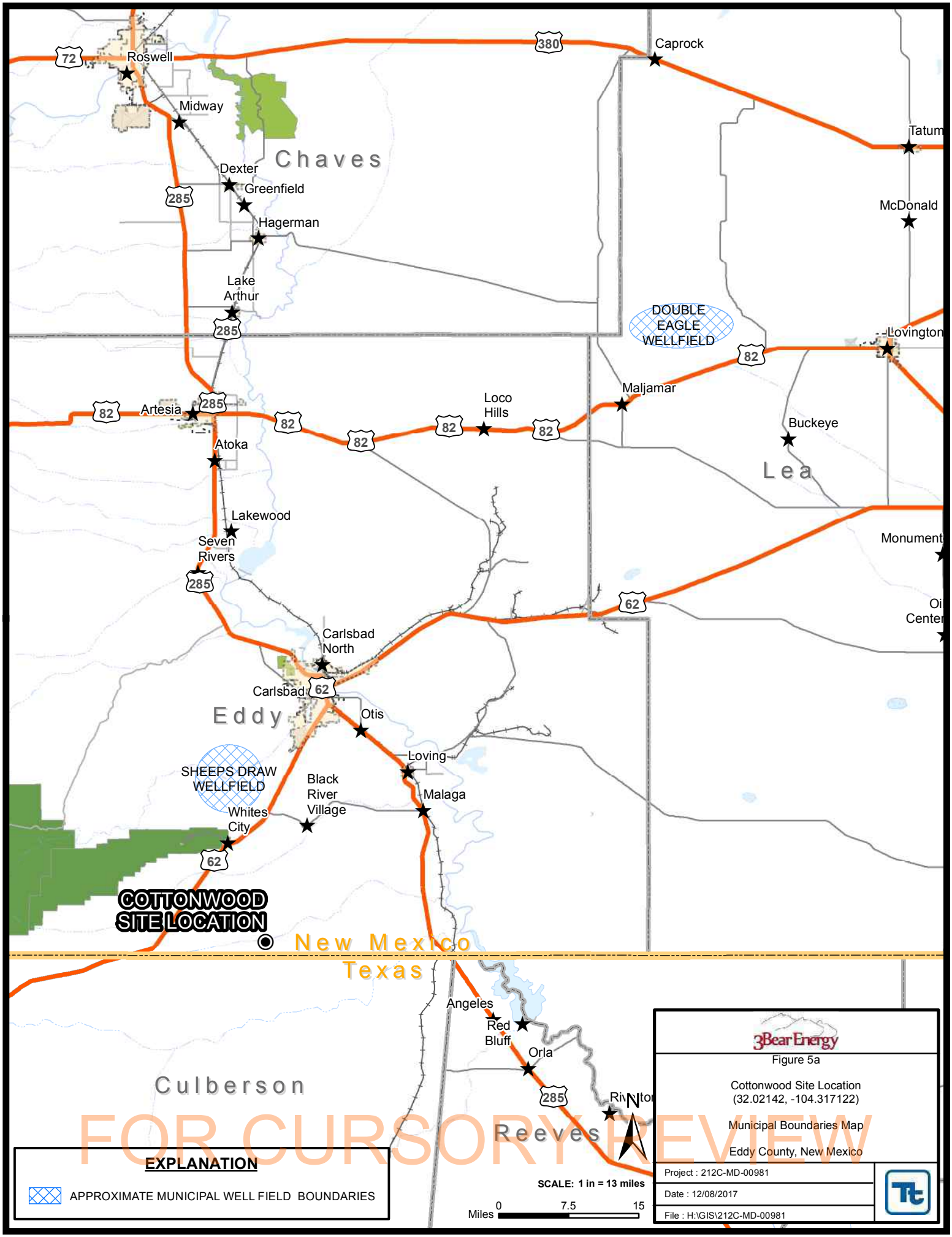
Eddy County, New Mexico

Project : 212C-MD-00981

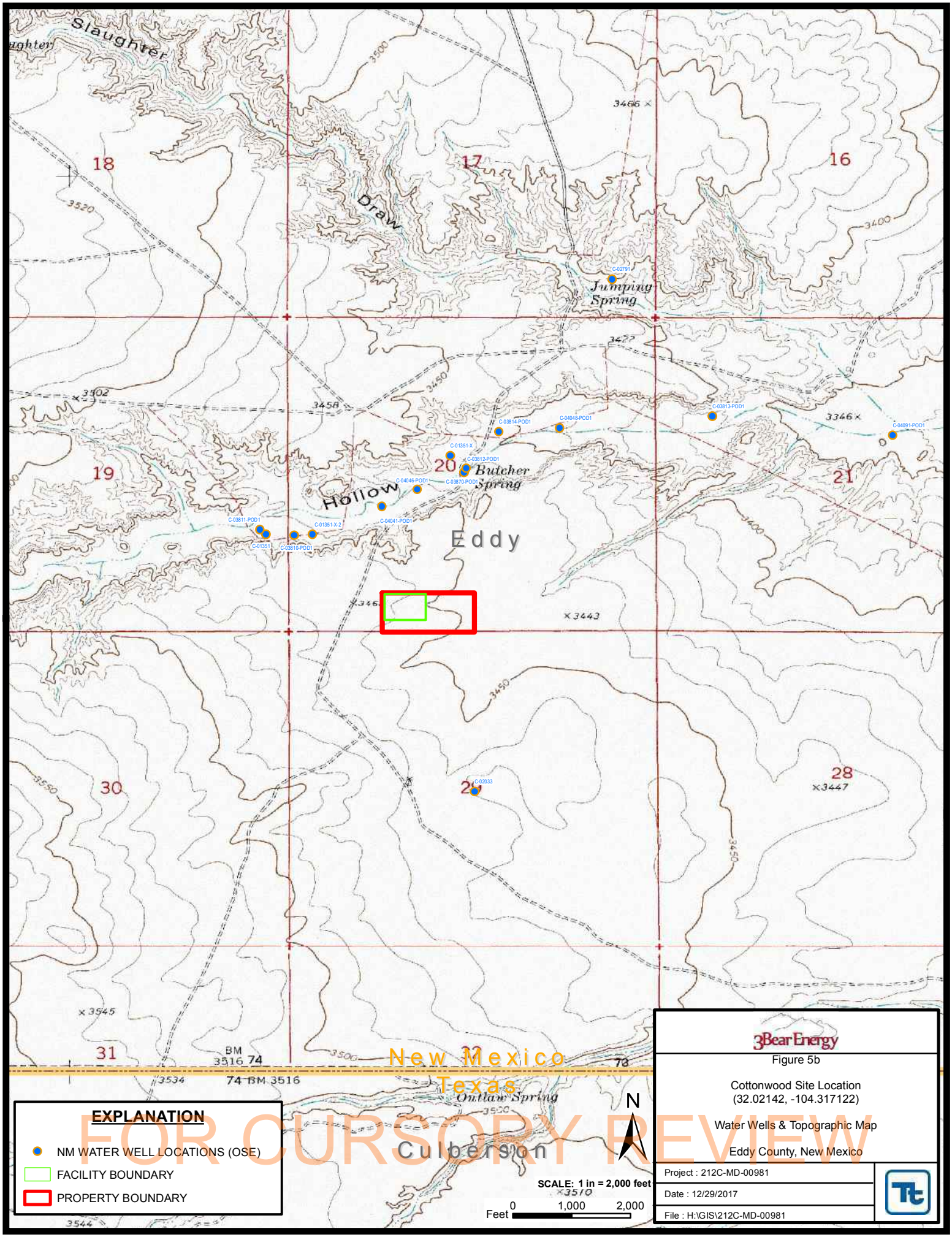
Date : 12/08/2017

File : H:\GIS\212C-MD-00981

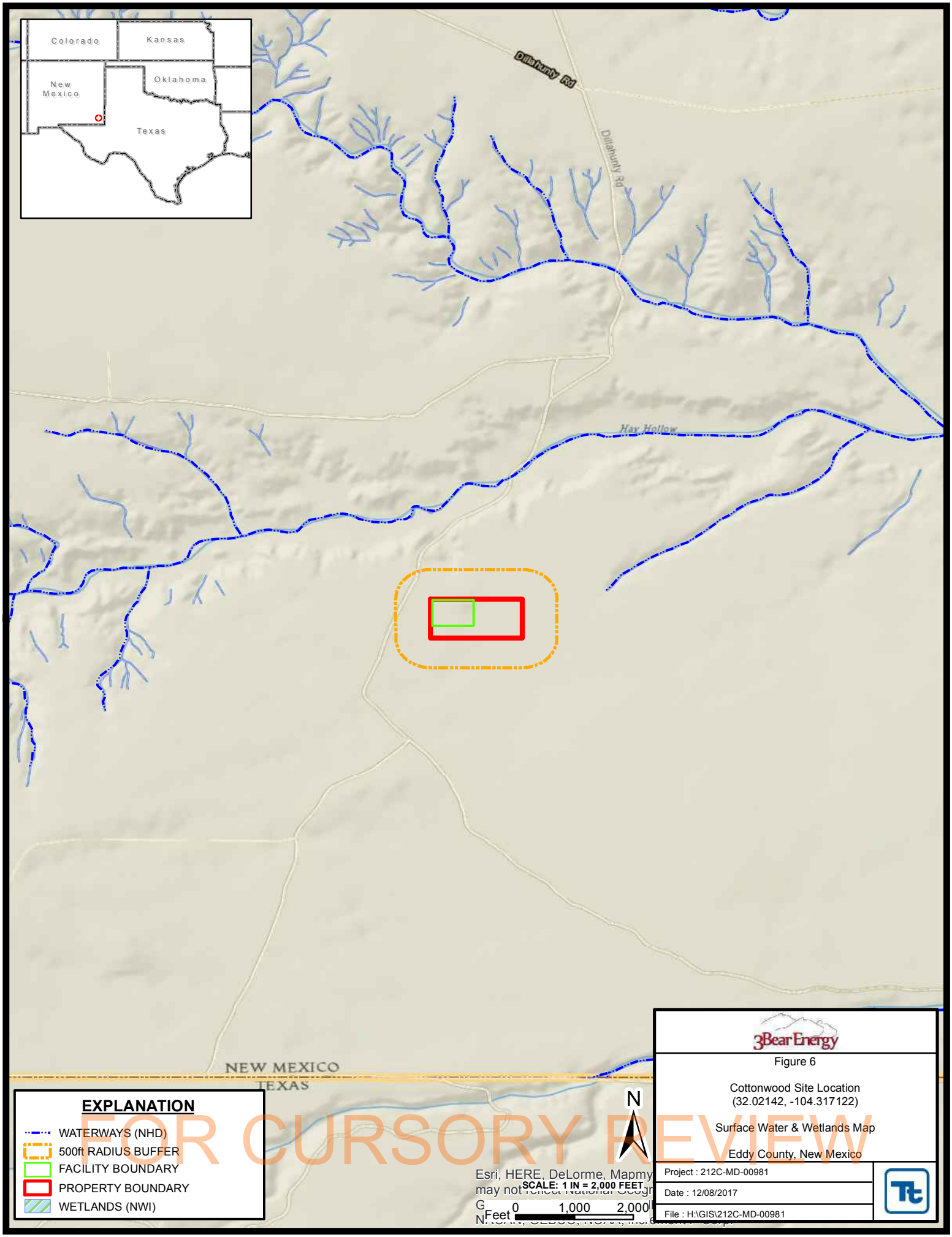
Mapped By: Isabel Marmolejo



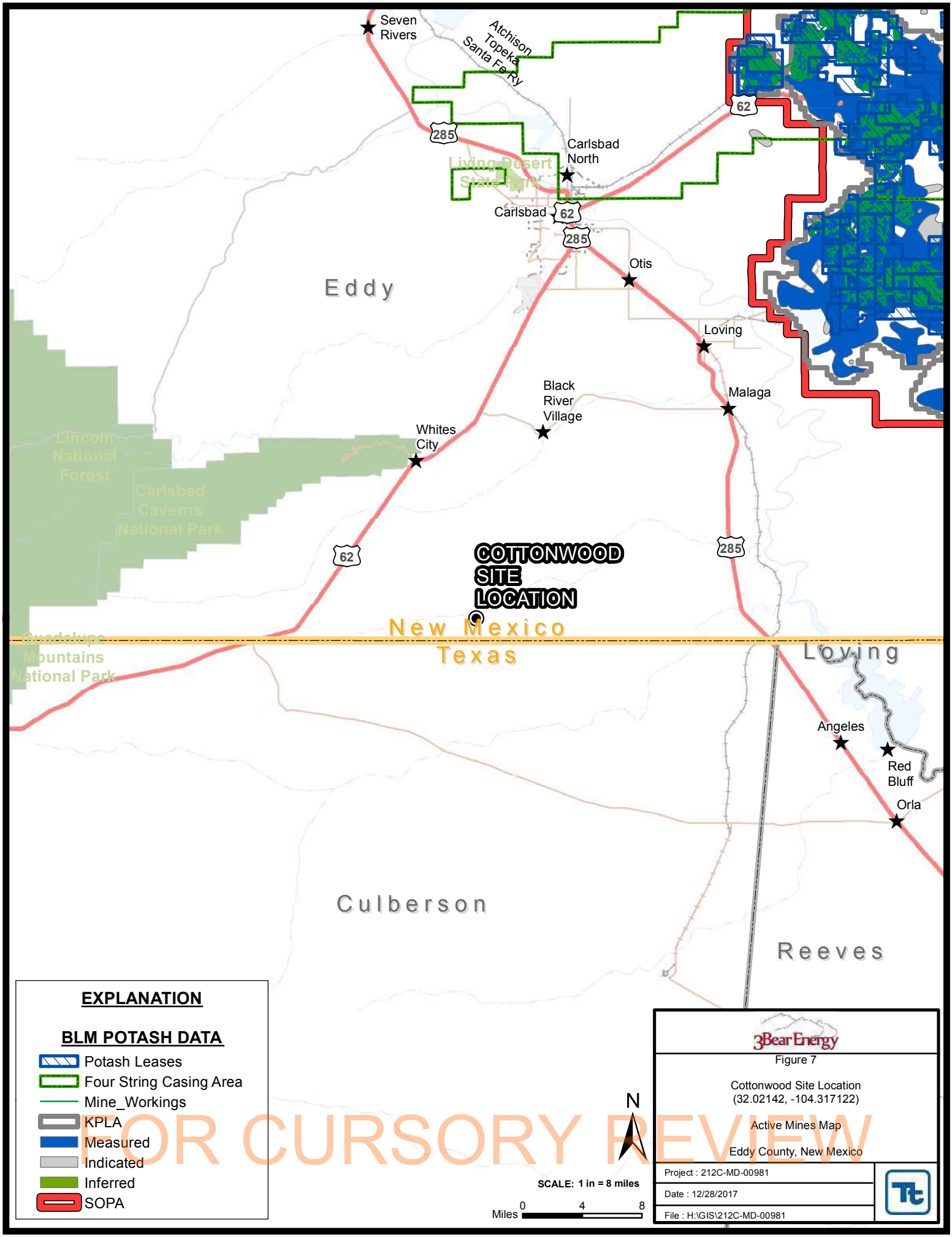
Mapped By: Isabel Marmolejo



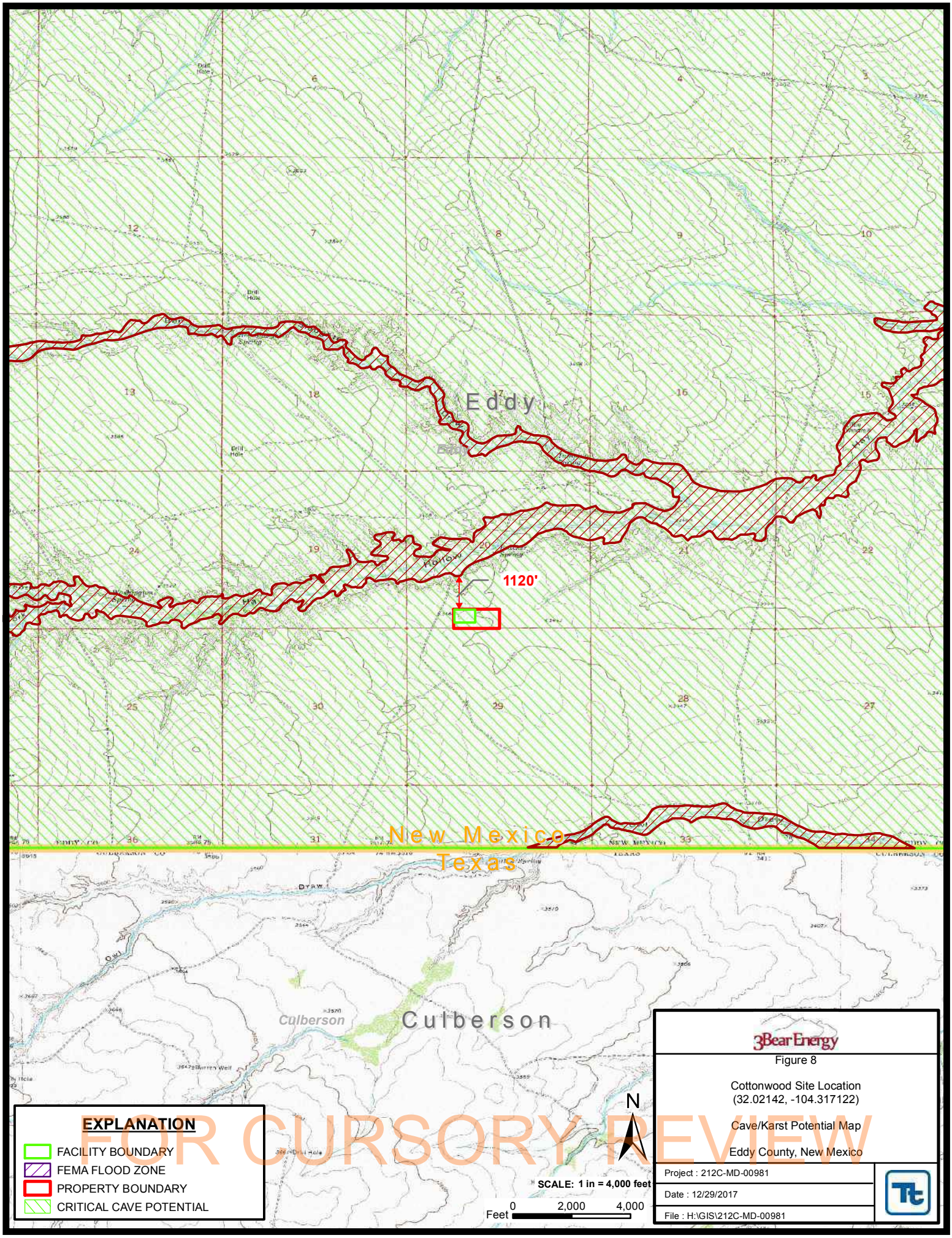
Mapped By: Isabel Marmolejo



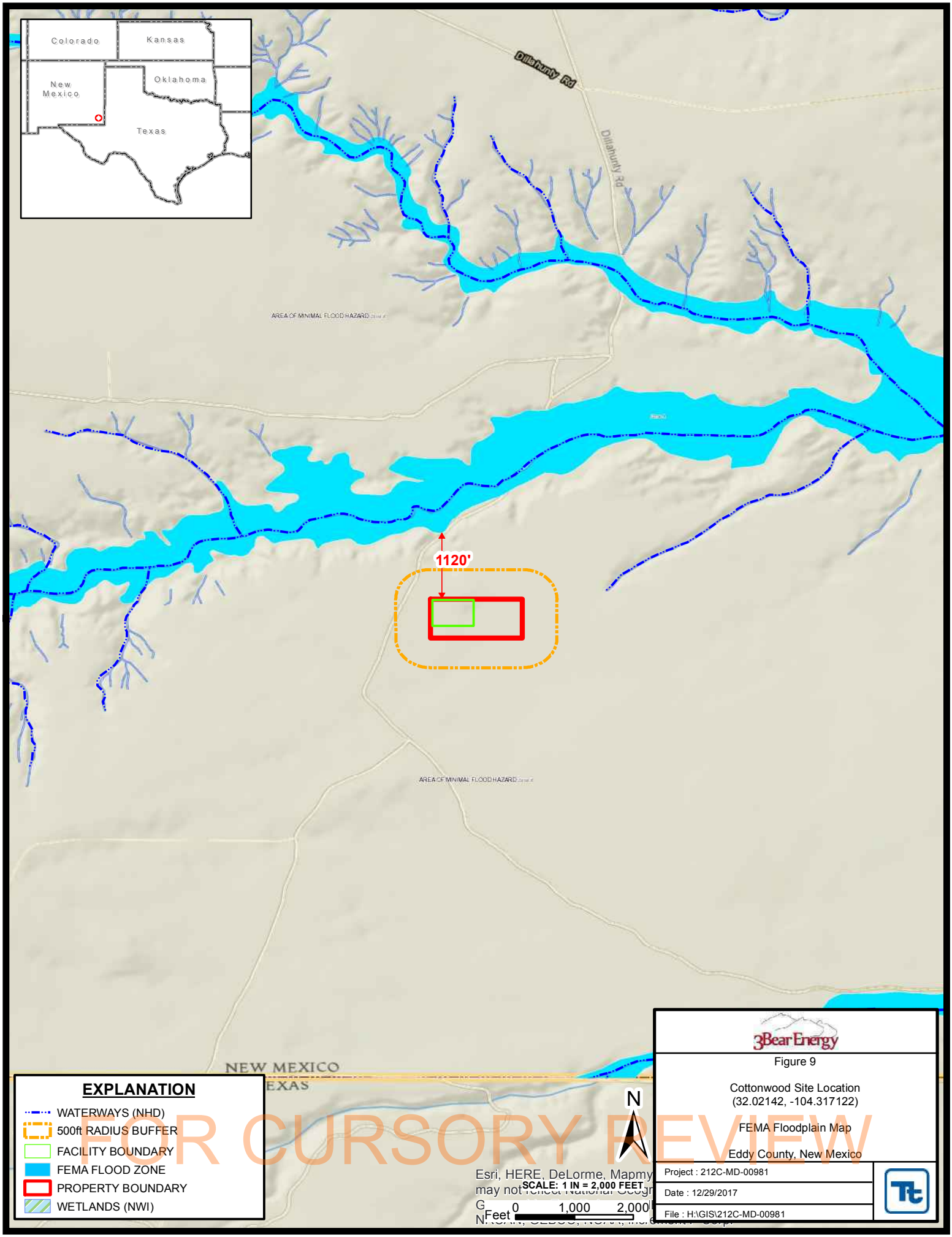
Mapped By: Isabel Marmolejo



Mapped By: Isabel Marmolejo

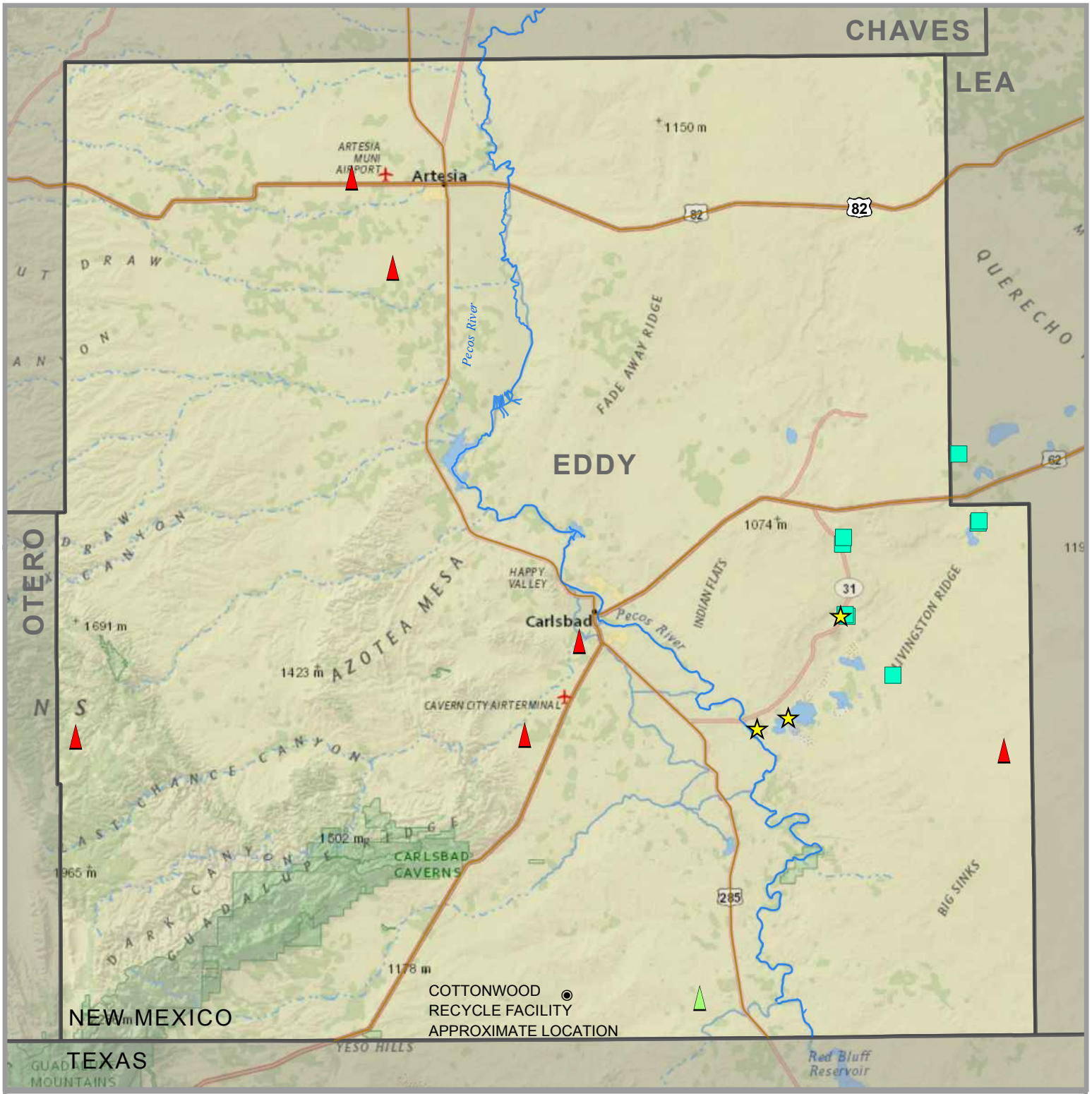


Mapped By: Isabel Marmolejo



Mapped By: Isabel Marmolejo

Active Mines in Eddy County, New Mexico, November 2014



Metals

Coal, Potash, Copper, Gold & Silver, Molybdenum

Industrial Minerals

Calcite, Gemstone, Gypsum, Humate, Perlite, Pumice, Salt, Silica / Flux, Silver Silica, Zeolites

Aggregate & Stone

Aggregate, Caliche, Clay & Shale, Dimension & Flagstone, Limestone, Red Dog, Scoria, Travertine

Data: November 2014 database query, Mining & Minerals Division, Mine Registration, Reporting & Safeguarding Program.
Basemap: Esri ArcGIS Online, National Geographic.
Map: Linda S. DeLay, GISP

NAD 83 UTM NM Zone13

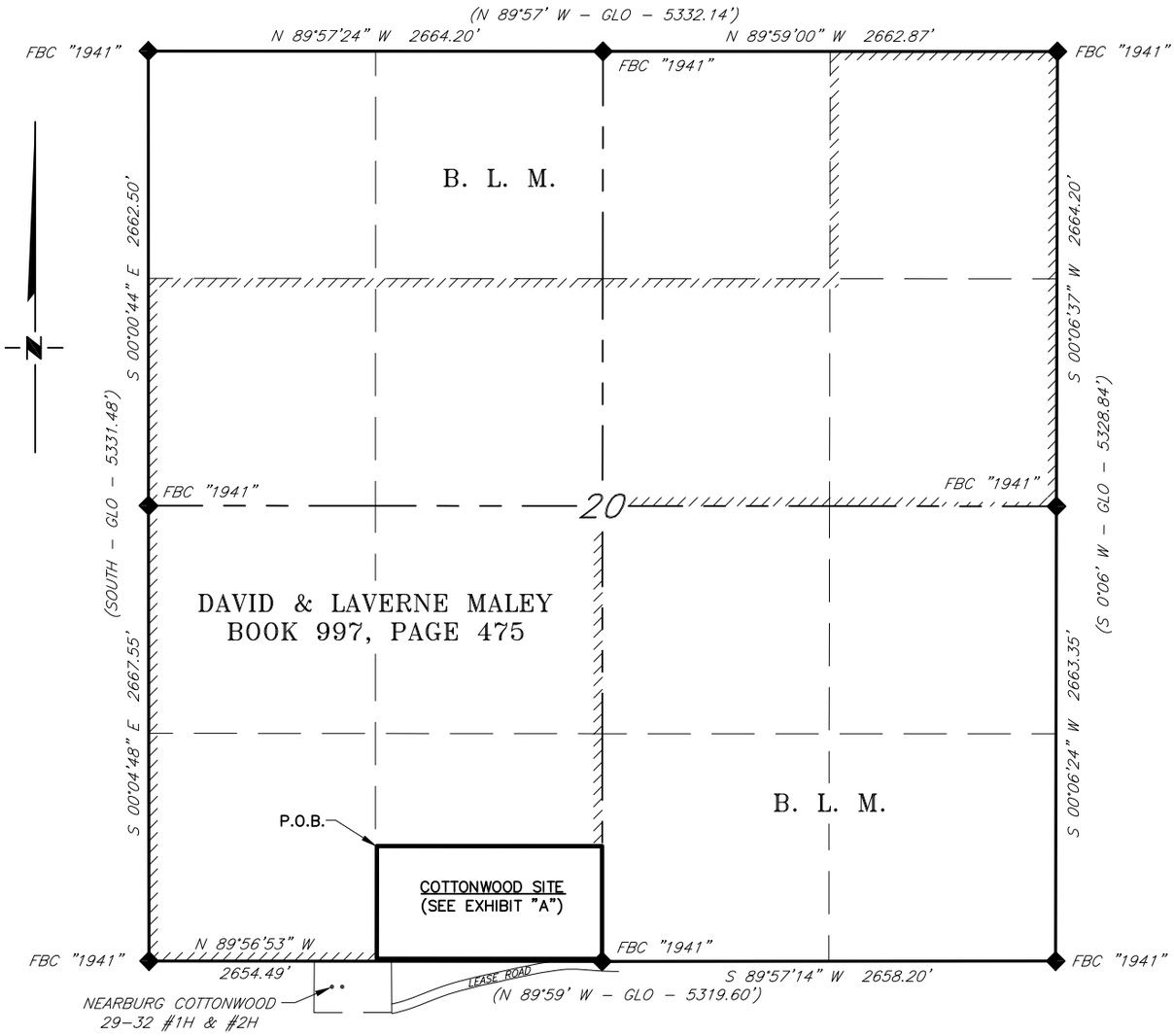
N W E S

0 5 10 20 Miles

APPENDICES

APPENDIX A – Cottonwood Water Recycling Facility, 20-Acre Property Survey Plats

3 BEAR ENERGY LLC
SURVEY OF THE PROPOSED
20 ACRE TRACT FOR THE COTTONWOOD SITE
SECTION 20, T26S, R26E,
N. M. P. M., EDDY CO., NEW MEXICO



PRELIMINARY

SCALE: 1" = 1000'
0 500' 1000'

BEARINGS ARE GRID NAD 83
NM EAST
DISTANCES ARE HORIZ. GROUND.

LEGEND
( ) RECORD DATA – GLO
◆ FOUND MONUMENT AS NOTED

Firm No.: TX 10193838 NM 4655451

NO.	REVISION	DATE

JOB NO.: LS1706382
DWG. NO.: 1706382–1

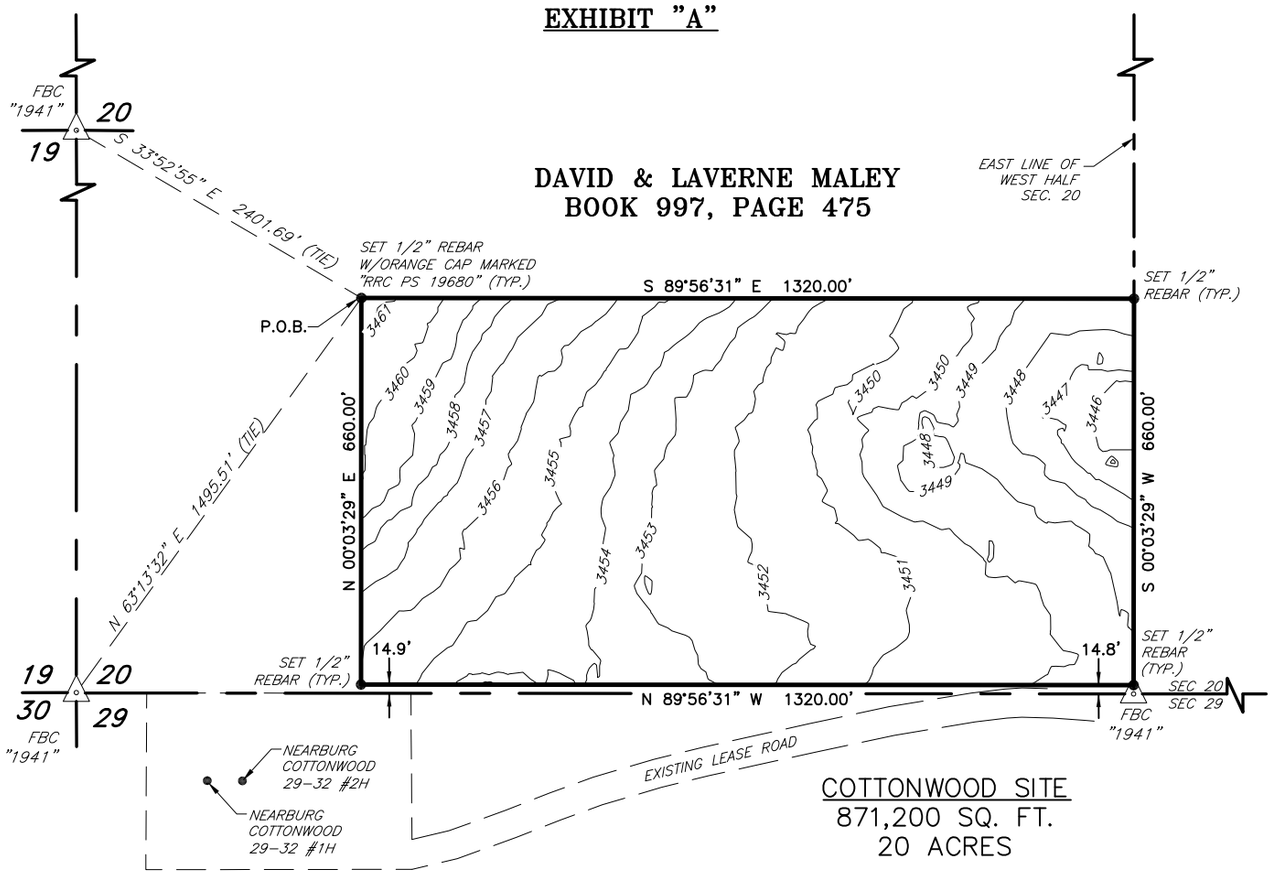
RRC

308 W. BROADWAY ST., HOBBS, NM 88240 (575) 964–8200

SCALE: 1" = 1000'
DATE: 6–22–2017
SURVEYED BY: BK/CG
DRAWN BY: LPS
APPROVED BY: RMH
SHEET: 1 OF 2

3 BEAR ENERGY LLC
SURVEY OF THE PROPOSED
20 ACRE TRACT FOR THE COTTONWOOD SITE
SECTION 20, T26S, R26E,
N. M. P. M., EDDY CO., NEW MEXICO

EXHIBIT "A"



PRELIMINARY

LEGEND

(-GLO-)	Record Data
△	Found Corner As Noted
●	Set 1/2" rebar w/ orange cap "RRC PS 19680"
P.O.B.	Point Of Beginning

SCALE: 1" = 300'
0 150' 300'

BEARINGS ARE NAD 83 GRID NM EAST & DISTANCES ARE HORIZ. GROUND.

DESCRIPTION

A tract of land situated within the Southwest quarter of Section 20, Township 26 South, Range 26 East, N. M. P. M., Eddy County, New Mexico, across the lands of David & Laverne Maley, according to a deed filed for record in Book 997, Page 475, of the Deed Records of Eddy County, New Mexico and being more particularly described by metes and bounds as follows:

BEGINNING at a set 1/2" rebar with an orange cap stamped "RRC PS 19680", which bears S 33°52'49" E, 2,401.64 feet, from a brass cap, stamped "1941", found for the West quarter corner of Section 20 and being N 63°13'27" E, 1,495.44 feet from a brass cap, stamped "1941", found for the Southwest corner of Section 20;

Thence S 89°56'31" E, 1,320 feet, to a set 1/2" rebar with an orange cap stamped "RRC PS 19680";

Thence S 00°03'29" W, 660 feet, along the East line of the West half of Section 20, to a set 1/2" rebar with an orange cap stamped "RRC PS 19680";

Thence N 89°56'31" W, 1.320 feet, to a set 1/2" rebar with an orange cap stamped "RRC PS 19680";

Thence N 00°03'29" E, 660 feet, to the Point Of Beginning.

Said tract of land contains 871,200 square feet or 20.00 acres, more or less.

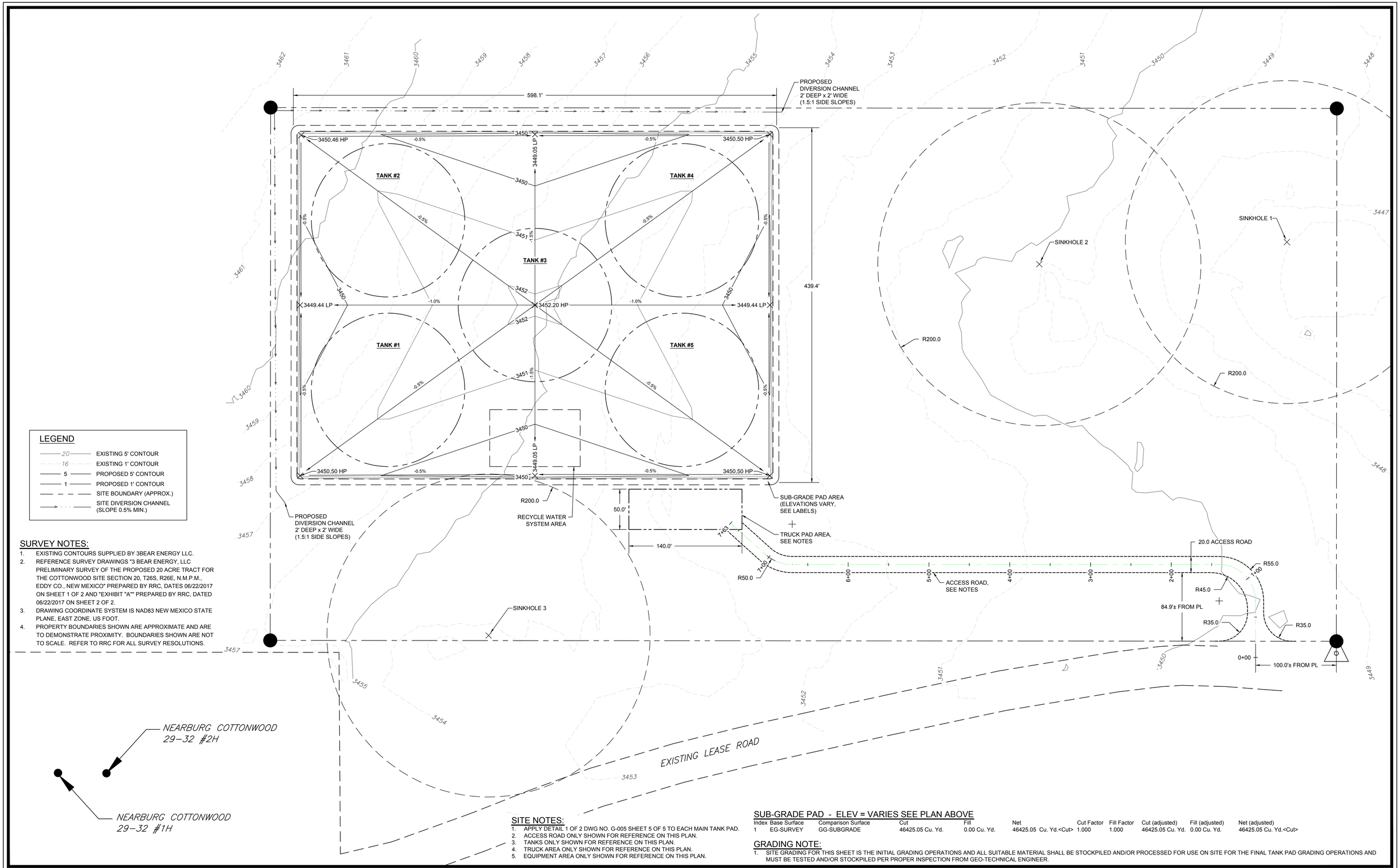
NO.	REVISION	DATE

JOB NO.: LS1706382
DWG. NO.: 1706382-2

RRC
308 W. BROADWAY ST., HOBBS, NM 88240 (575) 964-8200

SCALE: 1" = 300'
DATE: 6-22-2017
SURVEYED BY: BK/CG
DRAWN BY: LPS
APPROVED BY: RMH
SHEET: 2 OF 2

APPENDIX B – Cottonwood Water Recycling Facility Layout and Engineering Details, Documentation for the Containments, and Project Specifications



LEGEND

- EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- PROPOSED 5' CONTOUR
- PROPOSED 1' CONTOUR
- SITE BOUNDARY (APPROX.)
- SITE DIVERSION CHANNEL (SLOPE 0.5% MIN.)

SURVEY NOTES:

1. EXISTING CONTOURS SUPPLIED BY 3BEAR ENERGY LLC.
2. REFERENCE SURVEY DRAWINGS "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF THE PROPOSED 20 ACRE TRACT FOR THE COTTONWOOD SITE SECTION 20, T26S, R26E, N.M.P.M., EDDY CO., NEW MEXICO" PREPARED BY RRC, DATES 06/22/2017 ON SHEET 1 OF 2 AND "EXHIBIT "A"" PREPARED BY RRC, DATED 06/22/2017 ON SHEET 2 OF 2.
3. DRAWING COORDINATE SYSTEM IS NAD83 NEW MEXICO STATE PLANE, EAST ZONE, US FOOT.
4. PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND ARE TO DEMONSTRATE PROXIMITY. BOUNDARIES SHOWN ARE NOT TO SCALE. REFER TO RRC FOR ALL SURVEY RESOLUTIONS.

SITE NOTES:

1. APPLY DETAIL 1 OF 2 DWG NO. G-005 SHEET 5 OF 5 TO EACH MAIN TANK PAD.
2. ACCESS ROAD ONLY SHOWN FOR REFERENCE ON THIS PLAN.
3. TANKS ONLY SHOWN FOR REFERENCE ON THIS PLAN.
4. TRUCK AREA ONLY SHOWN FOR REFERENCE ON THIS PLAN.
5. EQUIPMENT AREA ONLY SHOWN FOR REFERENCE ON THIS PLAN.

SUB-GRADE PAD - ELEV = VARIES SEE PLAN ABOVE

Index	Base Surface	Comparison Surface	Cut	Fill	Net	Cut Factor	Fill Factor	Cut (adjusted)	Fill (adjusted)	Net (adjusted)
1	EG-SURVEY	GG-SUBGRADE	46425.05 Cu. Yd.	0.00 Cu. Yd.	46425.05 Cu. Yd.<Cut>	1.000	1.000	46425.05 Cu. Yd.	0.00 Cu. Yd.	46425.05 Cu. Yd.<Cut>

GRADING NOTE:

1. SITE GRADING FOR THIS SHEET IS THE INITIAL GRADING OPERATIONS AND ALL SUITABLE MATERIAL SHALL BE STOCKPILED AND/OR PROCESSED FOR USE ON SITE FOR THE FINAL TANK PAD GRADING OPERATIONS AND MUST BE TESTED AND/OR STOCKPILED PER PROPER INSPECTION FROM GEO-TECHNICAL ENGINEER.

Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
C	12/15/2017	ISSUED FOR REVIEW
D	12/22/2017	ISSUED FOR REVIEW
E	12/29/2017	ISSUED FOR REVIEW
F	01/09/2018	ISSUED FOR REVIEW & PERMITTING

NOT FOR CONSTRUCTION

DESIGNED NL
DRAWN JNB
CHECKED TM
DATE 11/15/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
EDDY COUNTY, NEW MEXICO
GPS (WGS84): 32.021682°N, -104.318203°W
SECTION 20, T26S, R26E

NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: NA

COTTONWOOD PRODUCED WATER RECYCLING FACILITY
CONTAINMENT AREA
RECYCLE WATER SYSTEM
GENERAL ARRANGEMENT
SUB-GRADE PAD GRADING PLAN

PROJECT NO. 212C-MD-00981
DRAWING NO. G-001
SHEET NO. 1 OF 5

ENGINEERED FILL MATERIAL NOTES:

THE FOLLOWING ARE NOTES FOR THE FILL PLACEMENT AND COMPACTION ON TOP OF LINER.

