CHAPTER 2: SITE CHARACTERISTICS*

2.0 INTRODUCTION

This chapter presents the relevant characteristics of the proposed HI-STORE Consolidated Interim Storage (CIS) Facility site (Site). The purpose of this chapter is to: (1) characterize local land and water use and population so that individuals and populations likely to be affected can be identified; (2) identify the external natural and man-induced phenomena for inclusion in design basis considerations; and (3) characterize the transport processes which could move any released contamination from the facility to the maximally exposed individuals and populations. More details regarding the environmental characteristics of the Site and surroundings is found in the Environmental Report (ER) [1.0.4].

* All references are placed within square brackets in this report and are compiled in Chapter 19 of this report

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location

The center of the Site is at latitude 32.583 north and longitude 103.708 west, in Lea County, New Mexico, 32 miles east of Carlsbad and 34 miles west of Hobbs (Figure 2.1.1). Larger population centers are Roswell, New Mexico, 74 miles to the northwest; Odessa, Texas, 92 miles to the southeast; and Midland, Texas, also to the southeast at 103 miles. The nearest international airport is located between Midland and Odessa, Texas 98 miles to the southeast.

2.1.2 Site Description

The Site is currently owned by the Eddy-Lea Energy Alliance (ELEA), a limited liability company owned by the cities of Carlsbad and Hobbs, and Eddy County and Lea County. In April 2016, Holtec and ELEA signed a memorandum of agreement (MOA) [2.1.1] covering the design, licensing, construction and operation of the Site. Among other things, that MOA provides the terms by which Holtec could purchase the Site. On July 19, 2016, the New Mexico Board of Finance approved the sale of the Site to Holtec [2.1.2].

The Site consists of mostly undeveloped land used for cattle grazing with the only boundary being a four-strand barb wire fence along the south side of the property until it nears Laguna Gatuna, where it turns south to the highway. This fence is the boundary between two grazing allotments administered by the Bureau of Land Management (BLM). The majority of allotments are grazed year-round with some type of rotational grazing. Figure 2.1.2 depicts the Site boundaries.

Rangelands comprise a substantial portion of the Site and provide forage for livestock. Pasture rotation, with some of the pastures being rested for a least a portion of the growing season, is standard management practice for grazing allotments. Grazing allotments near the site can be seen in Figure 2.1.3. Vegetative monitoring studies to collect data on the utilization of the land, and the amount of precipitation by pasture from each study allotment are conducted annually on Federal lands to compare production with consumption. Currently, the BLM permits nine animal unit months[1] per 640 acres [2.1.3]. Because the Site is privately held, it does not fall under the BLM range management rules, although the rules apply to most of the adjacent lands that are managed by the same rancher.

The following list of structures is shown on Figures 2.1.2, 2.1.13, and 2.1.20. A map of the utility infrastructure is shown on Figure 2.1.4. An aerial view of the Site is shown in Figure 2.1.5 and several plot views of the HI-STORE CIS Facility with all Phases complete are shown in Figures 2.1.6(a), (b), and (c).

- A communications tower in the southwest corner of the Site;
- A former producing gas and distillate well is located near the communications tower;
- A small water drinker (livestock) is located along the aqueduct in the northern half of the Site;

[1] An "animal unit month" is the amount of forage needed to feed a cow for one month.

- Oil recovery facility (abandoned) that still has tanks and associated hardware left in place in the northeast corner;
- An oil recovery facility with tanks and associated hardware still in place in the far southwest corner;
- Existing natural gas pipelines run underground along the North-South axis to the East of the Site;
- A temporary flexible pipeline for natural gas runs aboveground diagonally through the center of the Site.

As can be seen in Figure 2.1.2, the oil recovery facility that is currently in place in the southwest corner of the Site is a potential fire hazard to the SSCs of the CIS Facility. Table 2.1.4 lists conservative values for input parameters used to assess the risk this oil recovery facility poses to the SSCs of the CIS Facility. A detailed discussion of this evaluation is presented in Subsection 6.5.2.

The natural gas pipelines can be seen in Figures 2.1.13 and 2.1.20. The temporary flexible pipeline that runs aboveground through the center of the Site will be moved prior to or during the early construction phases of the CIS Facility. The natural gas pipelines which run along the North-South axis to the East of the site are underground and not considered to present a threat to the CIS Facility operations.

No water wells are located on the Site. However, the Site has been associated with oil and gas exploration and development with at least 18 plugged and abandoned oil and gas wells located on the property. However, none of these plugged and abandoned oil and gas wells are located within the area where the ISFSI would be located or where any land would be disturbed and they are not expected to affect the construction and operation of the CIS Facility. The plugged wells are estimated to be 30-70 years old. It is possible that hydrocarbon contamination exists at the Site as a result of these past practices [1.0.4]. There are no active wells on the Site and there are no plans to use any of the plugged and abandoned wells on the Site.

United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Maps of Lea County, NM [2.1.4] were reviewed in order to identify the soil units present at the Site. A Soil Survey Map is provided as Figure 2.1.7. About 90 percent of the soils within the Site are classified as Simona-Upton association (SR) and Simona fine sandy loam (SE). Simona soils are calcareous eolian deposits derived from sedimentary rock and consist of fine sandy loam underlain by gravelly fine sandy loam and cemented material, and gravelly fine sandy loam underlain by fine sandy loam and cemented material. The remaining soils (approximately 10 percent) consist of Midessa and wink fine sandy loam (MN), Mobeetie Potter Association (MW), Stony rolling land (SY), and Mixed alluvial land (MU). Details regarding the Site soil types and characteristics were compiled from Appendix D of the ER [1.0.4], and are summarized below.

Simona-Upton Association (SR)

Simona (50 percent of soil unit)

- 0 to 8 inches: gravelly fine sandy loam; saturated hydraulic conductivity (Ksat) of 14.11 to 42.34 micrometers per second.

- 8 to 16 inches: fine sandy loam; Ksat of 14.11 to 42.34 micrometers per second.
- 16 to 26 inches: cemented material (Petrocalcic Restrictive Layer i.e. Caliche); Ksat of 0.00 to 0.42 micrometers per second.

Upton (35 percent of soil unit)

- 0 to 8 inches: gravelly loam; Ksat of 4.23 to 14.11 micrometers per second.
- 8 to 18 inches: cemented material; Ksat of 0.07 to 4.23 micrometers per second.
- 18 to 60 inches: very gravelly loam; Ksat of 4.23 to 14.11 micrometers per second.

Simona fine sandy loam (SE)

- 0 to 8 inches: fine sandy loam; Ksat of 14.11 to 42.34 micrometers per second.
- 8 to 16 inches: gravelly fine sandy loam; Ksat of 14.11 to 42.34 micrometers per second.
- 16 to 26 inches: cemented material (Petrocalcic Restrictive Layer i.e. Caliche); Ksat of 0.0 to 0.42 micrometers per second.

Midessa and wink fine sandy loams (MN)

Midessa (45 percent of soil unit)

- 0 to 4 inches: fine sandy loam; Ksat of 14.11 to 42.34 micrometers per second.
- 4 to 22 inches: clay loam; Ksat of 1.35 to 1.55 micrometers per second.
- 22 to 60 inches: clay loam; Ksat of 4.23 to 14.11 micrometers per second.

Wink (40 percent of soil unit)

- 0 to 12 inches: fine sandy loam; Ksat of 14.11 to 43.34 micrometers per second.
- 12 to 23 inches: sandy loam; Ksat of 14.11 to 43.34 micrometers per second.
- 23 to 60 inches: sandy loam; Ksat of 14.11 to 43.34 micrometers per second.

Mobeetie-Potter Association (MW)

Mobeetie (70 percent of soil unit)

- 0 to 4 inches: fine sandy loam; Ksat of 14.11 to 43.34 micrometers per second.
- 4 to 24 inches: fines sandy loam; Ksat of 14.11 to 43.34 micrometers per second.
- 24 to 60 inches: fine sandy loam; Ksat of 14.11 to 43.34 micrometers per second.

Potter (24 percent of soil unit)

- 0 to 4 inches: gravelly fine sandy loam; Ksat of 4.23 to 14.11 micrometers per second.
- 4 to 14 inches: extremely cobbly loam; Ksat of 4.23 to 42.34 micrometers per second.

Stony rolling land (SY)

Torriorthents (85 percent of soil unit)

- 0 to 20 inches: extremely gravelly sandy loam; Ksat of 14.11 to 42.34 micrometers per second.
- 20 to 60 inches: bedrock; Ksat of 0.42 to 14.00 micrometers per second.

Mixed alluvial land (MU)

Ustifluvents (85 percent of soil unit)

- 0 to 60 inches: stratified sand to loamy fine sand to loam to sandy clay loam to clay loam to clay; Ksat of 0.42 to 141.14 micrometers per second.