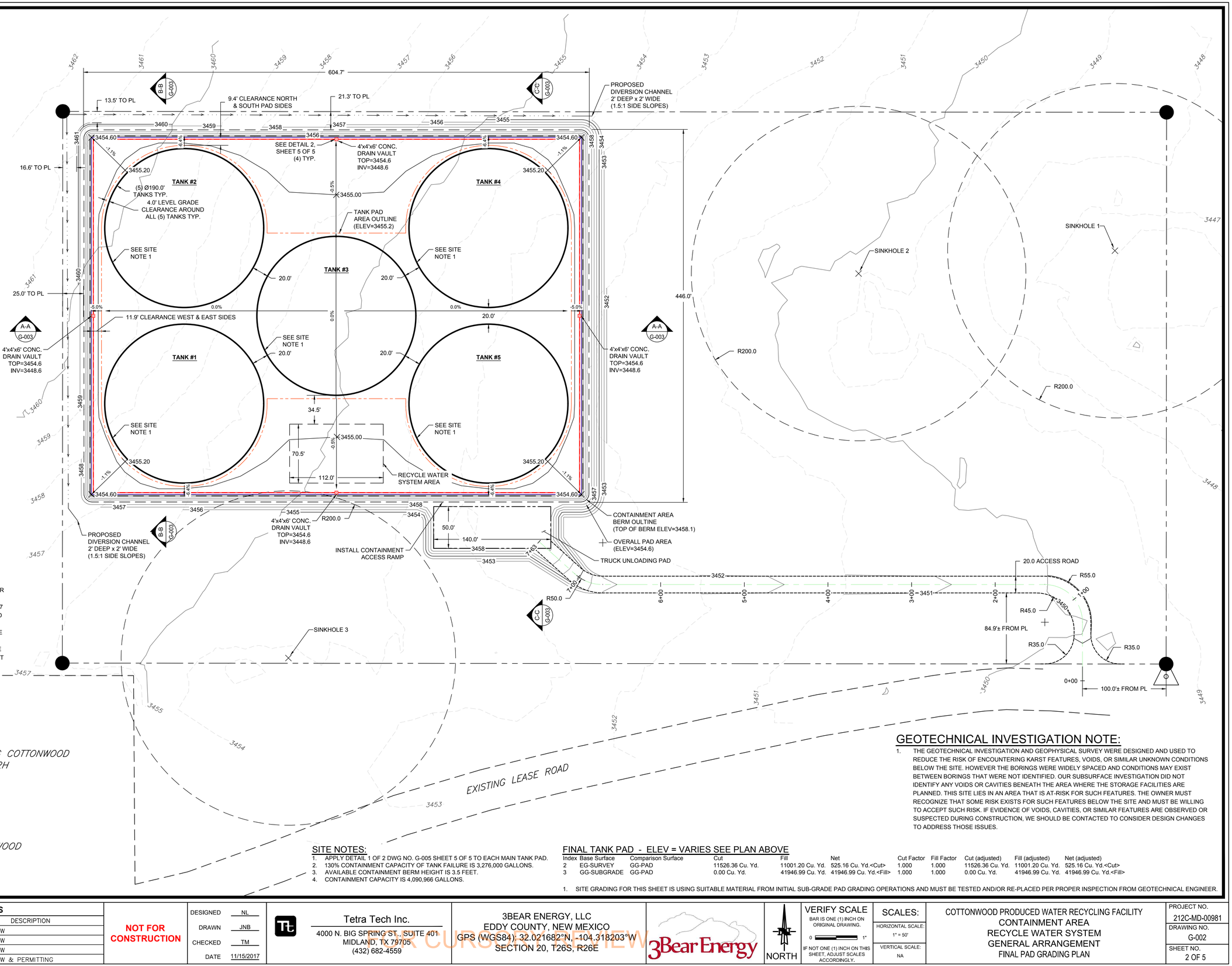
A. ON-SITE SOILS ARE SUITABLE FOR USE AS ENGINEERED FILL MATERIALS.
B. DITCHES OR TRENCHES FOR LEAK DETECTION IN PROXIMITY OF THE TANKS SHALL BE INSTALLED PRIOR TO FILL PLACEMENT FOR THE TANK PADS.
C. ENGINEERED FILL GRADATION SHALL BE A UNIFORM, GRANULAR MATERIAL HAVING 100 PERCENT PASSING THE 1 INCH SIEVE, 30 TO 70 PERCENT PASSING THE NO. 4 SIEVE, AND 3 TO 15 PERCENT PASSING THE NUMBER 200 SIEVE.
D. ENGINEERED FILL USED FOR PLACEMENT ON TOP OF LINER SHALL HAVE NO PROTRUSIONS EXCEEDING 1/4 INCH, ROCKS OR CLODS LARGER THAN 1/4" INCH. ROOTS, ORGANICS, FROZEN OR OTHERWISE DELETERIOUS MATERIALS.
E. ENGINEERED FILL MATERIALS OR SPECIAL MATERIALS USED FOR PLACEMENT BENEATH THE LINED CONTAINMENT TANKS SHALL MEET THE LINER AND LDS AS RECOMMENDED BY THE TANK MANUFACTURER.
F. INSTALLATION OF OVERLYING ENGINEERED FILL MATERIALS SHALL BE PLACED WITH A LOW GROUND PRESSURE WITH LESS THAN A 7 PSI TRACK PRESSURE. THIS MAY BE ACHIEVED WITH A D-5 OR SMALLER DOZER WITH LESS THAN 7 PSI TRACK PRESSURE.
G. THE INITIAL (FIRST) LIFT PLACEMENT OF THE ENGINEERED FILL, OVERLYING THE GEOSYNTHETICS, SHALL BE PLACED IN A 1-FOOT THICKNESS, PRIOR TO COMPACTION.
H. ENGINEERED FILL MATERIAL SHALL BE PLACED WITH A 'ROLLING' ACTION TO FULL LIFT THICKNESS (RATHER THAN PUSHED).
I. THE INITIAL (FIRST) LIFT SHALL BE INITIALLY COMPACTED WITH THE LGP DOZER TRACKS.
J. SUBSEQUENT LIFTS MAY BE PLACED IN 8" THICK LOOSE LIFTS AND COMPACTED TO AT LEAST 95 PERCENT OF STANDARD PROCTOR MAXIMUM DRY DENSITY (ASTM D 698).
K. BASES OF ENGINEERED FILL MATERIALS SHALL BE SCARIFIED TO AT LEAST 8-INCHES DEEP, MOISTURE-CONDITIONED OR DRIED TO WITHIN 2 PERCENT OF OPTIMUM MOISTURE CONTENT (8.6 %), PROCESSED TO A UNIFORM CONDITION, AND THEN COMPACTED TO AT LEAST 95 PERCENT OF MAXIMUM DRY DENSITY (110 PCF) DETERMINED BY STANDARD PROCTOR (ASTM D698).
L. CQA SHALL INCLUDE CLOSE AND CONTINUOUS INSPECTION DURING PLACEMENT OF ENGINEERED FILL MATERIAL ON TOP OF GEOSYNTHETICS TO CONFIRM UNDERLYING GEOSYNTHETIC MATERIALS ARE NOT CONTACTED OR OTHERWISE DAMAGED, EXCESS STRESSES ARE NOT PRODUCED IN THE MATERIALS, AND MINIMAL SLIPPAGE OCCURS BETWEEN THE GEOSYTHETICS.

LEGEND

- EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- PROPOSED 5' CONTOUR
- PROPOSED 1' CONTOUR
- SITE BOUNDARY (APPROX.)
- SITE DIVERSION CHANNEL (SLOPE 0.5% MIN.)
- 4'x4'x4' CONCRETE DRAIN VAULT (SET BASE MIN 0.5' BELOW SUB-GRADE ELEVATION)
- PROPOSED 6" PIPE, SEE DETAILS
- PROPOSED OVERALL PAD AREA
- PROPOSED BOTTOM, INSIDE OF CONTAINMENT BERM
- PROPOSED TANK PAD AREA

SURVEY NOTES:

1. EXISTING CONTOURS SUPPLIED BY 3BEAR ENERGY LLC.
2. REFERENCE SURVEY DRAWINGS "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF THE PROPOSED 20 ACRE TRACT FOR THE COTTONWOOD SITE SECTION 20, T26S, R26E, N.M.P.M., EDDY CO., NEW MEXICO" PREPARED BY RRC, DATES 06/22/2017 ON SHEET 1 OF 2 AND "EXHIBIT "A"" PREPARED BY RRC, DATED 06/22/2017 ON SHEET 2 OF 2.
3. DRAWING COORDINATE SYSTEM IS NAD83 NEW MEXICO STATE PLANE, EAST ZONE, US FOOT.
4. PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND ARE TO DEMONSTRATE PROXIMITY. BOUNDARIES SHOWN ARE NOT TO SCALE. REFER TO RRC FOR ALL SURVEY RESOLUTIONS.



SITE NOTES:

1. APPLY DETAIL 1 OF 2 DWG NO. G-005 SHEET 5 OF 5 TO EACH MAIN TANK PAD.
2. 130% CONTAINMENT CAPACITY OF TANK FAILURE IS 3,276,000 GALLONS.
3. AVAILABLE CONTAINMENT BERM HEIGHT IS 3.5 FEET.
4. CONTAINMENT CAPACITY IS 4,090,966 GALLONS.

FINAL TANK PAD - ELEV = VARIES SEE PLAN ABOVE

Index	Base Surface	Comparison Surface	Cut	Fill	Net	Cut Factor	Fill Factor	Cut (adjusted)	Fill (adjusted)	Net (adjusted)
2	EG-SURVEY	GG-PAD	11526.36 Cu. Yd.	11001.20 Cu. Yd.	525.16 Cu. Yd.<Cut>	1.000	1.000	11526.36 Cu. Yd.	11001.20 Cu. Yd.	525.16 Cu. Yd.<Cut>
3	GG-SUBGRADE	GG-PAD	0.00 Cu. Yd.	41946.99 Cu. Yd.	41946.99 Cu. Yd.<Fill>	1.000	1.000	0.00 Cu. Yd.	41946.99 Cu. Yd.	41946.99 Cu. Yd.<Fill>

1. SITE GRADING FOR THIS SHEET IS USING SUITABLE MATERIAL FROM INITIAL SUB-GRADE PAD GRADING OPERATIONS AND MUST BE TESTED AND/OR RE-PLACED PER PROPER INSPECTION FROM GEOTECHNICAL ENGINEER.

GEOTECHNICAL INVESTIGATION NOTE:

1. THE GEOTECHNICAL INVESTIGATION AND GEOPHYSICAL SURVEY WERE DESIGNED AND USED TO REDUCE THE RISK OF ENCOUNTERING KARST FEATURES, VOIDS, OR SIMILAR UNKNOWN CONDITIONS BELOW THE SITE. HOWEVER THE BORINGS WERE WIDELY SPACED AND CONDITIONS MAY EXIST BETWEEN BORINGS THAT WERE NOT IDENTIFIED. OUR SUBSURFACE INVESTIGATION DID NOT IDENTIFY ANY VOIDS OR CAVITIES BENEATH THE AREA WHERE THE STORAGE FACILITIES ARE PLANNED. THIS SITE LIES IN AN AREA THAT IS AT-RISK FOR SUCH FEATURES. THE OWNER MUST RECOGNIZE THAT SOME RISK EXISTS FOR SUCH FEATURES BELOW THE SITE AND MUST BE WILLING TO ACCEPT SUCH RISK. IF EVIDENCE OF VOIDS, CAVITIES, OR SIMILAR FEATURES ARE OBSERVED OR SUSPECTED DURING CONSTRUCTION, WE SHOULD BE CONTACTED TO CONSIDER DESIGN CHANGES TO ADDRESS THOSE ISSUES.

REVISIONS		
NO.	DATE	DESCRIPTION
C	12/15/2017	ISSUED FOR REVIEW
D	12/22/2017	ISSUED FOR REVIEW
E	12/29/2017	ISSUED FOR REVIEW
F	01/09/2018	ISSUED FOR REVIEW & PERMITTING

NOT FOR CONSTRUCTION

DESIGNED NL
DRAWN JNB
CHECKED TM
DATE 11/15/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
EDDY COUNTY, NEW MEXICO
GPS (WGS84): 32.021682°N, -104.318203°W
SECTION 20, T26S, R26E

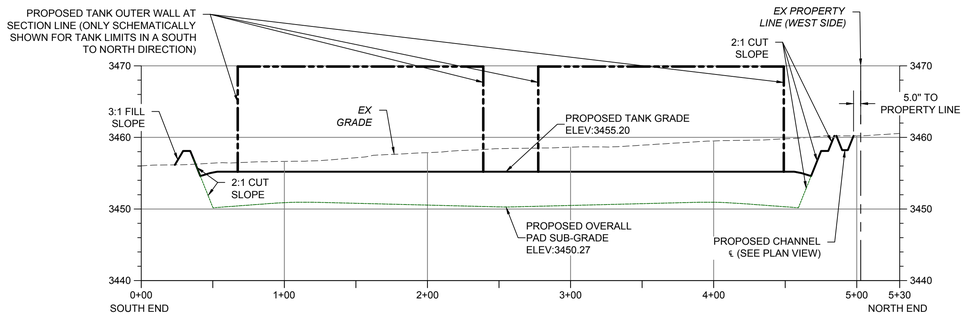
NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

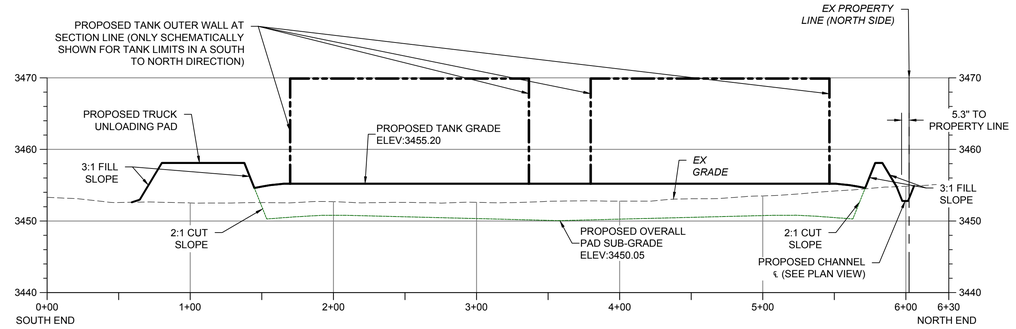
SCALES:
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: NA

COTTONWOOD PRODUCED WATER RECYCLING FACILITY
CONTAINMENT AREA
RECYCLE WATER SYSTEM
GENERAL ARRANGEMENT
FINAL PAD GRADING PLAN

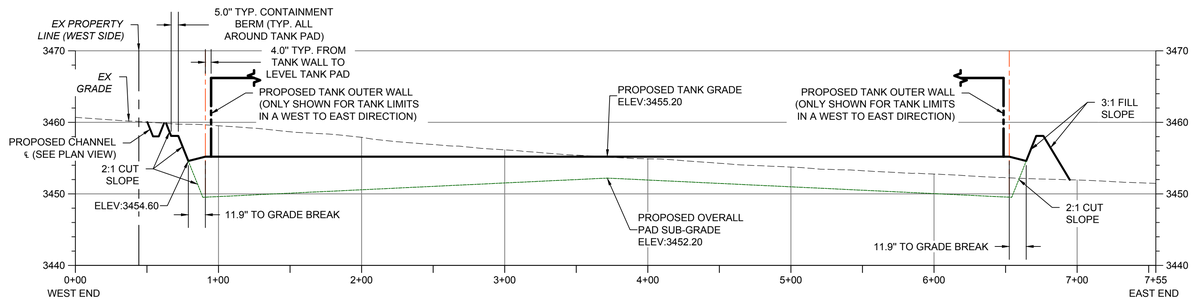
PROJECT NO. 212C-MD-00981
DRAWING NO. G-002
SHEET NO. 2 OF 5



Section B-B
Horz Scale: 1" = 50'
Vert Scale: 1" = 10'



Section C-C
Horz Scale: 1" = 50'
Vert Scale: 1" = 10'



Section A-A
Horz Scale: 1" = 50'
Vert Scale: 1" = 10'

SECTION NOTES:
1. MINIMUM HEIGHT ON CONTAINMENT BERM MUST BE 3.50'.

Know what's below. Call before you dig. nm811

REVISIONS		
NO.	DATE	DESCRIPTION
C	12/15/2017	ISSUED FOR REVIEW
D	12/22/2017	ISSUED FOR REVIEW
E	12/29/2017	ISSUED FOR REVIEW
F	01/09/2018	ISSUED FOR REVIEW & PERMITTING

NOT FOR CONSTRUCTION

DESIGNED NL
DRAWN JNB
CHECKED TM
DATE 11/15/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
EDDY COUNTY, NEW MEXICO
GPS (WGS84): 32.021682°N, -104.318203°W
SECTION 20, T26S, R26E

3Bear Energy

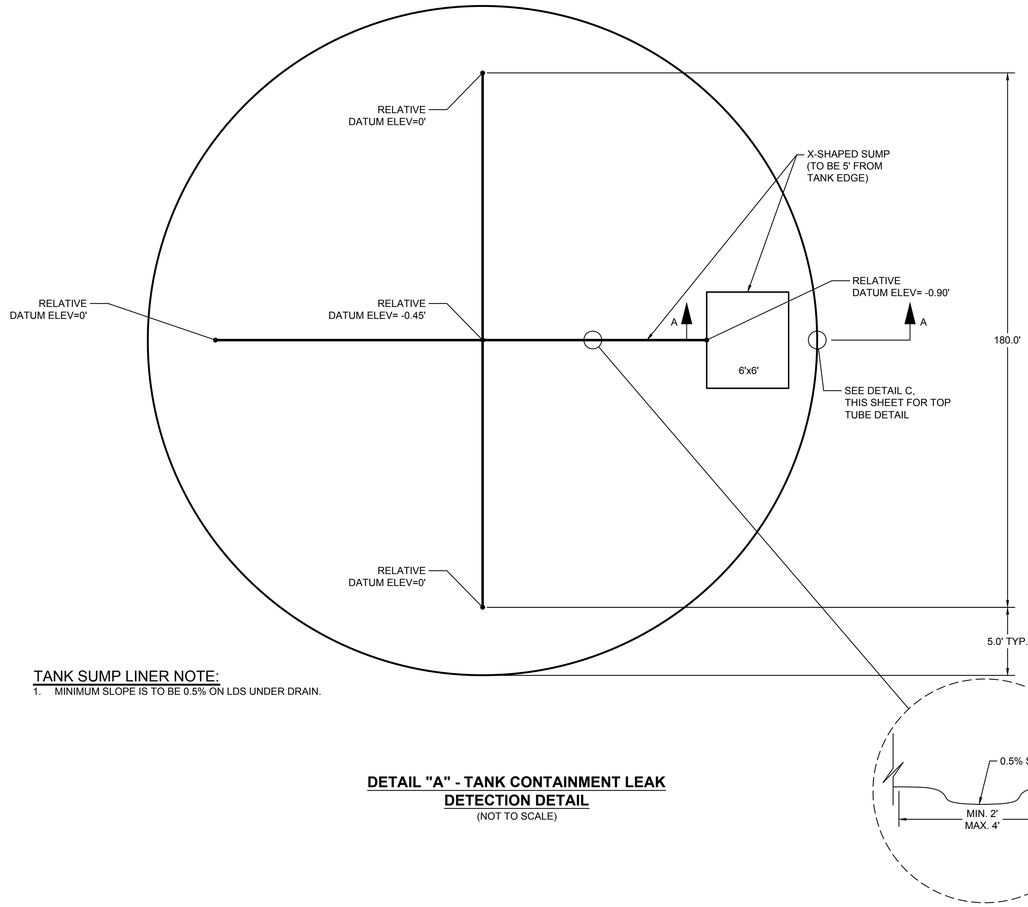
NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

COTTONWOOD PRODUCED WATER RECYCLING FACILITY
CONTAINMENT AREA
RECYCLE WATER SYSTEM
GENERAL ARRANGEMENT
PAD CROSS SECTIONS

PROJECT NO. 212C-MD-00981
DRAWING NO. G-003
SHEET NO. 3 OF 5

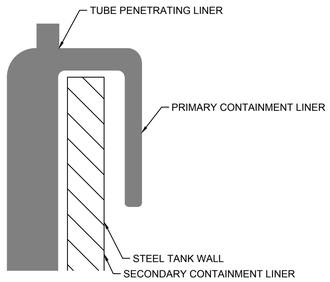


TANK SUMP LINER NOTE:

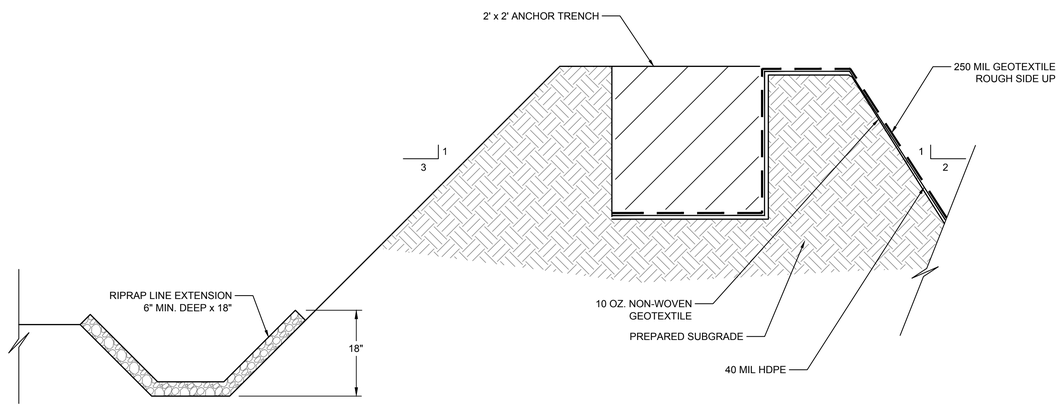
1. MINIMUM SLOPE IS TO BE 0.5% ON LDS UNDER DRAIN.

DETAIL "A" - TANK CONTAINMENT LEAK DETECTION DETAIL
(NOT TO SCALE)

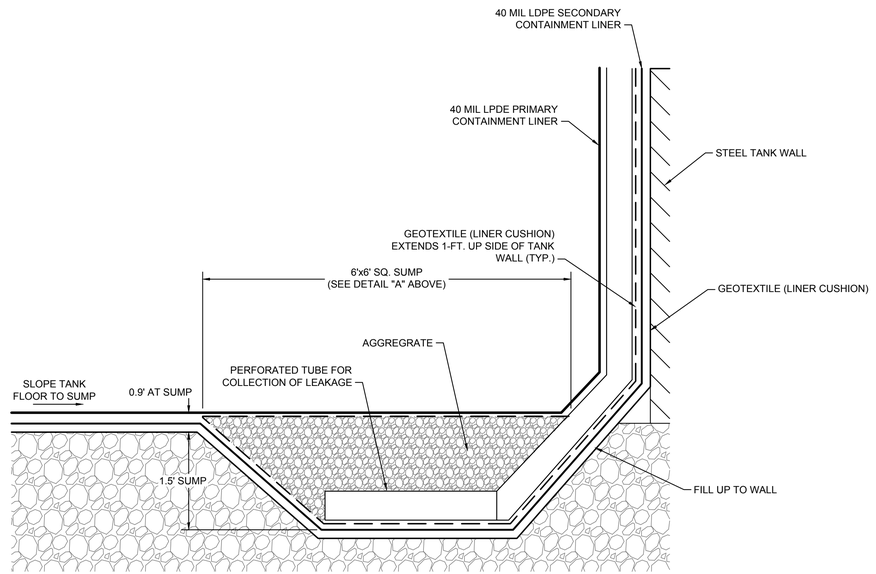
BLOW-UP OF TANK FLOOR DETAIL
(NOT TO SCALE)



DETAIL "C" - TUBE DETAIL
(AUTOMATED LEAK DETECTION
SYSTEM ADDED FOR CLARITY)
(NOT TO SCALE)



DETAIL "B" - ANCHOR TRENCH DETAIL
(GEOSYNTHETICS EXAGGERATED FOR CLARITY)
(NOT TO SCALE)



SECTION A-A - SUMP DETAIL
(NOT TO SCALE)

Know what's below. Call before you dig. nm811

REVISIONS		
NO.	DATE	DESCRIPTION
C	12/15/2017	ISSUED FOR REVIEW
D	12/22/2017	ISSUED FOR REVIEW
E	12/29/2017	ISSUED FOR REVIEW
F	01/09/2018	ISSUED FOR REVIEW & PERMITTING

NOT FOR CONSTRUCTION

DESIGNED NL
DRAWN JNB
CHECKED TM
DATE 11/15/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
EDDY COUNTY, NEW MEXICO
GPS (WGS84): 32.021682°N, -104.318203°W
SECTION 20, T26S, R26E

3Bear Energy

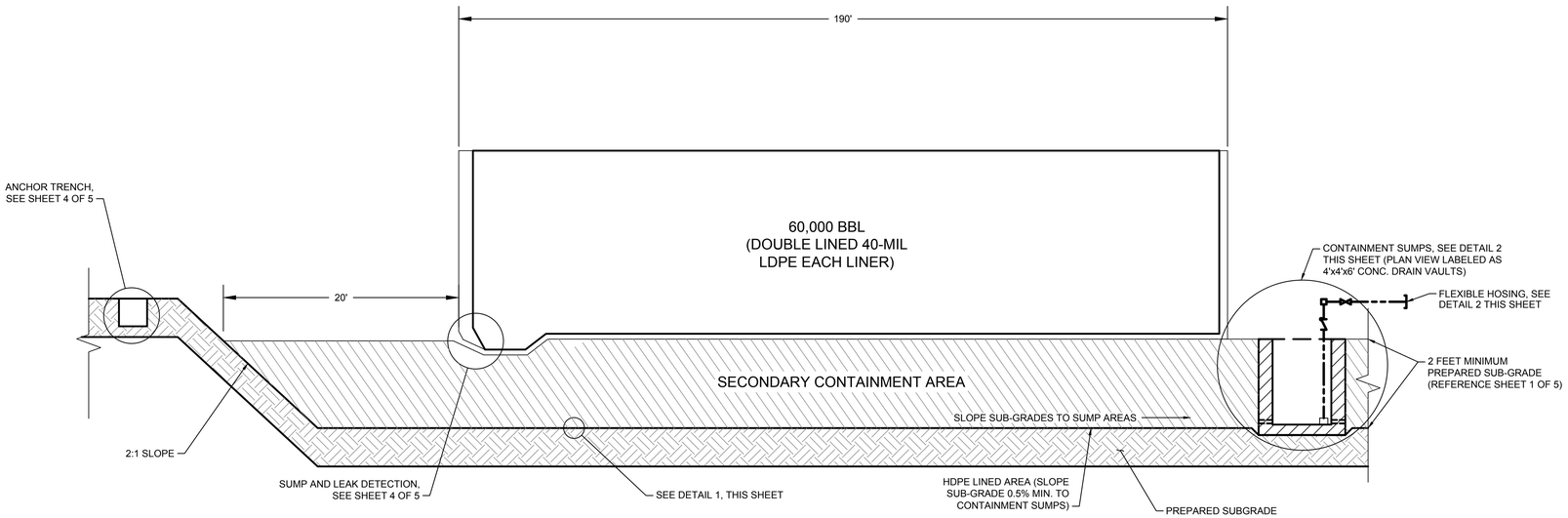
NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: AS NOTED
VERTICAL SCALE: NONE

COTTONWOOD PRODUCED WATER RECYCLING FACILITY
CONTAINMENT AREA
RECYCLE WATER SYSTEM
GENERAL ARRANGEMENT
DETAILS SHEET

PROJECT NO. 212C-MD-00981
DRAWING NO. G-004
SHEET NO. 4 OF 5



GENERAL TANK LAYOUT
TYPICAL FOR ALL 60,000 BARREL TANKS
(CONTAINMENT LINER DETAILS ARE PROVIDED ON SHEET 1 OF 5)
(NOT TO SCALE)

General Tank Specification:

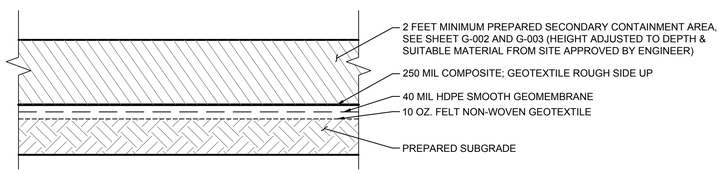
Each of the 60,000 bbl tanks shall be Well Water Solutions, Casper Wyoming Modular Large Volume Tank - Pathfinder Model or equivalent. Each tank shall be 190 feet in diameter and estimated at 12 feet tall. Tank shall be provide with a 40 mil. primary and secondary LDPE liner system with each tank having an independent leak detection sump. Each tank shall function independent of each other. Each tank shall be provided with ladder access to view the leak detection port on the tank. The tanks shall be constructed with MLVT Geomembrane panels and installed in accordance with Well water Solutions, Inc. installation manual. A detailed design of the tank system will be provided by Well Water Solutions as part of the submittal process for the purchasing of the tanks. The owner and owner engineer will agree on the design and quantities before the tanks are acquired and a purchase order is issued.

Prior to the installation of the tanks, the pad site within the tertiary containment shall be:

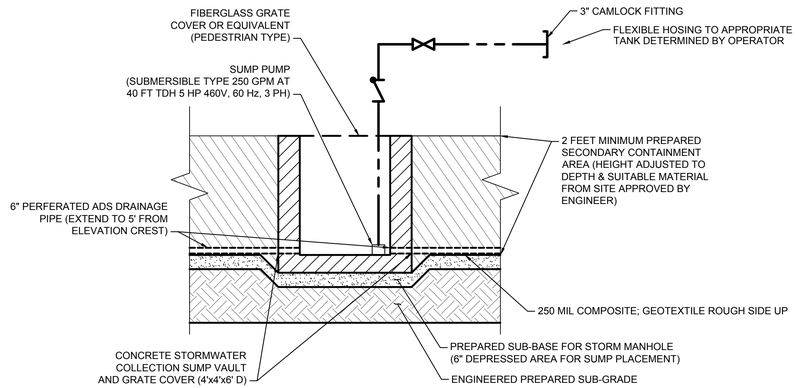
1. Free of debris and large shape rocks
2. Rolled and compacted in 6 inch lifts and be ready for heavy equipment traffic
3. less than a 1% grade from side to side on the pad
4. The underdrainage ditches for the tank liner shall be installed after the final pad grade it set
5. Installing company for the tanks will approve the pad preparation for the tank installation.

Well Water Solutions installation group will provide the general installation instruction for the tanks after pad has been prepared. The method of installation will be consistent with the defined Well Water Solutions installation guidelines (MLTV Erection Operations Manual). Visual inspection and testing will be in accordance with the guidelines of MLTV Erection Operations Manual. All records and design documents will be retained by "3Bear Energy, LLC".

The leak detection system will be installed to one low point that will be near a tank side wall. The leak detection system will start at a distance no less than 5 feet from the tank wall.



DETAIL 1
(NOT TO SCALE)



DETAIL 2
(NOT TO SCALE)

REVISIONS		
NO.	DATE	DESCRIPTION
C	12/15/2017	ISSUED FOR REVIEW
D	12/22/2017	ISSUED FOR REVIEW
E	12/29/2017	ISSUED FOR REVIEW
F	01/09/2018	ISSUED FOR REVIEW & PERMITTING

NOT FOR CONSTRUCTION

DESIGNED NL
DRAWN JNB
CHECKED TM
DATE 11/15/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
EDDY COUNTY, NEW MEXICO
GPS (WGS84): 32.021682°N, -104.318203°W
SECTION 20, T26S, R26E

NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: AS NOTED
VERTICAL SCALE: NONE

COTTONWOOD PRODUCED WATER RECYCLING FACILITY
CONTAINMENT AREA
RECYCLE WATER SYSTEM
GENERAL ARRANGEMENT
CONTAINMENT AND SUMP DETAILS

PROJECT NO. 212C-MD-00981
DRAWING NO. G-005
SHEET NO. 5 OF 5

SECTION 00 01 10 – TABLE OF CONTENTS

END OF SECTION 00 01 10

1/10/2018

SECTION 00 01 15 – LIST OF DRAWING SHEETS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The DRAWINGS listed in this SPECIFICATIONS section form part of the contract documents and applies to the installation of the 40 mil HDPE containment tertiary liner system for the tank farm at the Cottonwood Site.

B. CONTRACTOR shall completely coordinate the WORK shown on these DRAWINGS with all other contract WORK.

1.02 DRAWINGS INDEX

A. The following DRAWINGS are an integral part of the CONTRACT DOCUMENTS.

Drawing Number	Drawing Title
G-001	GENERAL ARRANGEMENT –SUBGRADE PAD GRADING PLAN
G-002	GENERAL ARRANGEMENT- FINAL PAD GRADING PLAN
G-003	GENERAL ARRANGEMENT – PAD CROSS SECTIONS
G-004	GENERAL ARRANGEMENT – DETAIL SHEET
G-005	GENERAL ARRANGEMENT – CONTAINMENT AND SUMP DETAILS

MATERIALS (NOT USED)
EXECUTION (NOT USED)

SECTION 31 11 00 – CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

1.01 SUMMARY

A. Requirements of this Section shall consist of CONTRACTOR providing all required clearing, grubbing, and stripping related labor, materials, equipment, tools, and services for the WORK.

1.02 DEFINITIONS

A. Clearing: Clearing shall consist of removal of all vegetation and the satisfactory disposal of brush, rubbish, and any other vegetation.

B. Grubbing: Grubbing shall consist of the removal and disposal of roots, root mats, stumps, logs, peat, and other objectionable matter which could adversely affect the quality of the subgrade or borrow materials.

C. Top soil: Top soil is the upper soil horizon which is characterized by a significant organic content.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 AREAS TO BE CLEARED AND GRUBBED

A. Perform clearing and grubbing only in areas identified by the ENGINEER OR OWNER. Clear and grub all areas where WORK is to take place.

B. Clear and grub all areas to a depth of approximately six inches and to the extent necessary to provide fill materials free of all objectionable matter described above. Clear and grub all areas within the extent of the property boundary and at least 10 feet beyond the proposed site footprint, including the project area and all borrow areas.

C. Vegetation located outside the construction limits shall not be damaged.

3.02 DISPOSAL OF CLEARED AND GRUBBED MATERIALS

A. All brush, vegetation, rubbish, organic soils, and other debris from clearing and grubbing operations, including all debris remaining from previous clearing operations, shall be stockpiled separately at a location designated by the OWNER.

3.03 EXCAVATING, STOCKPILING, AND WASTING TOPSOIL

A. If present, excavate topsoil from areas designated for project grading or construction, as encountered. In addition, excavate topsoil from areas designated for use as waste locations for earth subsoil material.

B. Remove lumped soil, vegetative material, boulders, and rocks from the excavated topsoil to be stockpiled.

C. Stockpile, if available, sufficient topsoil material on-site for use as vegetative cover for future reclamation purposes. Protect stockpile from erosion and grade to prevent ponding of water. Organic soils shall be segregated from soil materials that may be suitable for other uses described in these SPECIFICATIONS and shown on the DRAWINGS.

D. Dispose of excess topsoil and waste topsoil not intended for reuse in a location selected by the OWNER. Disposal and handling of this material shall be performed following the requirements of the appropriate government agencies.

END OF SECTION 31 11 00

SECTION 31 23 00 - EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

A. The section describes the following:

1. All excavation required to reach planned grades and contours, install project components, and to construct temporary run-on and run-off conveyance systems.
2. Placement of various fill materials:
   a. Compacted embankment fill or Engineered Fill
   b. Drainage Aggregate (Drain Rock)
3. Material placement and compaction
4. Site grading
5. Foundation preparation
6. Construction of fills and backfills
7. Compaction requirements
8. Site grading
9. Erosion and Sediment Control

B. The WORK shall be done in accordance with the SPECIFICATIONS and as shown on the DRAWINGS. Erosion and sediment control to be specified and performed by others.

C. The WORK includes furnishing all labor, tools, materials, equipment, and supervision necessary to construct the project as described in the contract documents.

1.02 TOLERANCES

A. All excavations shall be constructed within the tolerance as shown in these SPECIFICATIONS except where dimensions or grades are shown or specified as minimum or maximum in the DRAWINGS. All grading shall be performed to maintain slopes and drainages as shown in the DRAWINGS.

B. Excavate to within a horizontal and vertical tolerance of ± 0.1-foot on all slopes flatter than 10% and within a vertical tolerance of ± 0.2-foot on all slopes 10% or steeper unless otherwise approved by the ENGINEER or OWNER.

C. Place Drain Rock Aggregate within a vertical tolerance of ±0.1-ft, regardless of the steepness of the slope.

1.03 SUBSURFACE CONDITIONS

A. Subsurface investigations have been performed at the site by the ENGINEER. The results of the subsurface investigations can be provided to the CONTRACTOR at the CONTRACTOR'S request during the bidding interval.

B. The CONTRACTOR shall identify and locate utility lines, flow lines, wells, survey monuments, and other nearby structures prior to performing work. Utilities, flow lines, wells, survey monuments and other nearby structures shall be protected from damage during the WORK. Any damage to utility lines, flow lines, wells, survey monuments, and other nearby structures during the WORK shall be repaired by the CONTRACTOR at no additional cost to the OWNER. Costs associated with these repairs shall include the actual repair costs and all engineering costs required by the ENGINEER to coordinate and obtain regulatory approval of repairs, if required.

1.04 SUBMITTALS

A. Imported materials that will include Drain Rock Aggregate, Engineered Fill or others shall have material properties such as grain size distribution submitted to the OWNER or ENGINEER for material approval prior to delivery to the site.

1.05 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
2. ASTM D2434 – Test Method for Permeability of Granular Soils
3. ASTM D6913 – Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
4. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Tetra Tech, Inc. - Report of Geotechnical Investigation – Cottonwood Site Proposed Water Recycling Facility and Recycled Water Storage Tanks, December 2017.

1.06 DEFINITIONS

A. Liner – A completed system constructed as required by the DRAWINGS and SPECIFICATIONS, as specified in Section 33 47 13.

PART 2 - PRODUCTS

2.01 ENGINEERED FILL

A. Engineered Fill is defined as material obtained from excavations associated with the WORK or designated on-site borrow sources, approved by the ENGINEER, that meet the requirements of the SPECIFICATIONS and the Tetra Tech, Inc. - Report of Geotechnical Study Cottonwood Site, December 2017.

B. Engineered Fill material shall be free of debris, organics, oversized material (clods or rocks greater than 1 inch in diameter), frozen material, ice, snow, deleterious, or other unsuitable materials.

C. The aggregate for the Engineered Fill material for structural support shall consist of a uniform, granular material having 100 percent passing the 1 inch sieve, 30 to 70 percent passing the No. 4 sieve, and 3 to 15 percent passing the number 200 sieve. Do not use additives such as, but not limited to lime, cement, or fly ash, to modify aggregate to meet requirements.

D. The CONTRACTOR or contractor supplier will provide laboratory testing results to the OWNER for all fill material used in construction for verification of material compliance as required for the project.

E. Based on the results of the geotechnical investigation, native soils at the Cottonwood Site in Eddy County, New Mexico, are suitable for use as "Engineered Fill" as described in this Section and Section 2.02.

2.02 ENGINEERED FILL MATERIAL USED IN SUBGRADE PREPARATION

A. The upper six inches of the containment area bottom, interior embankment slopes, and sump shall be regular, smooth, and compacted; and shall be free of sharp changes in elevation, voids deeper than two inches, protrusions exceeding 1/4-inch, rocks larger than 1.0 inch, clods, organic debris, and standing water, other unsuitable objects, deleterious materials, or soft unsuitable areas.

B. Engineered Fill material used for the lined containment tanks' subgrade where liner will be installed shall be prepared as recommended by the manufacturer for liner and leak detection system installation. The fill shall be shall be free of sharp changes in elevation, voids deeper than two inches, protrusions exceeding 1/4-inch, rocks larger than 1/4-inch, clods, organic debris, and standing water, other unsuitable objects, deleterious materials, or soft unsuitable areas.

2.03 DRAINAGE AGGREGATE (DRAIN ROCK)

A. Drainage Aggregate (Drain Rock) is defined as engineered fill material consisting of selected or processed granular material that meets the requirements of the SPECIFICATIONS and is in accordance with this section. Drain Rock shall be obtained from on-site approved stockpiles or outside sources approved by the ENGINEER or OWNER.

B. The Drain Rock shall be clean washed sand and gravel with the following gradation:

TABLE 2.1 – DRAIN ROCK GRADATION

Sieve Size	Percent by Weight
1 ½ inch	100
1 inch	95-100
½ inch	25-60

No. 4	0-10

TABLE 2.1 – DRAIN ROCK GRADATION

Sieve Size	Percent by Weight
No. 8	0-5

Particles shall be rounded and free of sharp, angular edges that may damage the liner.

C. Drain Rock Aggregate shall be free of organic material, frozen material, ice, snow, or excess moisture.

D. Drain Rock Aggregate material must be hard, durable, and not subject to grain crushing. Individual rock fragments shall be dense, sound, and resistant to abrasion and shall be free from cracks, seams, and other defects that would tend to increase their destruction from water and frost actions. Drain Rock Aggregate shall be less than 5 percent carbonate.

E. Material shall be graded within the SPECIFICATION limits with a uniform grading of coarse to fine particles. No gap-graded material, as determined by the ENGINEER, shall be acceptable.

F. Verify that all necessary pre-construction submittals such as conformance testing of the Drain Rock Aggregate have been performed prior to placement or importing.

PART 3 - EXECUTION

3.01 PREPARATION, EXAMINATION, AND PROTECTION OF EARTHWORK

A. Provide construction staking and grade control. Establish and set required lines, levels, grade, contours, and datum by construction staking.

B. Provide for dust control in accordance with site requirements and OWNER'S direction.

C. Provide for dewatering as necessary for finish excavation and fill placement.

D. Locate, identify, and protect all utilities and existing structures from damage (including overhead and suspended utilities).

E. Protect temporary or permanent bench marks, survey stakes, settlement monuments, existing structures, fences and existing WORK from damage or displacement by construction equipment and vehicular traffic.

F. Coordinate traffic control, operations, and haul routes with the OWNER and LINER CONTRACTOR as needed.

G. Note that topography shown on DRAWINGS may differ from topography at time of construction.

H. Protect the exposed surfaces of compacted lifts from drying and cracking due to excessive heat, or softening due to excessive moisture, until overlying fill material is placed and compacted.

I. Any earthen surface upon which the liner is installed shall be prepared and compacted in accordance with the project SPECIFICATIONS. The surface shall be smooth, firm, and unyielding. The top six-inches of fill beneath the surface shall be free of:

1. Vegetation/Roots/Sticks
2. Construction debris
3. Sharp, angular rocks
4. Rocks larger than 1 inch in diameter
5. Void spaces
6. Abrupt elevation changes
7. Standing water
8. Cracks larger than six millimeters in width
9. Any other foreign matter that could contact the liner

J. Immediately prior to liner deployment, LINER CONTRACTOR shall arrange for the subgrade to be final-graded by the EARTHWORK CONTRACTOR to fill in all voids or cracks, then smooth-rolled to provide the best practicable surface for the liner. At completion of this activity, no wheel ruts, footprints or other irregularities in the subgrade are permissible. Furthermore, all protrusions extending more than 0.5-inches from the surface shall be removed, crushed, or pushed into the surface with a smooth-drum roller compactor.

K. On a continuing basis, the OWNER or OWNER's REPRESENTATIVE shall examine the subgrade for suitability before liner placement.

L. It shall be the CONTRACTOR'S responsibility to indicate to the OWNER or ENGINEER any change in the condition of the subgrade that could cause the subgrade to be non-compliance with any SPECIFICATION requirement. If the CONTRACTOR has not notified the OWNER or ENGINEER of changes that cause the subgrade to be non-compliant and installs the liner, then the CONTRACTOR has determined and assumes responsibility that the subgrade is acceptable for liner installation.

M. At the crest of the embankments, an anchor trench for the liner shall be constructed by the EARTHWORK CONTRACTOR as detailed on the DRAWINGS. Any deviation from the anchor trench details shown on the DRAWINGS requires review and approval by the ENGINEER. No loose soil shall be allowed at the bottom of the trench, and no sharp corners or protrusions shall exist anywhere within the trench.

N. Verify as applicable that all underlying components such as geosynthetics and piping have been installed, tested, and accepted in accordance with the DRAWINGS and SPECIFICATIONS.

3.02 EXCAVATION

A. Excavate material shown on the DRAWINGS and as necessary to complete the WORK. Excavation carried below the grade lines shown on the drawings shall be repaired as specified by the OWNER unless previously approved by the OWNER. Correction of all over-excavated areas shall be at the CONTRACTOR's sole expense.

B. All necessary precautions shall be taken to preserve the material below and beyond the established lines of all excavation in the soundest possible condition. Any damage to the WORK beyond the required excavation lines due to wetting, drying, or the CONTRACTOR'S operations shall be repaired at the CONTRACTOR'S sole expense.

C. Excavation, shaping, and any other work related to material removal, shall be carried out by the method(s) considered most suitable, provided it meets the design intent as determined by the ENGINEER.

D. Limits of excavation to accomplish the WORK safely shall be determined by the CONTRACTOR. Any minimum excavation limits shown on the DRAWINGS are for material identification only and do not necessarily represent safe limits. All excavations shall be free of overhangs, and the sidewalls shall be kept free of loose material. As a minimum, the CONTRACTOR shall slope, bench and shore all excavations as necessary to prevent any unsafe conditions as required by OSHA 29 CFR 1926.651 and 1926.652.

E. Accurate trimming of the slopes of excavations to be filled will not be required, but such excavations shall conform as closely as practical to the established lines and grades.

F. For pipe trench excavations, grade trench bottom to provide uniform bearing for the entire length of pipe to be installed. Fill in voids, gaps, low points ("dips" or "bellys") and bridging areas within trench bottom and along the entire length of pipe.

G. Subsoil not to be used in the construction of earth fills or reclamation shall be stockpiled in areas designated by OWNER and in accordance with applicable laws, rules, and regulations.

H. Permanently stockpiled earth material shall be graded to drain and blended seamlessly into the natural landscape.

I. Provide and operate equipment adequate to keep all excavations and trenches free of water.

J. Excavate unsuitable areas of the subgrade and replace with approved fill materials. Compact to density equal to requirements for subsequent fill material.

K. The subgrade of the secondary containment shall be proof-rolled and compacted in place prior to fill placement or grading.

L. Grade top perimeter of excavation to prevent surface water from draining into excavation.

3.03 FILL PLACEMENT

A. General

1. Transport, process, place, spread, compact, and complete fill using the appropriate equipment to achieve lift thickness, design lines and grades and compaction specified in the DRAWINGS and SPECIFICATIONS.
2. To the extent practicable, fill shall be placed by routing the hauling and spreading units approximately parallel to the axis of the embankment.
3. Hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their traveled routes evenly over the surface of the fill.

4. Protect installed measurement instrumentation, structures, and utilities from damage.
5. Care shall be taken at all times to avoid segregation of material being placed, and all pockets of segregated or undesirable material shall be removed and replaced with material matching the surrounding material.
6. Each zone shall be constructed with materials meeting the specified requirements and shall be free from lenses, pockets, and layers of materials that are substantially different in gradation from surrounding material in the same zone.
7. No material shall be placed on material that is too soft, smooth, wet, or dry, or that has been damaged by drying, cracking, frost, runoff, or construction activities. Previously completed portions of the subgrade that are deemed unsuitable for construction shall be repaired until approved by the ENGINEER.
8. To the extent practicable, fill materials shall be brought to the placement area at the recommended moisture content.
9. Moisture conditioning is the operation required to increase or decrease the moisture content of material to within the specified limits for proper material placement and compaction. If moisture conditioning is necessary, it may be carried out by whatever method CONTRACTOR deems suitable, provided it produces the moisture content specified in the SPECIFICATIONS.
10. Placement of overlying Engineered Fill materials above secondary containment liner shall be placed with a low ground pressure with less than a 7 psi track pressure. This may be achieved with a D-5 or smaller dozer with less than 7 psi track pressure.
11. **Bases of engineered fill materials shall be scarified to at least 8-inches deep**, moisture-conditioned or dried to within 2 percent of optimum moisture content, processed to a uniform condition, and then compacted to at least 95 percent of maximum dry density determined by standard Proctor (ASTM D698).

3.04 MOISTURE CONTROL

A. Prior to and during all compacting operations, maintain moisture content within the limits recommended herein. Maintain uniform moisture content throughout the lift. To the extent practicable, add water to materials that are too dry at the site of excavation. Supplement, if necessary, by sprinkling and mixing water into the fill material prior to compaction. The soils at the site to be used for fill shall be compacted to at least 95 percent of the maximum dry density as determined by standard Proctor, ASTM D698. The moisture content shall be within minus 2 to 2 percent above optimum moisture content as determined by ASTM D698[1]. The soils shall be thoroughly mixed prior to placement and compaction to provide uniform water content throughout the fill.

B. Do not attempt to compact fill material containing excessive moisture. Aerate material by blading, disking, harrowing, or other methods, to dry the material to acceptable moisture content.

3.05 LIFT THICKNESS REQUIREMENTS

A. Berm Fill:

1. Placement lift thickness for Engineered Fill shall not exceed 6 inches prior to compaction with hand-operated compaction equipment and should not exceed 8 inches with heavy

machine operated compaction equipment. It is the CONTACTOR's responsibility to ensure that the compaction achieved meets the specifications.

2. The initial (first) lift placement of the Engineered Fill, overlying the geosynthetics, shall be placed in a 1-foot thickness, prior to compaction and shall be placed with a 'rolling' action to full lift thickness (rather than pushed).
3. Fill placement for anchor trenches shall not exceed 6 inches in loose lift thickness for each lift.

B. Drain Rock Aggregate:

1. Drain Rock Aggregate shall be placed and spread in lifts not exceeding 10 inches in thickness.

3.06 COMPACTION AND MOISTURE CONTENT REQUIREMENTS

A. After material placement, spreading, and leveling to the appropriate lift thickness, all material shall be uniformly compacted in accordance with the requirements for each type of fill as indicated on the following table:

TABLE 3.1 – COMPACTION AND MOISTURE CONTENT REQUIREMENTS

Fill Material	Compaction Specifications[1]	Moisture Content[1]
Engineered Fill	95% of modified Proctor maximum dry density with vibratory compactor	-2% to +2% of Optimum
Drainage Rock Aggregate	No requirements	No requirements

[1]As determined by ASTM D698

3.07 COMPACTION EQUIPMENT

A. Compaction equipment shall be maintained in good working condition at all times to ensure that the amount of compaction obtained is the maximum for the equipment. Caution needs to be taken when installing the lifts on the containment liner to prevent the liner material from being damaged.
The initial (first) 12" lift of engineered fill placed on top of liner shall be initially compacted with low-ground pressure dozer equipment. Subsequent lifts may be placed in 8" thick loose lifts and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698).

B. Compactor:

1. Fill is required to be compacted with a heavy vibratory-optional roller and a maximum roller speed of approximately 2 mph.
2. The roller/compactor shall be of self-propelled design to develop 10,000 pounds in weight per linear foot of width at rest on level ground or equivalent as approved by the ENGINEER.

C. Special Compactors:

1. Special compactors shall be used to compact materials that, in the opinion of the ENGINEER, cannot be compacted properly by the specified roller because of location or accessibility.
2. Special compaction measures shall be adopted, such as hand-held compactors, smooth drum rollers, or other methods approved by the ENGINEER, to compact fill material in trenches, around structures, around geosynthetics, and in other confined areas that are not accessible to the Compactor. The final surface on which the geosynthetics will be placed shall be compacted with a smooth drum roller.
3. Anchor trenches shall be compacted with a hand-operated compaction machine.

3.08 COMPACTION TESTING OF ENGINEERED FILL

A. Field compaction testing of each lift shall be performed by performing density and moisture testing of compacted fill placed and proof rolling to observe for soft areas and pumping of soils. It is recommended that a heavy, rubber-tired vehicle weighing at least 25 tons, such as a loaded water or dump truck or equivalent be used for performance of proof rolling. In addition, a minimum of one density/moisture test for each vertical foot of compacted fill placed shall be performed. This testing frequency shall be a minimum of one test for every 150 linear feet or 5000 square-feet in area. For smaller areas, a minimum of three compaction tests shall be performed for every lift.

B. Lifts failing to meet the moisture and density testing requirements shall be reworked to meet the required specifications.

C. Compaction testing of anchor trenches and the containment liner shall be performed such that puncturing of the geosynthetic materials is avoided.

3.09 SITE GRADING

A. Perform all placement of fill to lines and grades as shown in the DRAWINGS and/or established by the ENGINEER, with proper allowance for surface treatments (topsoil placement, etc.) where specified or shown. Neatly blend all new grading into surrounding, existing terrain.

END OF SECTION 31 23 00

SECTION 33 47 13 - GEOSYNTHETICS

PART 1 - GENERAL

1.01 SUMMARY

A. The WORK described in this SPECIFICATION section includes specifications for manufacturing and installing HDPE geosynthetics associated with the secondary containment.

B. Geosynthetics specifications and installation recommendations for the containment tanks shown on the engineering drawings will be performed in accordance with the MANUFACTURER'S recommendations for installation. Specifications for the containment tanks are not included in this document.

1.02 SUBMITTALS

A. The CONTRACTOR shall submit a letter to the OWNER prior to installation of the geosynthetics stating the subgrade is acceptable and does not void the warranty.

B. The CONTRACTOR shall submit the following product data to the ENGINEER:

1. Resin Data:

    a. Certification stating that the resin meets the SPECIFICATION requirements.

2. Geosynthetics Roll:

    a. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin.

C. Pre-Construction Submittals: Submit the following within 10 days of Notice to Proceed. Pre-Construction materials shall be submitted to the OWNER and ENGINEER.

1. The MANUFACTURER'S Information
    a. The MANUFACTURER'S name and address and primary contact.
    b. The manufacturing plant name and address where the geosynthetics for this project will be produced.
    c. The MANUFACTURER'S qualifications including:
        1) Evidence of production of at least 10 million square feet of geomembrane that meets the specifications.
        2) Certification that the MANUFACTURER has sufficient capacity to provide the required material in the given timeframe.
        3) A list of at least 10 projects for which geomembrane has been supplied by the MANUFACTURER, three of which shall have been for projects of similar size.

d. Product name and the MANUFACTURER'S description of the proposed geosynthetics and five representative samples of the product proposed for use on this project.
e. The MANUFACTURER'S material properties sheets (cut sheets) of proposed geosynthetic products meeting the requirements of the specification.
f. The MANUFACTURER'S Quality Control (MQC) Plan, including examples of geosynthetics certification documents, name and address of the quality control testing laboratory, quality control laboratory certification, examples of retesting notification, and documentation.
g. The MANUFACTURER'S written instructions for storing, handling, installing, seaming, protecting from hydration, and repairing the proposed geosynthetics, including recommendations for handling equipment (model number and load capacity).
h. Samples product warranty.

2. CONTRACTOR'S Information:
   a. CONTRACTOR'S name and address and primary contact.
   b. CONTRACTOR'S qualifications including a list of at least three previous projects of similar size to this project, including project name, location, size and date of installation, and evidence of installing at least 1 million square feet of geomembrane.
   c. The Construction Quality Control (CQC) Plan, including examples of subgrade certification documents, daily record documents, methods for repairing geomembrane and subgrade and example documents to certify repairs, method for removing rejected materials, proposed staffing, and proposed equipment.
   d. Description of welding equipment, techniques, and material, including a list of proposed equipment.
   e. A complete set of forms to be used for record installation CQC data.
   f. Résumés of key installation personnel. The Installation Supervisor, Master Seamers, and QC Representative must be clearly identified.
   g. Workmanship warranty.

D. The CONTRACTOR shall furnish SHOP DRAWINGS to the OWNER and ENGINEER as follows:

1. Installation layout SHOP DRAWINGS.
   a. Must show proposed panel layout including field seams and details.
   b. Must show panel identification numbers.
   c. Installed square footage of the geomembrane.
   d. Must be approved prior to installing the geomembrane.
   e. Approved SHOP DRAWINGS will be for concept only and actual panel placement will be determined by site conditions.

E. CONTRACTOR'S geosynthetics field installation quality assurance plan.

F. The CONTRACTOR will submit the following to the OWNER and ENGINEER upon completion of installation:

1. Certificate stating the geosynthetics have been installed in accordance with the contract documents.
2. Material and installation warranties:

a. Material shall be warranted against MANUFACTURER's defects for a period of five years from the date of geosynthetics installation.
b. Installation shall be warranted against defects in workmanship for a period of one year from the date of geosynthetics completion.

3. As-built drawings showing actual geosynthetics placement, seams, testing locations and results, and anchor trench details.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2. ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting
3. ASTM D1238 – Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
4. ASTM D1505 – Standard Test Methods for Density of Plastics by the Density-Gradient Technique
5. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics
6. ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
7. ASTM D4218 – Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
8. ASTM D4716 - Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
9. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
10. ASTM D4833 – Test Method for Index Puncture Resistance of Geomembranes and Related Products
11. ASTM D5035 - Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
12. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
13. ASTM D5596 – Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
14. ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
15. ASTM D5820 – Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
16. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
17. ASTM D5994 – Test Method for Measuring Core Thickness of Textured Geomembrane
18. ASTM D6364 - Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
19. ASTM D6392 – Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
20. ASTM D6693 – Test Method for Determining Tensile Properties of Non-reinforced Polyethylene and Non-reinforced Flexible Polypropylene Geomembranes
21. ASTM D7179 - Standard Test Method for Determining Geonet Breaking Force

22. ASTM D7406 - Standard Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products
23. ASTM D7466 – Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

B. Geosynthetic Research Institute (GRI)

1. GRI-GC8 Standard Guide for Determination of the Allowable Flow Rate of a Drainage Geocomposite
2. GRI GM14 - GM Sampling by Attributes
3. GRI GM10 – Specification for the Stress Crack Resistance of Geomembrane Sheet

4. GRI GM19 - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.04 DEFINITIONS

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

B. ENGINEER – Party, independent from manufacturer and CONTRACTOR, that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

C. Geosynthetics Manufacturer – The party responsible for manufacturing the geosynthetics rolls.

D. Geosynthetic Quality Assurance Laboratory (testing laboratory) – Party, independent from the OWNER, manufacturer, and CONTRACTOR, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing.

E. CONTRACTOR – Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.

F. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed value reported.

G. Panel – Unit area of a geomembrane that will be seamed in the field that is 10 square yards or larger.

H. Patch – Unit area of a geomembrane that will be seamed in the field that is less than 10 square yards.

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

1.05 QUALIFICATIONS

A. MANUFACTURER

1. MANUFACTURER shall have manufactured a minimum of 10 million square feet of HDPE geomembrane material during the last year.
2. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geonet material during the last year.
3. MANUFACTURER shall have a GAI-LAP Accredited Laboratory at the manufacturing facility.
4. MANUFACTURER shall have ISO 9001; 2008 certification.

B. CONTRACTOR

1. CONTRACTOR shall have installed a minimum of 1,000,000 square feet of geosynthetics in the last 3 years.
2. CONTRACTOR shall have worked in a similar capacity on at least 3 projects similar in complexity to the project described in the contract documents, and within a total of at least 400,000 square feet of geomembrane installation on each project.
3. The Installation Supervisor shall have worked in a similar capacity on at least 3 projects similar in size and complexity to the project described in the Contract Documents in the last 5 years.

1.06 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Geosynthetics labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geonet roll shall be wrapped with a material that will protect the geonet from damage due to shipment, water, sunlight, and contaminants.

C. The CONTRACTOR shall note any visible damage to roll materials on the Bill of Lading prior to unloading roll materials. Should any visible damage be noted, CONTRACTOR or ENGINEER shall notify the MANUFACTURER in writing immediately.

D. Labeling – Each roll of geosynthetics delivered to the site shall be labeled by the manufacturer. The label will identify:

1. Manufacturer’s name
2. Product identification
3. Thickness
4. Length
5. Width
6. Roll number
7. Date and time of production
8. Resin lot number

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

F. Storage – The on-site storage location for geosynthetics material, provided by the CONTRACTOR to protect the geosynthetics from punctures, abrasions and excessive dirt and moisture, should 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
6. Geosynthetics shall not be stacked higher than three rolls

G. Handling – Materials are to be handled so as to prevent damage. The CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the geosynthetics.

1.07 WARRANTY

A. Material shall be warranted, against manufacturer's defects for a period of five years from the date of geosynthetics installation.

B. Installation shall be warranted against defects in workmanship for a period of one year from the date of geosynthetics completion.

PART 2 - PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

A. Material shall be GSE Environmental (GSE) HD Smooth Geomembrane or equivalent HDPE geomembrane meeting the thickness, texture, and color requirements as shown on the DRAWINGS.

B. Geomembrane Rolls

1. Geomembrane rolls must 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, 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 Table 1, 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.

C. Geomembrane roll testing values for a 40-mil smooth and testing frequencies requirements are presented in Table 2.1 below.

TABLE 2.1: MINIMUM VALUES FOR 40-MIL SMOOTH HDPE GEOMEMBRANES			
Property	**Test Method (1)**	**Testing Frequencies**	**Minimum Value(s)**
Thickness, (minimum average) mil Lowest individual value	ASTM D5994 / D5199	Every roll	40 36
Density, g/cm3	ASTM D792 / D1505	200,000 lb	0.940
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 in/min G.L. = 2.0 in	20,000 lb	 152 700
Tear Resistance, lb	ASTM D1004	45,000 lb	28
Puncture Resistance, lb	ASTM D4833	45,000 lb	72
Carbon Black Content, %	ASTM D1603*/4218	20,000 lb	2.0 – 3.0
Carbon Black Dispersion	ASTM D5596	45,000 lb	+Note 1
Oxidative Induction Time, min (Standard OIT)	ASTM D3895, 200° C; 02, 1 atm	200,000 lb	≥ 100
Melt Flow, g/10 min.	ASTM D1238, 190° C; 2.16kg	200,000 lb	≤ 1.0
Oven Aging With HP OIT, (% retained after 90 hours)	ASTM D5721 ASTM D5885, 150° C; 500 psi O_2	Per resin formulation	80
UV Resistance With HP OIT, (% retained after 1600 hours)	ASTM D5885, 150° C; 500 psi O_2	Per resin formulation	50 (+Note 2)

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

2.02 RESIN

1. Resin shall be first quality, compounded polyethylene resin.
2. Resin testing values and testing frequencies requirements are presented in Table 2 below. Natural resin (without carbon black) shall meet the following additional minimum requirements:

TABLE 2.2: RAW MATERIAL VALUES			
Property	**Test Method (1)**	**Testing Frequencies**	**Value**
Density (g/cm3)	ASTM D792 / D1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	Once Per Resin Lot	≤ 1.0

[1]Manufacturer may utilize 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.

2.03 EQUIPMENT

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

1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge 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.

B. Extrudate Rod or Bead

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

PART 3 - EXECUTION

3.01 EXAMINATION

A. Preparation of surfaces to be lined shall be completed by the EARTHWORKS CONTRACTOR but the LINER CONTRACTOR AND TANK INSTALLATION CONTRACTORS will be responsible for inspecting the prepared surfaces to verify that the surfaces are acceptable for liner placement and free from any rocks, clods, sticks, surface irregularities or debris which could damage the liner. Acceptance of the subgrade shall be provided in a written submittal.

B. All geosynthetics installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

3.02 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 WORK site.

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

C. The geosynthetics installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

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

1. Unroll geosynthetics using methods that will not damage geosynthetics and will protect underlying surface from damage (spreader bar, protected equipment bucket).
2. The geosynthetics roll shall be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.
3. Use full length rolls or those with a significant length remaining at the top of the slope so that no roll end occurs on side slopes.
4. Place ballast (commonly sandbags) on geosynthetics, which will not damage geosynthetics, to prevent wind uplift.
5. Personnel walking on geosynthetics shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geosynthetics.

6. Do not allow heavy vehicular traffic directly on geosynthetics. Rubber-tired ATVs and trucks are acceptable if wheel contact is less than six pounds per square inch.

E. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material. This practice will be used to prevent excessive tension (trampolines) from developing. This is particularly important in cold weather conditions.

F. Anchor trench compacting equipment shall not come into direct contact with the geosynthetics. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

3.03 FIELD SEAMING

A. Seams shall meet the following requirements:

1. To the maximum extent possible, orient seams parallel to line of 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 five feet 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 ENGINEER and CONTRACTOR.
5. All seam overlaps shall be aligned consistent with the requirements of the welding equipment being used. Seams shall be made by lapping the uphill material over the downhill material with sufficient overlap. Extrusion seaming shall have a minimum overlap of six inches. Wedge-welded seaming shall have a minimum overlap of six inches.
6. Seaming of the geomembrane at material temperatures below 32 degrees F and above 170 degrees F must be successfully demonstrated to the ENGINEER using prequalification test seams to demonstrate that the seams comply with these SPECIFICATIONS.

B. Geonet Components:

1. Adjacent edges along the length of the geonet roll shall be overlapped a minimum of 6 inches or as recommended by the ENGINEER.
2. The overlapped edges shall be joined by tying the geonet structure with cable ties.
3. These ties shall be spaced every 5 feet along the roll length.
4. Adjoining rolls across the roll width should be shingled down in the direction of the slope and joined together with cable ties spaced every foot along the roll width.

C. During Welding Operations

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

D. 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. Number 80-grit sandpaper shall be used.
3. Grinding shall not reduce the thickness of the geomembrane more than one mil.
4. Purge welding apparatus of heat-degraded extrudate before welding.
5. Extrusion welding shall be considered a secondary means of welding and shall be used for repairs unless otherwise approved by ENGINEER.

E. 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.
4. Hot wedge welding shall be considered the primary method of welding and shall be used for panel seaming unless otherwise approved by ENGINEER.

F. 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. A minimum of two trial welds shall be required per day, per welding apparatus, one made prior to the start of work and one completed at mid-shift. Additional trial welds will be required after repairs are made to the apparatus.
4. Cut six one-inch wide by six-inch long test strips from the trial weld.
5. Quantitatively test three specimens for peel adhesion, and then three specimens for shear strength.
6. Trial weld specimens shall pass when the results shown in Table 3 are achieved in both peel and shear test.

Table 3.1: MINIMUM WELD VALUES FOR HDPE GEOMEMBRANES

Property	Test Method	Minimum Value
Peel Strength (fusion), ppi	ASTM D 6392	98
Peel Strength (extrusion), ppi	ASTM D 6392	78
Shear Strength (fusion & ext.), ppi	ASTM D 6392	121

7. The break, when peel testing, occurs in the liner material itself, not through peel separation (Film Tear Bond (FTB) break).
8. The break is ductile.
9. A test will be considered a failure if one specimen on either peel or shear testing does not meet the requirements on Table 3 or does not achieve an FTB break.
10. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.
11. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed two additional trial welds.

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

H. 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.

3.04 FIELD QUALITY ASSURANCE

A. The manufacturer and CONTRACTOR shall participate in and conform to all terms and requirements of the OWNER'S quality assurance program. The CONTRACTOR shall be responsible for assuring this participation.

B. Quality assurance requirements are as specified in this section.

C. Field Testing

1. Non-destructive testing shall be carried out as the seaming progresses, not at completion of all field seaming. Each seam shall be non-destructive tested.

a. Vacuum Testing

1) Shall be performed in all extrusion welds performed during installation and in accordance with ASTM D 5641.
2) The vacuum box assembly shall consist of the following:

a) Rigid housing;
b) Transparent viewing window;
c) Soft rubber gasket attached to bottom of housing;
d) Porthole or valve assembly;
e) Vacuum gauge; and
f) A vacuum pump capable of delivering a minimum of a 27 psi vacuum.

3) When vacuum testing, the installer shall:

a) Carefully trim all overlapped material using an approved cutting instrument. The "pull-tear" method of overlap removal shall not be accepted;
b) Clean windows, gasket surfaces, and check for leaks;
c) Wet a strip of geomembrane approximately 1 foot by 2.5 feet (length of box) with soapy solution;
d) Place the vacuum box over the wetted area;
e) Ensure that a leak-tight seal is created;
f) Apply a minimum vacuum pressure of five psi;

g) For a period of not less than 15 seconds, examine the length of weld through the viewing window for the presence of soap bubbles;
h) If no bubbles appear after 15 seconds, move the box over the next adjoining area with a minimum three inches of overlap and repeat the process;
i) Areas where soap bubbles appear shall be marked, repaired, and re-tested;
j) All vacuum testing will be documented by the CONTRACTOR'S QC Technician and submitted to the ENGINEER at the end of each WORK shift. The liner shall be indelibly marked near the seam to indicate passing or failing test results accordingly.

b. Air Pressure Testing

1) Shall be performed in all hot wedge welds performed during installation and in accordance with ASTM D 5820;
2) The equipment for pressure testing shall include the following:

a) Air pumps equipped with a pressure gauge capable of generating and sustaining a pressure of 30 pounds per square inch (psi); and
b) Sharp hollow needles or other pressure feed devices approved by the ENGINEER. The liner shall be indelibly marked near the tested area to indicate passing or failing test results accordingly.

3) To perform the air pressure test, the installer's QC Technician shall:

a) Pass air through the channel to guarantee a clear pathway;
b) Seal both ends of the seam to be tested;
c) Insert a needle or other approved pressure-feed device into the tunnel created by double hot wedge seaming;
d) Energize the air pump to 30 psi;
e) Close the valve while sustaining the air pressure and allow the air to reach ambient liner temperature;
f) Read the pressure gauge;
g) Sustain the test for a minimum of five minutes and re-read the pressure gauge;
h) If the loss of pressure exceeds three psi after a two-minute period or does not stabilize, faulty areas shall be located and repaired. After testing, pressure-feed devices shall be removed and insertion points sealed; and
i) All pressure testing shall be documented by the CONTRACTOR'S QC Technician and submitted to the ENGINEER by the end of each WORK shift. The liner shall be indelibly marked near the seam to indicate passing or failing test results accordingly.

c. Alternative testing methods other than vacuum or pressure testing may be proposed by the CONTRACTOR and will be subject to the approval of the ENGINEER prior to their use.
d. At locations where seams cannot be non-destructively tested, the CONTRACTOR shall:
1) Cap-strip seams with the same geomembrane when possible; and

2) If the seam is accessible to testing equipment prior to final installation, non-destructively test the seam prior to final installation.

e. Seaming and cap-stripping operations will be observed by the ENGINEER for uniformity and completeness.

2. Destructive Testing (performed by the CONTRACTOR with observation from the ENGINEER)

a. Location and frequency of testing

1) Collect destructive test samples at a frequency of one per every 500 lineal feet of seam length per machine used.
2) Test locations will be determined after seaming.
3) Exercise method of attributes as described by GRI GM-14 to minimize test samples taken.

b. Sampling Procedures are performed as follows:

1) The CONTRACTOR shall cut samples at locations designated by the ENGINEER as seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.
2) The ENGINEER will number each sample, and the location will be noted on the installation as-built.
3) Samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise (length may vary to minimize cutting of the liner).
4) Cut 10 two-inch wide by six-inch long test strips from each end of the samples for field testing.
5) The remaining sample shall be distributed as follows:

a) One portion for CONTRACTOR, 12 by 12 inches
b) One portion for the third party laboratory, 12 by 18 inches
c) Additional samples may be archived if required by OWNER

6) The CONTRACTOR shall repair all holes in the geomembrane resulting from destructive sampling.
7) Repair and test the continuity of the repair in accordance with these SPECIFICATIONS.

c. Destructive testing procedures

1) Destructive testing shall be performed in accordance with ASTM D6392.
2) Quantitatively test five specimens for peel adhesion, and then five specimens for shear strength.
3) Destructive testing specimens shall pass when the results shown in Table 3 are achieved in both peel and shear test.
4) The break, when peel testing, shall occur in the liner material itself, not through peel separation (FTB).
5) The break is to be ductile.

6) A test will be considered a failure if one specimen on either peel or shear testing does not meet the requirements on Table 3 or does not achieve an FTB break.

3. Failed Seam Procedures

a. If the seam fails, the CONTRACTOR shall follow one of two options:

1) Reconstruct the seam between any two passed test locations.
2) Trace the weld to intermediate locations at least 10 feet minimum or where the seam ends in both directions from the location of the failed test. If necessary the failed seam shall be traced to previous days of seaming for the particular machine.
3) All tracing events shall be recorded by the ENGINEER.

b. An additional sample is required for the next seam welded using the same welding device regardless of the length of the next seam.
c. If the new sample passes, then the failed 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 is to be reconstructed.

3.05 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. Install additional liner anywhere excessive tension (trampolines) exists and to avoid excessive tension.

D. The CONTRACTOR shall be responsible for repair of defective areas.

E. Agreement upon the appropriate repair method shall be decided between the ENGINEER or OWNER and CONTRACTOR by using one of the following repair methods:

1. Patching – Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter. Patch materials shall be of the same material type and thickness as the material being repaired. A patch shall be a minimum of 12 inches larger in all directions than the area requiring repair. All patches shall have rounded corners;
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; or
6. Remove the unacceptable seam and replace with new material.

F. 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 geomembrane which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness; and
3. Extend patches or caps at least six inches for extrusion welds and six inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

G. Repair Verification

1. Number and log each patch repair (performed by the ENGINEER)
2. Non-destructively test each repair using methods described in this SPECIFICATION
3. Any rips, tears or damaged areas on the deployed geonet shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches 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, the two portions of the geonet shall be cut out, and the two portions of the geonet shall be joined in accordance with these SPECIFICATIONS.

3.06 DEPTH OR ELEVATION MARKINGS

A. Following completion of geomembrane installation paint depth or elevation markings as shown on the DRAWINGS.

B. Paint shall be non-corrosive and weather resistant.

SECTION 33 47 13.15 - GEOTEXTILES

PART 1 - GENERAL

1.01 SUMMARY

A. The WORK described in this SPECIFICATION section includes the manufacture and installation of geotextile fabrics as stand-alone items only and not included as part of a geocomposite.

1.02 SUBMITTALS

A. Product Data

1. The CONTRACTOR shall provide to the ENGINEER a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile. The certification shall state that the furnished geotextile meets Minimum Average Roll Value (MARV) requirements of the SPECIFICATION as evaluated under the manufacturer's quality control program. The certification shall be attested to by a person having legal authority to bind the manufacturer.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM D4354 – Practice for Sampling of Geosynthetics for Testing
2. ASTM D4355 – Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
3. ASTM D4533 – Test Method for Index Trapezoid Tearing Strength of Geotextiles
4. ASTM D4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
5. ASTM D4751 – Test Method for Determining Apparent Opening Size of a Geotextile
6. ASTM D4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
7. ASTM D4873 – Guide for Identification, Storage, and Handling of Geotextiles
8. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
9. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles

B. American Association for Laboratory Accreditation (A2LA)

C. Geosynthetic Accreditation Institute (GAI) – Laboratory Accreditation Program (LAP)

D. National Transportation Product Evaluation Program (NTPEP)

1.04 DEFINITIONS

A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.05 QUALIFICATIONS

MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of geotextile material during the last year.

1.06 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Geotextiles labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.

C. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames (including welding sparks), excess temperatures, and any other environmental conditions that may damage the physical properties of the geotextile.

PART 2 - PRODUCTS

2.01 GEOTEXTILE

A. The geotextile shall be GSE Environmental (GSE) Nonwoven Geotextile or equivalent. The geotextile shall be manufactured with fibers consisting of long-chain synthetic polymers composed of at least 95% by weight of polyfins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

B. Woven slit film geotextiles (i.e., geotextiles made from yarns of a flat, tape-like character) shall not be allowed.

C. The geotextile shall weight shall be as identified in the drawings and meet at a minimum the requirements of Table 2.1. All numeric values in Table 2.1 except Apparent Opening Size (AOS) represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 2.1: 10 OZ GEOTEXTILE REQUIREMENTS			
Property	**Test Method**	**Units**	**Value**
Mass per unit Area	ASTM D5261	oz/yd^2	10
Grab Tensile Strength	ASTM D4632	lbs	270
Grab Tensile Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs	105
CBR Puncture Strength	ASTM D4833	lbs	725
Permittivity	ASTM D4491	sec^{-1}	1.0
Apparent Opening Size	ASTM D4751	U.S. Sieve	100
Water Flow Rate	ASTM D4491	gpm/ft^2	75
UV Resistance[1]	ASTM D4355	%	70

[1]After 500 hrs

2.02 QUALITY CONTROL

A. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP and A2LA for tests required for the geotextile, at a frequency meeting or exceeding ASTM D4354.

B. Geotextile properties, other than sewn seam strength, burst strength, and ultraviolet stability shall be tested by NTPEP to verify conformance with this SPECIFICATION.

C. Sewn seam strength shall be verified based on testing of either conformance samples obtained using Procedure A of ASTM D4354, or based on manufacturer's certifications and testing of quality assurance samples obtained using Procedure B of ASTM D4354. A lot size for conformance or quality assurance sampling shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.

D. Ultraviolet stability shall be verified by an independent laboratory on the geotextile or a geotextile of similar construction and yarn type.

PART 3 - EXECUTION

3.01 PREPARATION

A. Grading shall be done in such a way so as to prevent large voids from occurring along the geotextile contact. The graded surface shall be smooth and free of debris.

3.02 INSTALLATION

A. The geotextile installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

B. The geotextile shall be placed loosely with no wrinkles or folds, and with no void spaces between the geotextile and the ground surface. Successive sheets of geotextiles shall be overlapped a minimum of 12 inches, with the upstream sheet overlapping the downstream sheet.

C. Should the geotextile be damaged during installation or drainage aggregate placement, a geotextile patch shall be placed over the damaged area extending beyond the damaged area a distance of 12 inches, or the specified seam overlap, whichever is greater.

END OF SECTION 33 47 13.15

SECTION 33 47 13.16 – GEOCOMPOSITE DRAINAGE LAYERS

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the technical requirements for the manufacturing and installation of the geocomposite drainage layers. All materials must meet or exceed the requirements of this SPECIFICATION, and all work will be performed in accordance with the procedures provided in these project SPECIFICATIONS unless approved by the ENGINEER.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)
1. ASTM D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
2. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics
3. ASTM D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
4. ASTM D4354 Practice for Sampling of Geosynthetics for Testing
5. ASTM D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
6. ASTM D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity
7. ASTM D4533 Test Method for Index Trapezoid Tearing Strength of Geotextiles
8. ASTM D4716 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
9. ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
10. ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
11. ASTM D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
12. ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
13. ASTM D5261 Standard Test Method for Measuring the Mass Per Unit Area of Geotextiles
14. ASTM D6241Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
15. ASTM D7005 Standard Test Method for Determining The Bond Strength (Ply-Adhesion) of Geocomposites
16. ASTM D7179 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.

1.03 DEFINITIONS

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

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

C. 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.

1.04 QUALIFICATIONS

A. MANUFACTURER

MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geocomposite material during the last year.

B. CONTRACTOR

a. CONTRACTOR shall have installed a minimum of 3,000,000 square feet of geosynthetics in the last 3 years.
b. CONTRACTOR 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 a total of at least 3,000,000 square feet of geonet or geocomposite installation on each project.
c. The Installation Supervisor shall have worked in a similar capacity on at least 5 projects similar in size and complexity to the project described in the Contract Documents in the last 5 years.

1.05 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 shall handle all rolls in such a manner to ensure they are not damaged in any way.

   2. The CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the drainage material.

1.06 WARRANTY

A. Geonet portion of the material shall be warranted against defects for a period of 5-years from the date of the geocomposite installation. Geotextile portion of the material shall be warranted against defects for a period of 6-months 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.

PART 2 - PRODUCTS

2.01 GEOCOMPOSITE PROPERTIES

A. The geocomposite shall be manufactured by adhering a geotextile to a single side of a geonet core.

B. Two geocomposite materials shall be used as shown on the DRAWINGS. Each type of geocomposite specified shall have properties that meet or exceed the values listed in the following tables below.

TABLE 2.1: 250-MIL HYPERNET GEONET PROPERTIES			
Property	**Test Method**	**Frequency**	**Value**
Geocomposite			
Transmissivity, gal/min/ft	ASTM D 4716	1/540000 ft^2	4.8
Ply Adhesion, lb/in.	ASTM D 7005	1/50000 ft^2	1.0
Geonet			
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft^2	250
Transmissivity[1], gal/min/ft	ASTM D 4716	1/540,000 ft^2	14.5
Density, g/cm^3	ASTM D 792 / 1505	1/50,000 ft^2	0.94
Creep Reduction Factor	ASTM D 7406/7361	Per formulation	Maximum of 1.2 at 15,000 lb/ft^2
Tensile Strength (MD), lb/in	ASTM D 5035/7179	1/50,000 ft^2	55
Carbon Black Content, %	ASTM D 1603[2]/4218	1/50,000 ft^2	2.0

[1]Gradient of 0.1, normal load of 10,000 lb/ft^2, water at 70° F, between steel plates for 15 minutes.
[2]Roll Widths and Lengths have a tolerance of +/- 1%.

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 2.2: RAW MATERIAL VALUES		
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]Manufacturer may utilize 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.

2.02 MANUFACTURING QUALITY CONTROL

1. The geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the ENGINEER.
2. The geocomposite shall be tested according to the test methods and frequencies listed on Tables 1 and 2 which has been prepared based on product data sheets.

PART 3 - EXECUTION

3.01 FAMILIARIZATION

A. Inspection

1. Prior to implementing any of the work in the Section to be lined, the CONTRACTOR 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 CONTRACTOR has any concerns regarding the installed work of other Sections, the CONTRACTOR shall notify the ENGINEER.

3.02 MATERIAL PLACEMENT AND INSTALLATION

A. The geocomposite installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

B. 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.

C. Use full length rolls or those with a significant length remaining at the top of the slope so that no roll end occurs on side slopes.

D. In the presence of wind, all geocomposites shall be weighted down with ballast (i.e. sandbags or approved equal)

E. Ballast shall be used during placement and remain until replaced with cover material.

F. The geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

G. The drainage rock material shall be placed on the geocomposite in a manner that does not permit vehicular traffic directly on the geocomposite, and prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

H. No equipment shall be driven upon the geocomposite layer.

3.03 SEAMS AND OVERLAPS

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

B. Geonet Components

1. Butt seams 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 24 inches across the roll width. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 12 inches along the roll width.

2. Adjacent edge seams across the roll length 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 6 inches across the roll length. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll width.

C. Geotextile Components

1. The top layers of geotextiles shall be sewn together. The CONTRACTOR, upon approval by the ENGINEER, may propose to wedge weld the top layers of geotextile in lieu of sewing. The method for performing this work must be submitted to the ENGINEER for approval a minimum of 14 days before installation.

2. Geotextiles shall have a minimum 1-inch overlap before seaming or wedge welding. If wedge welding is proposed and approved, the CONTRACTOR must ensure that the geotextile is not burned, damaged, or punctured by the wedge welding process. The geotextiles shall be joined continuously to the adjacent and adjoining rolls to prevent material from migrating into the geonet core of the geocomposite.

3.04 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 inches 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 of this part.

END OF SECTION 33 47 13.16

END OF SECTION 33 47 13

SECTION 40 23 00 - POLYETHYLENE PIPE

PART 1 - GENERAL

1.01 SUMMARY

A. The WORK of this SPECIFICATION section shall consist of furnishing and installing the leakage collection and conveyance piping and appurtenances associated with the sump and collection trench as shown on the DRAWINGS.

B. The CONTRACTOR shall furnish all labor, materials, tools, equipment, and services for construction of the polyethylene piping and appurtenances.

C. Although such WORK may not be specifically indicated, CONTRACTOR shall furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a fully functional installation.

1.02 PIPEWORK AND APPURTENANCES

A. All drainage, collection and conveyance pipework shall be carefully fabricated and placed as shown on the DRAWINGS and approved by the OWNER.

B. All pipe invert elevations and gradients shall be accurately set. CONTRACTOR shall adequately anchor or ballast the pipe to prevent movement during construction.

1.03 REFERENCES

A. Provide IPS size HDPE pipe in accordance with the following standards and all other mandatory ASTM requirements detailed therein.

1. American Society for Testing and Materials (ASTM) most current versions and other applicable standards.
   a. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
   b. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
   c. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
   d. PPI TR – 33 Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe

1.04 SUBMITTALS

A. The CONTRACTOR shall submit the following:

1. Shop drawings of HDPE pipe, fittings, and manner of securing; a list of materials to be furnished; and the name of the pipe manufacturer;

2. Product data sheets showing compliance with the product requirements of this Section
3. Certifications of welder's qualifications for HDPE pipe fusion required for the project.

B. Submit manufacturer's installation instructions and maintain a copy on-site for reference during construction.

1.05 PIPE WELDERS QUALIFICATIONS

A. All operators conducting fusion welding activities must be certified by the manufacturer as technically qualified and properly experienced for fusion welding of HDPE pipe.

B. Submit names of certified operators in accordance with this Section.

PART 2 - PRODUCTS

2.01 HDPE PIPE

A. HDPE pipe and fittings shall be high-density, high molecular weight polyethylene pipe PE 4710.

B. High density polyethylene (HDPE) resin: compounded and manufactured specifically for producing HDPE pipe.

C. Pipe: Manufactured in accordance with ASTM D3350 and ASTM F 714.

D. The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials, and shall assure that the pipe will meet the material requirements of this specification. HDPE resins for manufacturing of pipe shall be checked for density, melt flow rate, and contamination. The facility shall have the necessary testing equipment to verify that pipe meets the AWWA and NSF standards. Pipe shall be checked for outside diameter, wall thickness, length, and surface finish on the inside and outside. The Manufacturer's production facilities shall be open for inspection by the Owner or Engineer.

E. Dimension Ratio (DR): As required by the DRAWINGS.

F. HDPE pipes shall be supplied in standard laying lengths not exceeding 40 feet.

G. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than manufactured perforations per design), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

H. Fitting at the toe of the slope for the leachate detection sump (LDS) pipe shall consist of a fabricated bend constructed of the same material as the pipe.

PART 3 - EXECUTION

3.01 GENERAL

A. Coordinate details of the prefabricated pipe penetration through the primary liner with the liner manufacturer and CONTRACTOR.

3.02 HANDLING AND PLACEMENT

A. HDPE pipe and fittings shall be installed as indicated on the DRAWINGS.

B. The CONTRACTOR shall exercise care when transporting, handling and placing pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

C. The CONTRACTOR shall comply with the pipe manufacturer's recommendations for handling, storage, and installation of all polyethylene pipe and fittings.

D. Ropes, fabric, or rubber-protected slings and/or straps shall be used when handling pipe. Chains, cables or hooks shall not be used as a means of handling pipe.

E. Pipe or fittings shall not be dropped or dragged over sharp objects.

F. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of pipe or fittings is 10% of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges, and scratches. CONTRACTOR shall be required to remove and replace damaged pipe, at no additional cost to the OWNER.

G. Whenever pipe laying is not actively in progress, the open ends of pipes that have been placed shall be closed using watertight plugs.

3.03 INSTALLATION

A. Pipe shall be laid on geotextile within the leak collection system as shown on the DRAWINGS.

B. All polyethylene pipe and fittings shall be installed in accordance with this SPECIFICATION and in conformance with the pipe manufacturer's written instructions.

C. The CONTRACTOR shall carefully examine all pipe and fittings for cracks, damage, or defects before installation.

D. The interiors of all pipes and fittings shall be inspected, and foreign materials shall be completely removed from the pipe and fitting interiors before they are moved into their final positions.

E. Do not damage underlying WORK, soil layers or geosynthetic installations during pipe installation operations. Repair all damaged WORK.

3.04 JOINTS AND CONNECTIONS

A. Fusion joining equipment shall be as supplied by, leased from, or approved by the pipe manufacturer.

B. Joining techniques and operating procedures shall carefully follow written instructions provided by the pipe manufacturer and the joint equipment supplier. A copy of such instructions, including heating time, cooling time, fusion temperature, and fusion pressure for each size of pipe shall be present at any location in which butt-fusion is being carried out.

C. Fusion Joining Requirements:

1. All HDPE pipe shall be joined to itself by the heat fusion process which produces homogeneous, seal, leak tight joints. Tie-ins between sections of HDPE pipe shall be made by butt fusion whenever possible.

D. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42. A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F 2620. Considerations should be given to and provisions made for adverse weather conditions, such as temperatures below freezing, precipitation, or wind, which is accepted by the owner/engineer.

3.05 PERFORATIONS

A. Perforations as shown on the DRAWINGS may be manufactured or field constructed with approval from the ENGINEER or OWNER.

END OF SECTION 40 23 00

Engineering and Standard Operating Procedures (QA/QC) for the Above Ground Storage Tanks (AST) Also known as Modular Large Volume Tanks (MLVT)

The reader is hereby notified that all information, reports, drawings, plans, diagrams, and specifications contained herein are the confidential property of Well Water Solutions and Rentals, Inc. ("WWSR") and constitute proprietary trade secret material. Ownership of any tangible and intangible property, including intellectual property, is and shall be reserved and retained by WWSR. Unless otherwise authorized by WWSR in advance by written permission: (a) any use of WWSR confidential property shall be limited to legitimate, good faith purposes associated with regulatory compliance; (b) no person shall allow or in any way assist the disclosure, transfer, dissemination or use of any confidential property except for regulatory compliance purposes; and (c) only original, signed versions of this document may be authorized for use and review, and reproduction of or digitally storing this document by any method is strictly prohibited. Any violation, breach or threatened breach, whether voluntary or inadvertent, of the aforementioned limitations and prohibitions will cause irreparable injury to WWSR and shall entitle WWSR to injunctive relief against, and recover all attorney fees and cost from, any person in breach or threatening to breach said prohibition.

Table Of Contents

1.1

EMERGENCY ACTION PLAN

EMERGENCY PERSONNEL NAMES AND PHONE NUMBERS

DESIGNATED RESPONSIBLE PERSONNEL (Highest ranking manager at the site, such as, crew supervisor or crew lead.)

Name: _____ Phone: _____

EMERGENCY COORDINATOR:
Name: Brian Bullock Phone: 307-267-3964

AREA MONITORS:

Controller: Mike Karaouni Phone: 307-247-0791
US Sales Manager: Chad Campbell Phone: 307-259-1987

TANKS
Pennsylvania Area: Andrew Lehman Phone: 970-630-3530
Kerry Horter Phone: 307-262-2058
Wyoming, North Dakota
Texas New Mexico: JW Morris Phone: 307-267-8075

WATER TRANSFER
Wyoming: Ben Ledford Phone: 307-277-4681

WELL WATER SOLUTIONS AND RENTALS OWNERSHIP

CEO Chris Songe Phone: 307-247-1143
PRESIDENT Sean Lovelace Phone: 307-267-1878

EVACUATION ROUTES

- Evacuation routes have been posted in each work area. The following information is marked on evacuation maps.

    1. Emergency exits
    2. Primary and secondary evacuation routes
    3. Locations of fire extinguishers
    4. Fire alarm pull station locations
    5. Assembly points

- Site personnel should know at least two evacuation routes.
- All emergency numbers listed in this manual are for the Casper WY area. All field employees shall list in the space provided all emergency numbers needed for the regions that they are working in on the following form or in the JSA (Pre Job Safety Analysis).