Appendix D of the ER [1.0.4] provides additional information regarding soil descriptions, soil features, and physical, chemical, and engineering properties, including soil salinity. Laboratory analyses of soil samples within the Site indicated chloride concentrations of 26-43,000 mg/kg in the soil [2.1.3]. The soil samples were taken in the eastern portion of the Site, in areas previously used for oilfield disposal. The highest chloride concentrations are considered to be localized and not reflective of the concentrations where the CISF would be located [2.1.3]. A review of the available soil data, including engineering properties of the Site soils, indicates favorable conditions for foundations, utilities, surface pavement, and other improvements [2.1.3]. Removal of fill would not induce seismic activity or affect subsurface faults [1.0.4]. Section 4.3 of the ER [1.0.4] provides additional details regarding the potential impacts of the CIS Facility on soils, including a discussion of construction activities adjacent to a finished ISFSI structure.

In December of 2017, a site characterization for HI-STORE CISF Phase 1 was completed . The field explorations included borings and geophysical testing at the HI-STORE site. Figure 2.1.8 shows the location of the 9 borings and ancillary borings. Detailed profiles for these borings can be found in the Geotechnical Data Report prepared by GEI [2.1.24] or in Sections 2.5 and 2.6 of this report.

Vegetation and habitats within the Site and immediately surrounding area are common within the region. The Site does not support any vegetation of significance. Significance is defined in this document as any plant, animal, or habitat that: (1) has high public interest or economic value or both; or (2) may be critical to the structure and function of the ecosystem or provide a broader ecological perspective of the region.

The Project area is in the primary vegetation community of Desert Grasslands, which is widespread at lower elevations in southern and western New Mexico. These communities are characterized by significant amounts of grasses and less than 10 percent of total cover being forbs and shrubs [2.1.5]. Typical vegetation in Desert Grassland communities include black grama (*Bouteloua eriopoda)*, blue grama (*Bouteloua gracilis)*, bluestem, buffalo grass (*Bouteloua dactyloides)*, western wheatgrass (*Pascopyrum smithii*), galletas (*Hilaria spp.)*, tobosa (*Pleuraphis mutica)*, alkali sacaton (*Sporobolus airoides*), three-awn (*Aristida spp*.), mesquite (*Prosopis spp*.), serviceberry (*Amelanchier denticulate)*, skunkbush sumac (*Rhus trilobata*), sand sagebrush (*Artemisia filifolia)*, Apache plume (*Fallugia paradoxa*), creosotebush (*Larrea tridentata)*, and cliffrose (*Purshia mexicana*). With appropriate moisture

(generally more than is typically experienced) sunflower (*Helianthus annuus*), croton (*Croton spp.)*, and pigweed (*Amaranthus palmeri)* may grow in disturbed or ponded depressions.

A biological survey in October of 2016 (Appendix B in the ER [1.0.4]) also documented a variety of mesquite scrubland and very few grassland species. This further indicates that vegetation in the area has changed from a desert grassland to mesquite scrubland due to overgrazing. The dominant species documented during this survey include broom snakeweed, honey mesquite, prairie verbena *(Glandularia bipinnatifida)*, prickly pear (*Opuntia engelmannii)*, scarlet globemallow *(Sphaeralcea coccinea)*, silverleaf nightshade *(Solanum elaeagnifolium)*, tobosa grass, western peppergrass *(Lepidium montanum)*, and wooly croton *(Croton capitatus)*.

The topography of the Site shows a high point located on the southern border of the Site and gentle slopes leading to the two drainages (Laguna Plata and Laguna Gatuna). Both of these drainages would be able to accept a one day severe storm total within the 7.5 inch range with excess free board space. The natural drainage of the Site is useful by providing a natural area for impoundment of excess runoff during severe storms [2.1.3]. Figures 2.1.9 – 2.1.11 depict the topography for the Site and the surrounding area.

There are no United States Army Corps of Engineers (USACE) jurisdictional wetlands on the Site [2.1.3]. Additionally, there no floodplains identified or mapped for the Site or Lea County, New Mexico [2.1.6, 2.1.7].

2.1.3 Population Distribution and Trends

This section describes population distribution and trends for the 50-mile region of influence (ROI) surrounding the proposed Site including Lea and Eddy Counties in New Mexico and Andrews and Gaines Counties in Texas (see Figure 2.1.12). Lea County is primarily rural, as are the other counties in the ROI. Between 2000 and 2010, the population in the ROI has grown at a slower rate in comparison to New Mexico-wide population growth. Population estimates in the ROI are projected to grow at a slower rate than New Mexico, increasing 10 percent between 2015 and 2025 while New Mexico is projected to increase 19 percent during the same time period. Table 2.1.1 lists historical population and Table 2.1.2 lists projected population in the ROI and New Mexico and Texas.

The population in the ROI in 2015 was estimated to be 166,914 [2.1.9]. In 2015, 43 percent of the population of the ROI resided in Lea County, New Mexico. Between 2010 and 2015, the counties within the ROI all experienced an increase in population. Gaines County, Texas had the greatest increase at 14 percent, while Eddy County, New Mexico had the lowest increase at seven percent during the same time period.

The nearest residence to the Site is the Salt Lake Ranch located 1.5 miles north of the Site. There are additional residences at the Bingham Ranch, two miles to the south, and near the Controlled Recovery Inc. complex, three miles to the southwest. There is an average population of less than 20 residents among the five ranches within a six mile radius. This is a population density of less than 5 residents per square mile [2.1.3]. Table 2.1.3 presents the population density per square mile of land for the ROI in 2010. Figure 2.1.13 presents a sector map of population in segments surrounding the Site for distances of 1, 2, 3, 4, and 5 miles. As shown on that Figure, there are only 9 people living within 5 miles of the proposed Site. As discussed in Section 3.8.1 of the ER, population estimates in the Region of influence (ROI) are projected to grow at a slower rate than

New Mexico, increasing 10 percent between 2015 and 2025, while New Mexico is projected to increase 19 percent during the same time period. Assuming a 10 percent growth between 2015 and 2025, the projected population living within 5 miles of the CIS Facility would grow from 9 to 10 persons.

With regard to transient populations within 5 miles of the CIS Facility, Holtec contacted all employers within 5 miles and determined that there are currently approximately 303 persons working within 5 miles of the CIS Facility boundary, broken down as follows:

- Land Farm (R360 Disposal): 1.9 miles southwest of the CIS Facility Site boundary; 43 full time equivalent (FTE) workers;
- Intrepid East Mine: 4.9 miles east of the CIS Facility Site boundary; 210 FTE's;
- Intrepid North Mine: 4.2 miles west of the CIS Facility Site boundary; 40 FTE's;
- Caliche Mine: 4 miles southwest of the CIS Facility Site boundary; 10 FTE's [2.1.14].

With regard to future projections, there are no reasonably foreseeable projects expected to occur within 5 miles of the CIS Facility boundary and no changes to the existing transient workforce were forecast by the employers in the area [2.1.14]. Consequently, it is assumed that the transient population of 303 workers would remain constant going forward.

The nearest local school facilities, daycare, nursing homes and hospitals are located in Hobbs, NM. The educational institutions include three colleges, a high school and an alternative high school, three middle schools, twelve elementary schools, and two private schools. The Lea Regional Medical Center is the nearest hospital. There are no school facilities or hospitals located within 5 miles of the proposed Site.

Because the only mechanism for radiological exposure would be from radiation (neutrons and gamma rays) emitted from the storage casks, the highest public dose would result from an individual located as close to the SNF casks as possible. For details on the radiation protection evaluation for the Site, see Chapter 11 of this SAR.

2.1.4 Land and Water Use

As shown on Figure 2.1.14 and 2.1.15, almost all of the land immediately surrounding the Site is owned and managed by the BLM. Land uses in the area are limited to oil and gas exploration and production, oil and gas related services industries, livestock grazing, and limited recreational activity. Lands within six miles of the Site are privately owned, state lands, or BLM lands. Land use within six miles of the Site falls into two categories; livestock grazing and mineral extraction.

Within 50 miles of the Site, except for the communities located in the area, the land use and ownership is essentially the same as within the six mile radius. Along with the mining, grazing, and oil/gas activity, agriculture is a major activity [2.1.3].

Lea County is approximately 2.8 million acres in size. Property ownership is 17 percent Federal government, 31 percent state government, and 52 percent private. The Federally-owned land is primarily located in the southwestern portion of the county, the state-owned land is predominately located throughout the middle, and the privately owned land primarily extends

from north to south in the county's eastern portion. Large tracts of land in Lea County are privately owned by farmers, ranchers, oil, gas, and mining companies. Urbanized areas near cities and towns include ownership of smaller tracts of land for residential, municipal, and commercial purposes. Approximately 93 percent of Lea County is used as range land for grazing, and approximately 4 percent is used for crop farming. Urban areas and the roadway system account for the remaining land use. Most of the land actively farmed in Lea County is irrigated [2.1.15].

Mineral extraction in the area consists of underground potash mining and oil/gas extraction. Both industries support major facilities on the surface, although mining surface facilities are confined to a fairly small area. Intrepid Mining LLC (Intrepid) owns two potash mines located within 6 miles of the Site. The Intrepid North mine, located nearly 6 miles to the west, is no longer actively mining potash underground. However, the surface facilities are still being used in the manufacture of potash products. The Intrepid East facility is still mining its underground potash ore [2.1.3]; however, it too is nearly 6 miles to the southwest of the site. Mineral resources near the Site, as determined from the USGS Mineral Resources Data System and the New Mexico Mining Minerals Division, are mapped on Figure 2.1.12. The USGS and NM MMD databases indicate that the CIS Facility is not co-located with existing mining facilities.

Potash was discovered in southeastern New Mexico in 1925 in a well that was being drilled for oil and gas. By the mid-1930s, there were 11 companies exploring for potash in southeastern New Mexico. The potash in southeastern New Mexico has been a major potash resource. The remaining potash reserves are estimated to be 500 million tons. Potash production continues in the Delaware Basin with active mining by Intrepid Mining and Mosaic Co. Although much of the high-grade zones have been mined out, exploration for commercially viable deposits continues [2.1.16].

Conventional mechanized underground mining operations are the most widely used method for the extraction of potash ore. A variety of mining techniques and equipment may be employed depending on factors such as: the orebody depth, geometry, thickness and consistency, the geological and geotechnical conditions of the ore and surrounding rock, and the presence of overlying aquifers. Methods in widespread use include variations of room and pillar, longwall, cut and fill, and open slope techniques. After the ore is extracted, it is generally transferred by bridge conveyor, shuttle cars or load-haul-dump units to a system of conveyors that carry it to underground storage bins, prior to haulage to the surface through a shaft by automated skips. On rare occasions shallow mines may use a decline and conveyor arrangement [2.1.20].

In general, potash ore zones are nearly flat lying; the potash ore is mined with slightly modified conventional coal-mining equipment. Room and pillar workings are commonly 6 feet high; as much as 60-70 percent of the ore is removed during the first stage of mining. Some operations also use a second "pillar-robbing" mining technique, allowing overlying rock to settle slowly. In this manner, as much as 92 percent of the ore may be removed [2.1.20, 2.1.16].

When the potash to be extracted is at a depth of 3,000 feet or deeper and/or the potash it is located in sedimentary rock then solution mining provides a cost effective, efficient and safe way to extract the resource. Conventional mining involves extracting a lot of rock material to access

the mineral resource resulting in large underground caverns and this excess waste material must also be stored on surface. With solution mining, a brine is heated and injected into the deposit to dissolves the potash. The potash-rich brine is then pumped out of the cavern to the surface where the water is evaporated. Solution mining is currently used at a number of operations in New Mexico, and Intrepid Potash was recently approved to conduct solution mining of potash minerals in order to extract some of the remaining ore from suspended mines in the main potash mining area [2.1.16].

Subsidence is the phenomenon or response that occurs when an underground opening is created. In the Delaware Basin, subsidence caused by human activities largely has occurred as a result of potash mining and activities involving the withdrawal or injection of fluids for oil and gas production and brine extraction. Subsidence from mining creates voids that cause collapse of strata above the mining level. The overlying and surrounding rock or soil naturally deforms in an effort to arrive at a new and more stable overall equilibrium position. This equilibrium-seeking action can result in both vertical and horizontal ground movement, and, if not controlled or minimized, can cause damage to both surface and subsurface structures. It can result in the development of undesirable surface topography, such as surface cracking or collapse, sinkholes, blocking or changing stream channels, and modification of drainage pathways. The rate of subsidence is largely dependent on the type of material being mined and the amount of material mined [2.1.16].

The magnitude, rate of development, and surface expression of the subsidence process are controlled by several factors, most of which are interdependent. These include mining method, depth of extraction, size and configuration of openings, rate of advance or extraction, seam thickness, topography, lithology, structure, hydrology, in situ stresses, and rock strength and deformational properties. Taken collectively, they demonstrate the complexity of the subsidence process [2.1.22].

Subsidence is expected in areas where 90 percent extraction rates occur with the room-and-pillar mining technique typically used in potash mining. Subsidence is not expected where 60-70 percent extraction rates are employed (e.g., first stage potash mining). The amount of subsidence is similar to findings concerning historic potash mining in the area where, given an average 6-feet mining extraction height, the maximum subsidence was found to be a nominal 4 feet. Subsidence fractures have been observed in the land surface above workings that have collapsed at depths of 1,000 feet or more [2.1.16].

As a general rule, the amount of maximum subsidence (i.e., the depth of subsidence) that could occur cannot exceed the thickness of the zone of mineral extracted (the mining thickness). Maximum subsidence depth, however, is seldom observed, due to one or more of the following reasons:

- Because subsidence actually spreads over an area somewhat larger than the mined area, the subsidence is proportionally less.
- Convergence, or closure of the mined area, is never fully complete or total, so some voids inevitably remain, reducing the amount of subsidence.

- The overlying rocks expand slightly in volume due to breakage as the ground moves downward into the mined area, resulting in a "bulking" effect, which contributes to a reduction in subsidence volume and depth.
- The subsidence process can be slow for rocks that creep—several hundred (or more) years may be required for ultimate subsidence to occur [2.1.16].

It is important to note that both historic data and anecdotal evidence suggest that for the southeastern New Mexico potash mines, virtual completion of the maximum surface subsidence profile occurs within just a few years (5 to 7 years) after completion of mining [2.1.16].

In some instances, surface subsidence induced by underground mining may alter river and stream drainage patterns, disrupt overlying aquifers, and damage buildings and infrastructure. The degree of subsidence depends on factors such as orebody thickness and geometry, the thickness of the overlying rock and the amount of ore recovered. The effects of subsidence have been reduced to some extent, through either: (1) the design of the ore extraction layout so as to reduce the rate and extent of subsidence, or (2) by backfilling openings with processing wastes such as salt tailings, to reduce or prevent subsidence [2.1.21].

Figure 2.1.17 shows potash that has been historically mined within 6 miles of the proposed CIS Facility. As shown on that figure, the nearest mined potash is approximately 2 miles from the southwestern boundary of the CIS Facility Site. However, no active potash mines are within 4.2 miles of the Site. Per Mr. Robert Baldridge, Operations Manager for Intrepid Potash, potash mines in the area are generally a maximum of approximately 1,800-3,000 feet in depth, and the thickness of the zone of mineral extracted is a fraction of this total depth [2.1.19]. According to Golder and Associates, "the zone of disturbance of strata above the mine workings extends beyond the limit of the mine workings and data from the southeast New Mexico potash fields suggest that a reasonable limit for defining this zone of disturbance would be an angle of 45 degrees from the vertical" [2.1.18]. Consequently, for potash mining at a nominal 3,000-feet depth, the subsidence effects area could extend 3,000 feet beyond the edge of the mine workings [2.1.18]. Given that the nearest historic potash mine is approximately 2 miles away from the CIS Facility, subsidence effects at the CIS Facility Site from past or current potash mines would not be expected to occur.

With regard to the nearest potash mine (the National Potash Mine, located approximately 4.2 miles west of the Site, and shown on Figure 2.2.1 of the SAR), no deep mining has occurred at that mine since 1982. Given that surface subsidence generally occurs within 5 to 7 years after completion of mining, no further subsidence from that mine is expected. That mine is considered a surface facility and is used by Intrepid Potash as a warehouse and distribution center [2.1.19].

With regard to potential future potash mining near the CIS Facility, Figures 2.1.18 and 2.1.19 show the locations of potash core holes and potash leases within 6 miles of the CIS Facility Site. As shown on those figures, numerous potash core holes have been drilled in the areas surrounding the CIS Facility and there are potash leases surrounding the CIS Facility Site. As previously stated in Section 2.6.4 of the SAR, with regard to potential future drilling on the Site, Holtec has an agreement with Intrepid Mining LLC (Intrepid) such that Holtec controls the mineral rights on the Site and Intrepid will not conduct any potash mining on the Site.