EMERGENCY PHONE NUMBERS

FIRE DEPARTMENT: Emergency 911
Non-emergency 307-237-7260 (Bar Nunn volunteer FD)

AMBULANCE: Emergency 911
Non-emergency 307-237-7260 (Bar Nunn volunteer FD)

POLICE: Emergency 911
Non-emergency 307-235-9282 (Sheriff's office dispatch)

POWER COMPANY: 1-888-221-7070 (Rocky Mountain Power)

WATER COMPANY: 307-265-7034 (Wardwell Water and Sewer district)

GAS COMPANY: 1-800-563-0012 (Source Gas)
Local Number 307-234-6216

EMERGENCY REPORTING AND EVACUATION PROCEDURES

Types of emergencies to be reported by site personnel are:

- MEDICAL
- FIRE
- SEVERE WEATHER
- BOMB THREAT
- CHEMICAL SPILL
- EXTENDED POWER LOSS
- OTHER (specify)_____

  (e.g., active shooter, terrorist attack/hostage)

MEDICAL EMERGENCY

- Call medical emergency phone numbers
  - Ambulance
  - Fire Department
  - Police

Provide the following information:

a. Nature of medical emergency
b. Location of the emergency (address, building number, room number)
c. Your name and phone number you are calling from

- Do not move victim unless absolutely necessary
- Call the following personnel trained in CPR and First Aid to provide the required assistance prior to the arrival of professional medical help:

Brian Bullock	HSE Manager	307-267-3964
Local Emergency Response		TBD

- If trained personnel are not available, as a minimum, attempt to provide the following assistance:
  1. Stop the bleeding with firm pressure on the wounds (note: avoid contact with blood and other body fluids.)
  2. Clear the air passage using the Heimlich maneuver in case of choking.
- In case of rendering assistance to personnel exposed to hazardous materials, consult the SDS (Safety Date Sheet) and wear the appropriate PPE (personal protective equipment) attempt First Aid ONLY if trained and qualified.

FIRE EMERGENCY

When fire is discovered:

- Activate the nearest fire alarm (if installed)
- Notify the local fire department by calling 911.

Be prepared to give location, (address, building number, room number) your name and number you are calling from.

- If alarm is not available, notify site personnel about the fire emergency by the following means.
    - Voice communication
    - Phone paging
    - Radio
    - Other (specify)_____

Fight fire ONLY if:

- The Fire Department has been notified.
- The fire is small and is not spreading to other areas.
- Escaping the area is possible by backing up to the nearest exit.
- The fire extinguisher is in working condition and personnel are trained to use it.

Upon being notified about the fire emergency, occupants must:

- Leave the building using the designated escape routes.
- Assemble in the designated area (specify location)
- Remain outside until the component authority (Designated official or designee) announces that it is safe to reenter.

Designated official, Emergency Coordinator, or supervisors must,

- Disconnect utilities and equipment unless doing so jeopardizes his/her safety.
- Coordinate an orderly evacuation of personnel.
- Perform an accurate head count of personnel reported to the designated area.
- Determine a rescue method to locate missing personnel.
- Provide the Fire Department personnel with the necessary information about the facility.
- Perform assessment and coordinate with ownership for office closing procedures.

Area monitors must:

- Ensure that all employees have evacuated the area.
- Report any problems to the Emergency Coordinator at the assembly area.

EXTENDED POWER LOSS

In the event of extended power loss to the facility, certain precautionary measures be taken depending on the geographical location and environment of the facility:

- Unnecessary electrical equipment and appliances should be turned off in the event that power restoration would surge causing damage to electronics and effecting equipment.
- Facilities with freezing temperatures should turn off and drain the following lines in the event of a long term power loss.
    - Fire sprinkler system
    - Standpipes
    - Portable water lines
    - Toilets
- Add propylene-glycol (anti-freeze) to drains to prevent traps from freezing.
- Equipment that contains fluids that may freeze due to long term exposure to freezing temperatures should be moved to heated areas, drained of liquids, or provided auxiliary heat sources.

Upon restoration of heat and power:

- Electronics should be brought up to ambient temperatures before energizing to prevent condensate from forming on circuitry.
- Fire and portable water piping should be checked for leaks from freeze damage after the heat has been restored to the facility and water turned back on.

CHEMICAL SPILL

In the event of a spill, always consult the SDS and check safe distances and appropriate PPE (Personal Protective Equipment).

When a large spill has occurred:

- Immediately notify the designated official and Emergency Coordinator.
- Contain the spill with available equipment (e.g. pads, brooms, absorbent powder, etc.)
- Secure the area and alert other on site personnel.
- DO NOT attempt to clean the spill unless trained to do so.
- Attend to any injured personnel and call the medical emergency number, if required.
- Call a local spill cleanup company or the fire department (if arrangements have been made) to perform a large chemical spill cleanup.

Fire department Non-emergency 307-237-7260 (Bar Nunn volunteer FD)

- Evacuate building as necessary.

When a small spill has occurred:

- Notify Supervisor
- If toxic fumes are present, secure the area (with caution tape or cones) to prevent other personnel from entering.
- Deal with the spill in accordance with the instructions described in the SDS.
- Small spills must be handled in a safe manner, while wearing the proper PPE.

TELEPHONE BOMB THREAT CHECKLIST

INSTRUCTIONS: BE CALM, BE COURTEOUS. LISTEN. DO NOT INTERUPT THE CALLER.
YOUR NAME:_____TIME:_____DATE:_____
CALLER'S IDENTITY: SEX: MALE___FEMALE___ADULT____JUVENILE___APROX AGE____
ORIGIN OF CALL: LOCAL_____LON DISTANCE_____

Voice Characteristics	Speech	Language
___Loud ___Soft ___High pitch ___Deep ___Raspy ___Pleasant ___Intoxicated ___Other ACCENT ___Local ___Not local ___Foreign ___Region ___Race	___Fast ___Slow ___Distinct ___Distorted ___Stutter ___Nasal ___Slurred ___Other MANNER ___Calm ___Angry ___Rational ___Irrational ___Coherent ___Incoherent ___Deliberate ___Emotional ___Righteous ___Laughing	___Excellent ___Good ___Fair ___Poor ___Foul ___Other BACKGROUND NOISES ___Factory ___Trains ___Machines ___Animals ___Music ___Quiet ___Office ___Voices ___Machines ___Airplanes ___Street ___Party ___Traffic ___Atmosphere

BOMB FACTS

PRETEND DIFFICULTY HEARIN-KEEP CALLER TALKING-IF CALLER SEEMS AGREEABLE TO FURTHER CONVERSATION, ASK QUESTIONS LIKE:
When will it go off? Certain Hour_____Time Remaining_____
Where is it located? Building_____Area_____
What kind of bomb?_____
What kind of package?_____
How do you know so much about the bomb?_____
What is your name and address?_____
If building is occupied, inform caller that detonation could cause injury or death.
Call the Sheriff at 307-235-9282 and relay information about the call.
Did the caller appear familiar with the shop or location (by his/her description of the bomb location)?
Write out the message in its entirety and any other comments on a separate sheet of paper and attach it to this checklist.

Notify your supervisor immediately.

SEVERE WEATHER AND NATURAL DISASTERS

Tornado:

- When a warning is issued by sirens or other means, seek inside shelter. Consider the following:
    1. Small interior rooms on the lowest floor and without windows.
    2. Hallways on the lowest floor away from doors and windows.
    3. Rooms constructed with reinforced concrete, brick, or block with no windows.
- Stay away from outside walls and windows.
- Use arms to protect head and neck.
- Remain sheltered until the tornado threat is announced to be over.

Earthquake:

- Stay calm and await instructions from the Emergency Coordinator and/or the designated official.
- Keep away from overhead fixtures, windows, filing cabinets, and electrical power.
- Assist people with injuries in finding a safe place.
- Evacuate as instructed by the Emergency Coordinator and/or the designated official.

Flood:

If indoors:

- Be ready evacuate as directed by the Emergency Coordinator and/or the designated official.
- Follow the designated primary and secondary routes.

If outdoors:

- Climb to high ground and stay there.
- Avoid driving or walking through flood water.
- If car stalls, abandon it immediately and climb to higher ground.

Blizzard:

If indoors:

- Stay calm and await instructions from the Emergency Coordinator or the designated official.
- Stay indoors.
- If there is no heat:
    1. Close off unneeded rooms and areas.
    2. Stuff towels or rags in cracks under doors.
    3. Cover windows at night.
- Eat and drink. Food provides the body energy and heat. Fluids prevent dehydration.

- Wear layers of loose-fitting, lightweight, warm clothing if available.

If outdoors:

- Find a dry shelter. Cover all exposed parts of the body.
- If shelter is not available:
    1. Prepare a lean-to, windbreak, or snow cave for protection from the wind.
    2. Build a fire for heat and to attract attention. Place rocks around the fire to absorb and reflect heat.
    3. DO NOT eat snow. It will lower your core body temperature. Melt it first.

If stranded in a car or truck:

- Stay in the vehicle!
- Run the motor for about ten minutes every hour. Open the window a little for fresh air to avoid carbon monoxide poisoning. Make sure the exhaust pipe is not blocked.
- Make yourself visible to rescuers.
    1. Turn on the dome light at night when running the engine.
    2. Tie a colored cloth to the antenna or door.
    3. Raise the hood after the snow stops falling.
- Exercise to keep blood circulating and to keep warm.

1.2

Company Information	Victim Information
Company Name_____	Name_____
Location_____	Category: Injury Illness (circle one)
Company Man_____	Location_____
Phone_____	Job Title_____
	Department_____
	Date_____

Incident Information

What was the injury or illness?_____

Time work began?_____

What happened? (short explanation of how the incident occurred)_____

_____

_____

What object or substance directly harmed the employee?_____

_____

Unsafe acts by people: (circle all that apply)

Operating without permission	Unsafe lifting
Operating at unsafe speeds	Taking an unsafe position or posture
Servicing Equipment with power	Distraction, teasing, or horseplay
Making a safety device inoperative	Failure to wear PPE
Using defective equipment	Failure to use available equipment
Using equipment incorrectly	Other_____

Did you see the potential incident while preforming the job? YES or NO

Explain_____

_____

Did you notify the supervisor of the unsafe acts or conditions prior to the incident? YES or NO

Explain_____

_____

_____

Where was the supervisor prior to and during the incident?_____

_____

How could this incident have been avoided? (circle all that apply)

Stop the activity Train supervisor Routinely inspect for the hazard
Guard the hazard Redesign task steps PPE
Train employee Write a new policy or procedure
Other_____

Was there corrective action taken? YES or NO
What correction action was taken?_____
_____
_____
_____
List all unsafe conditions leading to injury._____
_____
_____
What happened? (short explanation of how injury occurred)_____
_____
_____
_____
Was the supervisor notified of unsafe acts or conditions prior to injury? YES or NO
Explain_____
_____
Where was the supervisor prior to/during to the injury?_____
_____
How could this injury have been avoided?_____
_____
Was corrective action taken? YES or NO
What corrective action was taken?_____
_____
_____

NEAR MISS REPORT

A near miss is a potential hazard or incident that has not resulted in any personal injury. Unsafe working conditions, unsafe employee work habits, improper use of equipment or use of malfunctioning equipment have the potential to cause work related injuries. It is everyone's responsibility to report and /or correct these potential accidents/incidents immediately. Please complete this form as a means to report these near-miss situations.

Department/Location_____ Date: _____

Time _____ O am O pm

Please check all appropriate conditions:

O Unsafe Act
O Unsafe Condition
O Unsafe equipment
O Unsafe use of equipment

Description of incident or potential hazard: _____

_____

_____

Employee Signature_____ Date _____

(optwnaf)

NEAR MISS INVESTIGATION

Description of the near-miss condition: _____

_____

Causes (primary and contributing)_____

_____

Corrective action taken (Remove the hazard, replace, repair, or retrain in the proper procedures for the task)

_____

_____

_____

Signed: _____ Date Completed _____

Not completed for the following reason: _____

Management _____ Date _____

1.3 JSA will be filled out prior to the start of the day or different new task.

JOB SAFETY ANALYSIS REPORT

COMPANY _____

LOCATION _____

SUPERVISOR _____

DATE : _____

Task Description: _____

Task	Hazard Description:

Safety Solutions and Suggestions:

Personnel Names	Personnel Signatures	TIME IN

Sign out: I here by certify that I was not injured on the job and there was not work stoppage

Printed Name	Signature	TIME OUT

1.4

TRUCK PRETRIP CHECKLIST

Operator	**Date**
Truck #	**Gas/Diesel**

OPERATOR MUST COMPLETE CHECKLIST AT THE START OF THE DAY
Mileage Beginning_____Mileage Ending_____

Visual checks	**OK**	**Service**	**N/A**	**Notes**
Tire Condition				
Head/Tail lights				
Warning lights				
Fluid Levels				
Battery conn.				
Seatbelts				
Mirrors				
Gauges				
Fluid leaks				
Oil change				
Horn				
Steering				
Ops check				
Check oil				
Check coolant				
Diesel additive				
Battery levels				
Tire pressure				
Brakes				
Brake fluid				
Power steering				
Belts/hoses				
In service?	**Yes**	**No**		

TRAILER PRETRIP CHECKLIST

Operator	**Date**
Trailer #	**Dual Tandem/Single**

Pre-trip	**Ok**	**Service**	**Notes**
Check gooseneck, connection, safety latch, & emergency Brake away			
All lights and connection			
Tires, pressure, hub, and lugs			
Deck boards, condition, clean, broken			
Min 12 straps and 4 chains and ratchet boomers			
Date of last DOT inspection with proof and registration			
In service?	**Yes**	**No**	

FORKLIFT PRE USE CHECKLIST

FORKLIFT #_____ LOCATION_____

DAY_____SHIFT_____TIME_____

ITEM INSPECTED	OK	HIGH	LOW	AMOUNT ADDED
Fuel level				
Oil level				
Leaks under lift				
Forks, backrest, and Carriage				
Mast, Chain, Hydraulic lines				
Check Frame for cracks				
Tires, tire pressure, Axles				
Overhead Guard				
Fuel tank and connections				
Hydraulic cylinders and levels				
Battery and Cables				
Seat and Seatbelt				
Horn and backup alarm				
Lights and ops manual				
Gauges and instruments				
Brakes and Emergency brake				
Hydraulic controls and lift				
Steering				
Check boom for leaks and cracks				
All glass and wipers				
All Mirrors				

BACKHOE PRE USE CHECKLIST

BACKHOE #_____ LOCATION_____

DAY_____SHIFT_____TIME_____

ITEM INSPECTED	OK	HIGH	LOW	AMOUNT ADDED
Fuel level				
Oil level				
Leaks oil, hydraulic, fuel				
Check belts and hoses for cracks				
Battery and cables				
Inspect frame for cracks				
Check Hydraulic lines and fittings				
Check steps and handles				
Check bucket and teeth				
Inspect stabilizers and pads				
Lights and signals				
Horn and backup alarm				
All glass and wipers				
Instruments and gauges				
Steering				
Check tires and pressure				
Check all brakes				
Grease all points daily				

Aerial lift pre-use inspection checklist

Operator _____ Date _____ Aerial or scissor lift ID _____

Unit type: Location

1. Safety Precautions	OK, NO, NA	2. Check Operations	OK, NO, NA
Windy		Horn	
Less than 20-25 MPH		Guage	
PPE		Brakes	
Wheel chock or Brake		Lights	
Working surface -Level		Steering	
Power Lines or Electrical Source		Attatchments or Accessories	
Load Limits		Back up Alarm	
Outriggers		Warning lights	
Other		Other	
3. Vehicle Inspection	OK, NO, NA	**4. Platform Lift Inspection**	OK, NO, NA
Oil Level		Lift and travel controls and switches	
Hydraulic Oil level		Placards, Decals, and Control ID labels	
Fuel Level		Handrails, Guardrails, and Safety Chains	
Check lift and area for leaks		Platform deck and toeboards	
Coolant level		Other	
Tire pressure and condition of tires			
Battery and charger			
Ground control switches			
Other			
Comments			

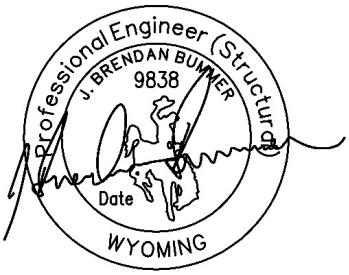
2.1

Modular Large Volume Tank

STRUCTURAL DESIGN SPECIFICATIONS

Prepared for:
WELL WATER SOLUTIONS
Casper, Wyoming

July 1, 2014



Prepared by:
PILLAR STRUCTURAL ENGINEERING
1964 E. 1st Street
Casper, Wyoming 82601
(307) 265-3900
(307) 265-3559 fax
www.pillarse.com

Structural Design Specifications

Project:	Modular Large Volume MLVT
Project No.:	14-06087
Date:	July 1, 2014
Pages 1-8:	General References Project Summary Structural Design Certification MLVT Erection Operations Manual MLVT Inspection and Testing Specifications
Attachments:	Design Drawings

GENERAL REFERENCES

Manual of Steel Construction – Load and Resistance Factor Design, Third Edition, American Institute of Steel Construction.

Welded Steel Tanks for Oil Storage – API Standard 650, Eleventh Edition, June 2007, American Petroleum Institute.

Tank Inspection, Repair, Alteration, and Reconstruction – API Standard 653, Fourth Edition, April 2009, Addendum 1, August 2010, American Petroleum Institute.

PROJECT SUMMARY

These specifications have been prepared for Well Water Solutions, a supplier of MLVT's located in Casper, WY.

The specifications herein include the structural design certification, MLVT erection operations manual, and MLVT inspection and testing specifications. All other components of the policy requirements including site preparation and liner certification and installation are provided and certified by others. These specifications have been prepared as general guidelines specific to the MLVT's provided only by Well Water Solutions.

2.2

PILLAR STRUCTURAL ENGINEERING

June 30, 2015

Well Water Solutions and Rental, Inc.
2130 W. 40th
Casper, WY 82604
Attn: Sean Lovelace

Re: Portable Frac Tank Certification – Pinned Seams

Dear Mr. Lovelace:

Per your request our office has performed a structural analysis of the portable frac tanks as well as the associated accessories. This analysis was performed to determine that the tanks meet the required strength criteria under operating conditions according to the AISC Manual of Steel Construction.

The tanks range in diameter from approximately 81 to 190 feet and are 11 feet, 8 inches in height and are designed to store water. They are constructed of individual steel reinforced panels that are connected together with a patent pending steel pin system.

The following tanks sizes were included in the analysis:

- 10,000 BBL – Approximately 81'Ø
- 20,000 BBL – Approximately 108'Ø
- 30,000 BBL – Approximately 135'Ø
- 40,000 BBL – Approximately 156'Ø
- 50,000 BBL – Approximately 176'Ø
- 55,000 BBL – Approximately 183'Ø
- 60,000 BBL – Approximately 190'Ø

The tanks are constructed of the following materials:

- Tank Panels – ASTM A36, 36 ksi Steel Plate
- Horizontal & Vertical Framing – ASTM A500, Grade B, 46 ksi Structural Steel Tubing
- Connecting Pins - ASTM A36, 36 ksi Steel Round Bar

PILLAR STRUCTURAL ENGINEERING

1964 East 1st Street
Casper, WY 82601

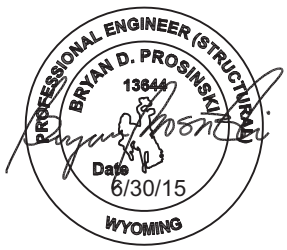
PHONE (307) 265-3900
FAX (307) 265-3559
WEB SITE http://www.pillarse.com

Our office has determined that the portable frac tanks, as described herein, are capable of supporting the operating load conditions in conformance with the AISC Manual of Steel Construction.

Calculations of this analysis can be provided upon request.

If you have any questions or require additional information please contact our office.

Sincerely,



Bryan Prosinski, P.E., S.E.
Pillar Structural Engineering

PILLAR
STRUCTURAL
ENGINEERING

June 30, 2015

Well Water Solutions and Rental, Inc.
2130 W. 40th
Casper, WY 82604
Attn: Sean Lovelace

Re: Portable Frac Tank Certification – Pinned Seams

Dear Mr. Lovelace:

Per your request our office has performed a structural analysis of the portable frac tanks as well as the associated accessories. This analysis was performed to determine that the tanks meet the required strength criteria under operating conditions according to the AISC Manual of Steel Construction.

The tanks range in diameter from approximately 81 to 190 feet and are 11 feet, 8 inches in height and are designed to store water. They are constructed of individual steel reinforced panels that are connected together with a patent pending steel pin system.

The following tanks sizes were included in the analysis:

- 10,000 BBL – Approximately 81'Ø
- 20,000 BBL – Approximately 108'Ø
- 30,000 BBL – Approximately 135'Ø
- 40,000 BBL – Approximately 156'Ø
- 50,000 BBL – Approximately 176'Ø
- 55,000 BBL – Approximately 183'Ø
- 60,000 BBL – Approximately 190'Ø

The tanks are constructed of the following materials:

- Tank Panels – ASTM A36, 36 ksi Steel Plate
- Horizontal & Vertical Framing – ASTM A500, Grade B, 46 ksi Structural Steel Tubing
- Connecting Pins - ASTM A36, 36 ksi Steel Round Bar

PILLAR STRUCTURAL ENGINEERING

1964 East 1st Street
Casper, WY 82601

PHONE (307) 265-3900
FAX (307) 265-3559
WEB SITE http://www.pillarse.com

Our office has determined that the portable frac tanks, as described herein, are capable of supporting the operating load conditions in conformance with the AISC Manual of Steel Construction.

Calculations of this analysis can be provided upon request.

If you have any questions or require additional information please contact our office.

Sincerely,

Bryan Prosinski, P.E., S.E.
Pillar Structural Engineering

PILLAR
STRUCTURAL
ENGINEERING

June 30, 2015

Well Water Solutions and Rental, Inc.
2130 W. 40th
Casper, WY 82604
Attn: Sean Lovelace

Re: Portable Frac Tank Certification – Pinned Seams

Dear Mr. Lovelace:

Per your request our office has performed a structural analysis of the portable frac tanks as well as the associated accessories. This analysis was performed to determine that the tanks meet the required strength criteria under operating conditions according to the AISC Manual of Steel Construction.

The tanks range in diameter from approximately 81 to 190 feet and are 11 feet, 8 inches in height and are designed to store water. They are constructed of individual steel reinforced panels that are connected together with a patent pending steel pin system.

The following tanks sizes were included in the analysis:

- 10,000 BBL – Approximately 81'Ø
- 20,000 BBL – Approximately 108'Ø
- 30,000 BBL – Approximately 135'Ø
- 40,000 BBL – Approximately 156'Ø
- 50,000 BBL – Approximately 176'Ø
- 55,000 BBL – Approximately 183'Ø
- 60,000 BBL – Approximately 190'Ø

The tanks are constructed of the following materials:

- Tank Panels – ASTM A36, 36 ksi Steel Plate
- Horizontal & Vertical Framing – ASTM A500, Grade B, 46 ksi Structural Steel Tubing
- Connecting Pins - ASTM A36, 36 ksi Steel Round Bar

PILLAR STRUCTURAL ENGINEERING

1964 East 1st Street
Casper, WY 82601

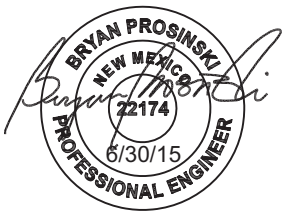
PHONE (307) 265-3900
FAX (307) 265-3559
WEB SITE http://www.pillarse.com

Our office has determined that the portable frac tanks, as described herein, are capable of supporting the operating load conditions in conformance with the AISC Manual of Steel Construction.

Calculations of this analysis can be provided upon request.

If you have any questions or require additional information please contact our office.

Sincerely,



Bryan Prosinski, P.E., S.E.
Pillar Structural Engineering

PILLAR
STRUCTURAL
ENGINEERING

June 30, 2015

Well Water Solutions and Rental, Inc.
2130 W. 40th
Casper, WY 82604
Attn: Sean Lovelace

Re: Portable Frac Tank Certification – Pinned Seams

Dear Mr. Lovelace:

Per your request our office has performed a structural analysis of the portable frac tanks as well as the associated accessories. This analysis was performed to determine that the tanks meet the required strength criteria under operating conditions according to the AISC Manual of Steel Construction.

The tanks range in diameter from approximately 81 to 190 feet and are 11 feet, 8 inches in height and are designed to store water. They are constructed of individual steel reinforced panels that are connected together with a patent pending steel pin system.

The following tanks sizes were included in the analysis:

- 10,000 BBL – Approximately 81'Ø
- 20,000 BBL – Approximately 108'Ø
- 30,000 BBL – Approximately 135'Ø
- 40,000 BBL – Approximately 156'Ø
- 50,000 BBL – Approximately 176'Ø
- 55,000 BBL – Approximately 183'Ø
- 60,000 BBL – Approximately 190'Ø

The tanks are constructed of the following materials:

- Tank Panels – ASTM A36, 36 ksi Steel Plate
- Horizontal & Vertical Framing – ASTM A500, Grade B, 46 ksi Structural Steel Tubing
- Connecting Pins - ASTM A36, 36 ksi Steel Round Bar

PILLAR STRUCTURAL ENGINEERING

1964 East 1st Street
Casper, WY 82601

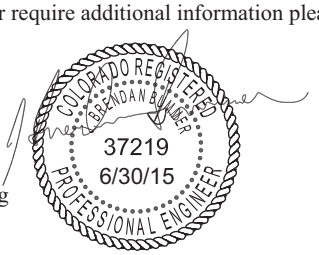
PHONE (307) 265-3900
FAX (307) 265-3559
WEB SITE http://www.pillarse.com

Our office has determined that the portable frac tanks, as described herein, are capable of supporting the operating load conditions in conformance with the AISC Manual of Steel Construction.

Calculations of this analysis can be provided upon request.

If you have any questions or require additional information please contact our office.

Sincerely,



J. Brendan Bummer, P.E.
Pillar Structural Engineering

PILLAR
STRUCTURAL
ENGINEERING

June 30, 2015

Well Water Solutions and Rental, Inc.
2130 W. 40th
Casper, WY 82604
Attn: Sean Lovelace

Re: Portable Frac Tank Certification – Pinned Seams

Dear Mr. Lovelace:

Per your request our office has performed a structural analysis of the portable frac tanks as well as the associated accessories. This analysis was performed to determine that the tanks meet the required strength criteria under operating conditions according to the AISC Manual of Steel Construction.

The tanks range in diameter from approximately 81 to 190 feet and are 11 feet, 8 inches in height and are designed to store water. They are constructed of individual steel reinforced panels that are connected together with a patent pending steel pin system.

The following tanks sizes were included in the analysis:

- 10,000 BBL – Approximately 81'Ø
- 20,000 BBL – Approximately 108'Ø
- 30,000 BBL – Approximately 135'Ø
- 40,000 BBL – Approximately 156'Ø
- 50,000 BBL – Approximately 176'Ø
- 55,000 BBL – Approximately 183'Ø
- 60,000 BBL – Approximately 190'Ø

The tanks are constructed of the following materials:

- Tank Panels – ASTM A36, 36 ksi Steel Plate
- Horizontal & Vertical Framing – ASTM A500, Grade B, 46 ksi Structural Steel Tubing
- Connecting Pins - ASTM A36, 36 ksi Steel Round Bar

PILLAR STRUCTURAL ENGINEERING

1964 East 1st Street
Casper, WY 82601

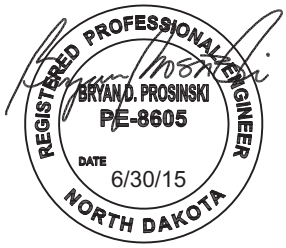
PHONE (307) 265-3900
FAX (307) 265-3559
WEB SITE http://www.pillarse.com

Our office has determined that the portable frac tanks, as described herein, are capable of supporting the operating load conditions in conformance with the AISC Manual of Steel Construction.

Calculations of this analysis can be provided upon request.

If you have any questions or require additional information please contact our office.

Sincerely,



Bryan Prosinski, P.E., S.E.
Pillar Structural Engineering

PILLAR
STRUCTURAL
ENGINEERING

KEYSTONE
FIELD ENGINEERING INC.
"Practical Engineering Solutions"

Box 7866 5014 Industrial Road, Drayton Valley, Ab. T7A 1LS Ph: (780) 542-3096 Fax: (780) 542-6405

Engineering Compliance

July 6, 2015 **KFE Project #151055**

Water Well Solutions and Rentals, Inc.
Attn: Scott Sandler
2130 W. 40th
Casper, Wyoming (USA) 82604

Attention: Mr. Scott Sandler

Re: Portable Frac Tank Engineering Review and Compliance – Pinned Seams
Sizes: 10K, 20K, 30K, 40K, 50K, 55K and 60K Tanks

A structural engineering review was conducted by Peter Vann (P. Eng) of Keystone Field Engineering Inc. for the above noted tank sizes. It was determined that the 'pinned' tank panel connections are capable of supporting the operating load conditions; and the panel lift points are of suitable construction according to the Canadian Handbook of Steel Construction (latest addition). The certified liner for the tanks shall have a minimum bonded seam strength of 40 ppi.

If you have any questions, please contact the office at 780-542-3096.

PERMIT TO PRACTICE
KEYSTONE FIELD ENGINEERING INC
Signature
Date July 6, 2015
PERMIT NUMBER: P 10239
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

PROFESSIONAL ENGINEER ALBERTA
2015-07-06

Peter Vann, P. Eng
Structural Engineer

KEYSTONE FIELD ENGINEERING INC.
PV/ kj
Reference:
Drawings completed by Nalco FabTech

www.keystonefieldeng.com

2.3

I. MLVT ERECTION OPERATIONS MANUAL

A. PRE CHECKS
1. Complete JSA prior to any work commencing
2. Confirm MLVT location and inspect for proper compliance with *WYOGC* requirements and site preparation recommendations.
3. Inspect trenches for proper construction according to site preparation recommendations.
4. Check weather conditions for the entire day to assure there will be proper weather conditions. If wind exceeds 15-20 MPH consider stopping work or consider deploying liner once all but one MLVT panels have been erected to provide a satisfactory wind block.
5. Review compaction tests for conformance with site preparation recommendations.
6. Comply with MLVT Inspection and Testing Specifications.

B. TOOLS, MATERIALS, and EQUIPMENT
1. Hard Hat
2. FRC Clothing
3. Gloves and Safety Glasses
4. Fall Arrest Gear
5. Box Knife
6. Drills with Deep Well Sockets
7. Telehandler Attachment
8. Telehandler (9,000 lb. or larger)
9. Optional Telehandler Man Basket with OSHA Certified Load Rating
10. Man Lift

C. MLVT ERECTION PROCEDURE
1. Inspect ditches, find center of MLVT and paint the ring for the MLVT. 40K=156'Ø, 30K=135' Ø, 20K=108' Ø, 10K=82' Ø.
2. Once the ring is painted make a mark 15' out from the ring around the outside. This mark is used as a reference point to assure there is enough liner to go over the MLVT walls once they are erected.
3. Unroll and position the 10 ounce geotextile fabric to all sides of the ring. Ensure the center mark labeled on the geotextile fabric is in the center of the MLVT. Adjust the geotextile if necessary.
4. Once the geotextile fabric is laid out and free of large wrinkles unroll and pull the liner out past the edges of the geotextile fabric. All layers should overlap each other and the liner should extend past the 15' mark. Once you have ensured the geotextile fabric and liner are square and centered it is ok to then begin to fill the trenches with water. Take care not to walk on liner that has no geotextile fabric underneath it. Make sure boots are clean and free of rocks before walking on any liner.
5. Once the geotextile fabric and liner are pulled out, begin to set the ring by first folding the geotextile fabric and the liner back onto itself to expose the MLVT diameter line for the MLVT panel ring.

6. Put telehandler attachment on telehandler (Remove round bar holding forks onto telehandler and reinsert through custom attachment and re-secure bar to carriage.) and use attachment to place the first panel on the line. Secure the panel in place to secondary equipment with a certified chain. Secondary equipment may be a backhoe or other large machinery.
7. Continue to set panels in a counter clockwise fashion by placing the female holes of the new panel onto the male pins of the previous panel. Set the rest of the ring in this same manner. (At each panel joint secure a 16 ounce geotextile strip to top pin of the panel and drape to the inside of the MLVT. Spray glue or tape in place on the interior joint to provide added liner protection at these points.)
8. Hang one to two fill lines and secure them with ratchet straps to give the water trucks a place to continue filling the MLVT as the remainder of the panels are erected.
9. Once there are enough panels (about half) in place for the MLVT to hold itself erect, begin pulling liner up the wall and placing temporary clips to hold in place. Take care to leave sufficient slack in the liner. Ensure that the person in the man basket has on the appropriate fall arrest gear.
10. Before setting the last panel hang the manifold and connect the suction line and strainer box. (Make sure suction hose is connected in a straight alignment to assure good suction.)
11. Set the last panel of the MLVT.
12. Begin setting the permanent clips by adjusting liner in a straight and loose manner to allow for tightening as water is added to the MLVT. Ensure that personnel setting the clips are wearing the proper fall arrest gear.
13. When the liner is adjusted correctly, place 2 clips per panel and tighten the bolts with impact drills.
14. Continue setting clips in this manner until all clips are placed. It is very critical to have around 12-16 inches of water in the MLVT before all clips are installed. Monitor the MLVT closely until the minimum required amount of water is in the MLVT. If there is not at least 12 inches of water in the MLVT, install the clips only on every other panel. This will break any vacuum created from wind and will prevent the liner from shifting. Once the required amount of water is in the MLVT it must be fully clipped.
15. Once all clips are set, trim back the excess liner and discard.
16. Hang all remaining plumbing and secure with ratchet straps.
17. Walk location and pick up ALL trash.
18. Secure all materials and trash to be removed from location and leave location.

2.4

VISUAL INSPECTIONS AND TESTING SPECIFICATIONS

A. VISUAL INSPECTION AND TESTING FREQUENCY
   1. Panels will be visually inspected when loading prior to a job.
   2. Inspection of panel connections paying special attention to the vertical welds from the 1" thick plates to the wall sheeting.
   3. Inspections of exterior tank walls in use should be done twice a year or as state specifications require.
   4. Wall sheeting thickness should be verified after every 50 sets-ups.

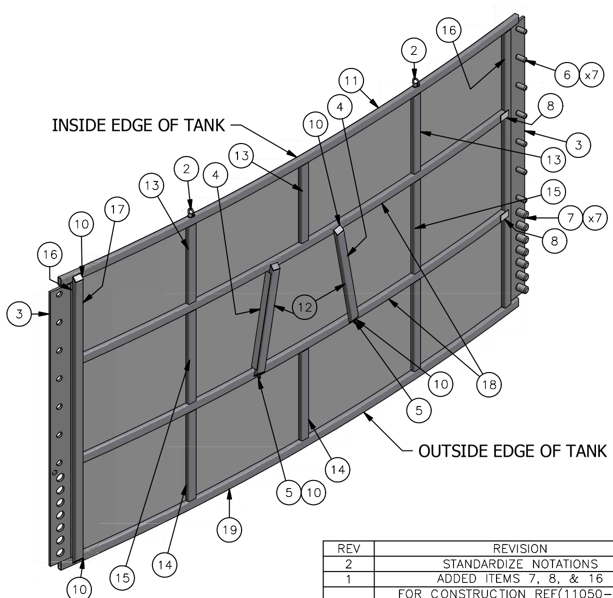
B. VISUAL INSPECTION GUIDELINE
   1. Inspection for deficiencies in the MVLT panel, panel connection, and connection components. Deficiencies include damaged panels, or panel connection components. Excessive corrosion of steel, and cracked welds.
   2. Inspection for leaks on erected tanks.
   3. Inspect for any indication of panel or connection fatigue.

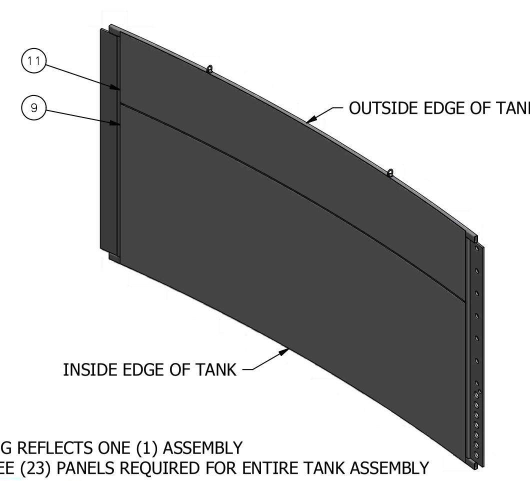
C. MAGNETIC PARTICLE EXAMINATION
   1. Magnetic Particle Examination must be performed after 50 tank setups of a single tank.
   2. It must include all welded joints.
   3. Any deficiencies must be repaired to an as new condition.

Inspection records should be kept and stored by MVLT owner.

2.5

CK	ITEM	QTY	DESCRIPTION	WIDTH	LENGTH	MATERIAL	CLENGTH (in)	WEIGHT
	1	14	BAR, ROUND, 5/8" (LOCK PIN)		6 1/2 in	A36	6.50	
	2	2	D-RING, 1/2" B38, WORKING LOAD 4080 lbs			A29/A29M -91 1045(C-1045), MODIFIED TO WELD DOWN		2
	3	2	FBAR, 1"	10 in	131 1/2 in	A36	131.50	373
	4	2	FBAR, 10GA	3 in	43 1/8 in	A36	86.25	99
	5	2	PAD EYE, #2			CROSBY GROUP, S-264		0
	6	7	PIN, 2" DIA		4 1/2 in	KUSTOM KONCEPTS, A1018	31.50	3
	7	7	PIN, 3 " DIA		4 1/2 in	KUSTOM KONCEPTS, A1018	31.50	8
	8	2	PLATE, 3/16"	3 in	5 in	A36	10.00	2
	9	1	PLATE, 3/16"	96 in	240 in	A36	240.00	156
	10	6	SHEET, 10GA	2 1/2 in	3 3/4 in	A36	22.50	3
	11	1	SHEET, 10GA	42 1/2 in	240 in	A36	240.00	50
	12	2	TUBE, 4" x 2" x 1/4" (MITER BOTH ENDS)		52 in	A500B CLEAN COAT	104.00	55
	13	3	TUBE, 4" x 2" x 3/16"		37 1/4 in	A500B CLEAN COAT	74.50	43
	14	3	TUBE, 4" x 2" x 3/16"		42 3/4 in	A500B CLEAN COAT	128.25	74
	15	2	TUBE, 4" x 2" x 3/16"		44 in	A500B CLEAN COAT	88.00	50
	16	2	TUBE, 4" x 2" x 3/16"		132 in	A500B CLEAN COAT	264.00	151
	17	1	TUBE, 4" x 2" x 3/16" (MITER BOTH ENDS)		137 1/2 in	A500B CLEAN COAT	137.50	78
	18	2	TUBE, 4" x 2" x 3/16", (ROLL TO 155'-6 7/8" I.D.)		236 3/8 in	A500B CLEAN COAT	472.75	271
	19	2	TUBE, 4" x 2" x 3/16", (ROLL TO 155'-6 7/8" I.D.)		253 7/8 in	A500B CLEAN COAT	507.75	291





NOTES:
-THIS DRAWING REFLECTS ONE (1) ASSEMBLY
-TWENTY THREE (23) PANELS REQUIRED FOR ENTIRE TANK ASSEMBLY

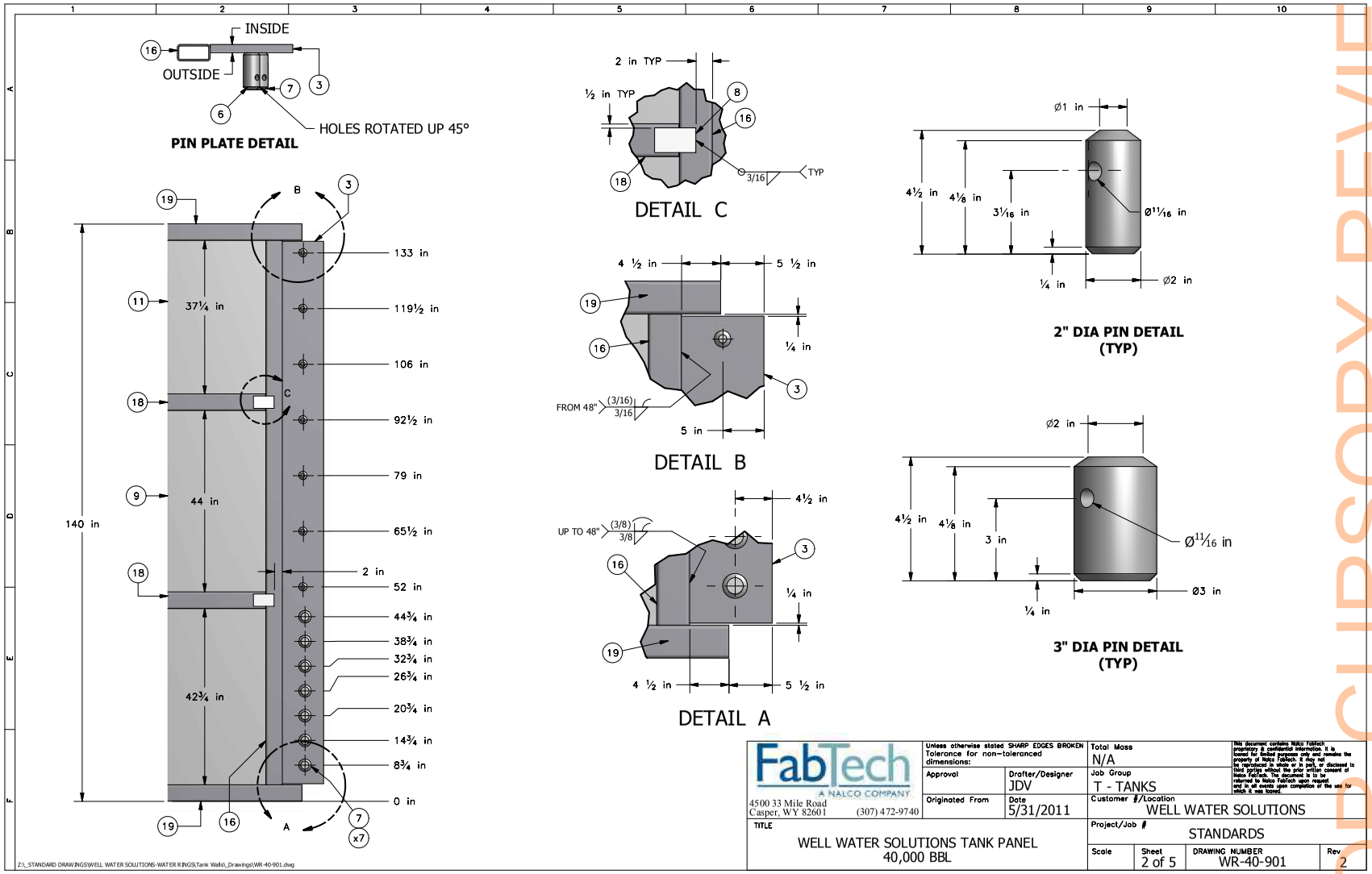
REV	REVISION	DATE	BY
2	STANDARDIZE NOTATIONS	1/17/2012	JDV
1	ADDED ITEMS 7, 8, & 16	12/09/11	DSG
0	FOR CONSTRUCTION REF(11050-901) CHANGED HEIGHT AND LOCATION OF PINS REF(11078-40-901)	9/1/2011	CJD

FabTech A NALCO COMPANY
4500 33 Mile Road
Casper, WY 82601 (307) 472-9740

Unless otherwise stated SHARP EDGES BROKEN Tolerance for non-toleranced dimensions:
Approval
Drafter/Designer JDV
Originated From
Date 5/31/2011
Total Mass N/A
Job Group T - TANKS
Customer #/Location WELL WATER SOLUTIONS
Project/Job # STANDARDS