Oil in southeastern New Mexico was discovered in 1909, 8 miles south of Artesia, but the well was never completed as a producer due to mechanical problems. Oil and gas production began in the New Mexico portion of the Delaware Basin in 1924 with the discovery of the Dayton-Artesia Field. Until the year 2000, 4.5 billion barrels of oil had been produced mainly from fields on the Northwest Shelf and Central Platform areas in the Delaware Basin. More than 3.5 billion barrels of the total production was extracted from Permian-age rocks. The U.S. Geological Survey (USGS) estimates that the greater Permian Basin area, including parts of southeastern New Mexico and west Texas, contains substantial undiscovered oil and gas resources on the order of 1.3 billion barrels of oil and 41 trillion cubic feet of gas [2.1.16].

As a precaution for the potash mines in this region, the mining companies historically left protection pillars around the oil and gas boreholes. Well casing corrosion is a common problem in the Delaware Basin, caused by contact with the brine fluids being withdrawn or injected depending on the purpose of the well. There are documented cases where escape of unsaturated brines and dissolution of salt formations caused catastrophic collapse to the surface, not only in the Delaware Basin, but in other basins having substantial thicknesses of salt layers and numerous wells penetrating the salt for the purpose of fluid withdrawal [2.1.16].

Thousands of wells have been drilled through evaporate formations in the Delaware Basin to explore for and produce oil and gas (see Figure 2.1.20, which depicts wells immediately surrounding the CIS Facility) Because of the extent of the evaporites (salt and anhydrite), drilling and completion operations have to be conducted in a manner that prevents the dissolution of the salt and protects the well during drilling and through the productive lives of the wells, often 20 to 30 years or more. Oil and gas exploration targets range from relatively shallow oil and gas at 5,000 feet deep in the Delaware Canyon Formation to deep gas targets in middle Paleozoic formations in excess of 16,000 feet deep [2.1.16].

Salt can be extracted from subsurface formations by using wells that inject fresh water to dissolve the salt followed by extraction of the saturated water. In the Delaware Basin, these wells are referred to as brine wells. Brine wells in the Delaware Basin are used to extract saline water for use in oil and gas well drilling and workover fluids. Recently, a few brine wells in Eddy County that were 200 to 300 feet in diameter and 100 to 200 feet deep suffered catastrophic collapse causing sinkhole development at the surface. Each of the wells associated with the collapse were former oil and gas wells converted to brine wells. At one brine well in Carlsbad, New Mexico, geophysical surveys indicated the presence of subsurface fracturing, cavities, and collapse, but no surface manifestation of collapse has occurred other than tilting of the ground surface [2.1.16].

There are several examples in the Permian Basin of catastrophic subsidence as a result of suspected oil field casing corrosion and dissolution of salt. The examples of subsidence associated with oil and gas operations include the Wink Sinks I and II and the Jal Sink. There are other similar incidents that occurred in areas underlain by salt in Texas and in Kansas. The Wink Sinks developed in the Hendrick oil field in Winkler County, Texas, near the town of Wink, which is approximately 75 miles southeast of the proposed CIS Facility Site. Wink Sink I developed in 1980 and Wink Sink II occurred in 2002 [2.1.16].

The Jal sinkhole, which developed in 2001, is located about 8 miles northwest of Jal, New Mexico and approximately 50 miles southeast of the proposed CIS facility Site. The geologic settings of the Wink and Jal sinkholes are similar to that of the CIS Facility Site as they occurred at the basin margin above the Capitan Reef. In each incident, sinkholes formed around a well location and the sinks had diameters ranging from 200 to over 700 feet. Although the exact cause of development of these sinkholes is not known, it is suspected that casing failure allowed unsaturated water to come into contact with, and subsequently dissolve, salt layers [2.1.16]. Potash deposits are located around and within the Site as shown on Figure 2.1.21. With regard to potential future drilling on the Site, Holtec has an agreement [2.6.9] with Intrepid such that Holtec controls the mineral rights on the Site and Intrepid will not conduct any potash mining on the Site. An area for a potash mine nearby and west of the Site has been identified as shown on Figure 2.1.21; while the operational and construction footprint for the CIS Facility does not intersect the area for the potash mine (identified on Figure 2.1.21 as “Belco shallow” and “Belco deep” potash drill islands), the proposed railroad spur has the potential to cross these drill islands.

The Belco Shallow and Belco Deep drill islands are located approximately 0.25 and 0.5 miles, respectively, from the CIS Facility Site boundary, and are intended to accommodate multiple oil and gas well locations, all or most of which will be horizontal wells completed below the Bone Springs formation (7,800 feet below the ground surface. Oil and gas drilling has occurred on those drill islands in the past and could be used in the future. Similarly, as shown on Figure 2.1.20, oil and gas wells have been drilled in the Green Frog Café Drill Island located just east of the proposed CIS Facility [2.1.17]. Water demand in Lea County increased 33 percent from 1985 to 1995 and in 1998, the demand was about 189,000 acre-feet per year. Similar increases in water use from 1985 to 1995 occurred in Irrigated Agriculture (33 percent) Public Supply (26 percent), Domestic (40 percent), Livestock (106 percent) and Commercial (21 percent) use categories. The water use by category, as a percentage of Lea County’s total, is 78 percent Irrigated Agricultural, 10 percent for Public Water Supply, 7 percent Mining, and 3 percent Power. Present water use by Domestic, Livestock, Commercial Reservoir Evaporation, and Recreation uses are all less than 1 percent of the total use [2.1.15].

The largest water use in Lea County is for non-municipal irrigation. The New Mexico Office of the State Engineer (NMOSE) has on record a total of 2,007 non-municipal wells with an associated water right of 344,600 acre-feet. The next largest user group is municipalities, with water rights of 48,000 acre-feet). The city of Hobbs is the largest water-rights holder with water rights of 20,100 acre-feet per year [2.1.15].

Over the next 40 years, if unrestrained, the water use in Lea County is estimated to increase to approximately 360,000 acre-feet, 90 percent greater than the 1995 total. The largest part of this increase is anticipated to come from Irrigated Agricultural, which is projected to require 290,000 acre-feet in 2040, in response to demands for feed from Lea County’s expanding dairy industry. All other water use categories are expected to increase in Lea County over the next 40 years. Specifically, 55 percent Public Supply, 58 percent Domestic, 364 percent Livestock, 58 percent Commercial, 134 percent Industrial, 32 percent Mining, 57 percent Power, and 55 percent Recreation are estimated above 1995 uses. These other categories account for a total of approximately 70,000 acre-feet per year of the total annual 2040 estimate [2.1.15].

Table 2.1.1

POPULATION ESTIMATES FOR REGION OF INFLUENCE [2.1.9, 2.1.10, 2.1.11]

Area	Census 1990	Census 2000	Census 2010	Population Estimates as of July 1				
				2011	2012	2013	2014	2015
Lea	55,765	55,528	64,727	63,690	64,670	65,681	66,876	71,180
Eddy	48,605	51,633	53,829	53,288	53,693	54,284	54,834	57,578
Andrews	14,338	13,004	14,786	14,500	15,006	15,554	16,126	18,105
Gaines	14,123	14,467	17,526	17,123	17,572	18,019	18,496	20,051
Total ROI	**132,831**	**134,632**	**150,868**	**148,601**	**150,941**	**153,538**	**156,332**	**166,914**
New Mexico	1,515,069	1,819,046	2,059,179	2,037,136	2,055,287	2,069,706	2,080,085	2,085,109
Texas	16,986,510	20,851,820	25,145,561	24,774,187	25,208,897	25,639,373	26,092,033	27,469,114

Table 2.1.2

POPULATION PROJECTIONS FOR THE REGION OF INFLUENCE [2.1.10, 2.1.11]

Area	2020	2025	2030	2035	2040
Lea	78,407	85,773	93,712	102,090	110,661
Eddy	57,908	59,945	61,836	63,595	65,258
Andrews	16,450	17,244	17,973	18,695	19,378
Gaines	20,064	21,420	22,858	24,316	25,644
Total ROI	172,829	184,382	196,379	208,696	220,941
New Mexico	2,351,724	2,487,227	2,613,332	2,727,118	2,827,692
Texas	27,238,610	28,165,689	28,994,210	29,705,207	30,305,304

Table 2.1.3

POPULATION DENSITY PER SQUARE MILE OF LAND FOR THE REGION OF INFLUENCE, 2010 [2.1.12]

Area	2010
County	
Lea	14.7
Eddy	5.4
Andrews	9.9
Gaines	11.7
County Subdivision and Place	
Eunice City, Lea County	970.6
Hobbs City, Lea County	1,424.4
Jal City, Lea County	446.4
Lovington City, Lea County	2,320.9
Carlsbad City, Eddy County	903.3

Table 2.1.4

CONSERVATIVE VALUES USED TO EVALUATE OIL RECOVERY FACILITY FOR FIRE CONSIDERATIONS

Parameter Description	Distance (Units)
Nearest location of Loaded Conveyance on Haul Path to East of Oil Recovery Facility	450 (ft)
Nearest location of Loaded Conveyance on Haul Path to North of Oil Recovery Facility	350 (ft)
Nearest location of HI-STORM for Phase 1 to Oil Recovery Facility	1750 (ft)
Nearest location of HI-STORM for All Phases to Oil Recovery Facility	900 (ft)

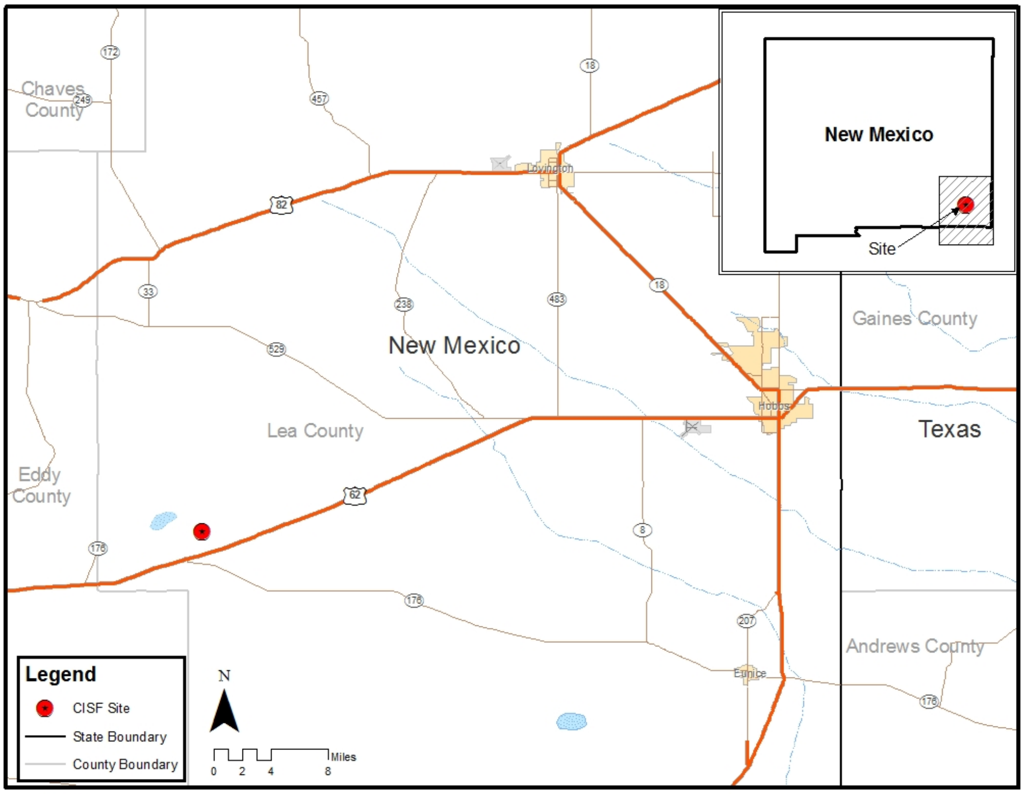


Figure 2.1.1: Location of HI-STORE

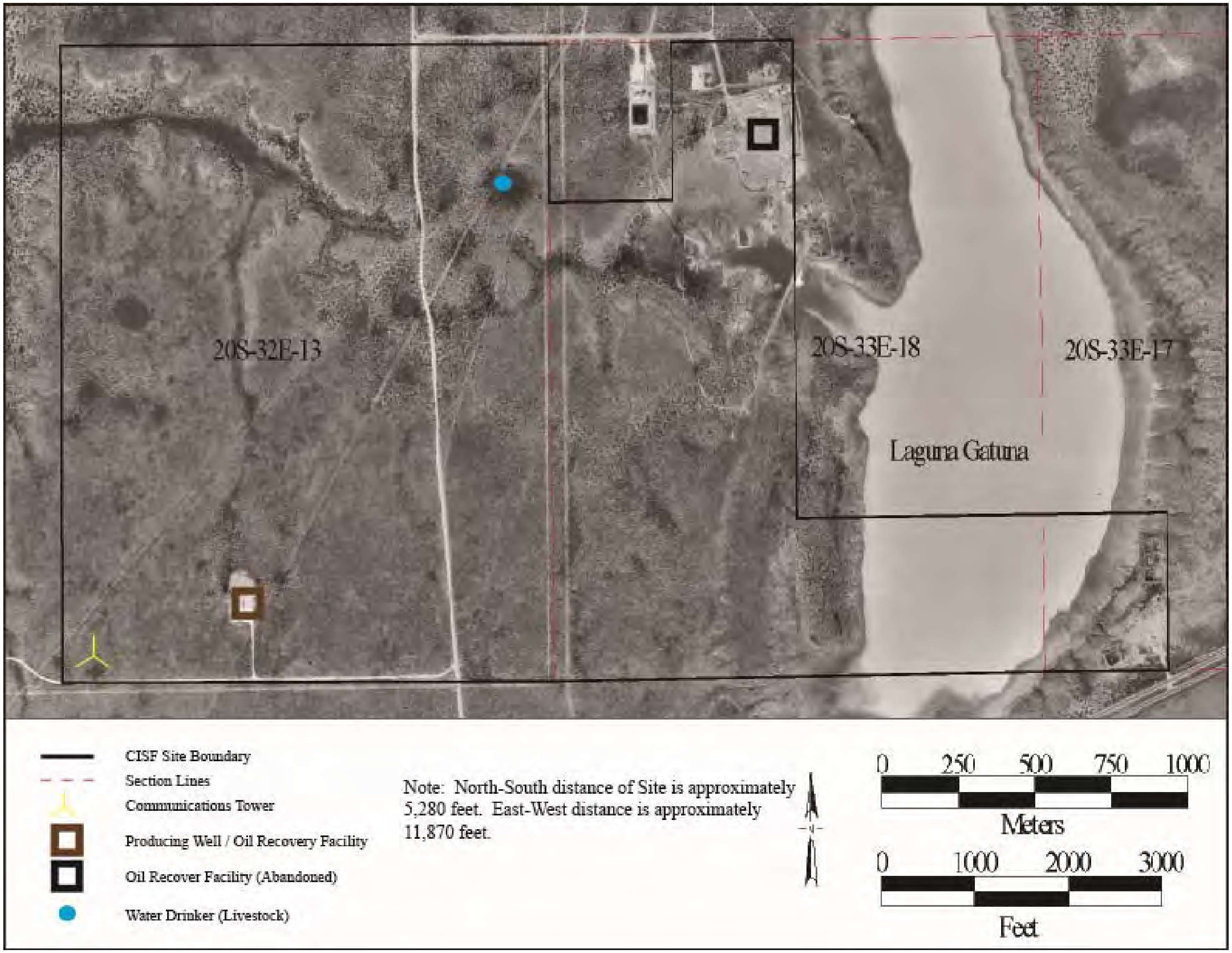


Figure 2.1.2: HI-STORE CIS Facility Site Boundaries [2.1.3]