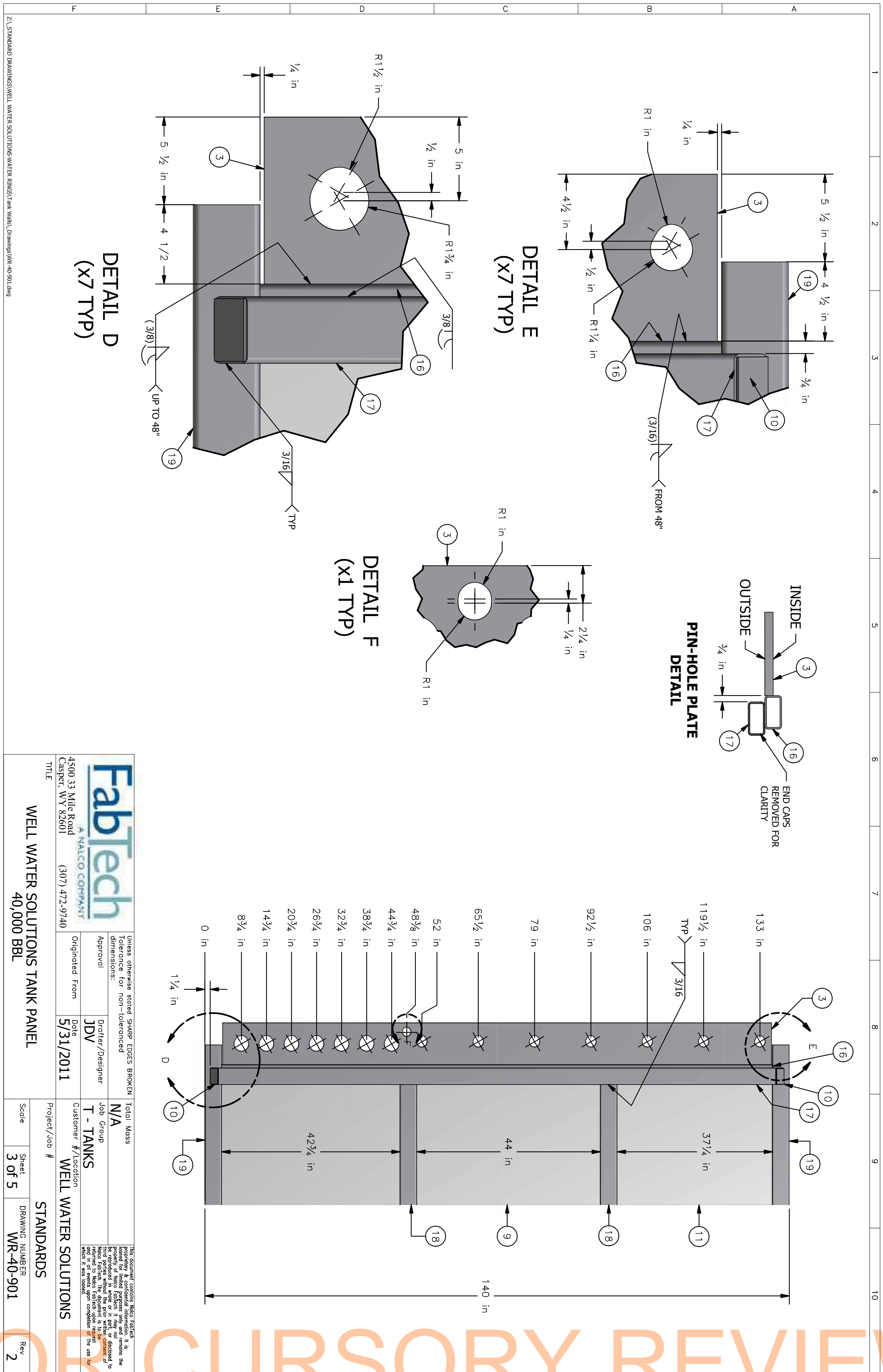
TITLE WELL WATER SOLUTIONS TANK PANEL 40,000 BBL
Scale
Sheet 1 of 5
DRAWING NUMBER WR-40-901
Rev 2

Z:_STANDARD DRAWINGS\WELL WATER SOLUTIONS-WATER RINGS\Tank Walls_Drawings\WR-40-901.dwg

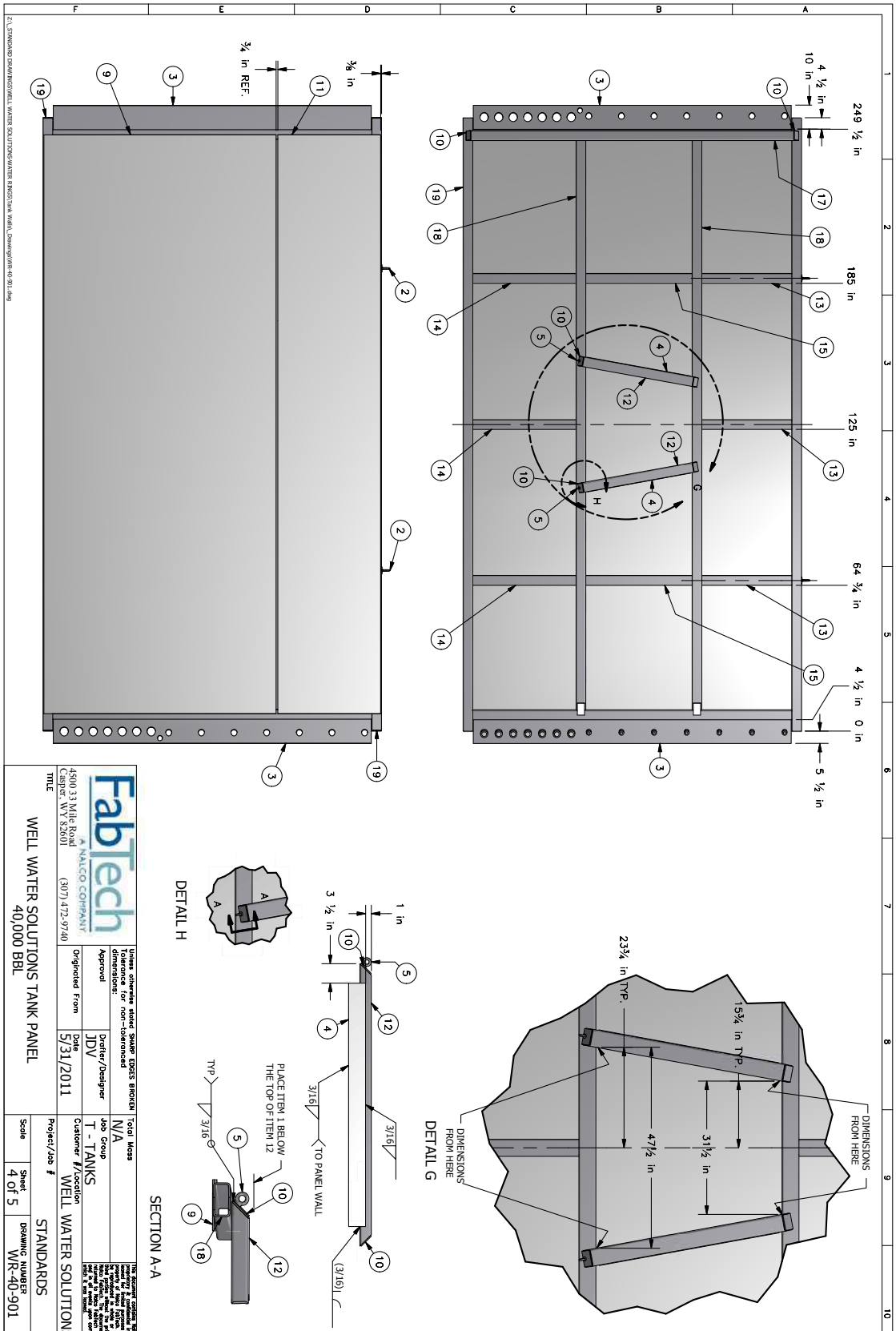


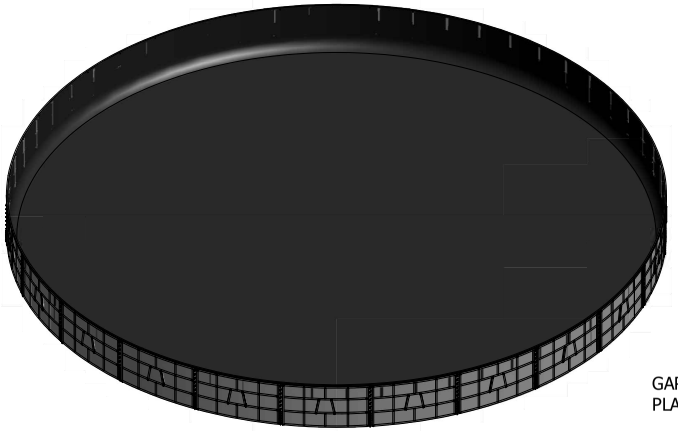
FabTech A NALCO COMPANY 4500 33 Mile Road Casper, WY 82601 (307) 472-9740	Unless otherwise stated SHARP EDGES BROKEN Tolerance for non-toleranced dimensions:	Total Mass: N/A	This document contains Nalco FabTech proprietary & confidential information. It is loaned for limited purposes only and remains the property of Nalco FabTech. It may not be reproduced in whole or in part, or disclosed to third parties without the prior written consent of Nalco FabTech. The document is to be returned to Nalco FabTech upon request and in all events upon completion of the use for which it was loaned.
	Approval	Drafter/Designer: JDV	Job Group: T - TANKS
	Originated From	Date: 5/31/2011	Customer #/Location: WELL WATER SOLUTIONS
TITLE: WELL WATER SOLUTIONS TANK PANEL 40,000 BBL			Project/Job #: STANDARDS
		Scale	Sheet: 2 of 5
		DRAWING NUMBER: WR-40-901	Rev: 2

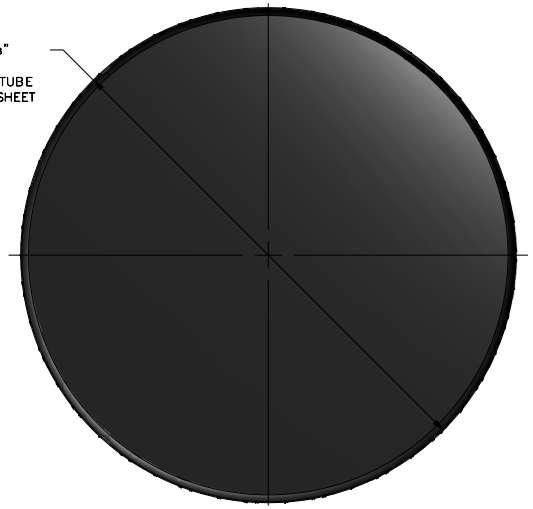
Z:_STANDARD DRAWINGS\WELL WATER SOLUTIONS-WATER RINGS\Tank Walls_Drawings\WR-40-901.dwg

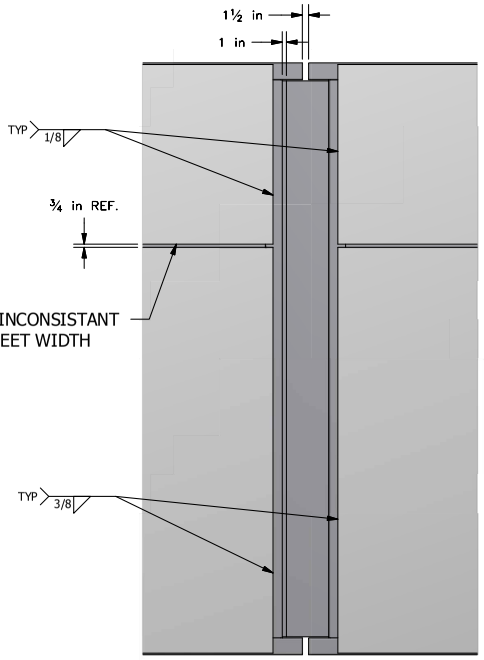


Confidential Proprietary Information is included in this report. Only original signed copies are to be distributed and used. If copies are made and or distributed without the consent approval of the president of WWS legal action may be taken.

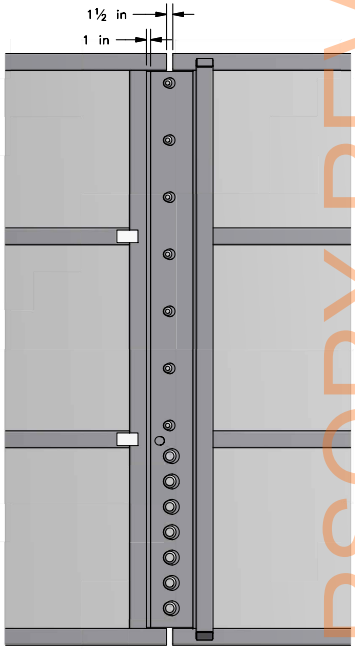








SEAM DETAIL
(INSIDE-OUT)



SEAM DETAIL
(OUTSIDE-IN)

FabTech
A NALCO COMPANY
4500 33 Mile Road
Casper, WY 82601 (307) 472-9740

Unless otherwise stated SHARP EDGES BROKEN
Tolerance for non-toleranced dimensions:

Approval	Drafter/Designer
	JDV
Originated From	Date
	5/31/2011

Total Mass: N/A
Job Group: T - TANKS
Customer #/Location: WELL WATER SOLUTIONS
Project/Job #: STANDARDS

TITLE: WELL WATER SOLUTIONS TANK PANEL
40,000 BBL

Scale | Sheet: 5 of 5 | DRAWING NUMBER: WR-40-901 | Rev: 2

Z:_STANDARD DRAWINGS\WELL WATER SOLUTIONS-WATER RINGS\Tank Walls_Drawings\WR-40-901.dwg

3.1

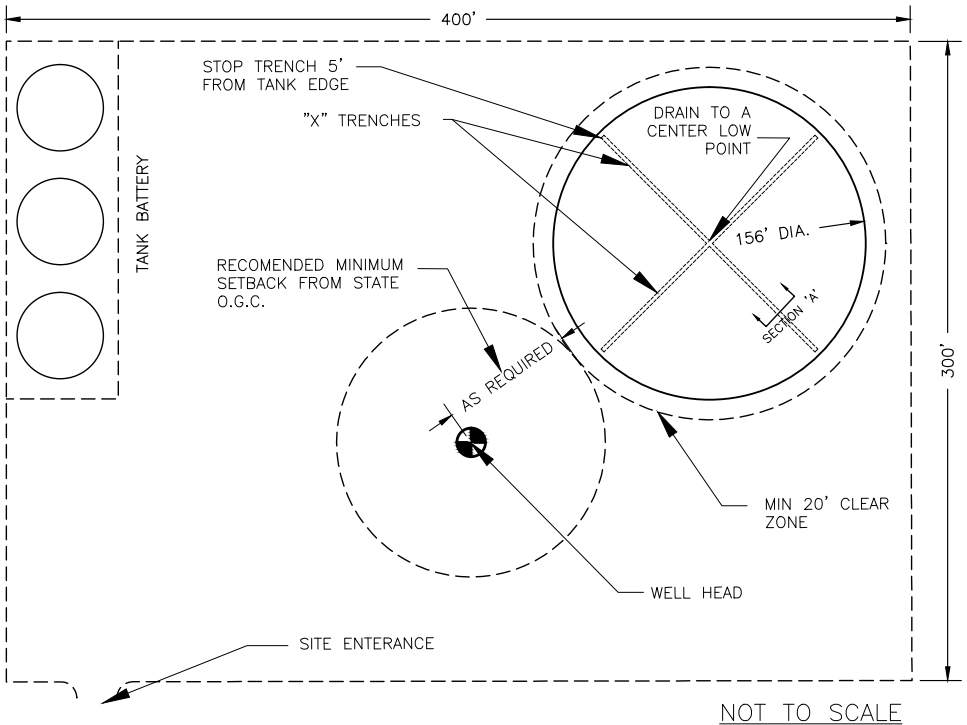
SITE INSPECTION

A. SITE PREPARATION
   1. MVLT site must be free of debris and or large sharp rocks. (Standard road base, sand, or dirt are recommended base materials)
   2. Site should have a 1% or less grade from side to side.
   3. Site should be compacted and graded for safe use of heavy equipment.
   4. Ditches shall be dug prior to construction, be sure to follow state guidelines on pre digging requirements.

B. SITE ACCEPTANCE
   1. Prior to setting the tank a crew supervisor should inspect the site and notify the required parties should they feel site is not suitable and does not meet required criteria.
   2. Once site has received the approval of the site supervisor the tank can begin to be erected by the contracted company following the guidelines set forth in the specific SOP.

3.2

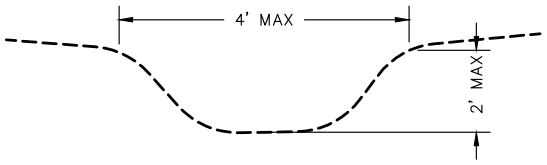
DATE: 06/30/14 DWG BY: MDW SHEET NO: 1 OF 1	MLVT LOCATION STANDARD MAP	FOR: WELL WATER SOLUTIONS & RENTALS ATTN: SEAN LOVELACE PO BOX 2105 CASPER, WYOMING 82602



TRENCH NOTES:

1. TRENCHES SHALL HAVE A MAXIMUM DEPTH OF 2' AND MAXIMUM WIDTH OF 4'.
2. TRENCHES SHALL BE CONSTRUCTED A MINIMUM DISTANCE OF 5' FROM TANK WALLS.
3. TRENCHES SHALL BE GRADED TO A COMMON CENTER SUCTION POINT.
4. TRENCH EDGES SHALL BE SMOOTH AND ROUNDED.

SECTION 'A'



WLC
ENGINEERING • SURVEYING • PLANNING
200 PRONGHORN, CASPER, WY. 82601

4.1

MLVT GEOMEMBRANE PANEL FABRICATION MANUAL

Well Water Solutions, Inc.

Colorado Lining International
Parker CO 80138
800-524-8672/303-841-2022
Fax: 303-841-5780
www.coloradolining.com

TERMINOLOGY

The following definitions will be used throughout this document.

Geomembrane Manufacturer- The party responsible for compounding resin into geomembrane roll goods.

Geomembrane Fabricator- The party who is responsible for welding the geomembrane roll goods, through factory fabrication using controlled welding methods, into geomembrane panels. **Colorado Lining International – 800-524-8672**

Geomembrane Installer -The party responsible for placing and/or joining geomembrane panels in the field or on the job site.

Geomembrane Sheet -The product of the Geomembrane manufacturer, provided on rolls to the fabricator.

Geomembrane or Panels or Geomembrane Panels -The term applied to multiple geomembrane sheets that have been welded together, through factory fabrication, under controlled conditions. The actual size of the panels will depend upon weight, mil thickness, and design configurations.

Sample -The piece of liner or seam section taken for testing. It is usually large enough to contain specimens for a series of tests.

Seam -The completed process of welding two geomembrane sheets together.

Specimen -The term applied to an individual part of a sample. Specimens are used to test peel and shear values of a welded seam.

Welding -The process whereby two sheets or panels of geomembrane are joined together.

MLVT – Modular Large Volume Tank

MLVT Geomembrane Liner – One or more factory fabricated Geomembrane Panel(s) for placement inside an engineered containment ring.

1.0 GENERAL

1.1 Products

A. The geomembrane material shall be 30 to 60 mils thick, as specified. The geomembrane shall be manufactured consisting of first quality ingredients. The finished compound shall be uniform in color, thickness, size and surface texture.

1.2 Markings

A. In the case of round tanks, panels shall include a highly visible "cross hair" style marking denoting the center point of the panel to coincide with the center point of the tank. Radial spoke-like markings will be painted on the panel surface to assist with field measures to assure vertical alignment up the tank walls.

2.0 Subgrade Preparation

A. The Earthwork Contractor shall be responsible for preparing and maintaining the subgrade in a condition suitable for installation of MLVT Geomembrane Panel. Any damage to the surface caused by weather conditions or other conditions must be repaired prior to MLVT Geomembrane Panel deployment. The installer will submit, prior to installing the MLVT Geomembrane Panel, written approval of the subgrade surface on which the MLVT Geomembrane Panel will be installed.

B. All surfaces in contact with the MLVT Geomembrane Panel must be free of sharp stones, stones over 3/8" in diameter, sticks and other debris that can puncture or tear the MLVT Geomembrane Panel. No standing water, mud, snow or excessive moisture should be on the subgrade when the MLVT Geomembrane Panel is deployed. Subgrade should be constructed of a firm stable material compacted to a 95% proctor.

3.0 Deployment of MLVT Geomembrane Panels

A. The MLVT Geomembrane Panel shall be placed at the edge of the tank layout and be lined up with the centerline of the tank layout. Unroll the MLVT Geomembrane Panel down the centerline of the tank layout. Verify the markings on the MLVT Geomembrane Panel line up with the tank layout. If needed adjust the placement of the MLVT Geomembrane Panel prior to proceeding with installation.

B. The MLVT Geomembrane Panel is then unfolded in the perpendicular direction to which it was unrolled in one direction. The next step is to unfold the MLVT Geomembrane Panel in the opposite direction of the first unfold direction.

C. See sketch at end of document for clarification of these steps.

4.0 MLVT Geomembrane Representative Welds

A. At the start of each day's work and once every 4 hours thereafter, before any welding machine shall be deployed on a liner panel, a sample of a representative seam shall be produced and evaluated for each welding machine to be utilized.

Representative welds shall also be required if there is a change in environmental conditions. Representative samples shall be prepared non-destructively using strips of geomembrane cut from excess sheets of liner being seamed. Peel and sheer samples are to be tested with a calibrated tensiometer. Field seam welding shall commence only after successful representative seam test results are achieved by each machine.

B. Test results shall be representative of subsequently made seams on an actual liner fabricated after the test. There shall be one representative seam evaluation made every four hours and on each machine utilized. Representative welds shall be recorded on the CLI Seam Quality Control Form which shall be available to customers upon request.

5.0 Seam Testing Criterion

Samples shall be non-destructive, not requiring patching of fabricated panels. Four test specimens (2 shear and 2 peel) shall be cut from each seam sample and tensiometer tested for bonded seam strength and peel adhesion. All test results shall be recorded in the Seam Quality Control Form.

A. Tensiometer Peel Strength Test:

Peel adhesion shall be in accordance with ASTM D 7747. In seam samples when tested in peel, failure shall occur resulting in a Film Tearing Bond (or "FTB"). The tensiometer peel test provides a numerical value for the peel strength achieved in addition to visually inspection for film tearing bonds. Samples should be 1" wide centered over the seam.

B. Tensiometer Tensile Strength Test:

Samples shall be tested with a tensiometer and evaluated for bonded seam strength (shear) using method ASTM D 7749.

C. Shear and peel test results shall conform to either GRI GM 19 requirements or to the manufacturer's requirements.

D. All Field Seams shall be 100% tested by high pressure air lance in accordance with ASTM D 4437.

6.0 Field Thermal Wedge Weld Seaming Procedures

A. Adjacent MLVT Geomembrane Panels shall be overlapped by approximately 4" for fusion welding. Panel edges to be seamed shall be clean of all foreign matter or debris before seaming commences. Welding can occur once the sheets to be joined have been cleaned and brought into their exact position.

B. When starting a new weld, the machine shall be manually placed into the overlapped sheet of material.

C. Welder alignment and temperature shall be monitored during the seaming process and adjustments will be made as necessary. The welded seams must be 100% visually inspected as welding machinery advances.

D. All cross seams or "T" intersections caused by material roll splices where 3 layers of membrane material occur shall be patched where they intersect with 3" or larger diameter patches of the MLVT Geomembrane material. Patches shall be applied by use of a hand held heat gun and seam roller. All patches and repairs shall be 100% tested by high pressure air lance or vacuum box in accordance with ASTM D 4437 and ASTM D 5641.

E. Should a defective seam be found, welding shall be ceased until the cause of the defect is determined and rectified and the seam is repaired. Documentation of the defect and repair shall be recorded on the Seam Quality Control Form.

7.0 Fold back of MLVT Geomembrane Panels

A. Once all field seaming is completed the outer limits of the MLVT Geomembrane Panels need to be folded back on top of themselves far enough to provide enough room for assembly of the steel tank sections without damage to the system.

8.0 MLVT Geomembrane Panel final deployment

A. Once the steel walls are assembled they need to be inspected for any sharp surfaces that could damage the MLVT Geomembrane Panels and there needs to be a support material placed as a chamfer at the transition from the wall to the subgrade to eliminate the possibility of stressing the MLVT Geomembrane panel at the 90 degree transition. This support material can be sand tubes, precut foam, etc.

B. Next the MLVT Geomembrane Panels need to be placed up and over the walls. This step is completed with the assistance of equipment used to lift the edge of the MLVT Geomembrane Panel up the height of the steel wall. Enough material should be lifted up and over the wall to create the proper overhang so the liner does not fall back off the wall while the clamping system is installed.

C. The MLVT Geomembrane Panels shall be protected at all times from damage and all equipment and methods used to lift, place and clamp shall not damage the MVLT GEomembrane Panel and shall not impart excess stress in the MVLT Geomembrane Panels and thermally welded seam areas.

D. ALL tank panel erection, assembly, placement and lifting of MVLT GEomembrane Panel is by others. CLI shall not be responsible for damages to the MVLT Geomembrane Panel after delivery / customer pickup or once installation is completed, if performed by CLI.

End of Specification

Quality Control Air Testing

Project:
Owner:
Engineer:
Contractor:
Supervisor:
Material:

Date of Test	Start Time	End Time	Seam No.	Seam Length	A C	A L	V B	S T	Pass/Fail	Welding Technician	Welder No.	Welder Speed	Welder Temp.
AC=Air Channel Test AL=Air Lance Test VB=Vacuum Box Test ST=Spark Test													

COLORADO LINING INTERNATIONAL
1062 Singing Hills Road Parker, Colorado 80138 / 1-800-524-8672 / 303-841-2022 / Fax 303-841-5780 / www.coloradolining.com

4.4

MLVT GEOMEMBRANE PANEL INSTALLATION MANUAL

Well Water Solutions, Inc.

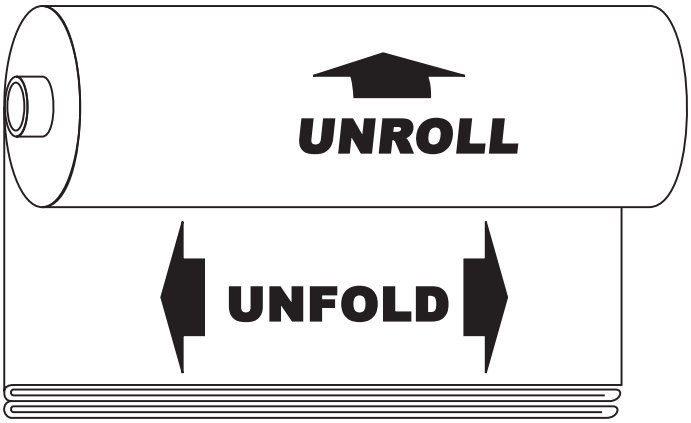
COLORADO LINING INTERNATIONAL

Colorado Lining International
Parker CO 80138
800-524-8672/303-841-2022
Fax: 303-841-5780
www.coloradolining.com

COLORADO LINING INTERNATIONAL
www.coloradolining.com

DEPLOYMENT OF DUAL DIRECTION ACCORDION FOLDED PANELS

(SHEET 1 OF 2)

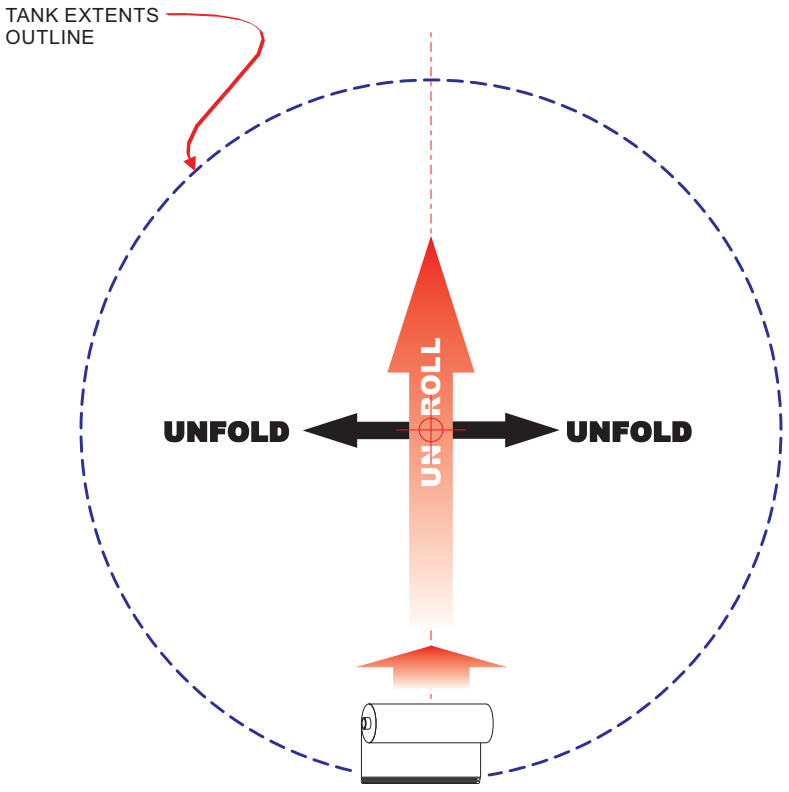


COLORADO LINING INTERNATIONAL
www.coloradolining.com

DEPLOYMENT OF DUAL DIRECTION ACCORDION FOLDED PANELS

(SHEET 2 OF 2)

CLI FABRICATES FRAC TANK PANEL LINERS AND UNDERLAYMENTS IN A DUAL DIRECTION ACCORDION FOLDED MANNER SO THAT THE PANELS CAN BE DEPLOYED ON THE TANK'S CENTERLINE. AFTER THE INITIAL UN-ROLLING THE PANELS ARE THEN UN-FOLDED IN PERPENDICULAR DIRECTIONS

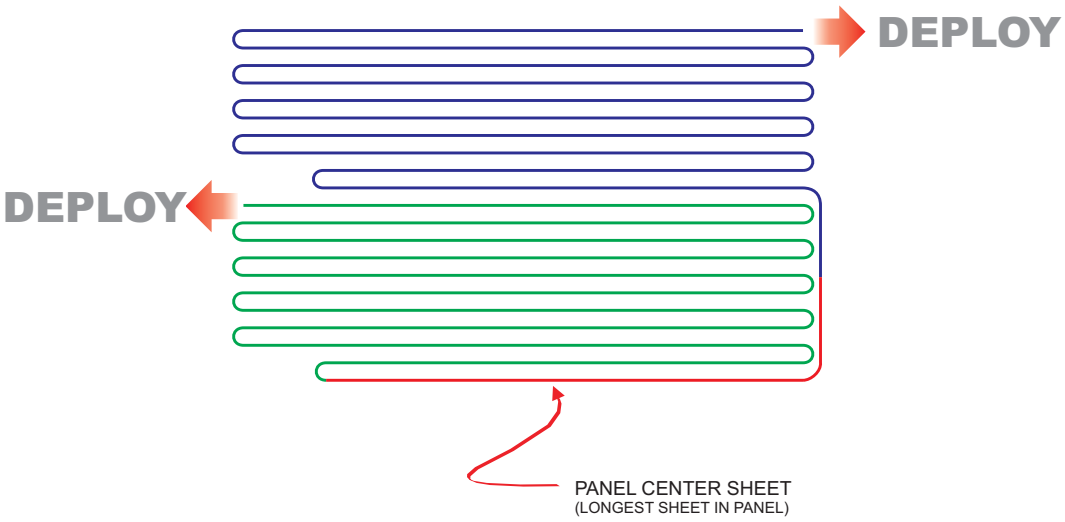


UNROLL PANEL
ON TANK'S
CENTERLINE
PRIOR TO WALLS
GOING UP

COLORADO LINING INTERNATIONAL
www.coloradolining.com

DOUBLE DIRECTION ACCORDION FOLDED PANEL SCHEMATIC

(SHEET 1 OF 2)

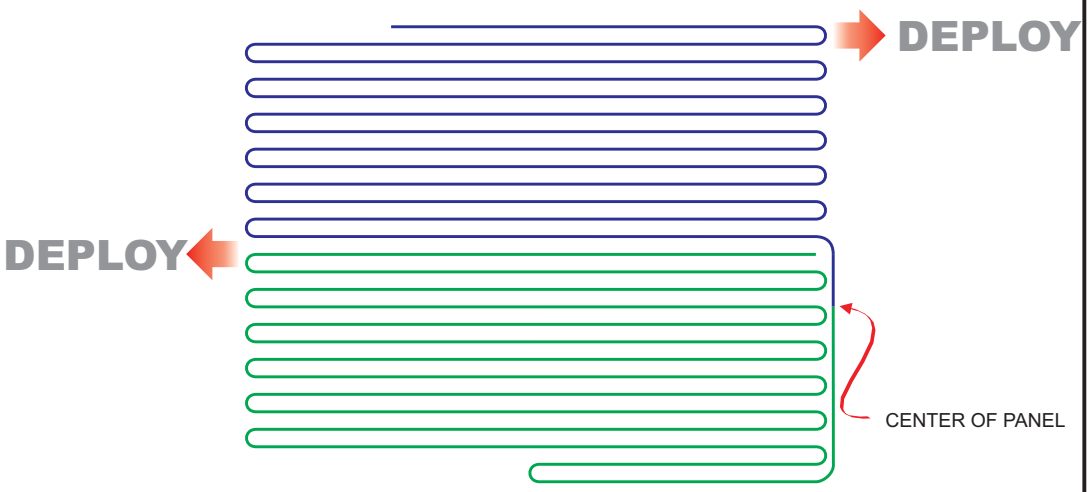


EXAMPLE OF A 21 SHEET B-24 TANK LINER

COLORADO LINING INTERNATIONAL
www.coloradolining.com

DOUBLE DIRECTION ACCORDION FOLDED PANEL SCHEMATIC

(SHEET 2 OF 2)



EXAMPLE OF A 26 SHEET B-40 TANK LINER

4.5

COLORADO LINING INTERNATIONAL

CO:800.524.8672
TX: 888.546.4641
www.coloradolining.com

RPE - REINFORCED POLYETHYLENE

RPE is a proven solution to many containment needs due to its excellent puncture resistance and UV stability.

Colorado Lining can supply you with custom sized panels or facilitate a full installation with one of our certified installation crews. We want to work with you to make your job a success.

Products & Features:

- Warranty Info:
  - 36 MIL: 15 YEAR
  - 45 MIL: 20 YEAR
- Fish Friendly
- Flexible
- Available In Custom Sized Panels
- Extremely Durable
- Quick Installation
- UV Stable
- Available In 30, 36, & 45 Mils

Uses & Applications:

- Wastewater Treatment Plants
- Agriculture Ponds
- Baffle Curtains
- Oil and Gas Temporary
- Evaporation Ponds
- Golf Course Ponds
- Drop-In & Large Tank Liners
- Irrigation Reservoirs & Canals

Project Photo: Hangman Valley Golf Course in Spokane, WA
Pond Liner
27,000 SF 36 Mil RPE

RPE Product Data Sheet

Available in 30, 36, & 45 mil

Properties	Test Method	30 mil		36mil		45mil	
		Min Roll Averages	Typical Roll Averages	Min Roll Averages	Typical Roll Averages	Min Roll Averages	Typical Roll Averages
Appearance		Black/Black		Black/Black		Black/Black	
Thickness		27 mil	30 mil	32 mil	36 mil	40 mil	45 mil
Weight lbs Per MSF (oz/yd^2)		130 lbs (18.7)	144 lbs (20.7)	156 lbs (22.5)	173 lbs (25)	198 lbs (28.52)	210 lbs (31.70)
Construction		Dense scrim reinforced polyethylene					
***Ply Adhesion**	ASTM D 6635	19 lbs or FTB	24 lbs or FTB	19 lbs or FTB	24 lbs or FTB	32 lbs or FTB	37 lbs or FTB
Tensile Strength LBF/IN	ASTM D 7003	160 lbf MD 150 lbf DD	170 lbf MD 168 lbf DD	178 lbf MD 160 lbf DD	190 lbf MD 172 lbf DD	185 lbf MD 170 lbf DD	198 lbf MD 184 lbf DD
Tensile Elongation @ Break % (Film Break)	ASTM D 7003	500 MD 430 DD	604 MD 508 DD	450 MD 400 DD	542 MD 447 DD	600 MD 420 DD	687 MD 624 DD
Tensile Elongation @ Break % (Scrim Break)	ASTM D 7003	32 MD 30 DD	35 MD 31 DD	32 MD 30 DD	36 MD 33 DD	32 MD 30 DD	35 MD 31 DD
Tongue Tear Strength	ASTM D 5884	160 lbf MD 125 lbf DD	187 lbf MD 168 lbf DD	140 lbf MD 100 lbf DD	174 lbf MD 157 lbf DD	80 lbf MD 115 lbf DD	114 lbf MD 147 lbf DD
Grab Tensile (Scrim Break)	ASTM D 7004	270 lbf MD 255 lbf DD	293 lbf MD 274 lbf DD	300 lbf MD 285 lbf DD	316 lbf MD 304 lbf DD	335 lbf MD 335 lbf DD	369 lbf MD 363 lbf DD
Grab Tensile Elongation @ Break% (Scrim Break)	ASTM D 7004	25%	30%	28%	32%	25%	34%
HPOIT	ASTM D 5885	800 min	2400 min	800 min	2400 min	800 min	2400 min
Puncture Resistance	ASTM D 4833	90 lbf	105 lbf	100 lbf	129 lbf	100 lbf	150 lbf
Maximum Use Temperature			180° F		180° F		180° F
Minimum Use Temperature			-70° F		-70° F		-70° F

The data listed in this data sheet is representative of initial production runs. These values may be revised at anytime without notice as additional test data becomes available.

Note: To the best of our knowledge, unless otherwise stated, these are typical property values and are intended as guides only, not as specification limits. Chemical resistance, odor transmission, longevity as well as other performance criteria is not implied or given and actual testing must be performed for applicability in specific applications and/or conditions. COLORADO LINING INTERNATIONAL, INC. MAKES NO WARRANTIES AS TO THE FITNESS FOR A SPECIFIC USE OR MERCHANTABILITY OF PRODUCTS REFERRED TO, no guarantee of satisfactory results from reliance upon contained information or recommendations and disclaims all liability for resulting loss or damage

www.coloradolining.com

Liners with similar properties can be substituted as long as mil thickness is meet.

5.0
PATENTS AND PATENT PROTECTION

Well Water Solutions & Rentals Inc. has the first two patents in this field that protects two separate hinge connection designs. Also included in the patents are the quick connecting attachment and the industries safest and strongest liner clamp design to date.


US008376167B2

(12) **United States Patent**
Lovelace et al.

(10) **Patent No.: US 8,376,167 B2**
(45) **Date of Patent: Feb. 19, 2013**

(54) **PORTABLE RESERVOIR FRAME**

(75) Inventors: **Sean Michael Lovelace**, Casper, WY (US); **Christopher Jason Songe**, Casper, WY (US)

(73) Assignee: **Energy Innovations, LLC**, Casper, WY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/469,883**

(22) Filed: **May 11, 2012**

(65) **Prior Publication Data**

US 2012/0223073 A1 Sep. 6, 2012

Related U.S. Application Data

(63) Continuation of application No. 13/245,492, filed on Oct. 21, 2011.

(51) **Int. Cl.**
B65D 6/00 (2006.01)

(52) **U.S. Cl.** **220/4.17**; 220/4.16; 220/693; 220/567; 220/4.12

(58) **Field of Classification Search** 220/1.6, 220/4.12, 4.16, 4.17, 9.4, 23.9, 495.06, 495.08, 220/567, 681, 693
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,875,666	A *	9/1932	Schwemlein	220/693
3,233,251	A *	2/1966	Barrera	52/245
3,648,303	A *	3/1972	Stewart et al.	52/5
4,124,907	A *	11/1978	Laven	52/169.7

FOREIGN PATENT DOCUMENTS

CA	2692016	7/2010

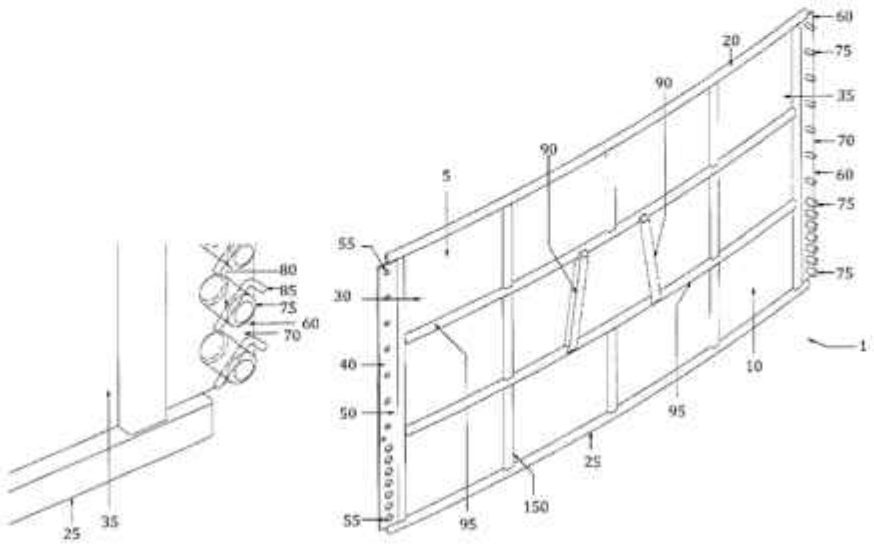
* cited by examiner

Primary Examiner — Anthony Stashick
Assistant Examiner — Christopher McKinley
(74) *Attorney, Agent, or Firm* — Gordon Silver, Ltd.; Ronald C. Gorsche

(57) **ABSTRACT**

A portable reservoir frame composed of interlocking panels secured by a series of flanges having holes and pegs. An inner liner to hold liquid inside the reservoir frame is presented.

16 Claims, 11 Drawing Sheets



US008365937B2

(12) **United States Patent**
Lovelace et al.

(10) **Patent No.: US 8,365,937 B2**
(45) **Date of Patent: Feb. 5, 2013**

(54) **PORTABLE RESERVOIR FRAME**

(75) Inventors: **Sean Michael Lovelace**, Casper, WY (US); **Christopher Jason Songe**, Casper, WY (US)

(73) Assignee: **Energy Innovations, LLC**, Casper, WY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **13/469,845**

(22) Filed: **May 11, 2012**

(65) **Prior Publication Data**

US 2012/0234829 A1 Sep. 20, 2012

Related U.S. Application Data

(63) Continuation of application No. 13/426,286, filed on Mar. 21, 2012, which is a continuation-in-part of application No. 13/245,492, filed on Oct. 21, 2011.

(51) **Int. Cl.**
B65D 6/00 (2006.01)

(52) **U.S. Cl.** **220/4.17**; 220/4.16; 220/693; 220/567; 220/4.12

(58) **Field of Classification Search** 220/565, 220/567, 1.6, 4.16, 4.12, 9.4, 495.06, 495.08, 220/23.9, 4.17, 693, 681

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,076,382	A *	10/1913	Maloney	220/4.17
1,875,666	A *	9/1932	Schwemlein	220/693
2,123,035	A *	7/1938	Ashley	220/693
2,914,149	A *	11/1959	Walker	52/394
3,233,251	A *	2/1966	Barrera	52/245
3,562,822	A *	2/1971	Wall	52/245
3,648,303	A *	3/1972	Stewart et al.	52/5
3,736,599	A *	6/1973	Kessler et al.	52/169.7
3,793,651	A *	2/1974	Pitti et al.	52/169.7
3,819,079	A *	6/1974	Levens	220/4.13
4,048,773	A *	9/1977	Laven	52/169.7
4,124,907	A *	11/1978	Laven	52/169.7
4,223,498	A *	9/1980	Ventrice	52/249
4,240,562	A *	12/1980	Holschlag	220/565
4,860,914	A *	8/1989	Derni et al.	220/4.28
4,932,558	A *	6/1990	Katavolos	220/666
5,054,135	A *	10/1991	Dallaire et al.	4/506
5,161,264	A *	11/1992	Dugas	4/506
5,294,019	A *	3/1994	Looker	220/683
6,071,213	A *	6/2000	Raasch et al.	482/29
7,311,827	B2 *	12/2007	Clark et al.	210/232
7,766,184	B2 *	8/2010	Avery et al.	220/573.1
7,918,764	B2 *	4/2011	VanElvenlaghe	482/27
2009/0127255	A1 *	5/2009	Rood, Jr.	220/1.5

FOREIGN PATENT DOCUMENTS

CA	2692016	7/2010

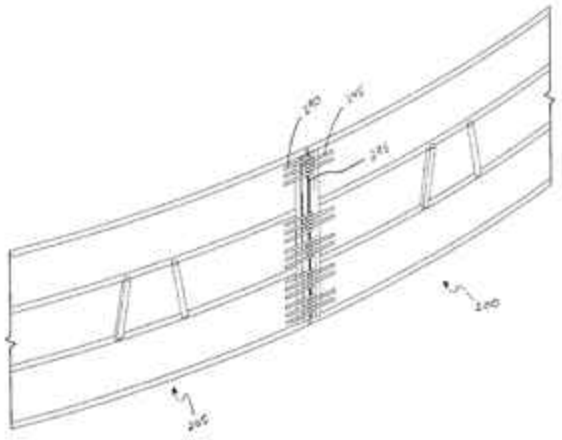
* cited by examiner

Primary Examiner — Anthony Stashick
Assistant Examiner — Christopher McKinley
(74) *Attorney, Agent, or Firm* — Gordon Silver Ltd.; Ronald C. Gorsché

(57) **ABSTRACT**

A portable reservoir frame having a number of interlocking panels secured by a plurality of interleaved knuckle members is provided.

20 Claims, 20 Drawing Sheets



6.1

WWS SOP
"DOUBLE LINED TANK"

DOUBLE LINER TANK ERECTION STANDARDS

Well Water Solutions & Rentals Inc. tanks are fully designed and engineered up to a 60,000 BBL capacity. Minimum 30 mill liners must be used for both the primary and secondary liner.