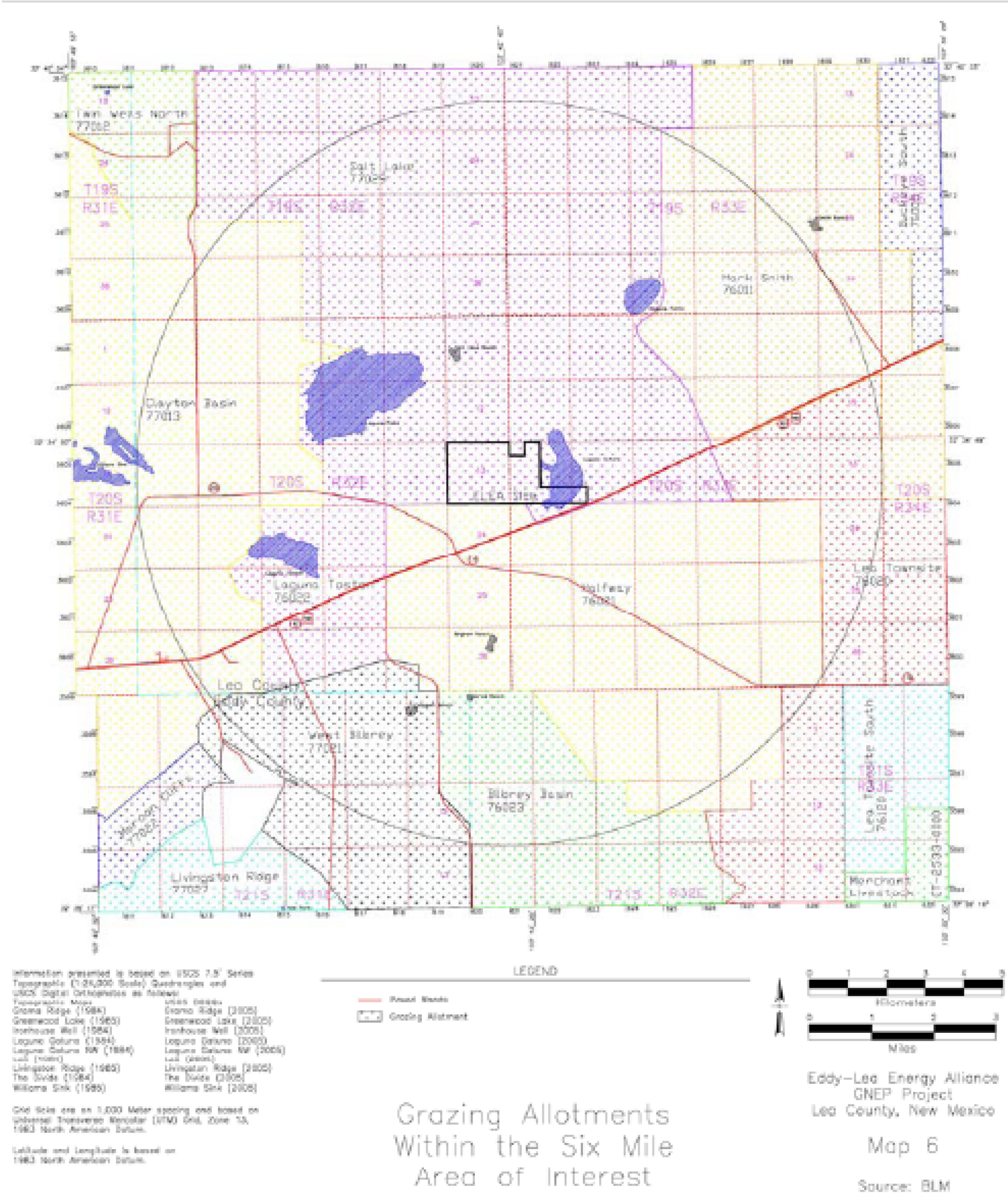


Figure 2.1.3: Grazing Allotments near the CIS Facility Site

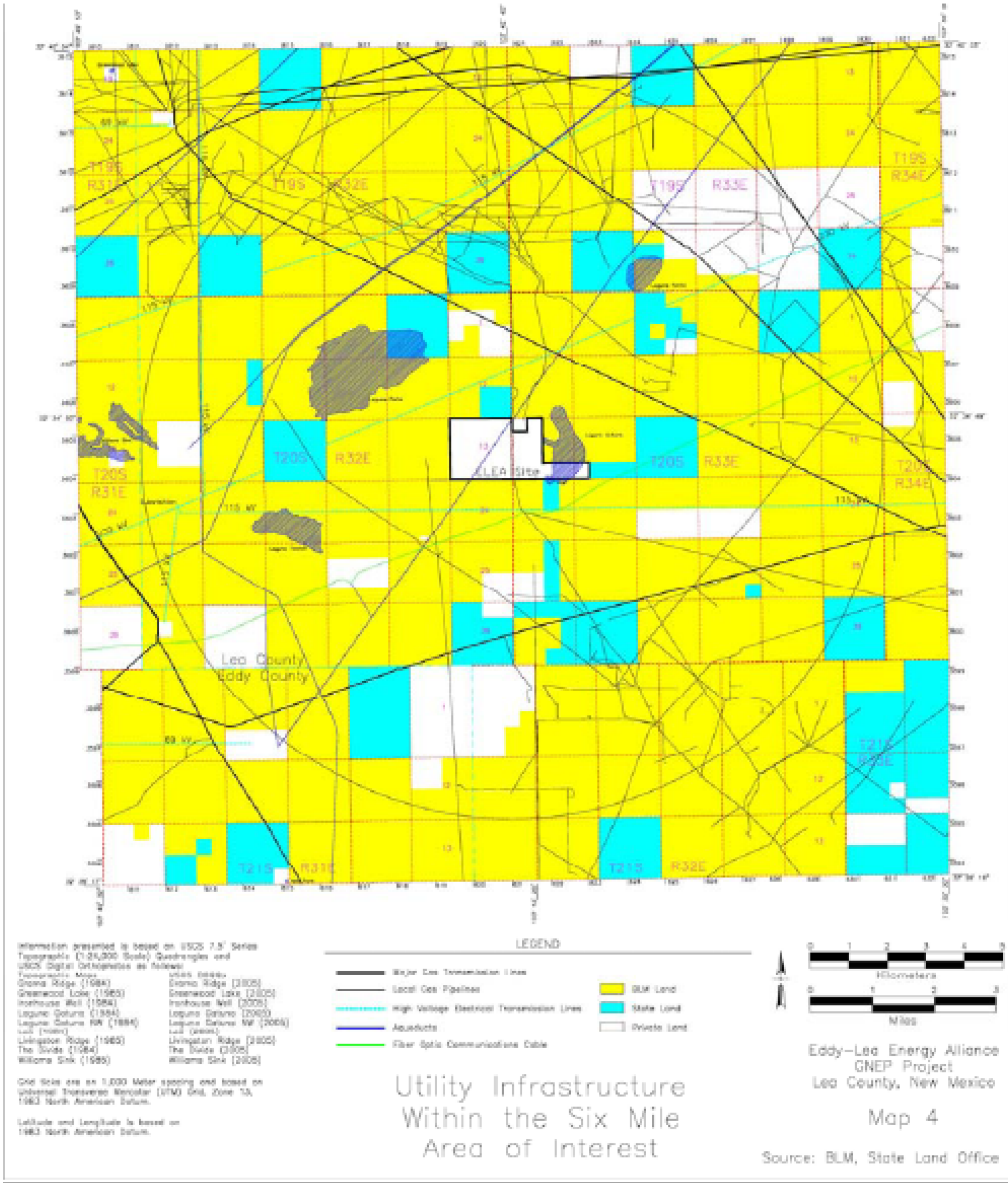


Figure 2.1.4: Utility Infrastructure near the CIS Facility Site

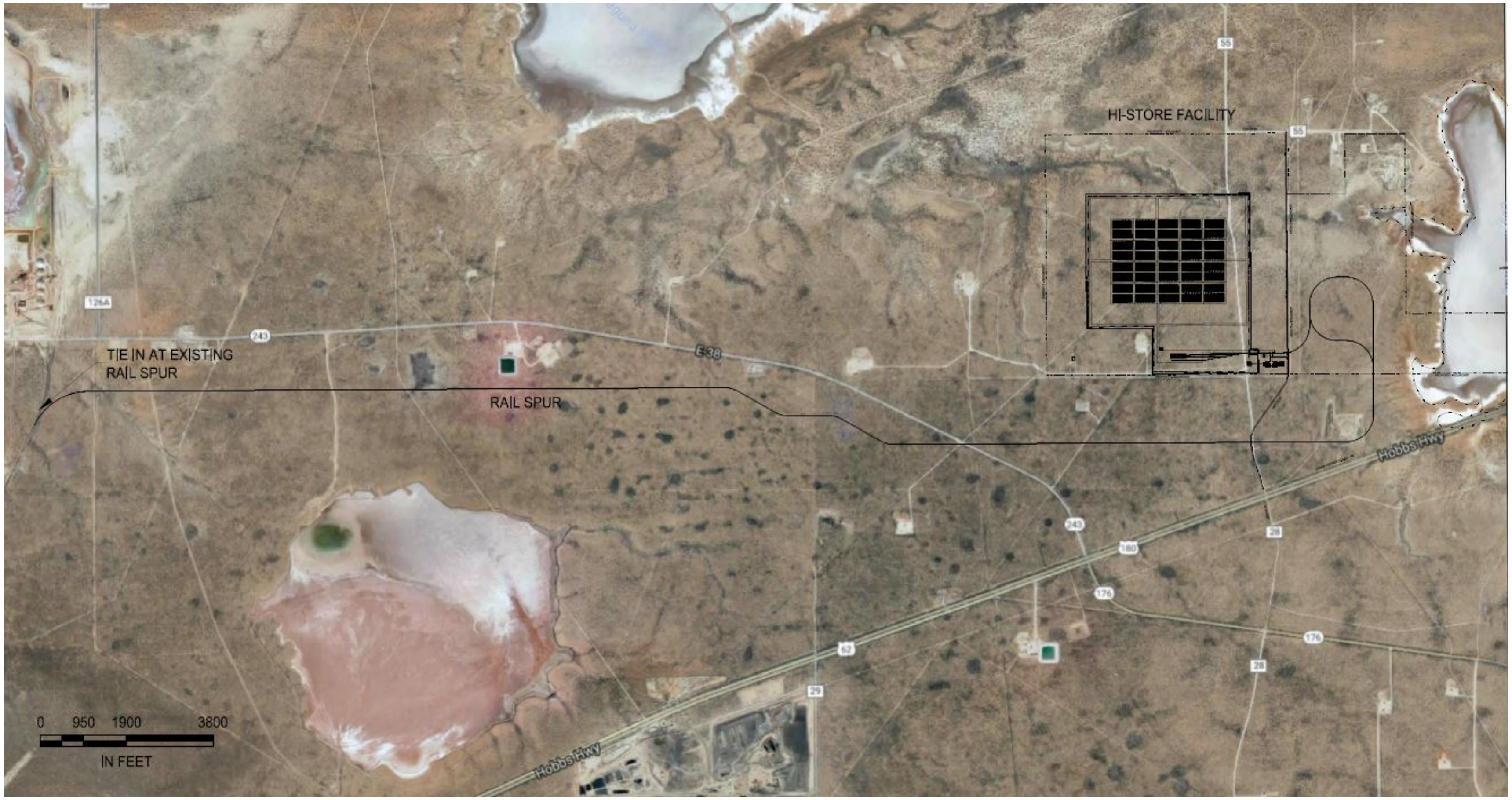