STANDARD OPERATING PROCEDURE FOR DOUBLE LINER TANK

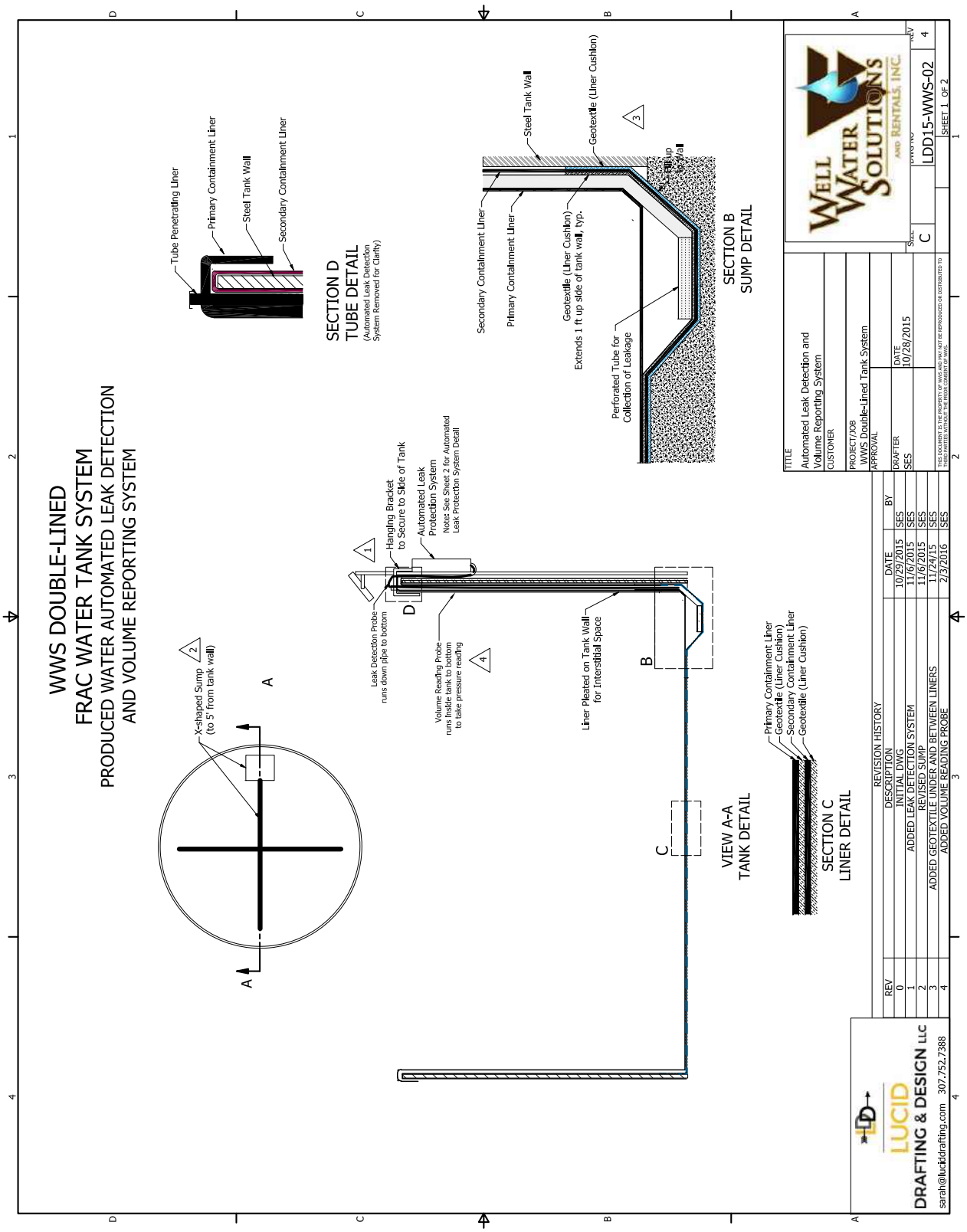
The following procedures are to be performed during the erection of a double liner tank.

- Site preparation must meet all state guidelines and WWS SOP standards before proceeding with erection including but not limited to compaction and or ditch construction.
- Once site is approved for construction the erection crews can begin the set up process once JSA and any other pre setup documents are completed.
- Once tank location is chosen the tanks outer diameter will be painted on the ground using supplied equipment. The ditches if any will then be dug to design standards of WWS and its customer.
- After the ditches are prepared the crew will roll out a geotextile on the ground to create added protection for the primary and secondary liners from rocks or other debris.
- At the point all liners and liner protections are in place panels for the tank can now begin to be erected.
- Start by placing the first panel on top of painted ring line and support first panel with alternate equipment. Continue this process until all panels but one are erected.
- Place all piping and components that need to be assembled in the tank at this point.
- Crews will then begin to pull and fasten the liner and or liners to the top of the walls of the tank. Also at this time if a bird net is needed we then place net and accessories into tank at this time.
- As the liner is being pulled and secured fresh water will be dumped onto the primary liner to seat it properly in the ditches and start the filling process. Total water volume to properly complete a tank set in one day and is approximately 7% of the total volume. If this can not be accomplished additional changes may occur for additional labor to finis the job.
- After completing piping and access ladder placements the last panel can be placed and liners can be completed.

- Place viewing platform for tank next to tank and secure to the tank with strapping.
- Water should still be getting pumped into the primary tank as quickly as possible until it reaches a minimum of 12" in depth in the shallowest spot. This depth assures the wind will not move the liner around.
- Once all personnel has been checked and accounted for and the supervisor has fully inspected the tanks he can sign off on the job and the customer can begin to fill with produced water.

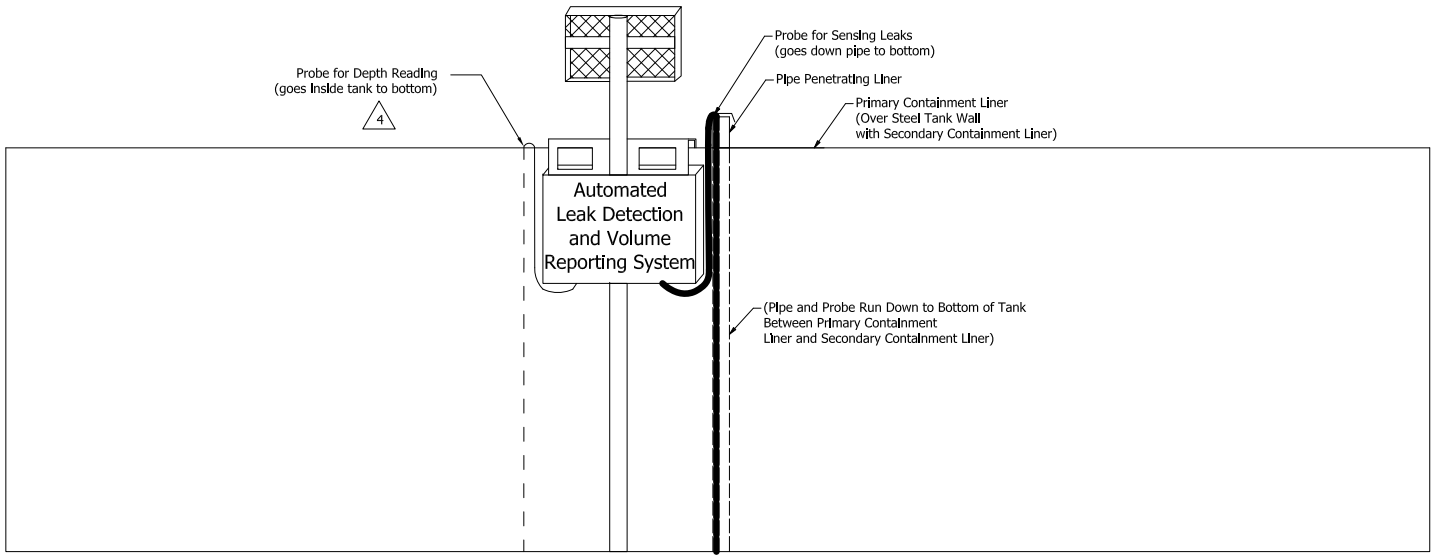
OPTIONAL EQUIPMENT

- Automated Leak Detection and Tank Volume System (Reports via Cellular and Satellite to server. Customers receive log in to custom web page for viewing. Normal Reporting is hourly but more frequency reporting can be set up.)
- Custom piping per customer spec



WWS DOUBLE-LINED
FRAC WATER TANK SYSTEM
PRODUCED WATER AUTOMATED LEAK DETECTION AND VOLUME REPORTING SYSTEM

1 AUTOMATED LEAK DETECTION SYSTEM



TITLE	Automated Leak Detection and Volume Reporting System
CUSTOMER	
PROJECT/JOB	WWS Double-Lined Tank System
APPROVAL	
DRAFTER	SES
DATE	10/28/2015
SIZE	C
DWG NO	LDD15-WWS-02
REV	3
SHEET	2 OF 2

WELL WATER SOLUTIONS AND RENTALS, INC.

WELL WATER SOLUTIONS AND RENTALS, INC.

Tank Size	Panel Count	Inside Diameter (ft)	Inside Diameter (m)	Volume (Bbls)	Volume (ft^3)	Volume (m^3)	Bbls/inch	M^3/inch
10K	12	81' 2"	24.74	10,753	60,365.96	1,709.37	76.797	12.208
20K	16	108' 2-11/16"	32.99	19,115	107,320.70	3,038.98	136.533	21.707
30K	20	135' 3-3/8"	41.23	29,867	167,691.82	4,748.50	213.336	33.918
40K - 2 panels	21	142' 0-9/16"	43.30	32,928	184,878.99	5,235.19	235.202	37.395
40K - 1 panel	22	148' 9-11/16"	45.36	36,139	202,905.81	5,745.65	258.135	41.040
40K	23	155' 6-7/8"	47.42	39,499	221,771.01	6,279.86	282.135	44.856
40K + 1 panel	24	162' 4-1/16"	49.48	43,008	241,474.68	6,837.80	307.202	48.842
40K + 2 panels	25	169' 1-3/16"	51.54	46,667	262,016.72	7,419.49	333.336	52.996
40K + 3 panels	26	175' 10-5/16"	53.60	50,475	283,397.28	8,024.92	360.536	57.321
40K + 4panels	27	182' 7-9/16"	55.67	54,433	305,616.30	8,654.09	388.803	61.814
40K + 5 panels	28	189' 4-11/16"	57.73	58,539	328,673.77	9,307.00	418.136	66.479

APPENDIX C - "3-Bear Cottonwood Site, Recycled Water Facility – Eddy County, NM 3D Seismic Imaging and Geologic Karst Characterization" prepared by Tetra Tech, dated October 26, 2017

AND

CAVE & KARST EVALUATION OF THE COTTONWOOD PROJECT SITE, SOUTH ½ OF THE SE OF THE SW IN SECTION 20, TOWNSHIP 26S, RANGE 26E prepared by Mr. David S. Belski., dated August 23, 2017.

3-Bear Cottonwood Site, Recycled Water Impoundment and SWD, Eddy County, NM 3D Seismic Imaging and Geologic Karst Characterization

#117-0536031
October 27th, 2017

PRESENTED TO

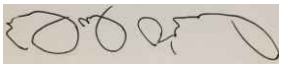
3-Bear Energy, LLC
Mike Soloman, SVP Engineering
1512 Larimer Street, Suite 540
Denver, CO 80202

PRESENTED BY

Tetra Tech
350 Indiana Street
Suite 500
Golden, CO 80401

(303) 217-5700
tetratech.com

Jamey Turner, WY P.G. #3750 — 10/26/2017
Sr. Geologist/Geophysicist



Dan O'Connell, Ph.D. — 10/26/2017
Sr. Geologist/Geophysicist

Approved by:

Nathan Langford, P.E. — 10/27/2017
Project Manager

TABLE OF CONTENTS

LIST OF FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 PURPOSE

The results presented herein provide results from active-source seismic imaging data collected in October 2017 at the 3-Bear Cottonwood site in Eddy County, New Mexico to identify the best foundation quality areas in the 20-acre property extent. Published geologic data are compiled to characterize the site stratigraphy and surficial geology to provide context for the near surface high-resolution geophysical imaging (Figure 1).

1.2 SCOPE OF WORK

The scope of work (SOW) includes the use of 3D seismic imaging and desktop geologic characterization to provide subsurface imaging of potential karst features to inform the placements of surface infrastructure in support of 3 Bear operations. This report summarizes the data interpretation and recommendations for the Cottonwood site.

2.0 SITE GEOLOGY

The Cottonwood site is located on surficial sand deposits overlying the Permian Castile Formation, (USGS, 1957). The total original thickness of the Castile Formation is approximately 1,825 feet in the vicinity of the McBride No. 1 Well drilled in the Delaware Basin, which reports the following stratigraphy (from the bottom up): 200 feet of interlaminated white anhydrite and gray to brown limestone, above which is a saline section of 515 feet of halite and limestone, an overlying section of 560 feet of anhydrite with limestone laminae, and 305 feet of overlying white anhydrite (USGS, 1957). In the vicinity of the McBride No. 1 well, approximately 125 ft. of gypsum has been eroded from the top of the formation. The thickness of the Castile Formation at the Cottonwood site has not been confirmed at this time, but typically the upper originally anhydrite facies have weathered into gypsum.

In the region around Eddy County, NM, anhydrite facies of the Castile Formation near the ground surface that have been exposed to water and weathering processes have weathered to gypsum. Locally, residual gypsum and clastics of the formerly overlying Solado Halite are intact; The Salado deposits mostly weathered away before the Pleistocene, and where still present are collapsed and typically look like breccia.

Where present at the site, surficial Quaternary (Pleistocene-Holocene) sands should be 70% quartz / 30% carbonate. More recent geologic mapping in nearby 7.5 minute quadrangles (e.g., Otis, Loving) show these sands vary in thickness from a few feet to ~200 feet (Pederson and Dehler, 2004). Regionally, anhydrite is characterized by regular planar bedding, and gypsum bedding is convoluted and irregular.

3.0 SEISMIC IMAGING

3.1 SEISMIC DATA ACQUISITION

Figure 3 shows the source and receiver positions. A total of 756 receiver stations were used across 28 north-south receiver lines of 27 receivers per line. The receiver array spanned 1350 feet east-west and 650 feet north-south. A total of 985 Vibroseis source positions were used at nominal 25 inline (north-south) spacing and 50 foot (east-west) crossline spacing. The Vibroseis source positions extended west, north, and south of the receivers to ensure full coverage of a 1320 foot east-west by 660 foot north-south survey area (Figure 3).

The entire survey had to be moved 75 feet north of the original property southwest corner because the well-pad and piping from the adjacent hydraulic fracturing operation extended nearly 70 feet into the intended survey area. The survey area was moved north to avoid damaging the plastic pipes exposed at the surface with seismic acquisition vehicles, particularly the 64,000-lb Vibroseis truck required to overcome noise from the continuously operating hydraulic fracturing well located less than 200 feet from the southwest corner of the property.

Vibroseis sweep testing was conducted with sweeps from 2 Hz to 96 Hz to 2 Hz to 140 Hz to find the Vibroseis sweep with the best combinations of high signal to noise and high frequency energy content. To eliminate noise

from the adjacent hydraulic fracturing operation and obtain the best resolution of karst structure, a Vibroseis sweep from 2 Hz to 140 Hz over a duration of 28 seconds was selected for production seismic acquisition. A total of > 3 GB of correlated Vibroseis data were acquired for a record length of three seconds per source point.

A RTK GPS survey was conducted to obtain high-accuracy receiver positions (with uncertainties <10 cm in receiver position). A sub-meter accuracy GPS RTK system on the Vibroseis provide source locations.

3.2 SEISMIC DATA PROCESSING

Figure 4 shows the extent of the 3D seismic data volume coverage at the site. The GPS survey was used to assign source and receiver positions and elevations for processing. Several processing methods were used to develop quick screens to identify areas well suited for foundation investigations and to screen off areas that are likely to be unsuitable. These processing approaches included surface wave group velocity and attenuation mapping as a function of frequency, joint total-energy-duration mapping to delineate areas of strong persistent resonance, acoustic-wave (Vp) first-arrival mapping of shallow low- and high-velocity regions, and three-dimensional (3D) Vp tomography using first-arrival time data.

The first-arrival times were picking from > 450,000 receiver ground motion recordings and a total of 342,588 high-quality first-arrival times were used to estimated 3D Vp from the ground surface to > 150 ft. depth using 8.2 foot 3D cells. Finite-frequency 3D wave-equation tomography was used with the first-arrival-time data to estimate 3D Vp.

The 3D Vp model reproduced the first-arrival-time data to within picking uncertainties of 1.5 ms. The 3D Vp model was output as SEGY data to import into the OpendTect 3D visualization and interpretation system to map areas most likely to have suitable foundation properties.

3.3 SEISMIC DATA AND INTERPRETATIONS

Surface-wave attenuation was used as an initial mapping attribute. However, the surface-wave attenuation mapping was potentially overly conservative and could eliminate potential useful foundation areas. Subsequent full 3D Vp tomographic analyses showed Vp attributes provided the best delineation of likely karst regions and larger areas with laterally persistent high-strength properties.

Areal mapping is provided to outline the best areas for positioning boreholes to identify acceptable areas for foundations. As an initial estimate for locating site boreholes, first-arrival time data were used in the 20 m to 65 m source-receiver offset range to estimate areas of anomalous depth-averaged Vp above the nominal water-table depth of 33 feet. This accomplished within one day of receiving the seismic data from the field crew to establish initial drilling target locations and priorities. This initial screening analysis identified areas of slowest Vp which are unlikely to provide acceptable foundation properties which are shown as colored-coded (red and yellow) areas in Figure 5. Based on the initial screening analysis, the areas most likely to provide the best foundation conditions in the property are shown as color-coded (blue and green) areas in Figure 6.

Areas on the surface with large trees and dense vegetation are confined to low-velocity areas outside the higher-velocity yellow-green areas in Figure 7 demonstrating that the 3D Vp model delineates areas of known surface karst features as local laterally lower-velocity regions. We interpret the tree root systems to bioturbate the gypsum bedrock and create pathways for surface water to infiltrate and dissolve bedrock. Thus, the 3D Vp tomography provides the best delineation of karst and best maps areas to focus investigations to identify acceptable foundations areas (Figure 7 and Figure 7 kmz provided as a separate digital file). The yellow areas have the thickest and stiffest foundation properties (i.e., highest seismic velocities that delineate intact bedrock) from the water table elevation to the surface (Figure 7). Only areas of yellow and green in Figure 7 should be considered

for foundation investigations since the rest of the areas in Figure 7 are likely to be impacted by varying degrees of karst development unsuitable for foundations.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the initial shallow Vp maps (Figure 5 and Figure 6) and surface-wave attenuation mapping, 16 drilling targets were defined within the data footprint to characterize subsurface conditions and investigate seismic anomalies. Two drill holes in the yellow-green portion of Figure 7 encountered mostly continuous gypsum in the 17-60 foot depth range (depths < 33 feet are likely above the water table). We recommend confining subsequent drilling to locations within the yellow-green regions of Figure 7 to avoid karst structure and focus drilling investigations in areas most likely to have the best foundation properties.

5.0 REFERENCES CITED

Green, G.N., Jones G.E., 1997, The Digital Geologic Map of New Mexico in ARC/INFO Format: USGS Open File Report 97-0052, 9 p.

Pederson, J.L., Dehler, C.M., 1994, Geologic Map of the Otis 7.5-minute Quadrangle, New Mexico Bureau of Geology OF-GM 98.

USGS, 1957, Geology of the Carlsbad Caverns East Quadrangle.

APPENDIX A: VP TOMOGRAPHY

480000 520000 560000 600000 640000 680000

3640000 3620000 3600000 3580000 3560000 3540000

N

Artesia

Chaves County

Eddy County

Lea County

Carlsbad

Hobbs

Eunice

Jal

Brantley Lake State Park

Carlsbad Caverns National Park

Guadalupe Mountains National Park

Otero County

Site

New Mexico

Texas

New Mexico

Texas

SCALE 1:600,000

0 24,500 49,000 98,000 ft

Notes:
Coordinate System: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

TITLE:
Site Location
3 Bear Energy, Cottonwood Site

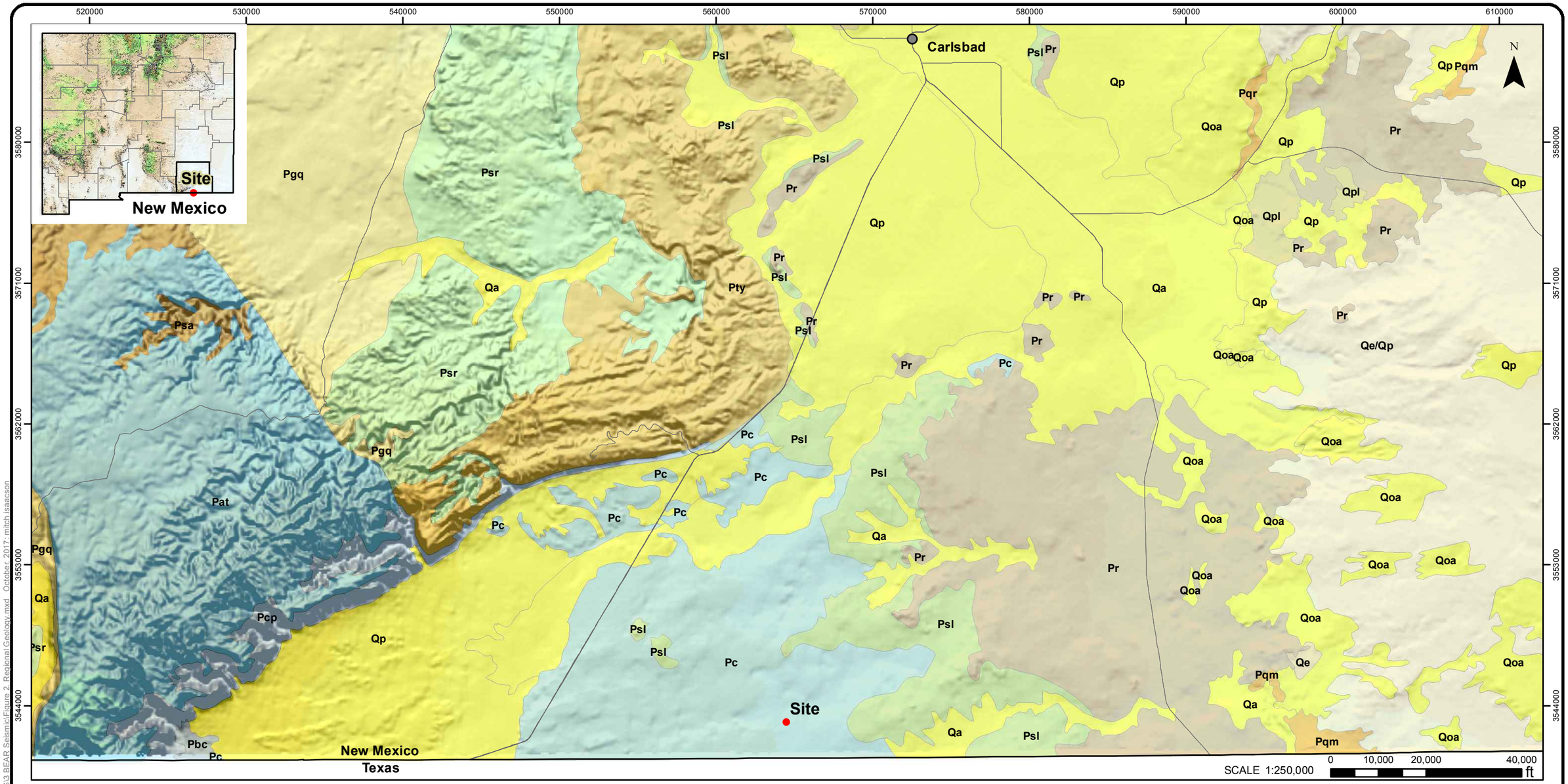
LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO
DRAFTED	MRI
PROJECT#	117-0536031
DATE	10/24/2017

FIGURE
1

3Bear Energy

C:\Users\mjh.isaacson\Desktop\C Drive\O PROJECTS\3 BEAR Seismic\Figure 1 - Site Location.mxd October 2017 mjh.isaacson



Legend

- Site Location
- State Boundary
- Roads

Permian Deposits

- Pqr, sandstone, mudstone
- Pr, carbonate, fine-grained mixed clastic
- Psa, carbonate, fine-grained mixed clastic
- Psl, evaporite, sandstone
- Psr, evaporite, fine-grained mixed clastic
- Pty, fine-grained mixed clastic, carbonate
- Pat, fine-grained mixed clastic, dolostone (dolomite)
- Pbc, sandstone, limestone
- Pc, evaporite, limestone
- Pcp, carbonate
- Pgq, carbonate, sandstone
- Pqm, sandstone, mudstone

Quaternary Deposits

- Qa, alluvium
- Qe, eolian
- Qe/Qp, eolian
- Qoa, alluvium
- Qp, alluvium
- Qpl, lake or marine deposit (non-glacial), alluvium

Notes:
Geologic map source: Green, G.N., and Jones, G.E., 1997, The Digital Geologic Map of New Mexico in ARC/INFO Format: U.S. Geological Survey Open-File Report 97-0052, 9 p.; http://pubs.usgs.gov/of/1992/ofr-92-0052.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator Datum: North American 1983

TITLE:
Regional Geology
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE	2
DRAFTED	MRI		
PROJECT#	117-0536031		
DATE	10/24/2017		

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 2_Regional Geology.mxd October, 2017 mitch.isaacson

Legend

- Seismic Investigation Area
- Vibroseis Source Locations
- Geophone Receiver Locations

Notes:
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
Seismic Aquisition Sources and Receivers
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE	3
DRAFTED	MRI		
PROJECT#	117-0536031		
DATE	10/24/2017		

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 3, Source Receiver Locations v2.mxd October, 2017 mitch.isaacson

Legend

3D Seismic Volume Data Extent

Notes:
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
3D Seismic Volume Data Extent
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE 4
DRAFTED	MRI	
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 5_Vp Tomography Low Vp Areas.mxd October 2017 mitch.isaacson

564200 564300 564400 564500 564600 564700 564800

3543200 3543100 3543000 3542900

N

SCALE 1:1,900 0 80 160 320 ft

Legend

Low Vp Anomaly
(1042 masl, 15m bgs)

0.2 0.4 0.6 0.8 1.0

Notes:
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
Vp Tomography Low Vp Areas
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE
DRAFTED	MRI	5
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 5 Vp Tomography Low Vp Areas.mxd October 2017 mitch.isaacson

564200 564300 564400 564500 564600 564700 564800

3543200 3543100 3543000 3542900

N

SCALE 1:1,900 0 80 160 320 ft

Legend

High Vp Anomaly
(1042 masl, 15m bgs)

1.0 0.8 0.6 0.4 0.2

Notes:
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
Vp Tomography Slice High Vp Areas
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

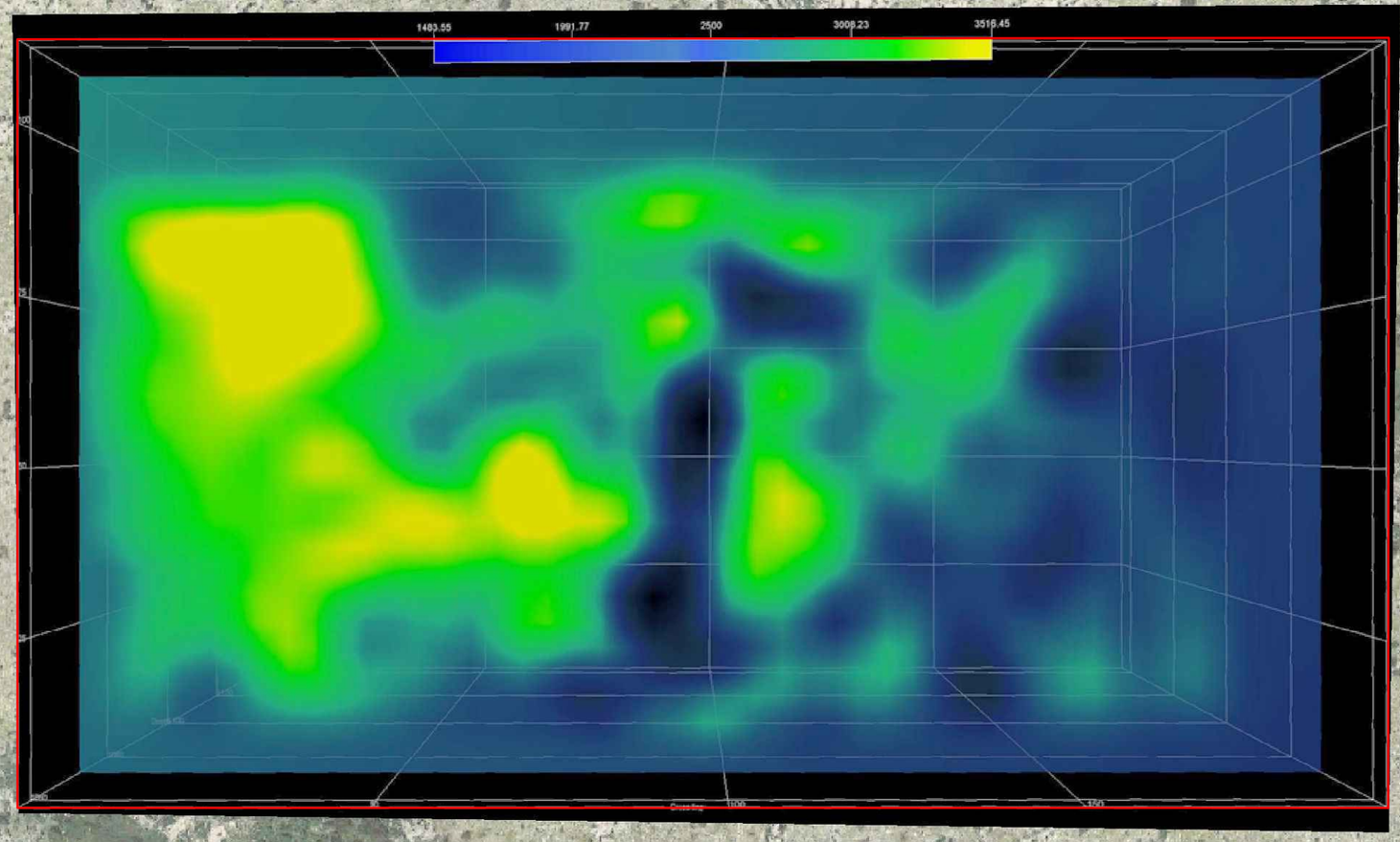
APPROVED	JT, DRHO	FIGURE
DRAFTED	MRI	6
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 6 Vp Tomography High Areas.mxd October 2017 mitch.isaacson

564200 564300 564400 564500 564600 564700 564800

3543200 3543100 3543000 3542900



N

SCALE 1:1,900 0 80 160 320 ft

Legend

3D Seismic Volume Data Extent

3D Seismic Vp Slice (1042 masl, 15m bgs)
Velocity (m/s)

1480 1990 2500 3010 3515

Notes:
Vp velocities greater than 2500 m/sec (green and yellow) delineate areas with preferable foundation conditions relative to lower velocity areas (blue and black) that are expected to be characterized by higher levels of subsurface dissolution.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: emptyStr=Transverse Mercator, Datum: emptyStr=North American 1983

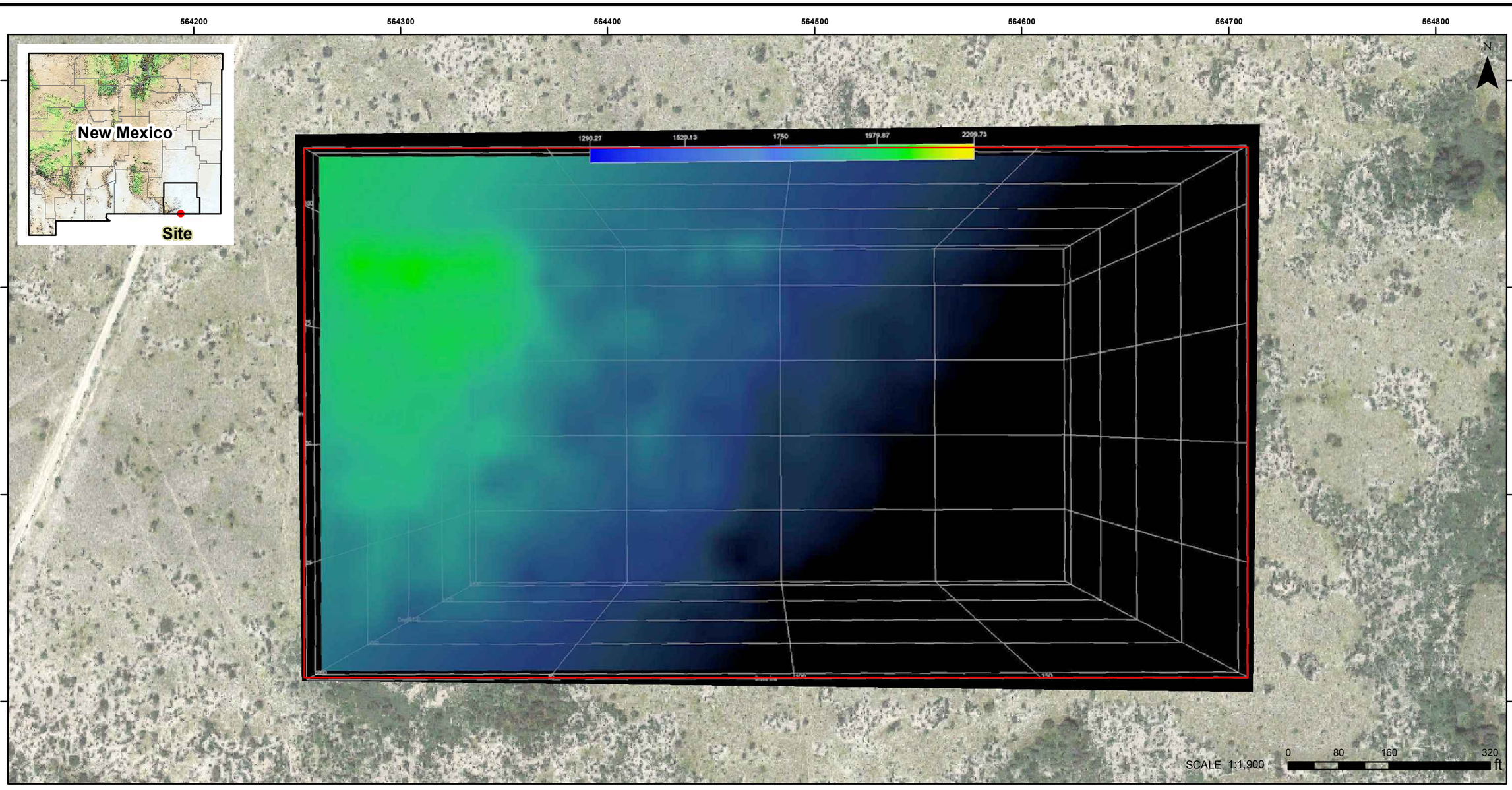
TITLE:
Vp Tomography Slice Elevation (15m bgs)
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE	7
DRAFTED	MRI		
PROJECT#	117-0536031		
DATE	10/24/2017		

3Bear Energy

C:\Users\mitch.leaeson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 7 Vp Tomography 1042m.mxd October 2017 mitch.leaeson



Legend

3D Seismic Volume Data Extent

3D Seismic Vp Slice (1052 masl, 5m bgs)
Velocity (m/s)

1290 1520 1750 1980 2210

Notes:
Vp velocities greater than 1750 m/sec (green and yellow) delineate areas with preferable foundation conditions relative to lower velocity areas (blue and black) that are expected to be characterized by higher levels of subsurface dissolution.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
Vp Tomography Slice Elevation (5m bgs)
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

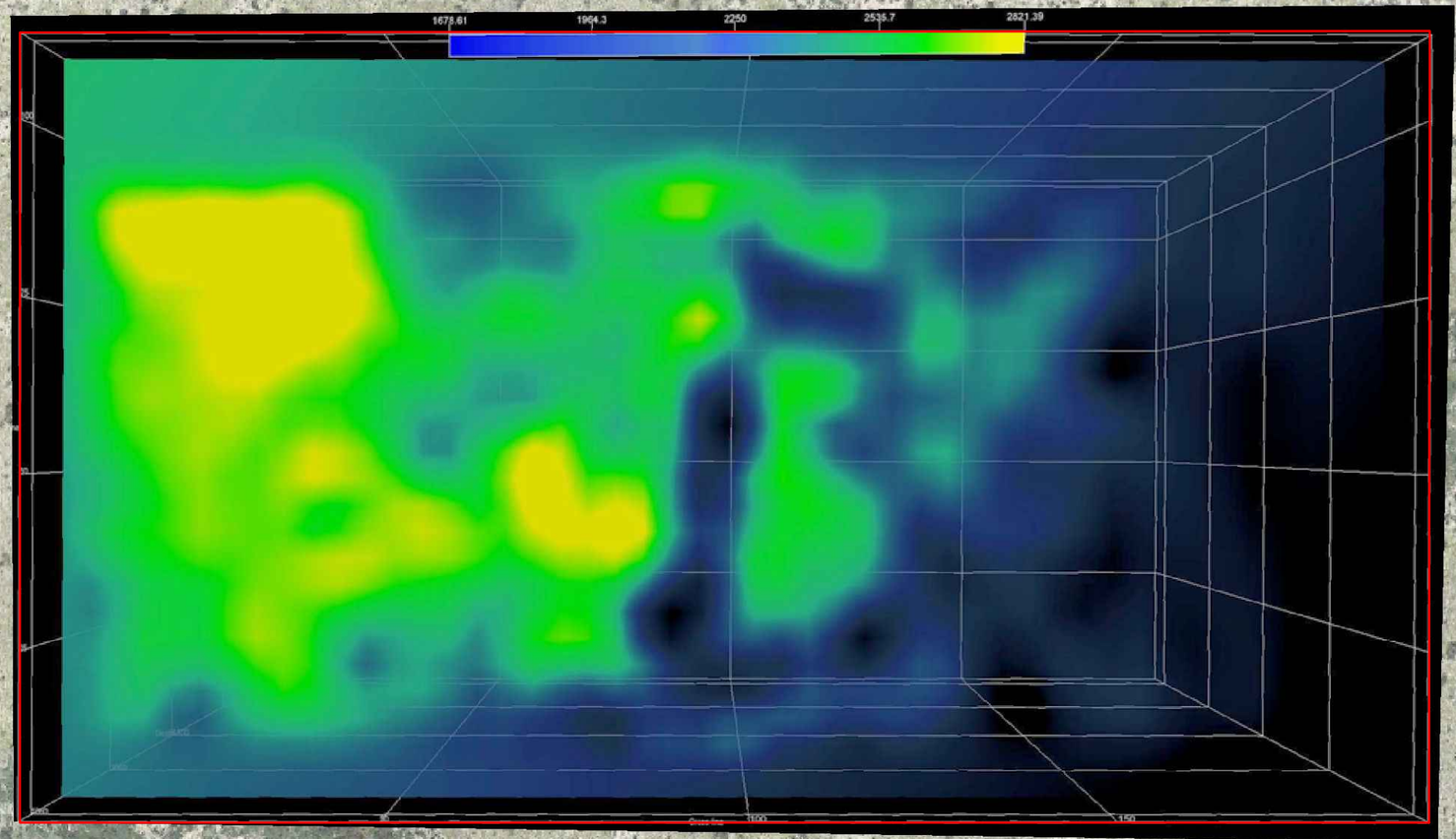
APPROVED	JT, DRHO	FIGURE
DRAFTED	MRI	A-1
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Appendices A1 1052m.mxd October 2017 mitch.isaacson

564200 564300 564400 564500 564600 564700 564800

3543200 3543100 3543000 3542900



N

SCALE 1:1,900 0 80 160 320 ft

Legend

3D Seismic Volume Data Extent

3D Seismic Vp Slice (1047 masl, 10m bgs)
Velocity (m/s)

1680 1960 2250 2540 2820

Notes:
Vp velocities greater than 2250 m/sec (green and yellow) delineate areas with preferable foundation conditions relative to lower velocity areas (blue and black) that are expected to be characterized by higher levels of subsurface dissolution.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

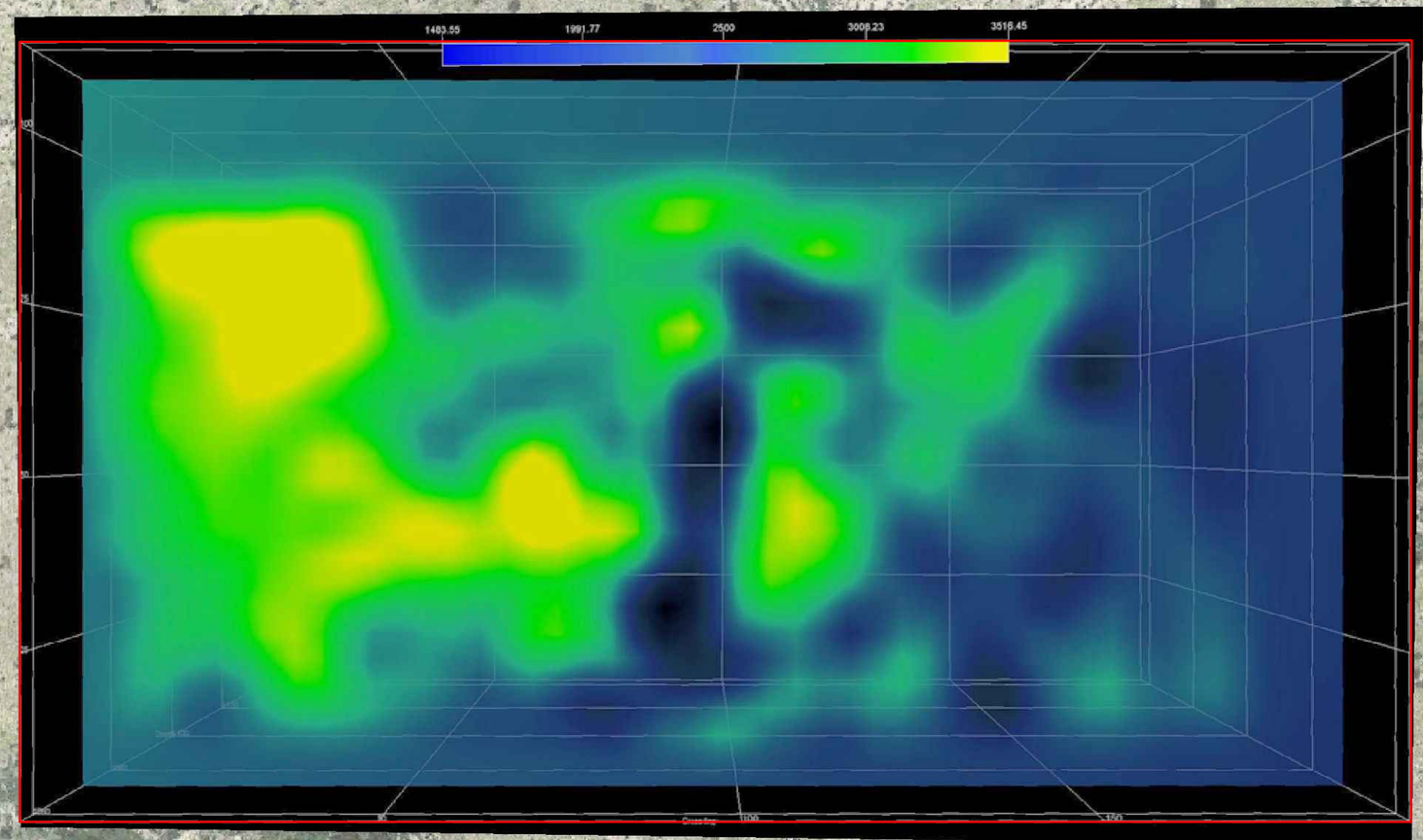
TITLE:
Vp Tomography Slice Elevation (10m bgs)
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE
DRAFTED	MRI	A-2
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Appendices A2.mxd October 2017 mitch.isaacson



564200 564300 564400 564500 564600 564700 564800

3543200 3543100 3543000 3542900

N

SCALE 1:1,900

0 80 160 320 ft

Legend

3D Seismic Volume Data Extent

3D Seismic Vp Slice (1042 masl, 15m bgs)
Velocity (m/s)

1480 1990 2500 3010 3515

Notes:
Vp velocities greater than 2500 m/sec (green and yellow) delineate areas with preferable foundation conditions relative to lower velocity areas (blue and black) that are expected to be characterized by higher levels of subsurface dissolution.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: emptyStr=Transverse Mercator, Datum: emptyStr=North American 1983