Figure 2.1.5: Aerial View of the Site (Full Build-Out) [2.1.8]

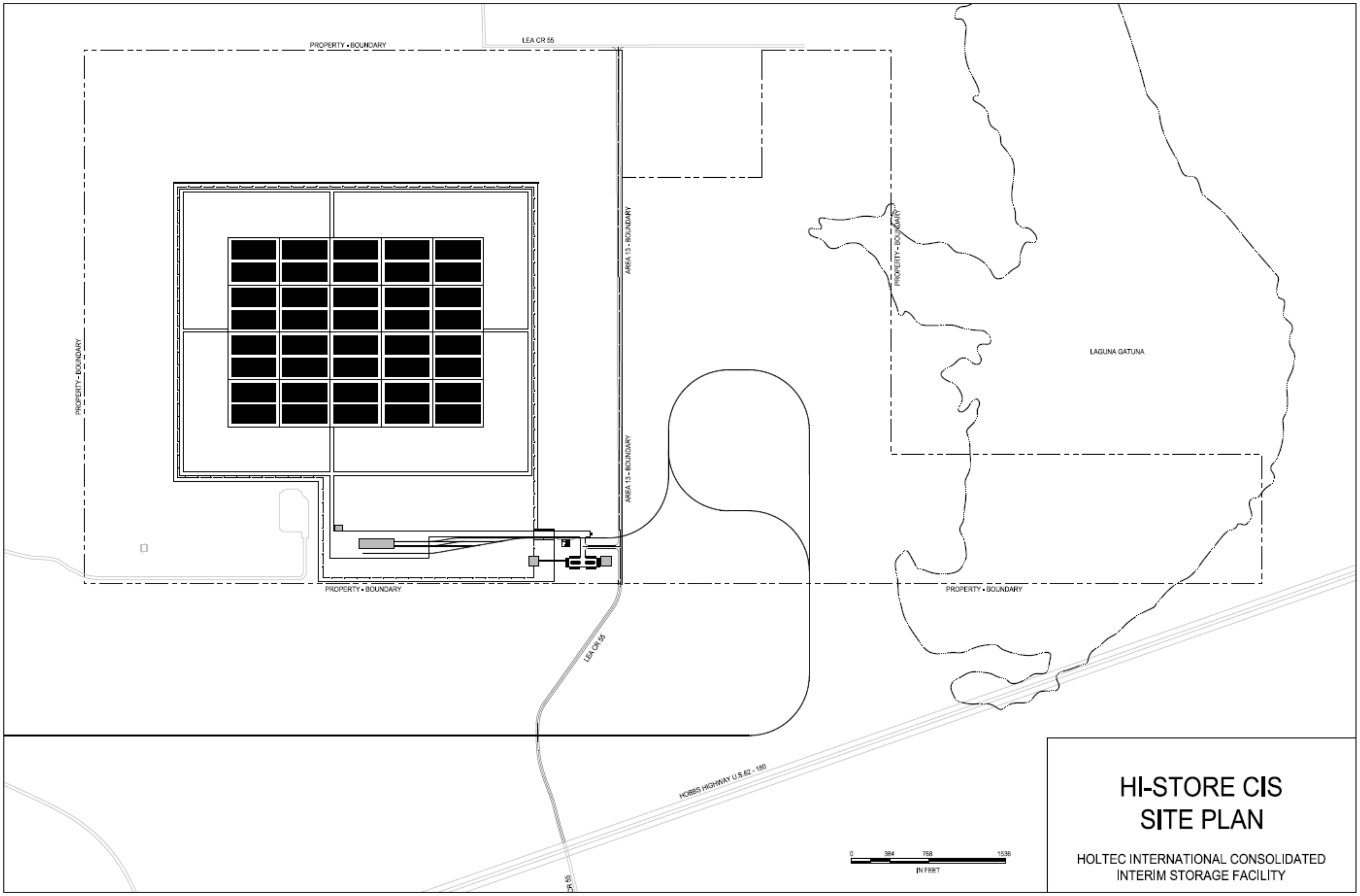


Figure 2.1.6(a): Site Layout [2.1.8]

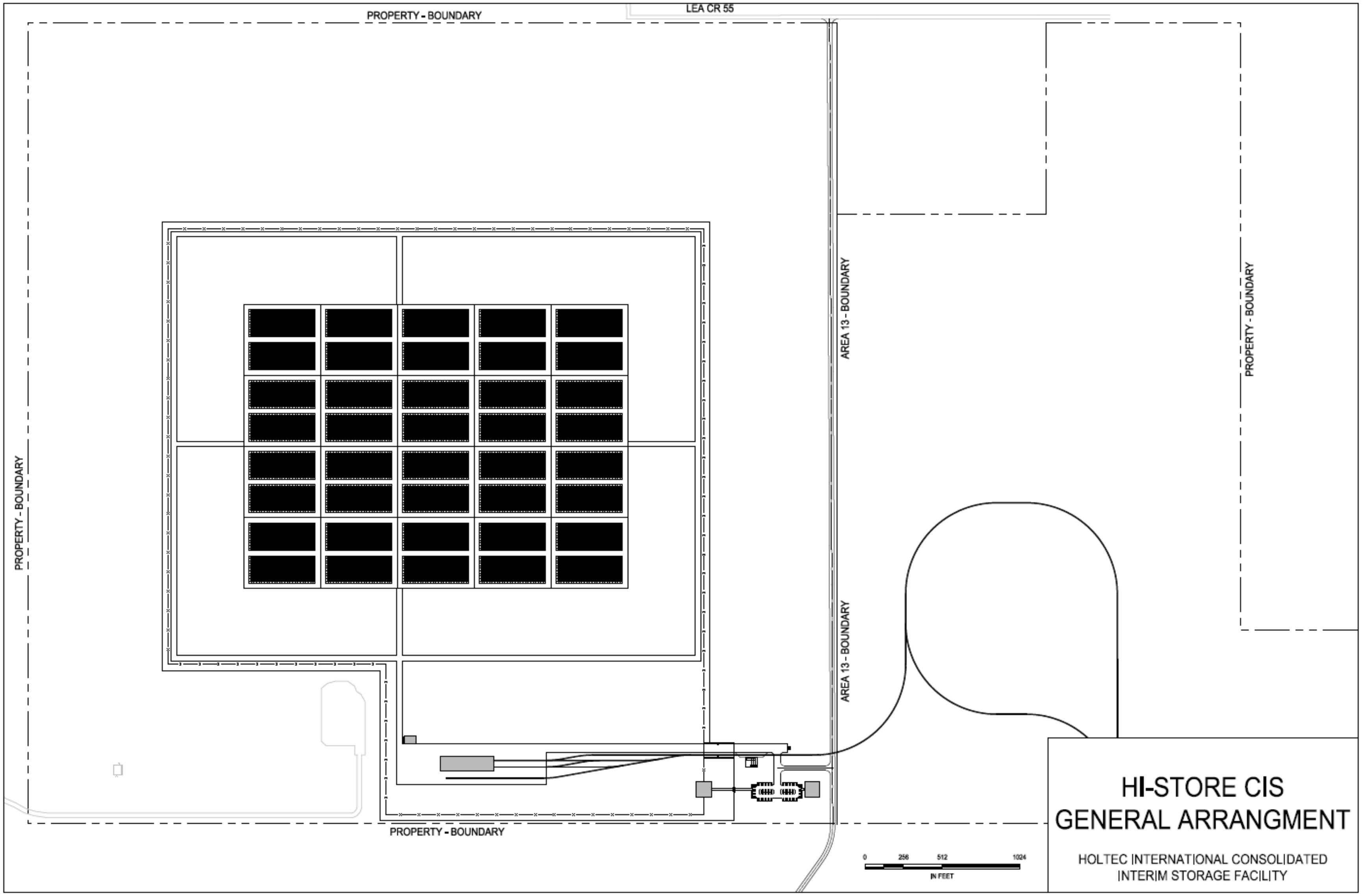


Figure 2.1.6(b): Site Layout [2.1.8]