TITLE:
Vp Tomography Slice Elevation (15m bgs)
3 Bear Energy, Cottonwood Site

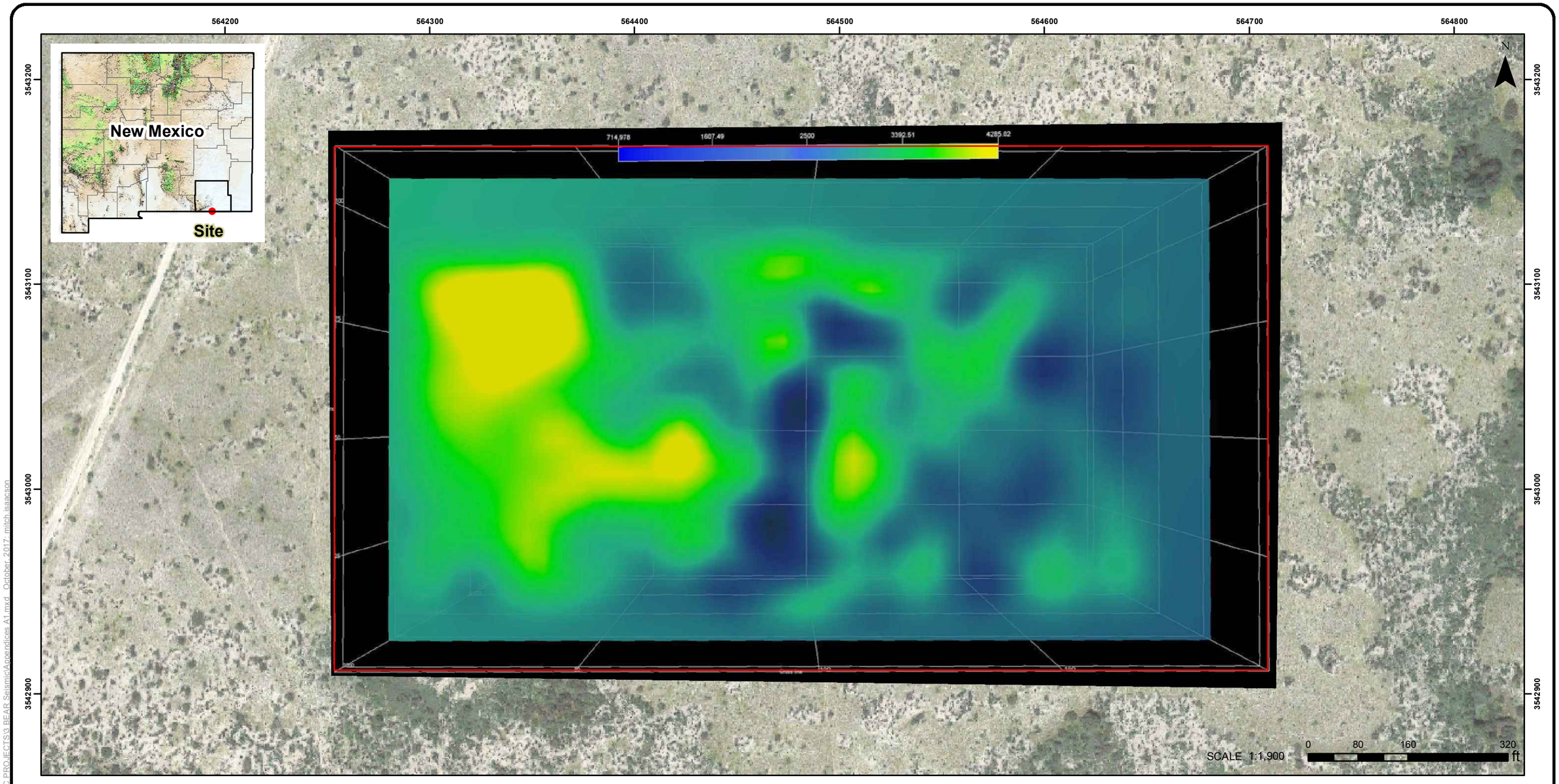
LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO
DRAFTED	MRI
PROJECT#	117-0536031
DATE	10/24/2017

FIGURE
A-3

3Bear Energy

C:\Users\mitch.leaseon\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Figure 7 Vp Tomography 1042m.mxd October 2017 mitch.leaseon



C:\Users\mitch.isaacson\Desktop\C Drive\C PROJECTS\3 BEAR Seismic\Appendices A1.mxd October 2017 mitch.isaacson

Legend

3D Seismic Volume Data Extent

3D Seismic Vp Slice (1037 masl, 20m bgs)
Velocity (m/s)

710 1610 2500 3390 4290

Notes:
Vp velocities greater than 2500 m/sec (green and yellow) delineate areas with preferable foundation conditions relative to lower velocity areas (blue and black) that are expected to be characterized by higher levels of subsurface dissolution.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
Vp Tomography Slice Elevation (20m bgs)
3 Bear Energy, Cottonwood Site

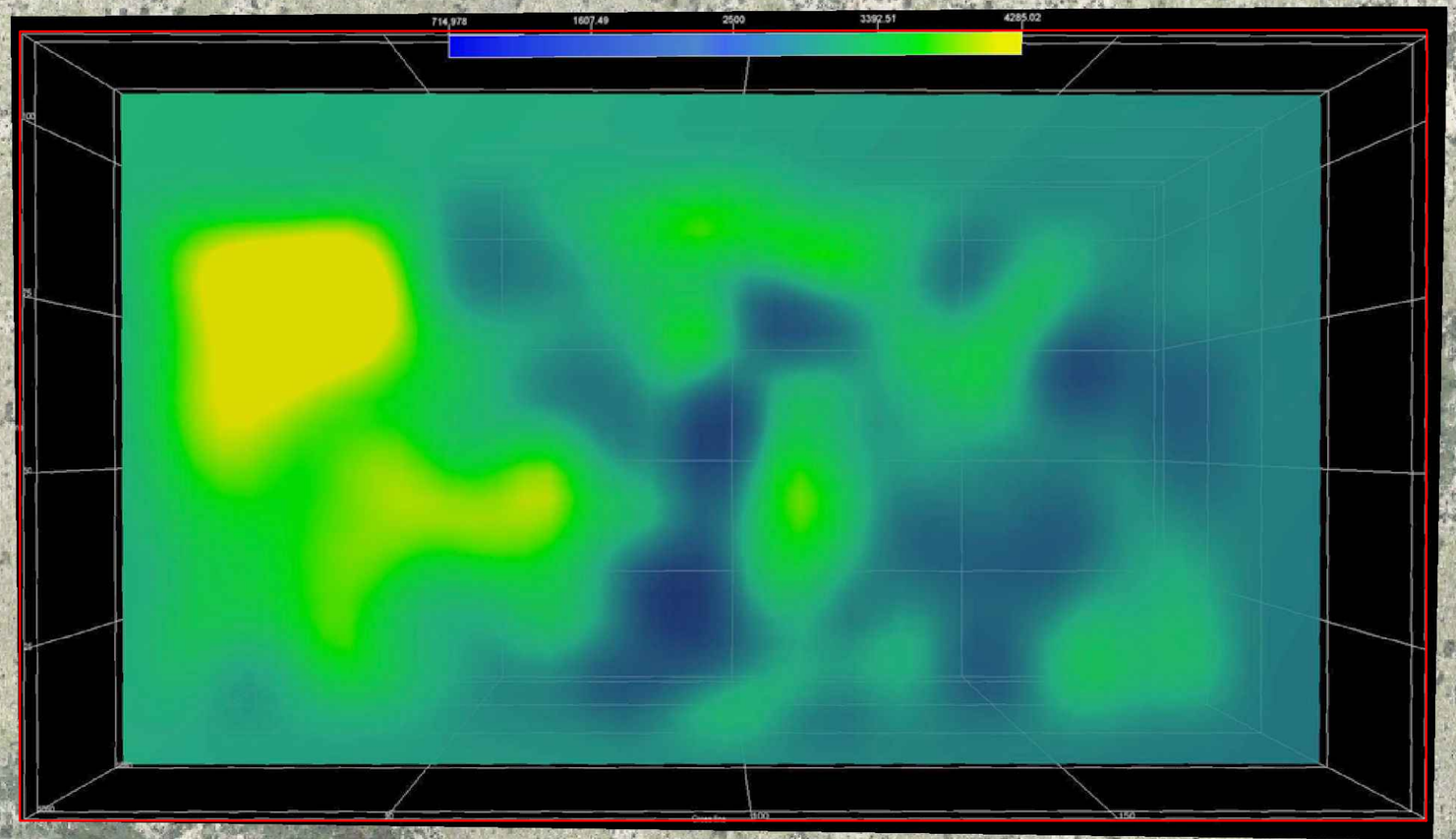
LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE
DRAFTED	MRI	A-4
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

564200 564300 564400 564500 564600 564700 564800

3543200 3543100 3543000 3542900



N

SCALE 1:1,900 0 80 160 320 ft

Legend

3D Seismic Volume Data Extent

3D Seismic Vp Slice (1032 masl, 25m bgs)
Velocity (m/s)

710 1610 2500 3390 4290

Notes:
Vp velocities greater than 2500 m/sec (green and yellow) delineate areas with preferable foundation conditions relative to lower velocity areas (blue and black) that are expected to be characterized by higher levels of subsurface dissolution.
Coordinate System: NAD 1983 UTM Zone 13N, Projection: Transverse Mercator, Datum: North American 1983

TITLE:
Vp Tomography Slice Elevation (25m bgs)
3 Bear Energy, Cottonwood Site

LOCATION:
Eddy County, New Mexico

APPROVED	JT, DRHO	FIGURE
DRAFTED	MRI	A-5
PROJECT#	117-0536031	
DATE	10/24/2017	

3Bear Energy

COPY OF 3BEAR PROPERTY SURFACE SURVEY FOR KARST, DATED AUGUST 23, 2018

3BEAR ENERGY
1512 LARIMER STREET, SUITE 540
DENVER, CO 80202

23 AUGUST, 2017

CAVE & KARST EVALUATION OF THE COTTONWOOD PROJECT SITE, SOUTH ½ OF THE SE OF THE SW IN SECTION 20, TOWNSHIP 26S, RANGE 26RE

Work was started and completed on 22 AUGUST, 2017

The PROPOSED PROJECT SITE, SOUTH ½ of SE of the SW, SECTION 20, T26S, R26E were identified and walked on a 30 meter grid, south to north starting at the SE corner stake. Any cave & karst concerns were identified by coordinates and listed in this report.

The GPS locations are obtained using Garmin e-Trex hand-held GPS units using 13S, WGS 84 as the datum.

Corner stakes were identified at these locations:

SE CORNER STAKE	**564688E, 3542916N**
NE CORNER STAKE	**564688E, 3543120N**
NW CORNER STAKE	**564285E, 3542120N**
SW CORNER STAKE	**564285E, 3542916N**

Boundary stakes were identified at these locations:

West boundary stakes located at:	**564285E, 3542979N**
	564285E, 3543041N
East boundary stakes located at:	**564688E, 3542979N**
	564688E, 3543041N

South boundary stakes located at: 564322E, 3542916N
564387E, 3542916N
564445E, 3562916N
564506E, 3542916N
564570E, 3542916N

North boundary stakes located at: 564322E, 3563120N
564387E, 3542120N
564445E, 3543120N
564503E, 3543120N
564570E, 3543120N

Cave & karst locations were identified at these coordinates:

A small surface drainage hole was discovered at 564669E, 3543067N. It is in a depression buried in a large clump of trees and bushes and is 4 feet x I foot x 2 feet deep. The drainage hole is clogged with surface debris. This feature drains the immediate area. This feature is on the extreme east boundary of the project area.

A larger cave/surface drainage hole was discovered at 564576E, 3543059N. This feature is located in a depression within a large clump of trees and bushes and is 9 feet long and 3 feet deep. This feature was also clogged with surface debris and drains the immediate area. This feature is located on the extreme east boundary of the project area.

Another large thick growth of bushes and trees is located at 564369E, 3542917N. This thick feature, like the two above features, is located in low spots in the surface terrain. Water pools in these low spots and drains underground. This feature is located along the south edge of the project area.

All of these drainages could lead to underground voids but there is no surface indication of this. All these clumps of trees are also wildlife habitats. Care should be taken so not to disturb the environment.

The surface consists of red/brown soil and sand with scattered pieces of limestone, sandstone and gypsum.

Photographs were taken and are included with this report.

David S. Belski
Cave and Karst Surface Evaluation

SE CORNER STAKE, 564688E, 3542916N

TYPICAL BOUNDARY STAKE

SURFACE DEPRESSION WITH DRAINAGE HOLE 564669E, 3543067N

SURFACE DEPRESSION WITH DRAINAGE HOLE, 564669E, 3543067N

SMALL CAVE/DRAINAGE HOLE, 564576E, 3543059N

SMALL CAVE/DRAINAGE HOLE, 564576E, 3543059N

APPENDIX D – Report of Geotechnical Investigation
Cottonwood Site Proposed Water Recycling Facility and Recycled Water Storage Tanks

TETRA TECH

3Bear Energy, LLC
Cottonwood Site

Proposed Water Recycling Facility and Recycled Water Storage Tanks

SW ¼ of Section 20, Township 26 South,
Range 26 East,
Eddy County, New Mexico

December 2017

complex world
CLEAR SOLUTIONS™

Report of Geotechnical Investigation
Cottonwood Site
Proposed Water Recycling Facility and Recycled Water Storage Tanks

Eddy County, New Mexico

Prepared for:

Mr. Mike Solomon & Mr. Jesse Fiedorowicz
3Bear Energy, LLC
1512 Larimer St. Suite 540, Denver, Colorado 80202
Phone: (333) 626-8290

Prepared by:

Tetra Tech

4000 North Big Spring Street, Suite 401
Midland, Texas 79705
Phone (432) 682-4559; Fax (432) 682-3946

Tetra Tech Project No. 212C-MD-00981

Thomas A. Chapel
Principal Engineer

Reviewed by: Don Grahlherr, P.E.
Vice President
December 28, 2017

TABLE OF CONTENTS

EXECUTIVE SUMMARY

3Bear Energy (3Bear) plans to construct five above ground water storage tanks at their "Cottonwood" site located in Eddy County, New Mexico. In accordance with 3Bear's request, this report provides geotechnical design recommendations for the water storage tanks only and not the other facilities.

The water storage tanks will measure approximately 190 feet in diameter with a maximum height of twelve feet. Each tank will have a capacity of about 60,000 barrels (bbl). We understand each tank will consist of twenty-eight steel panels placed on Low-density polyethylene (LDPE) geomembrane liners, designed as a double liner and a leak detection system (LDS). The Earthwork Contractor will be responsible for preparing and maintaining the subgrade in the condition suitable for installation of LDPE Geomembrane as described in this report.

Between September 22nd and November 3rd, 2017, Tetra Tech and our drilling subcontractor drilled nineteen (19) exploratory soil borings to identify subsurface conditions and collect samples. Borings were drilled to depths ranging from 30 feet to 67 feet below the existing ground surface (bgs). Water was encountered at approximate depths ranging from 33 to 44 feet (bgs) in five borings.

The borings predominantly encountered 10 to 33 feet of medium dense to very dense silt to silty sand (with significant gypsum content), over medium hard, fresh weathered gypsum bedrock. At various depths of the silt/sand layer, some weak soil cementation was observed.

New Mexico Oil Conservation Division Rules published in the New Mexico Administrative Code (NMAC) have specific requirements for "pits" associated with oil and gas exploration and production. A hydrogeological study to meet the requirements of the NMAC could be performed to determine whether the groundwater encountered in this investigation is a perched layer or a continuous water bearing feature. Alternatively, 3Bear may ask for a variance based on equivalent protection of the environment based on an additional lined secondary containment.

Additional investigation and construction recommendations for the development of the site are provided in this report. We have prepared this executive summary solely to provide a general overview, and it should not be used for any purpose except that for which it was intended. We recommend a detailed review of the entire report for information about our findings, recommendations and other concerns related to geotechnical conditions for the site.

1.0 PURPOSE AND SCOPE OF STUDY

3Bear Energy, LLC (3Bear) plans to construct various facilities at their "Cottonwood" site located in Eddy County, New Mexico, including five above ground water storage tanks. 3Bear retained Tetra Tech to conduct a geotechnical engineering investigation for the portion of the site that will be subgrade for the proposed above ground storage tanks.

Tetra Tech's scope of work included the following.

1) Request a New Mexico 811 Utility locate;

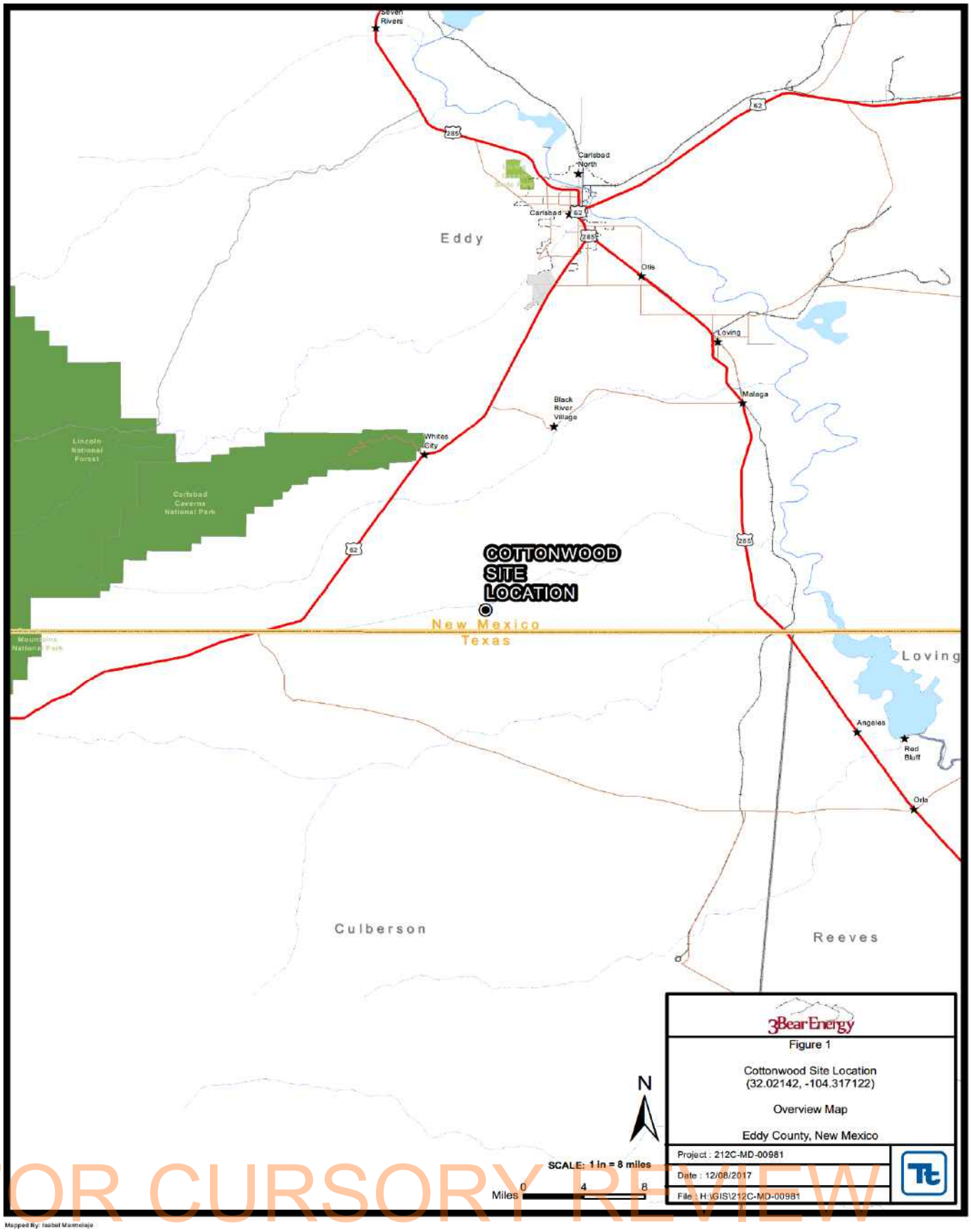
2) Mobilize a Failing 1500 Air Rotary rig to drill nineteen (19) borings to depths ranging from 30 feet to 67 feet below the existing ground surface (bgs) to characterize the subsurface and look for evidence of groundwater;

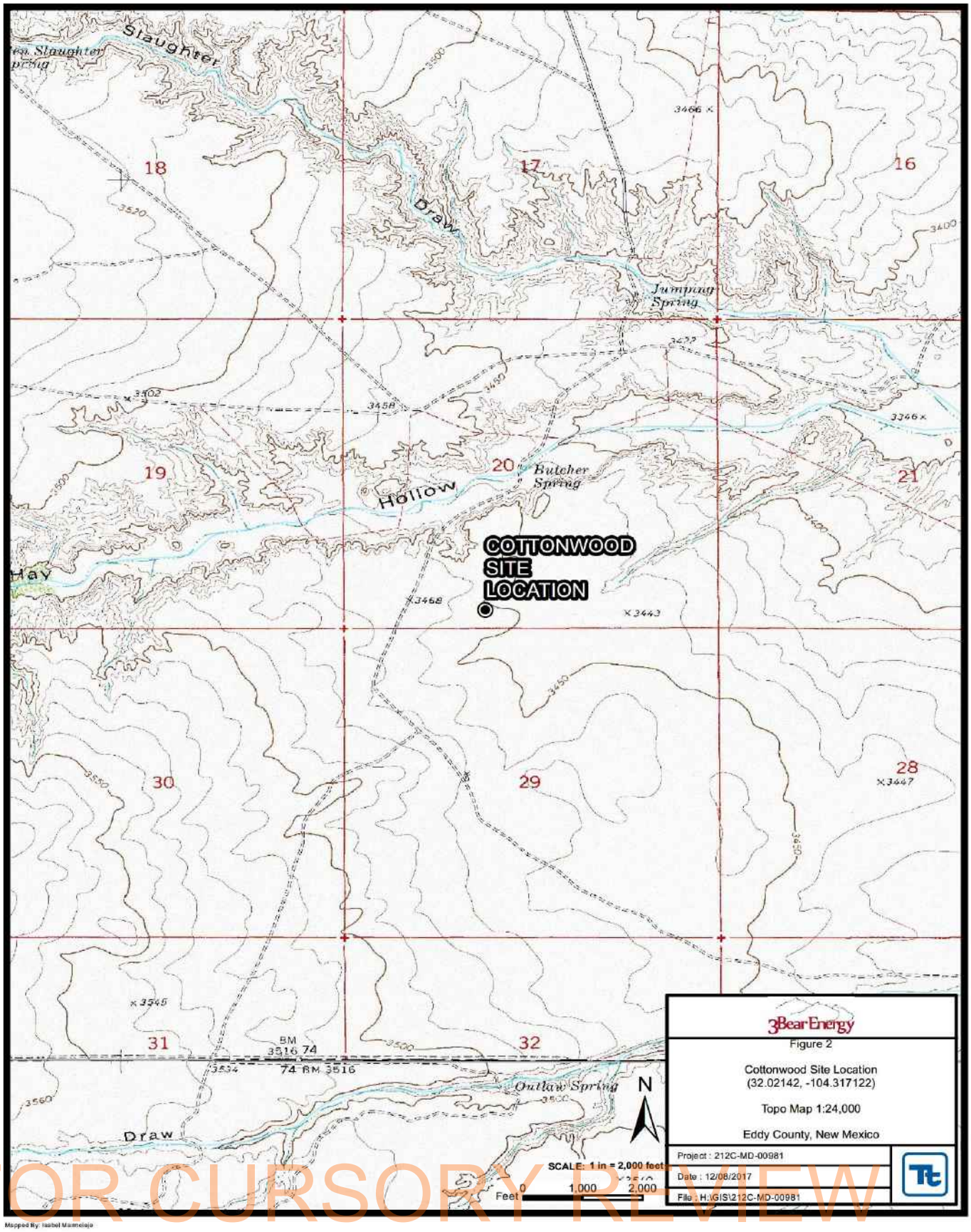
3) Collect Modified California Samples (MC) and/or rock core samples at 5 or 10-foot intervals for laboratory tests and to evaluate soil/rock consistency;

4) Backfill borings with soil cuttings after completion of drilling and 24-hour water level measurements, as required; and

5) Prepare a geotechnical engineering report summarizing the results of our investigation and providing geotechnical design criteria and recommendations for the five above ground water storage facilities.

The general location of the site is shown on the Site Location Map, Figure 1 and the general topography is shown on Figure 2.





2.0 SITE CONDITIONS

The project site for the proposed water storage facilities is identified as the Cottonwood Site. It is located 17 miles southeast of Whites City in Eddy County, New Mexico, and approximately 10 miles east of Highway 180 (U.S. Hwy 62 / National Parks Highway) along County Rd 424 (Dillahunty Road). GPS coordinates recorded at the SE corner of the site are 32.020512 N and 104.314973 W.

The site was heavily wooded with mesquite trees, native shrubs, and miscellaneous vegetation. Clearing with a bulldozer was necessary to access the boring locations at the site. The ground appeared to be relatively flat.

Based on the ground surface elevations obtained from a topographic map and a handheld, commercially available GPS device, the site slopes slightly down (less than 1degree) from the northwest to the southeast with elevations varying from approximately 3,461 feet to 3,452 feet above mean sea level (AMSL).

Surface utilities, fences, and access roads were not observed on the site at the time of drilling. Drainage streams, swales, playa, or other potential issues were not seen. The existing ground surface was cleared of shrubs and vegetation by 3Bear or their contractor prior to the drilling. A well pad is located at the southwest corner of the property and a lease road is adjacent to the south. On the north side of the access road, various pipelines were exposed. Prior to the drilling, an earthen ramp was built over the pipelines near the southeast corner of the site to allow for safe access from the lease road to the site.

A Cave & Karst Evaluation of the Cottonwood Project Site (Ref. [4]) was conducted by others on 22 August, 2017. Potential cave and karst locations were identified at these coordinates:

564669E, 3543067N	Small surface drainage hole
564576E, 3543059N	Larger cave/surface drainage hole
564369E, 3542917N	Large thick growth of bushes and trees

All of these drainages features could lead to underground voids but there is no surface indication of this. For this reason and because the area is prone to karst geologic formation as described in this report, 3 Bear retained Tetra Tech to conduct a geophysical study in October 2017. The purpose of the study was to identify potential karst features that could be in conflict with the placements of surface infrastructure. Drilling targets for this study were defined within the data footprint to avoid karst structure as described in the *Exploratory Soil Borings* Section of this report. Complete results of the geophysical survey are provided in Tetra Tech's Seismic and Geologic Karst Characterization Report, Ref. [3].

3.0 PROPOSED DEVELOPMENT

3Bear plans to construct five water storage tanks at their Cottonwood site located in Eddy County, New Mexico. The water storage tanks will each measure approximately 190 feet in diameter with a maximum height of twelve feet and have a capacity of about 60,000 barrels (bbl).

We understand each tank will consist of twenty-eight steel panels placed on Low-density polyethylene (LDPE) geomembrane liners, designed as a double liner equipped with a leak detection system (LDS). Additionally the underdrain system (collection lateral and sump) will be designed by Tetra Tech, considering the manufacturer's general recommendations for installation. In addition, the NMOCD has requested that all tanks be installed within a lined secondary containment area. This will be a High Density Polyethylene (HDPE) lined system with an underdrain, such as netting or other. A minimum of two feet of fill material will be placed on top of the secondary containment geosynthetics for support of the tanks.

The locations of the tanks on the property were selected to reduce the risk of constructing them above unknown karst features. The Earthwork Contractor will be responsible for preparing and maintaining the subgrade in the condition suitable for installation of LDPE Geomembrane as described in this report.

4.0 GEOLOGIC CONDITIONS

Mapping by the Natural Resources Conservation Service (NRCS, 2016) identifies the site soils as the RG - Reeves-Gypsum land complex (see Figure 4). These deposits are described as a residuum weathered from gypsum.

Review of mapping by the U.S. Geological Survey (see Figure 5) indicates that the Permian age Castile Formation entirely underlies the project site. This formation is described as white massive gypsum with some interlaminated white gypsum and dark-gray limestone in the lower part.

The bedrock and soils described above are often prone to karst formation and dissolution leaving voids and cavities, especially in the presence of groundwater. The size, orientation, and extent of such voids is difficult to predict using conventional exploratory geotechnical drilling. A geophysical study (Ref. [3].) was conducted by Tetra Tech in October 2017 to identify potential karst features that could be in conflict with the placements of surface infrastructure. That study, a Cave & Karst Evaluation of the Cottonwood Project Site (Ref. [4]), and this geotechnical investigation indicate that the western portion of the site is the most favorable location for the planned facilities in order to avoid karst features.

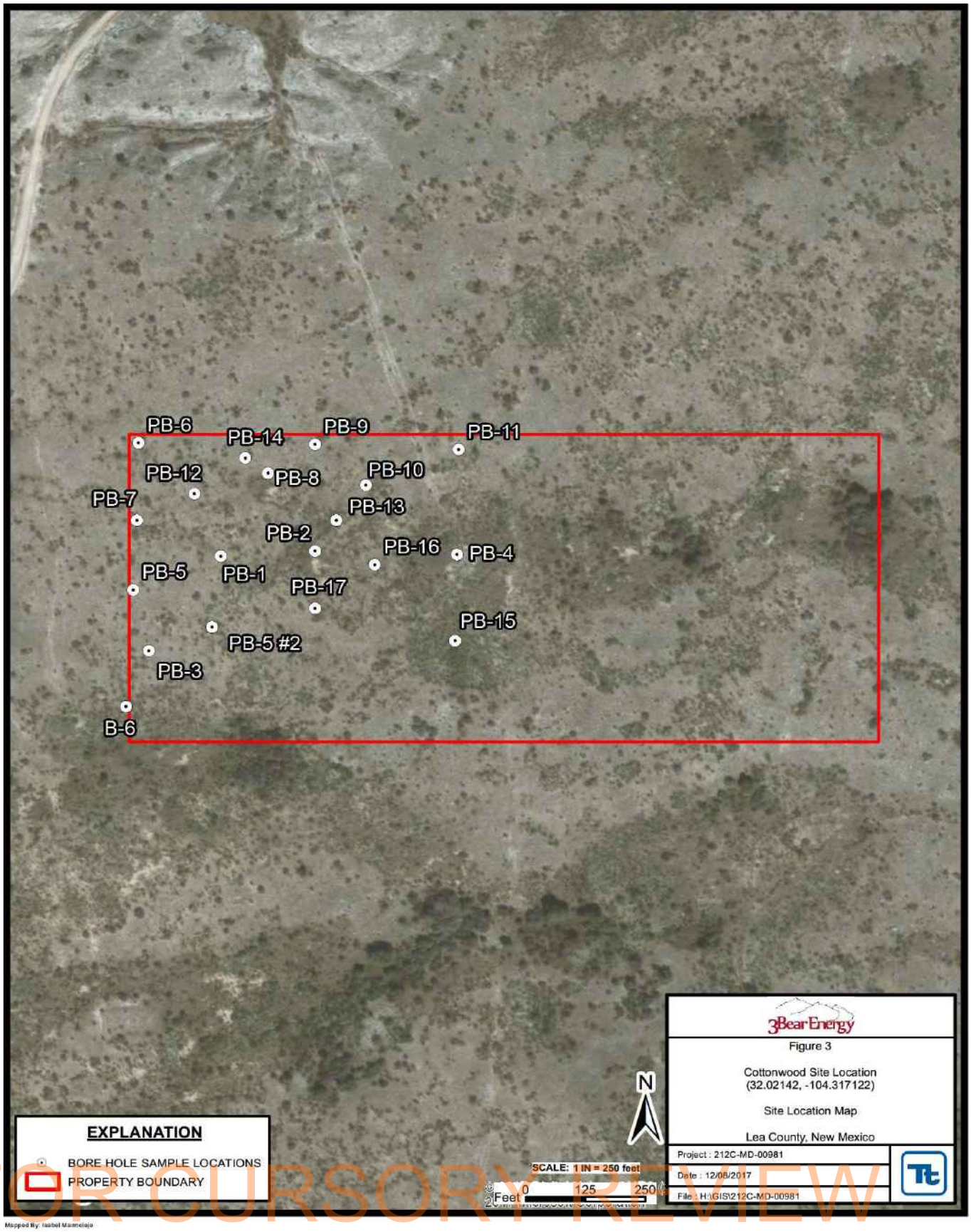
For this study, drilling targets were defined within the data footprint to reduce the risk of encountering potential karst structure as described in the *Exploratory Soil Borings* Section of this report. In general, our findings in this geotechnical study are consistent with the published geologic and NRCS characterization within the depths explored.

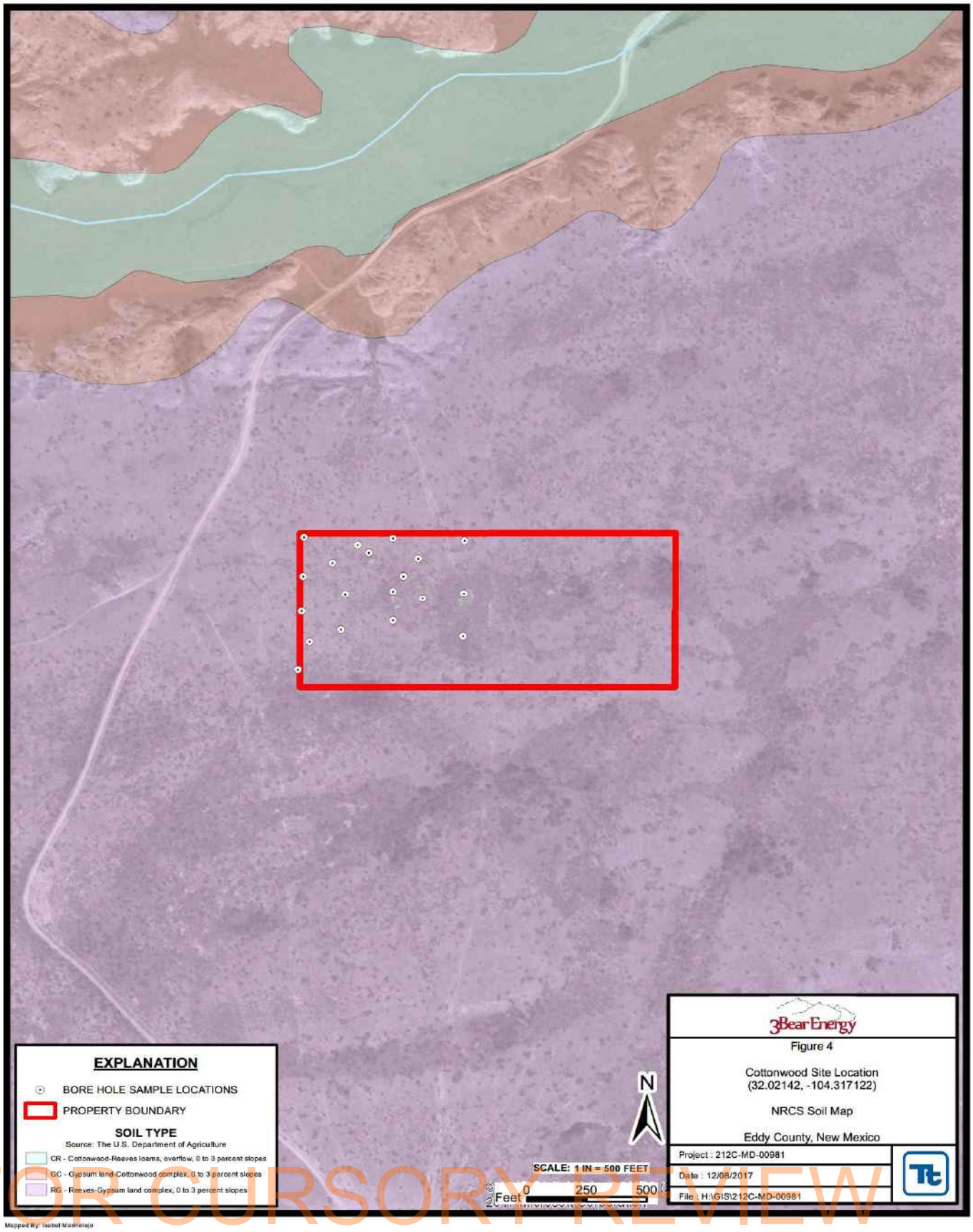
5.0 EXPLORATORY SOIL BORINGS

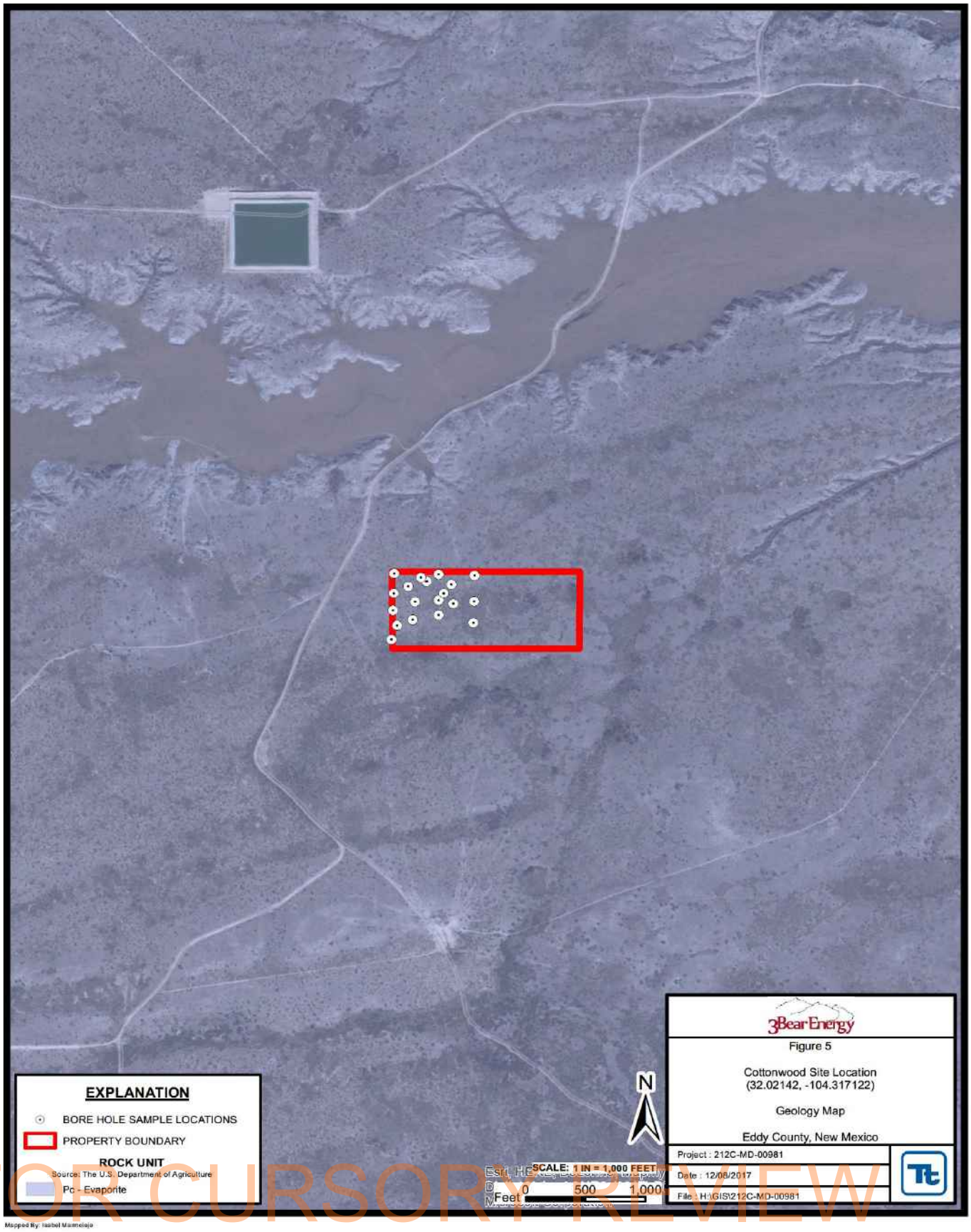
Tetra Tech drilled nineteen (19) exploratory soil borings (B-6, PB-5#2, PB-1 through PB-17) between September 22nd and November 3rd, 2017 to identify subsurface conditions at the site and to confirm conditions identified in the geophysical investigation. The locations of the borings were concentrated in the western portion of the site because that area was determined to have a lower risk of underground karst features that other portions of the site while meeting 3Bears' requirements for development of the proposed facilities. The complete list of borings, their location and depth below the existing ground surface (bgs), and water levels are presented in Table 1 below. The approximate locations of the borings are shown on Fig. 3, 4 and 5.

Boring ID	Latitude (DD)	Longitude (DD)	Depth Bgs (ft)	Depth to Bedrock Surface Bgs (ft)	Water Level Bgs (ft)
PB-1	32.02161	-104.31874	60	10	33
PB-2	32.02164	-104.31820	50	33	Not encountered
PB-3	32.02105	-104.31915	50	21	Not encountered
PB-4	32.02162	-104.31739	36	16	Not encountered
PB-5	32.02141	-104.31924	32	12	Not encountered
PB-5 #2	32.02119	-104.31879	60	17	Not encountered
PB-6	32.02228	-104.31921	30	12	Wet at 30
PB-7	32.02182	-104.31922	38	18	Not encountered
PB-8	32.02210	-104.31847	55	13	Not encountered
PB-9	32.02227	-104.31820	40	24	Not encountered
PB-10	32.02203	-104.31791	60	18 to 21; 31	Not encountered
PB-11	32.02224	-104.31738	30	Not encountered	Not encountered
PB-12	32.02198	-104.31889	67	11	38
PB-13	32.02182	-104.31808	30	Not encountered	Not encountered
PB-14	32.02219	-104.31860	34	14	Not encountered
PB-15	32.02111	-104.31740	61	22	43.5
PB-16	32.02156	-104.31786	30	15	Not encountered
PB-17	32.02130	-104.31820	36	16	Not encountered
B-6	32.02072	-104.31928	33	Not encountered	33

Table 1. Borings Location and Depth Summary







The boring locations were selected considering the proposed site development layout, previously located karst surface features (Ref. [4]), and surface-wave attenuation mapping presented in a Seismic and Geologic Karst Characterization Report, Ref. [3]. Drilling targets were defined within the data footprint to avoid karst structure and focused the drilling investigation in areas most likely to have the best foundation properties.

The proposed footprints of five water storage tanks were overlaid on the satellite image, and exploratory borings were placed to investigate these areas. GPS coordinates were obtained for each boring location. The boring locations were marked in the field by Tetra Tech using these coordinates and a commercially available handheld GPS unit. The boring locations were cleared for drilling by comparing the proposed locations to buried utility locations marked by New Mexico 811 utility locating services. In addition, Tetra Tech cleared the boring locations using hand-held pipeline locating instruments.

The borings were drilled by White Drilling Company from Clyde, Texas using a truck-mounted drilling rig. The ground surface was stable for the drilling rig to access the boring locations and there were no access issues other than occasionally moving to avoid obstacles (shrubs, bushes). Air Rotary drilling equipment was used to complete the borings. Tetra Tech's representative was on site to observe site conditions and the drilling operations, and to collect samples needed for our analysis.

To investigate the presence or absence of water that could influence the planned facility, all 19 of the borings were drilled to 30 feet bgs or deeper. Water was encountered in borings PB-1, PB-6, and B-6 borings while drilling or immediately afterwards. In borings, PB-12 and PB-15 water was encountered when measured after 54 hours and 4 hours, respectively. The depth to free water ranged from 33 to 43.5 ft bgs.

The boreholes were backfilled with the excavated soils following competition of drilling and water level measurements. Water from PB-12 and soils from PB-4, PB-3, PB-15, PB-11 and PB-6 borings were sampled and delivered to an environmental laboratory for purposes of analyzing for TPH, Chlorides and RCRA metals. The results of the environmental analysis are provided under separate cover.

Soil samples and rock core samples were collected at different depths as presented in Table 2. The B-6 location was an initial boring completed without sampling to attempt to determine the presence of water. In addition, two (2) composite bulk samples (PB-10 Bulk and PB-11 Bulk) from a depth of approximately 1 to 8 feet were collected from borehole PB-10 and PB-11 cuttings, respectively.

For samples collected using a modified California sampler, a 140-pound weight falling 30 inches was used to drive the sampler into the undisturbed soils and bedrock. After "seating" the sampler into undisturbed soil, the number of blows required to drive the sampler in sequential 6-inch intervals was recorded similar to the Standard Penetration Test (SPT) (ASTM D 1586). The number of blows for each 12-inch interval (N-value) was recorded on the logs and was used to categorize the consistency of the soil. The N-values were corrected for the larger diameter of the sample barrel. A thin walled "Shelby tube"

sample was also collected at a depth of 8 feet in all the borings except for PB-and B-6. A single tube core barrel was used to obtain samples of the bedrock encountered in 13 of the borings.

Boring ID	Modified California Bgs (ft)	Shelby Tube Bgs (ft)	Core Samples Bgs (ft)
PB-1	N/A	N/A	N/A
PB-2	1.5, 3.5, 6,13.5, 18.5, 23.5, 28.5	8	N/A
PB-3	1.5, 3.5, 6,13.5, 18.5,	8	21
PB-4	1.5, 3.5, 6,13.5	8	16
PB-5	1.5, 3.5, 6	8	12, 17
PB-5 # 2	1.5, 3.5, 6,13.5	8	17, 20, 30, 40, 50
PB-6	1.5, 3.5, 6	8	12
PB-7	1.5, 3.5, 6,13.5	8	18
PB-8	1.5, 3.5, 6	8	13, 20, 30, 40, 50
PB-9	1.5, 3.5, 6, 18.5, 23.5,	8	25
PB-10	1.5, 3.5, 6, 23.5, 28.5	8	18, 31, 40, 55
PB-11	6,13.5, 18.5, 23.5, 28.5	8	N/A
PB-12	1.5, 3.5, 6	8	11, 20, 40, 60
PB-13	1.5, 3.5, 6,13.5, 18.5, 23.5, 28.5	8	N/A
PB-14	1.5, 3.5, 6	8	N/A
PB-15	1.5, 3.5, 6, 13.5, 18.5	8	22
PB-16	1.5, 3.5, 6, 13.5	8	15
PB-17	1.5, 3.5, 6, 13.5	8	16
B-6	N/A	N/A	N/A

Table 2. Soil/Rock Core Sampling Summary

After drilling and sampling activities were complete, the borings were backfilled with soil cuttings. The soil boring logs are presented in Appendix A, and approximate locations of the borings are shown in Figure 3.

6.0 SUBSURFACE CONDITIONS

The boring locations were selected based on favorable indications determined during Tetra Tech's geophysical survey (discussed above). Information from the borings indicates the subsurface conditions were relatively consistent within the area where the borings were drilled and with those anticipated from the geophysical survey. Beneath vegetation and topsoil, all nineteen (19) borings encountered 10 to 33 feet of medium dense to very dense silt to silty sand (with significant gypsum content), over medium hard, fresh weathered gypsum bedrock. At various depths of the silt/sand layer, some weak soil cementation was observed. In boring PB-10 a layer of gypsum was interbedded with the silty sand from 18 to 21 feet. In that boring the gypsum was underlain by 10 feet of hard, slightly moist sandy clay. Boring PB-15 had a layer of low plasticity clay from the ground surface to a depth of 22 feet. In PB-15 the clay included zones of silt and weak cementation.

Other than some solubilization on gypsum cores from PB-5 and PB-12 no karst features were encountered.

Laboratory testing of a sample from PB-13 at a depth of 4 feet had a water soluble sulfate concentration of 11650 parts per million, indicating soils with significant gypsum content.

The chemical composition of gypsum includes a significant intercellular water content. When soils containing high concentrations of gypsum are oven dried at 110 degrees C in accordance with ASTM procedures, the intercellular water is driven off, causing the results to show abnormally high water content. Therefore, moisture content tests for samples from this site were re-run at 60 degrees C until a constant dry weight was recorded. Table 3 below, shows a comparison of water content test results for samples dried at both 110 degrees C and at 60 degrees C.

Boring ID	Depth Bgs (ft)	Water Content Dried at 110° C (%)	Water Content Dried at 60° C (%)	Difference (%)
PB-15	1	10.8	12.2	- 13
PB-15	6	20.2	6.7	66.8
PB-13	4	18.7	2.9	84.5
PB-13	14	26.8	3.9	85.4
PB-6	2.5	22.5	4.3	80.9
PB-6	6	33.8	12.1	64.2

Table 3. Moisture Content Summary

The in-situ moisture content of the samples dried at 60° C ranged from 2.9 to 12.2 percent, and the in-situ dry density ranged from 79.8 pounds per cubic foot (pcf) to 98.4 pcf. This difference could affect testing that occurs during construction and should be brought to the attention of the materials testing firm conducting testing during construction.

Silt and silty sand encountered in PB-5#2, PB-6, PB-10, PB-13 and PB-15 at 6 feet bgs was tested to determine the fines content (percent passing the #200 sieve). The fines content ranged from 46 to 94 percent. We conducted Atterberg limits test on PB-15 at 6 feet bgs and PB-13 at 4 feet bgs. Liquid limits ranged from 6 to 5, and the plasticity index ranged from 1 to 2.

Clay encountered in PB-15 at 1 foot bgs was tested to determine the fines content (percent passing the #200 sieve) and Atterberg limits. The fines content was 89 percent. The Liquid limit was 46 and the Plasticity Index was 18.

The index testing described above was conducted using the higher drying temperatures. A correction factor was applied based on the water content comparison testing described above, and the results appear reasonable. It should be noted however, that significant ranges of results may be observed due to the highly variable gypsum content.

Consolidation testing of the specimen of silt from PB-13 at 4 feet bgs indicated a swell of 0.6 percent with a swell pressure of 1050 pounds per square foot (psf) when inundated with water under a load similar to the existing overburden pressure. The compression index (Cc) was calculated to be 0.17 and the swell index (Cs) was calculated to be 0.03. Consolidation testing on the specimen of silt from PB-5 #2 at 8 feet indicated a consolidation of 6.6 percent when inundated with water under a load similar to the existing overburden pressure. The Cc and Cs were calculated to be 0.15 and 0.02 respectively. Water content corrections were also applied to the consolidation test data. We believe the results indicate reasonable performance of the site soils can be expected providing that they are prepared as recommended in this report.

The bulk sample (PB-10 Bulk) from the depth of approximately 10 feet had an optimum moisture content of 8.6 percent and a maximum dry density of 110 pounds per cubic foot (pcf) determined by standard Proctor test (ASTM D698) with water contents measured using a 60 degree C drying temperature.

7.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

7.1 Primary Geotechnical Considerations

The two primary concerns that will impact the design of the proposed water recycling facility is the presence of water encountered at 33 to 43.5 feet below the surface and the possibility of voids due to karst/evaporite subsurface conditions.

New Mexico Oil Conservation Division rule 19.15.34.11 (A) states that an operator shall not locate a recycling containment where groundwater is less than 50 feet below the bottom of the containment.

As per the surface survey, Ref. [4], and the Seismic and Geologic Karst Characterization Report, Ref. [3], the proposed site layout and drilling targets associated with the geotechnical investigation were defined within the data footprint to avoid karst features and structures. No karst features were encountered in the boreholes during the geotechnical investigation. It should be noted that some solubilization on gypsum cores from PB-5 and PB-12 was observed.

For the proposed above ground water storage tanks design, a significant concern is the measurement of water content in the field when compacting soil on the site. Based on the laboratory results, the soil on the site has a high concentration of water soluble sulfates, due to the presence of gypsum in the soil matrix. One of the potential sources of error with the nuclear gauge used for quality control during compaction effort, is water content measurements due to sources of hydrogen other than water, including hydrous minerals like gypsum. Under extremely unfavorable conditions the nuclear device (i.e. nuclear density gauge) can yield water content measurements that are as much as ten percentage points in error (almost always on the high side). Under favorable conditions, measurement error is less than one percent. The nuclear device should be calibrated for site specific soils and changing conditions within the site. Laboratory testing that is conducted during construction (Proctors, for example) should be done using a 60 degree C drying temperature instead of the customary 110 degrees C.

7.2 Site Preparation

Laboratory testing indicates that volume changes due to excavation and compaction of the existing soils (so called shrink/swell) will be on the order of 20 percent. Variability in site soils over short distances may result in the greater volume reduction between in situ soil volume and the volume of compacted soils.

To prepare the site for the tanks construction and installation of HDPE and LDPE liners, an area larger than the proposed footprint by at least 10 feet in plan dimension on all sides should be stripped of vegetation, roots, organic material, existing construction materials, debris, large sharp rocks and other unsuitable materials. Standard road base, sand, or other granular soil such as those described in the *Fill Placement and Compaction* section (below) are recommended base materials. A typical stripping depth is approximately 6 inches; however, the actual thickness will vary and should be based on field conditions and observations of the depth of organic containing materials (roots, etc). After stripping, we anticipate a moderately stable surface for support of construction equipment. Unsuitable areas (such as those with loose, wet, soft, yielding, and/or pumping subgrade) should be corrected before construction proceeds.

Obstructions that could hinder preparation of the site should also be removed, with particular attention given to unknown or un-documented below ground appurtenances and any existing above and below ground piping. Care should be taken not to damage any existing buried utilities located within the footprint of the proposed construction. Any resulting utility trenches/excavations due to replacement or relocation of utilities should be backfilled as discussed in the Fill Placement and Compaction section of this report.

The site should be well graded to prevent standing water and should be compacted and graded for the safe use of heavy equipment. Ditches or trenches such as liner/leak detection trenches, should be excavated and backfilled prior to pad construction following the manufacturer's guidelines.

7.3 Fill Placement and Compaction

On-site silt or silty sand soils free of rocks greater than 1 inch in diameter, organics, and debris are suitable for use as structural fill or backfill. The cemented soils will likely require additional processing beyond ripping to achieve a soil consistency and meet the maximum particle size dimension in the construction specifications. Fill and backfill should not be placed on organics or other deleterious materials. Soil on the site has high concentration of gypsum. Therefore, site should be well graded and drained to avoid areas of standing water. If additional fill is needed for construction of embankments or pads, imported fill should be a well-graded clayey sand (SC) or low plasticity clay (CL), or imported soils with engineering properties that are similar to on-site soils (depending on the intended use of the fill). For structural support, a uniform, granular material having 100 percent passing the 1 inch sieve, 30 to 70 percent passing the No. 4 sieve, and 3 to 15 percent passing the number 200 sieve is recommended. Prior to importation, samples of soils being considered as fill should be examined and evaluated by a geotechnical engineer for engineering properties to determine the suitability of the material for its intended use.

The bases of fills in soil should be scarified at least 8 inches deep, moisture-conditioned or dried to within 2 percent of optimum moisture content (8.6 %), processed to a uniform condition, and then compacted to at least 95 percent of maximum dry density (110 pcf) determined by standard Proctor (ASTM D698). For on-site and imported fill and backfill, moisture should be adjusted to within two percent of optimum moisture content as determined by standard Proctor and the soils thoroughly mixed prior to placement and compaction to provide uniform water content throughout the fill.

Fill and backfill should be placed in uniform lifts of 8 inches or less in loose thickness and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). Fill should be compacted using the heavy vibratory equipment. In areas with limited space for heavy equipment, appropriate compaction equipment such as a jumping jack or other hand tools should be used. Where smaller compacting equipment or hand tools are used, the fill lifts should be 6 inches or less in loose thickness. The contractor should select the equipment type based upon the fill soil conditions.

Special materials, lift thicknesses, and compaction requirements may be specified by the liner and LDS manufacturer. The recommendations above are for site grading and general fill and backfill below the liner/LDS. Additional recommendations are presented below in the *Geomembrane Liner Protection* section.

Placement and compaction of fill should be observed and tested by a qualified geotechnical engineer or their qualified representative during construction. Each vertical foot of compacted fill placed should be tested for compaction comparison to standard Proctor results. A minimum of one moisture/density verification test should be performed for every 5,000-square-feet of the compacted area, or for every 150-lineal feet of utility trench backfill. For smaller areas, a minimum of 3 verification tests should be conducted for every lift. Subsequent lifts should not be placed until the exposed lift has been tested to confirm compliance with the specified moisture and density. Lifts failing to meet the moisture and density requirements should be reworked to meet the required specifications prior to subsequent lifts being placed. Density and moisture verification testing is recommended to provide an indication that adequate earthwork is being performed. However, the quality of the fill and compaction is the sole responsibility of the earthwork contractor. Satisfactory verification testing is not a guarantee of the quality of the contractor's earthwork operations. Special care should be taken when measuring water content, as one of the potential sources of error with measurements using the nuclear gauge is presence of hydrogen other than water, including hydrous minerals like gypsum (present on the site). Under extremely unfavorable conditions the nuclear device can yield water content measurements that are as much as ten percentage points in error (almost always on the high side).

The specified moisture content must be maintained until compaction of the overlying lift, or until the cushioning sand layer or geotextile fabric and geomembrane liner are installed. Failure to maintain the specified moisture content could result in excessive soil movement resulting in embankment failure. The contractor must provide some means of controlling the moisture content (such as water hoses, water trucks, etc.). Maintaining subgrade moisture is always critical, but will require the most effort during warm, windy and/or sunny conditions.

7.4 Proof Rolling

Proof rolling of the subgrade prior to fill placement and liner installation should be used to detect areas of soft and/or pumping soil. Proof rolling should be conducted using a heavy, rubber-tired vehicle weighing at least 25 tons, with the tires inflated to the manufacturer's specified operating pressure. The entire area should be proof rolled, with each succeeding pass offset by not greater than one tire width. The geotechnical engineer or an experienced soils technician should be present during proof rolling activities to assist with the identification of unsuitable soil. Unsuitable soil should be undercut and reworked, or otherwise improved in a manner that is suitable to the design and approved by the geotechnical engineer.

7.5 Geomembrane Liner Protection

Where the exposed surface is rough, rock protrusions and sharp edges can potentially damage the geomembrane liner. Additionally, an irregular foundation with voids can create localized stress points on the geomembrane liner. The subsurface conditions at this site indicate silt to silty sand soils to a depth of about 10 feet deep. However, the tank bottom might be underlain by areas of cemented soil with rock-like protrusions and surface irregularities. If the protrusions are greater than $^{1}/_{4}$-inch or if voids greater than 2 inches deep will exist below the liner, a cushion, such as a fine grained sand layer, approximately 6 inches thick or a adequately designed cushion geotextile should be used to reduce the risk of damage to the liner. Liner requirements must meet those presented in the New Mexico Administrative Code (NMAC) 19.15.36.17.

7.6 Settlement of Subgrade

The on-site silty to sandy soils have a relatively low potential for post-construction settlement. Construction recommendations from above for subgrade proof rolling, subgrade improvements, and fill placement will reduce the amount of settlement. Due to the silty to sandy nature of the soils and limited anticipated grading, settlement of less than 1 inch is anticipated, most of which should occur during construction.

7.7 Permitting

If applicable, a permit application should be filed with the NMOCD in accordance with NMAC regulations prior to construction. Construction and installation in accordance with NMOCD regulations found in the NMAC and the design drawings and construction specifications is recommended. The NMOCD may require notification prior to construction and prior to operation of the pond.

8.0 CONCLUSIONS

Our investigation identified high concentrations of water soluble sulfates due to the presence of gypsum in the soil matrix. These conditions will require special attention to detail regarding water content and testing during construction, as described in the report (above).

It should also be noted that our geotechnical investigation and geophysical survey were designed and used to reduce the risk of encountering karst features, voids, or similar unknown conditions below the site. However the borings were widely spaced and conditions may exist between borings that were not identified. Our subsurface investigation did not identify any voids or cavities beneath the area where the storage facilities are planned, this site lies in an area that is at-risk for such features. The owner must recognize that some risk exists for such features below the site and must be willing to accept such risk. If evidence of voids, cavities, or similar features are observed or suspected during construction, we should be contacted to consider design changes to address those issues.

Special care is also warranted during liner construction to ensure that the liner and leak detection systems function as intended, as described above.

9.0 LIMITATIONS

This report was prepared from data developed during our field exploration, from site specific laboratory testing, and using engineering judgment. Our design recommendations were based on subsurface data and our experience with similar projects and subsurface conditions. Our borings were located to obtain a reasonable interpretation of subsurface conditions. It should be noted that the borings were widely spaced and variation in the subsoils between borings is likely. Although karst features are not anticipated based on the geophysical and geotechnical conditions encountered, such features could exist between the widely spaced borings. The owner must accept the risk of such conditions.

A qualified, experienced geotechnical engineer or their designated representative should observe the construction to look for evidence that would indicate differences in subsurface conditions from those described in this report. If any information becomes available that would alter our assumptions, conclusions or recommendations, the opinions presented in this report should be considered invalid until we have been contacted to review our recommendations based on the new information. The geotechnical engineer should review plans and specifications during the design. Placement and compaction of engineered fill, backfill, subgrade and other fills should be observed and tested by a representative of a Construction Materials Testing (CMT) firm during construction, and Tetra Tech should be retained to review these data.

We believe this study was conducted in a manner consistent with that level of skill and care ordinarily used by members of the profession currently practicing under similar conditions in the locality of this project. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report or in the analysis of the planned project from the geotechnical point of view, please contact us.

10.0 REFERENCES

[1] U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS, 2016). Web Soil Survey. Accessed October 10, 2017. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

[2] United States Geological Survey (USGS, 2005). Preliminary Integrated Geologic Map for the United States Central States. Open-File Report 2005-1351

[3] Tetra Tech (October 2017), Seismic and Geologic Karst Characterization, 3-Bear Recycled Water Impoundment and SWD Cottonwood Site, Eddy County, NM

[4] 3Bear Energy (August 2017), Cave & Karst Evaluation of the Cottonwood Project Site, South ½ of the SE of the SW in Section 20, Township 26S, Range 26RE

APPENDIX A

EXPLORATORY BORING LOGS

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-1

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/02/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021610 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318740 W** **DRILLED BY: Dallas Rader**

Notes: Not Recorded

DEPTH (ft)	SAMPLE TYPE	GRAPHIC LOG	MATERIAL DESCRIPTION
0			
			Medium Dense to Very Dense, Tan Brown, Fine Grained **SILT TO SILTY SAND**, Dry
10			10.0
			Medium Hard, White **GYPSUM**, Dry
			▼ Water level at 33 ft at the end of drilling and after 6 hours
40			

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-1

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	GRAPHIC LOG	MATERIAL DESCRIPTION
40			Medium Hard, White **GYPSUM**, Dry *(continued)*
45			
50			
55			
60			60.0
			Borehole terminated at 60.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-2

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/31/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021640 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318200 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Dense to Very Dense, Reddish Brown to Light Brown, Very Fine to Fine Grained **SILT TO SILTY SAND**, Dry to Moist at 30 ft, Some Weak Cementation, Low Plasticity
	MC 1	83	8-14-16		
5	MC 2	100	10-12-25		
	MC 3	94	14-25-50/5"		
10	ST 1	100			
15	MC 4	100	20-21-27		
20	MC 5	72	22-50/5"		
25	MC 6	72	19-50/6"		
30	MC 7	72	50/5"		
33.0					Medium Hard, White **GYPSUM**, Dry
35					
40					

(Continued Next Page)

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-2

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
40					Medium Hard, White **GYPSUM**, Dry *(continued)*
45					
50					50.0
					Borehole terminated at 50.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-3

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/03/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021050 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.319150 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					
	MC 1	100	7-50/6"		Very Dense to Medium Dense, Tannish White to Light Brown, Very Fine to Fine Grained **SILT TO SILTY SAND**, Dry, Some Weak Cementation, Low Plasticity, at 19 ft Medium Plastic Brown Clay Inclusion
5	MC 2	67	26-50/6"		
	MC 3	56	29-50/2"		
10	ST 1	100			
15	MC 4	100	12-6-7		
20	MC 5	100	8-8-8		
					21.0
25	RC 6	75 (75)			Medium Hard, White, Massive Fracturing **GYPSUM**, Slightly Moist, Fresh Weathering
30					
35					
40					

BOREHOLE/TP/WELL - VECTOR 3 BEAR COTTONWOOD EDDY CO.GPJ LAB SUMMARY.GDT 12/27/17

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-3

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
40					Medium Hard, White, Massive Fracturing **GYPSUM**, Slightly Moist, Fresh Weathering *(continued)*
45					
50				50.0	Borehole terminated at 50.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-4

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/02/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021620 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.317390 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Dense to Very Dense, Brown to Tannish White, Very Fine to Fine Grained **CLAYEY SAND TO SILTY SAND**, Dry, Some Weak Cementation, Low Plasticity
	MC 1	89	9-15-21		
5	MC 2	44	21-50/4"		
	MC 3	100	16-21-21		
10	ST 1	100			
15	MC 4	67	24-50/6"		
				16.0	Medium Hard, White **GYPSUM**, Dry
20					
25					
30					
35				36.0	Borehole terminated at 36.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-5

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/01/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021410 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.319240 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						Dense to Very Dense, Tan to White, Very Fine Grained **SILT TO SILTY SAND**, Dry to Slightly Moist at 3 ft, Some Weak Cementation at 3.5 ft
	MC 1	78	*5-6-23*			
5	MC 2	89	*25-28-50/6"*			
	MC 3	89	*16-18-20*			
10	ST 1	100				
						12.0
15	RC 1	100 (79)				Medium Hard, White, Blocky Fracturing **GYPSUM**, Dry, Fresh to Some Weathering, Thin Layers of Clay Inclusions, Solubilization Visible in Core
20						
25						
30						32.0
						Borehole terminated at 32.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-5 #2

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/23/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021190 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318790 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	83	5-14-50/2"	MC = 25.0% DD = 79.4 pcf LL = NP PL = NP PI = NP Fines = 93.5%	ML		Very Dense to Medium Dense, Tannish White to Light Brown, Very Fine Grained **SILT TO SILTY SAND**, Dry to Slightly Moist, Clay Inclusions at 14 ft
5	MC 2	89	29-23-16				
	MC 3	94	15-18-50/5"				
10	ST 1	100		MC = 1.5% DD = 81.3 pcf LL = NP PL = NP PI = NP Fines = 49.9%	SM		
15	MC 4	100	5-7-9				17.0
20	RC 1	60 (96)					Medium Hard, White, Broken to Blocky Fracturing **GYPSUM** Fresh Weathering, Dry to Slightly Moist
	RC 2	100 (63)					
25							
30							
35	RC 3	96 (92)					
40							

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-5 #2

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
45	RC 4	100 (96)					Medium Hard, White, Broken to Blocky Fracturing **GYPSUM** Fresh Weathering, Dry to Slightly Moist *(continued)*
50							
55	RC 5	95 (95)					
60							61.0
							Borehole terminated at 60.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-6

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/03/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.022280 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.319210 W** **DRILLED BY: Dallas Rader**

Notes: Soil wet at 30 ft bgs. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	89	2-7-50/4"	MC = 4.3% DD = 98.3 pcf LL = NP PL = NP PI = NP Fines = 48.1%	SM		Very Dense, Light Brown, Very Fine to Fine Grained **SILTY SAND TO SILT**, Dry to Slightly Moist at 10 ft
5	MC 2	33	50/5"				
	MC 3	67	27-50/6"	MC = 12.1% DD = 88.0 pcf LL = NP PL = NP PI = NP Fines = 60.9%	ML		
10	ST 1	100					12.0
15	RC 1	100 (100)					Medium Hard, White, Massive Fracturing **GYPSUM** Fresh Weathering, Dry to Wet at 30 ft, at 15.5 ft Some Small Voids
20							
25							
30							30.0
							Borehole terminated at 30.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-7

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/01/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021820 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.319220 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Medium Dense to Very Dense, Tannish White to Light Brown, Very Fine to Fine Grained **SILTY SAND TO SILT**, Dry, Some Weak Cementation
	MC 1	78	5-18-50/5"		
	MC 2	33	50/6"		
5					
	MC 3	100	12-11-13		
	ST 1	100			
10					
	MC 4	67	23-50/5"		
15					
					18.0
	RC 1	97 (57)			Medium Hard, White, Blocky Fracturing **GYPSUM** Fresh Weathering, Dry, at 21.75 ft Clay Inclusion
20					
25					
30					
35					
					38.0
					Borehole terminated at 38.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-8

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/24/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.022100 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318470 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Medium Dense to Very Dense, Dark Brown to Light Brown, Fine Grained **SILT TO SILTY SAND**, Dry
	MC 1	83	7-8-10		
5	MC 2	83	8-8-12		
	MC 3	94	12-27-31		
10	ST 1	75			
13.0					Medium Hard, White, Broken to Blocky Fracturing **GYPSUM** Fresh Weathering, Dry
15	RC 1	100 (88)			
20					
25	RC 2	98 (37)			
30					
35	RC 3	90 (86)			
40					

BOREHOLE/TP/WELL - VECTOR 3 BEAR COTTONWOOD EDDY CO.GPJ LAB SUMMARY.GDT 12/27/17

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-8

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
40					Medium Hard, White, Broken to Blocky Fracturing **GYPSUM** Fresh Weathering, Dry *(continued)*
45	RC 4	88 (88)			
50					
55	RC 5	90 (90)			
					55.0 Borehole terminated at 55.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-9

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/30/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.022270 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318200 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0						
	MC 1	94	5-23-50/5"			Medium Dense to Very Dense,Tannish White to Light Brown, Very Fine to Fine Grained **SILT TO SILTY SAND**, Dry to Slightly Moist, Some Weak Cementation, At 23 ft Brown Clay Inclusion
5	MC 2	100	21-16-12			
	MC 3	67	8-11-14			
10	ST 1	100				
15	MC 4	0	50/5"			
20	MC 5	78	23-50/6"			
24.0						
25	MC 6	22	50/4"			Medium Hard, White, Blocky Fracturing **GYPSUM**, Dry, Moderate Weathering, Clay Inclusions at 26.5 ft- 40 ft
30	RC 1	84 (78)		MC = 5.7% DD = 134.9 pcf MC = 5.0% DD = 131.7 pcf		
35						
40						
40.0						

Borehole terminated at 40.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-10

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/31/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.022030 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.317910 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	83	9-21-50/3"		ML		Dense to Very Dense, Tan to White, Fine Grained **SILT**, Dry to Slightly Moist, Some Weak Cementation, Non Plastic
5	MC 2	100	23-22-20				
	MC 3	100	11-21-22				
10	ST 1	100		LL = NP PL = NP PI = NP Opt. Moist = 8.6% Max DD = 110 pcf			10.0
							Dense to Very Dense, Tan to White, Fine Grained **SILT TO SILTY SAND**, Dry to Slightly Moist, Some Weak Cementation, Medium Plasticity
15	MC 4	0	50/5"				
20	RC 1	60 (41)		MC = 7.0% DD = 129.3 pcf			18.0 Medium Hard, White, Broken Fracturing **GYPSUM**, Dry, Fresh Weathering
							21.0 Hard, Light Brown to Brown, Fine Grained **SANDY CLAY** Slightly Moist, Some Weak Cementation, Low to Medium Plasticity
25	MC 5	33	50/5"				
30	MC 6	50	27-50/3"				
							31.0 Medium Hard, White to Gray, Blocky to Massive Fracturing **GYPSUM**, Dry, Fresh to Slight Weathering
35	RC 2	100 (83)					
40							

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-10

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							
45	RC 3	100 (100)					Medium Hard, White to Gray, Blocky to Massive Fracturing **GYPSUM**, Dry, Fresh to Slight Weathering *(continued)*
50							
55							
60	RC 4	100 (47)					60.0
							Borehole terminated at 60.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-11

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/03/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.022240 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.317380 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Very Dense, Light Brown to Brown, Fine Grained **SILT TO SILTY SAND**, Dry to Moist at 30 ft, Some Weak Cementation, Gypsum Fragments at 30ft
	MC 1	0	*50/4"*		
5	MC 2	0	*50/3"*		
	MC 3	89	*18-27-50/6"*		
10	ST 1	100			
15	MC 4	67	*22-50/5"*		
20	MC 5	100	*12-20-19*		
25	MC 6	56	*50/6"*		
30	MC 7	33	*50/6"*		
30.0					Borehole terminated at 30.0

BOREHOLE/TP/WELL - VECTOR 3 BEAR COTTONWOOD EDDY CO.GPJ LAB SUMMARY.GDT 12/27/17

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-12

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/01/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021980 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318890 W** **DRILLED BY: Dallas Rader**

Notes: Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					
	MC 1	100	10-27-50/6"		Very Dense to Medium Dense, Tannish White, Fine Grained **SILTY SAND TO SILT**, Dry to Slightly Moist at 0-5 ft, Some Weak Cementation, Low Plasticity
5	MC 2	100	22-14-24		
	MC 3	83	9-11-13		
10	ST 1	100			10.0
	RC 1	88 (77)			Medium Hard, White, Blocky to Massive Fracturing **GYPSUM**, Dry to Slightly Moist at 16 ft, Fresh Weathering, at 13.5ft and 21.5ft Very Thin Layer of Clay Inclusions, at 16 ft Visible Solubilization
15					
20					
	RC 2	80 (80)			
25					
30					
35					
40					

Water level at 38 ft 54 hours after drilling

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-12

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
40					
45	RC 3	93 (93)			Medium Hard, White, Blocky to Massive Fracturing **GYPSUM**, Dry to Slightly Moist at 16 ft, Fresh Weathering, at 13.5ft and 21.5ft Very Thin Layer of Clay Inclusions, at 16 ft Visible Solubilization *(continued)*
50					
55					
60					
65	RC 4	90 (90)			65.0
					Borehole terminated at 67.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-13

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/31/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021820 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318080 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							Hard to Very Stiff, Tan to White to Brown, Fine Grained **SILT**, Dry, Some Weak Cementation, Low Plasticity
	MC 1	89	7-12-50/4"	MC = 2.9% DD = 98.0 pcf LL = 6 PL = 5 PI = 1 Fines = 73.5%	ML		
5	MC 2	100	14-15-13				
	MC 3	100	15-24-31				
10	ST 1	17					
							12.0
				MC = 3.9% DD = 98.2 pcf LL = NP PL = NP PI = NP Fines = 46.2%			Very Dense, White to Brown, Fine Grained **SILTY SAND**, Dry, Some Weak Cementation, Low Plasticity
15	MC 4	100	20-25-25		SM		
20	MC 5	78	24-50/5.5"				
25	MC 6	17	50/3"				
30	MC 7	33	50/6"				30.0
							Borehole terminated at 30.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-14

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/01/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.022190 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318600 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Medium Dense to Very Dense, Tannish White, Fine Grained **SILT TO SILTY SAND**, Dry to Slightly Moist at 0-3 ft, Some Weak Cementation, Low Plasticity
	MC 1	100	5-12-8		
5	MC 2	100	20-23-29		
	MC 3	100	10-12-13		
10	ST 1	50			
					14.0
15	MC 4	0	50/2"		Medium Hard, White, **GYPSUM**, Dry
20					
25					
30					
					34.0
					Borehole terminated at 34.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-15

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/03/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021110 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.317400 W** **DRILLED BY: Dallas Rader**

Notes: Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0				MC = 12.2% DD = 79.8 pcf LL = 46 PL = 28 PI = 18 Fines = 89.4%	CL		Very Stiff to Hard, Brown to Light Brown, Fine Grained **CLAY TO SILT**, Dry to Slightly Moist, Some Weak Cementation, Low Plasticity
	MC 1	100	6-12-16				
5	MC 2	83	15-18-50/3"				
	MC 3	83	16-17-23	MC = 6.7% DD = 88.7 pcf LL = 13 PL = 11 PI = 2 Fines = 59.0%	ML		
10	ST 1	100					
15	MC 4	100	12-17-23				
20	MC 5	50	24-50/4"				
							22.0
25	RC 1	73 (48)					Medium Hard, White, Blocky Fracturing **GYPSUM**, Dry, Fresh to Some Weathering, Thin Layers of Clay Inclusions
30							
35							
40							

BOREHOLE/TP/WELL - VECTOR 3 BEAR COTTONWOOD EDDY CO.GPJ LAB SUMMARY.GDT 12/27/17

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-15

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							Medium Hard, White, Blocky Fracturing **GYPSUM**, Dry, Fresh to Some Weathering, Thin Layers of Clay Inclusions *(continued)*
45							Water level at 43.5 ft 4 hours after drilling
50							
55							
60							60.0
							Borehole terminated at 61.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-16

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 10/31/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021560 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.317860 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					
	MC 1	100	1-1-21		Medium Dense to Very Dense, Light Brown, Very Fine to Fine Grained **SILT TO SILTY SAND**, Dry to Slightly Moist, Some Weak Cementation, Low Plasticity
	MC 2	33	50/6"		
5					
	MC 3	100	10-10-10		
	ST 1	100			
10					
	MC 4	50	8-50/3"		
15					15.0
	RC 1	80 (48)			Medium Hard, White, Blocky Fracturing **GYPSUM**, Dry, Fresh Weathering, Thin Layers of Clay Inclusions at 15 ft
20					
25					
30					30.0
					Borehole terminated at 30.0

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: PB-17

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 11/01/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.021300 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.318200 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blow counts have been corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY % (RQD)	N Value	GRAPHIC LOG	MATERIAL DESCRIPTION
0					
	MC 1	100	12-27-50/6"		Very Dense to Medium Dense, Tannish White, Very Fine to Fine Grained **SILT TO SILTY SAND**, Dry, Some Weak Cementation, Low Plasticity
5	MC 2	67	18-50/5"		
	MC 3	100	10-11-11		
10	ST 1	100			
15	MC 4	100	16-23-50/4"		
				16.0	
20	RC 1	100 (100)			Medium Hard, White, Massive Fracturing **GYPSUM**, Dry, Fresh Weathering
25					
30					
35					
				36.0	Borehole terminated at 36.0

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-6

CLIENT 3 Bear Energy **PROJECT NAME** Cottonwood Site

PROJECT NUMBER 212C-MD-00981 **PROJECT LOCATION** Eddy County, New Mexico

DATE(S) OF DRILLING: 09/22/2017 **GROUND ELEVATION: NA** **METHOD: Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.020720 N** **LOGGED BY: Clint Merritt and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 104.319278 W** **DRILLED BY: Dallas Rader**

Notes: Not Recorded

DEPTH (ft)	SAMPLE TYPE	GRAPHIC LOG	MATERIAL DESCRIPTION
0			Medium Dense to Very Dense, Light Brown, Fine Grained **SILT TO SILTY SAND**, Dry
33.0			Water level at 33 ft at the end of drilling
			Borehole terminated at 33.0

APPENDIX B

LABORATORY SUMMARY

TETRA TECH

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

SUMMARY OF LABORATORY RESULTS

CLIENT 3 Bear Energy
PROJECT NUMBER 212C-MD-00981
PROJECT NAME Cottonwood Site
PROJECT LOCATION Eddy County, New Mexico

Borehole Identification	Depth	Water Content (%)	Dry Density (pcf)	Atterberg's Limits (LL/PL/PI)	Max Dry Density (pcf)/ OMC(%)	Fines Content (%)	USCS Classi-fication	Swell (%), Swell pressure (psf)	Cc, Cs	Unconf. Comp. Strength (psf)	Group Index	AASHTO Classifi-cation
PB-5 # 2	4.5	25.0*	79.4*	NP		93.5*	ML			1510	0	A-4
PB-5 # 2	8.0	1.5	81.3	NP		49.9	SM	-6.6	0.15, 0.02		0	A-2-4
PB-6	2.5	4.3	98.4	NP		48.1	SM				0	A-4
PB-6	6.0	12.1	88.1	NP		60.9	ML				0	A-4
PB-9	25.0	5.7*	134.9*							179480		
PB-9	29.0	5.0*	131.7*							43140		
PB-10	20.0	7.0*	129.3*							39850		
PB-10 Bulk	10.0			NP	110.0/8.6	51.5	ML				0	A-4
PB-13	4.0	2.9	97.9	6/5/1		73.5	ML	0.6, 1050	0.17,0.03		7	A-5
PB-13	14.0	3.9	98.2	NP		46.2	SM				0	A-2-4
PB-15	1.0	12.2	79.8	46/28/18		89.4	CL				11	A-7-6
PB-15	6.0	6.7	88.7	13/11/2		59.0	ML				4	A-4

* NOTE: Results may be affected by variable gypsum content of site soils.

APPENDIX E – Cottonwood Water Recycling Facility - Supporting Design and Geosynthetics Materials Documentation

PRODUCT DATA SHEET

GSE FabriNet 250 mil Geocomposite

GSE FabriNet 250 mil geocomposite consists of a 250 mil thick GSE HyperNet geonet heat-laminated on one or both sides with a GSE nonwoven needle-punched geotextile. The geotextile is available in mass per unit area range of 6 oz/yd² to 16 oz/yd². The geocomposite is designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions.

AT THE CORE:

A 250 mil thick GSE HyperNet geonet heat-laminated on one or both sides with a nonwoven needle-punched geotextile.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Roll Value (1)		
Geocomposite			6 oz/yd²	8 oz/yd²	10 oz/yd²
Transmissivity(2), gal/min/ft (m²/sec) Double-Sided Composite Single-Sided Composite	ASTM D 4716	1/540,000 ft²	 2.4 (5 x 10^{-4}) 7.2 (1.5 x 10^{-3})	 2.4 (5 x 10^{-4}) 7.2 (1.5 x 10^{-3})	 1.4 (3 x 10^{-4}) 4.8 (1x 10^{-3})
Ply Adhesion, lb/in	ASTM D 7005	1/50,000 ft²	1.0	1.0	1.0
Geonet Core(1,3) – GSE HyperNet					
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft²	250	250	250
Transmissivity(2), gal/min/ft (m²/sec)	ASTM D 4716		14.5 (3 x 10^{-3})	14.5 (3 x 10^{-3})	14.5 (3 x 10^{-3})
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in	ASTM D 7179	1/50,000 ft²	55	55	55
Carbon Black Content, %	ASTM D 4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile(1,3)					
Mass per Unit Area, oz/yd²	ASTM D 5261	1/90,000 ft²	6	8	10
Grab Tensile Strength, lb	ASTM D 4632	1/90,000 ft²	160	220	260
Grab Elongation	ASTM D 4632	1/90,000 ft²	50%	50%	50%
CBR Puncture Strength, lb	ASTM D 6241	1/540,000 ft²	435	575	725
Trapezoidal Tear Strength, lb	ASTM D 4533	1/90,000 ft²	65	90	100
AOS, US sieve(1) (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, sec^{-1}	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Water Flow Rate, gpm/ft²	ASTM D 4491	1/540,000 ft²	110	95	75
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	per formulation	70	70	70
NOMINAL ROLL DIMENSIONS(4)					
Roll Width, ft			15	15	15
Roll Length, ft	Double-Sided Composite Single-Sided Composite		230 260	210 260	210 250
Roll Area, ft²	Double-Sided Composite Single-Sided Composite		3,450 3,900	3,150 3,900	3,150 3,750

NOTES:

- (1)All geotextile properties are minimum average roll values except AOS which is maximum average roll value and UV resistance is typical value. Geonet core thickness is nominal value.
- (2)Gradient of 0.1, normal load of 10,000 psf, water at 70˚F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- (3)Component properties prior to lamination.
- (4)Roll widths and lengths have a tolerance of ±1%.

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

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

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

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

PRODUCT DATA SHEET

GSE HD Smooth Geomembrane

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

AT THE CORE:

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

Product Specifications

These product specifications meet GRI GM 13

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

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

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

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

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP]

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

PRODUCT DATA SHEET

GSE Nonwoven Geotextiles

GSE Nonwoven Geotextiles are a family of staple fiber needlepunched geotextiles. The geotextiles are manufactured using an advanced manufacturing and quality system to produce the most uniform and consistent nonwoven needlepunched geotextile currently available in the industry. GSE combines a fiber selection and approval system with an in-line quality control and a state-of-the-art laboratory to ensure that every roll shipped meets customer specifications.

AT THE CORE:
A family of geotextiles used for separation, filtration, protection and drainage applications.

Product Specifications

These product specifications meet GRI GT12, GRI GT13 and AASHTO M288

Tested Property[1]	Test Method	Frequency	Minimum Average Roll Value					
			NW4	NW6	NW8	NW10	NW12	NW16
AASHTO M288 Class			3	2	1	>1	>>1	>>>1
Mass per Unit Area, oz/yd^2	ASTM D 5261	90,000 ft^2	4	6	8	10	12	16
Grab Tensile Strength, lb	ASTM D 4632	90,000 ft^2	120	170	220	270	320	390
Grab Elongation, %	ASTM D 4632	90,000 ft^2	50	50	50	50	50	50
CBR Puncture Strength, lb	ASTM D 6241	540,000 ft^2	303	435	575	725	925	1,125
Trapezoidal Tear Strength, lb	ASTM D 4533	90,000 ft^2	50	70	95	105	125	155
Apparent Opening Size, Sieve No. (mm)	ASTM D 4751	540,000 ft^2	70 (0.212)	70 (0.212)	80 (0.180)	100 (0.150)	100 (0.150)	100 (0.150)
Permittivity, sec^{-1}	ASTM D 4491	540,000 ft^2	1.8	1.5	1.3	1.0	0.8	0.7
Water Flow Rate, gpm/ft^2	ASTM D 4491	540,000 ft^2	135	110	95	75	60	45
UV Resistance % retained after 500 hours	ASTM D 4355	per formulation		70	70	70	70	70
TYPICAL ROLL DIMENSIONS								
Roll Length[2], ft			300	300	300	300	300	300
Roll Width[2], ft			15	15	15	15	15	15
Roll Area, ft^2 Roll Area (yd^2)			4500 500	4500 500	4500 500	4500 500	4500 500	4500 500

NOTES:
- [1]The property values listed are in weaker principal direction. All values listed are Minimum Average Roll Values except apparent opening size in mm and UV resistance. Apparent opening size (mm) is a Maximum Average Roll Value. UV is a typical value.
- [2]Roll lengths and widths have a tolerance of ±1%.

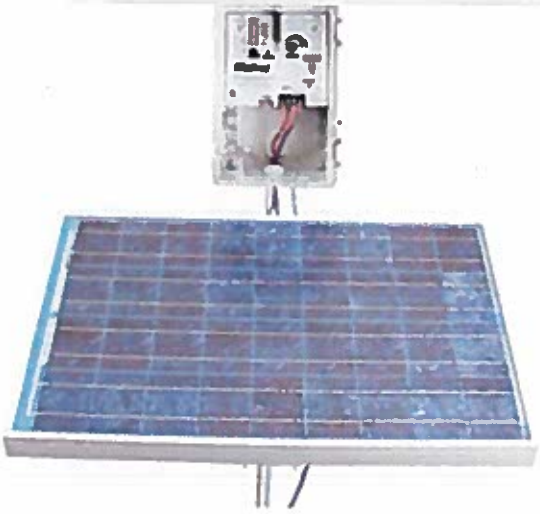
GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

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

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

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



★★★★★

Mega Blaster PRO

Our most powerful sonic bird control system uses intermittent distress calls to create a "danger zone" that frightens infesting birds away for good.

- Two high-output amplifiers with specially-designed 20-speaker tower
- Comes with four different configurations for common bird infestations
- Customizable settings
- Covers up to 30 acres (12 hectares)

This unit is capable of sound output up to 125 decibels.
HEARING PROTECTION IS RECOMMENDED.

SKU: MEGA

CATEGORY: SONIC BIRD CONTROL (HTTPS://BIRD-X.COM/PRODUCT-CATEGORY/SONIC-BIRD-CONTROL/)

DETAILS APPLICATIONS BENEFITS ADD & COMBINE SPECS REVIEWS (1)

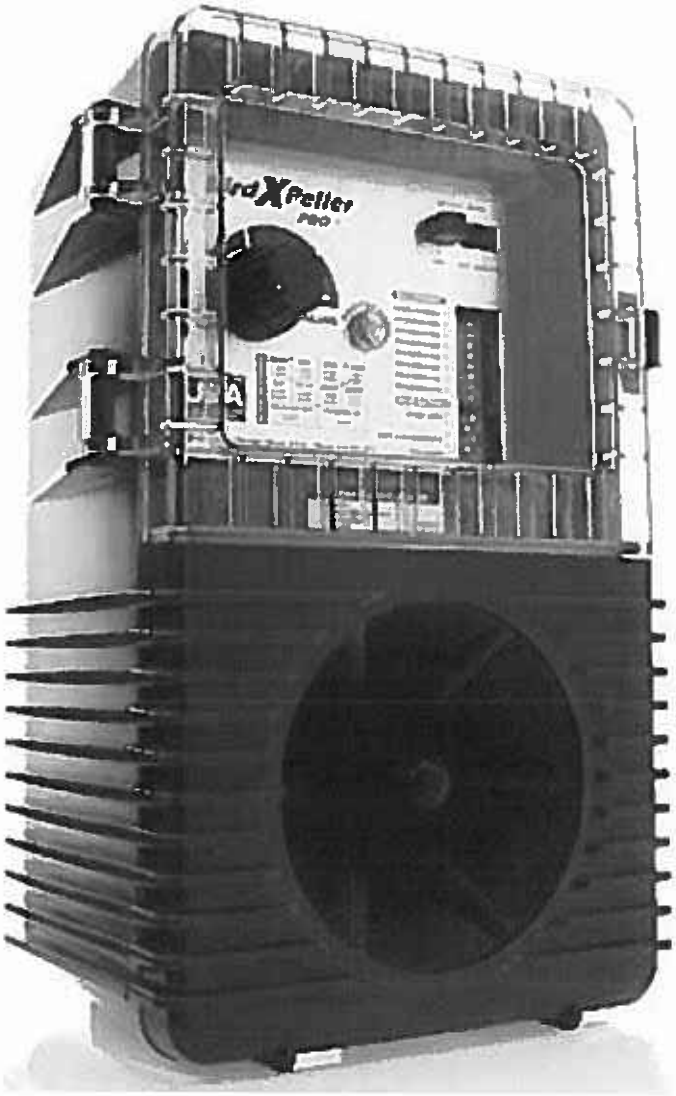
- Coverage: Up to 30 acres from single unit
- Box dimensions: Box 1: 23" x 18" x 16" (23 lbs, unit & speaker), Box 2: 32" x 24" x 5" (17 lbs, solar panel)
- Power Input: 12vDC (3 amps) via solar panel and battery
- Sound Pressure: up to 125 decibels
- Frequency: 2,000-10,000 Hz
- Compliance: UL & CE listed
- EPA Est. 075310-OR-001
- Included: Generating unit with two built-in high-output amplifiers, 20-speaker tower with audio cables, 40 watt solar panel, battery clips, & all mounting hardware.
- Proudly made in the USA

Download Mega Blaster PRO Instructions (https://bird-x.com/wp-content/uploads/Mega-Blaster-Instructions.pdf)

RELATED PRODUCTS

(https://bird-x.com/bird-products/electronic/sonic/critter-blaster-pro/)

Critter Blaster PRO (https://bird-x.com/bird-products/electronic/sonic/critter-blaster-pro/)
★★★★★
$670.00 – $690.00



(https://bird-x.com/bird-products/electronic/sonic/woodpecker-pro/)

Woodpecker PRO (https://bird-x.com/bird-products/electronic/sonic/woodpecker-pro/)
★★★★★
$280.15 – $299.95

(https://bird-x.com/bird-products/electronic/sonic/goosebuster/)

GooseBuster (https://bird-x.com/bird-products/electronic/sonic/goosebuster/)
★★★★★
$956.00 – $976.00

(https://bird-x.com/bird-products/electronic/sonic/airport-bird-control-system/)

Airport Bird Control System (https://bird-x.com/bird-products/electronic/sonic/airport-bird-control-system/)

Contact (Https://Bird-X.com/Contact/)

Customer Service (Https://Bird-X.com/Customer-Service/)

FAQs (Https://Bird-X.com/Faqs/)

Problem Solver (Https://Bird-X.com/Interactive-Problem-Solver/)

Environmental Issues (Https://Bird-X.com/Environmental-Issues/)

Blog (Https://Bird-X.com/Blog/)

Case Studies (Https://Bird-X.com/Case-Studies/)

International (Https://Bird-X.com/International/)

GSA (Https://Bird-X.com/Gsa/)

Architects (Https://Bird-X.com/Architects/)

Products For Retailers (Https://Bird-X.com/Products-For-Retailers/)

Products For PCO Installers (Https://Bird-X.com/Products-For-Pco-Installers/)

Installer Catalog (Https://Bird-X.com/Wp-Content/Uploads/Installer-Catalog-V3.0-APRIL-2017-FINAL-Print.pdf)

Full Catalog (Https://Bird-X.com/Wp-Content/Uploads/Bird-X_CATALOG_All.pdf)

Select Language Powered by Google Translate (https://translate.google.com)