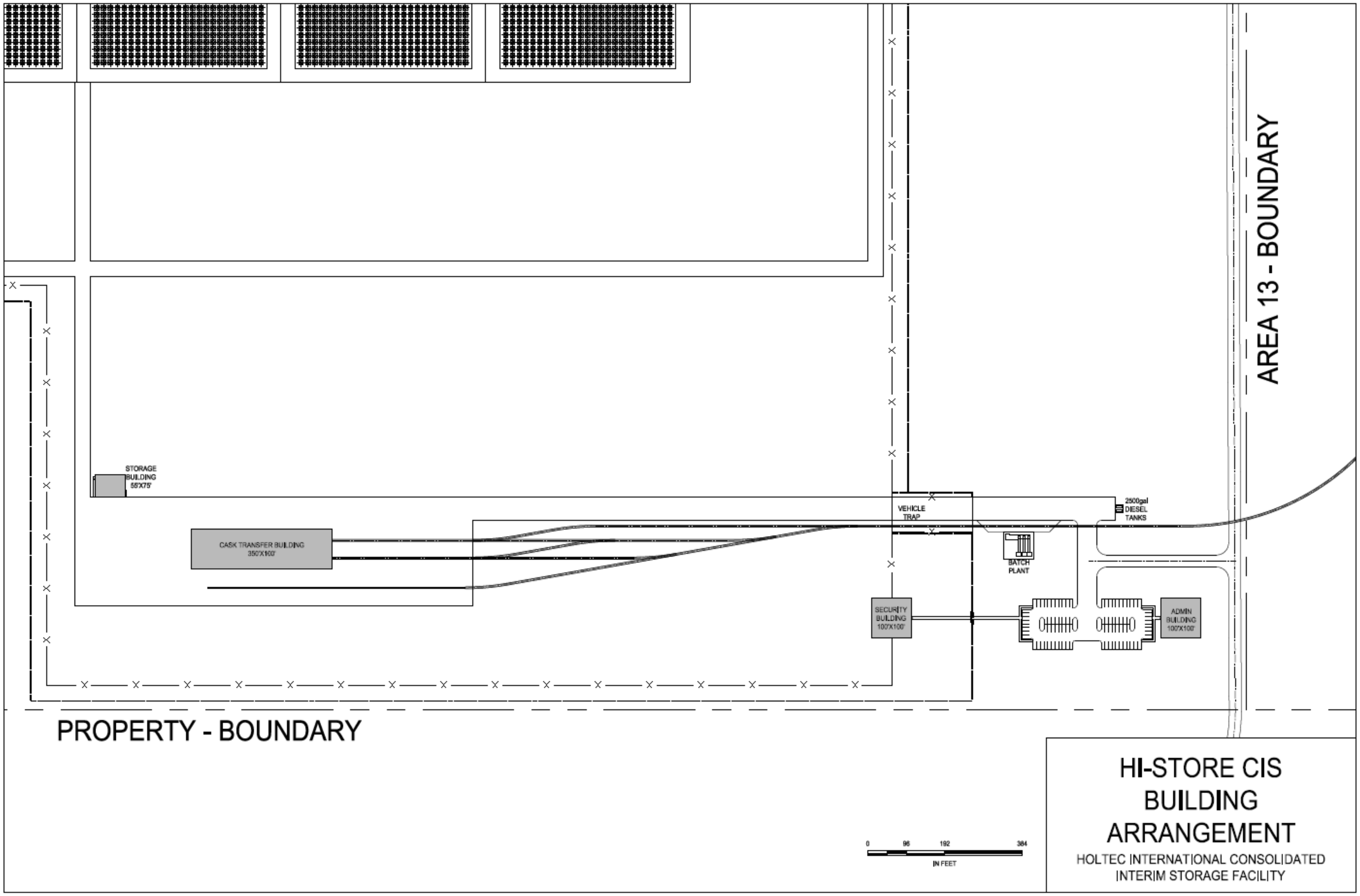


Figure 2.1.6(c): Site Layout [2.1.8]

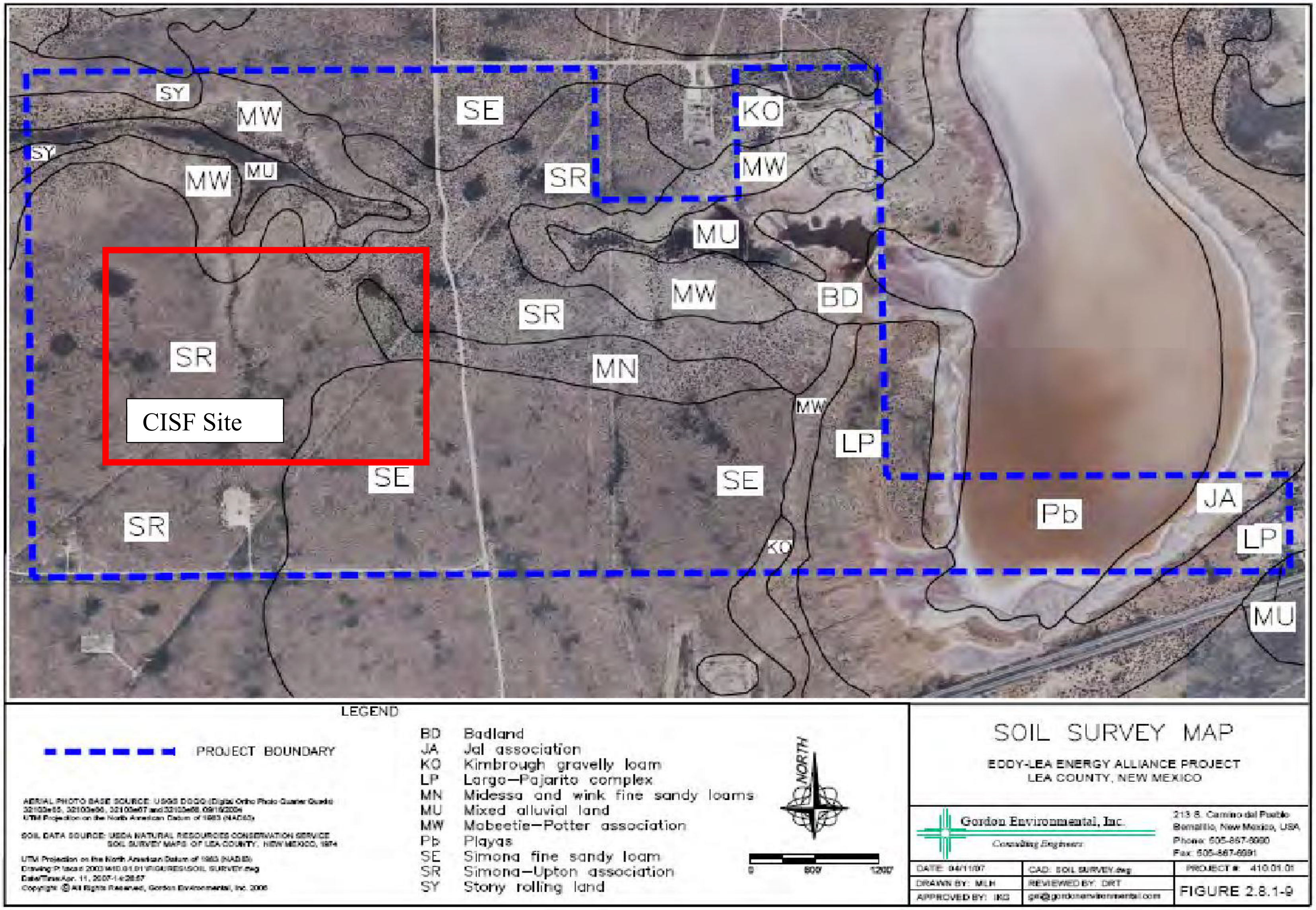


Figure 2.1.7: Soils Survey Map [2.1.3]

Security-Related Information
Withheld under 10 CFR 2.390

Figure 2.1.8: Phase 1 Boring Location Map [2.1.24]

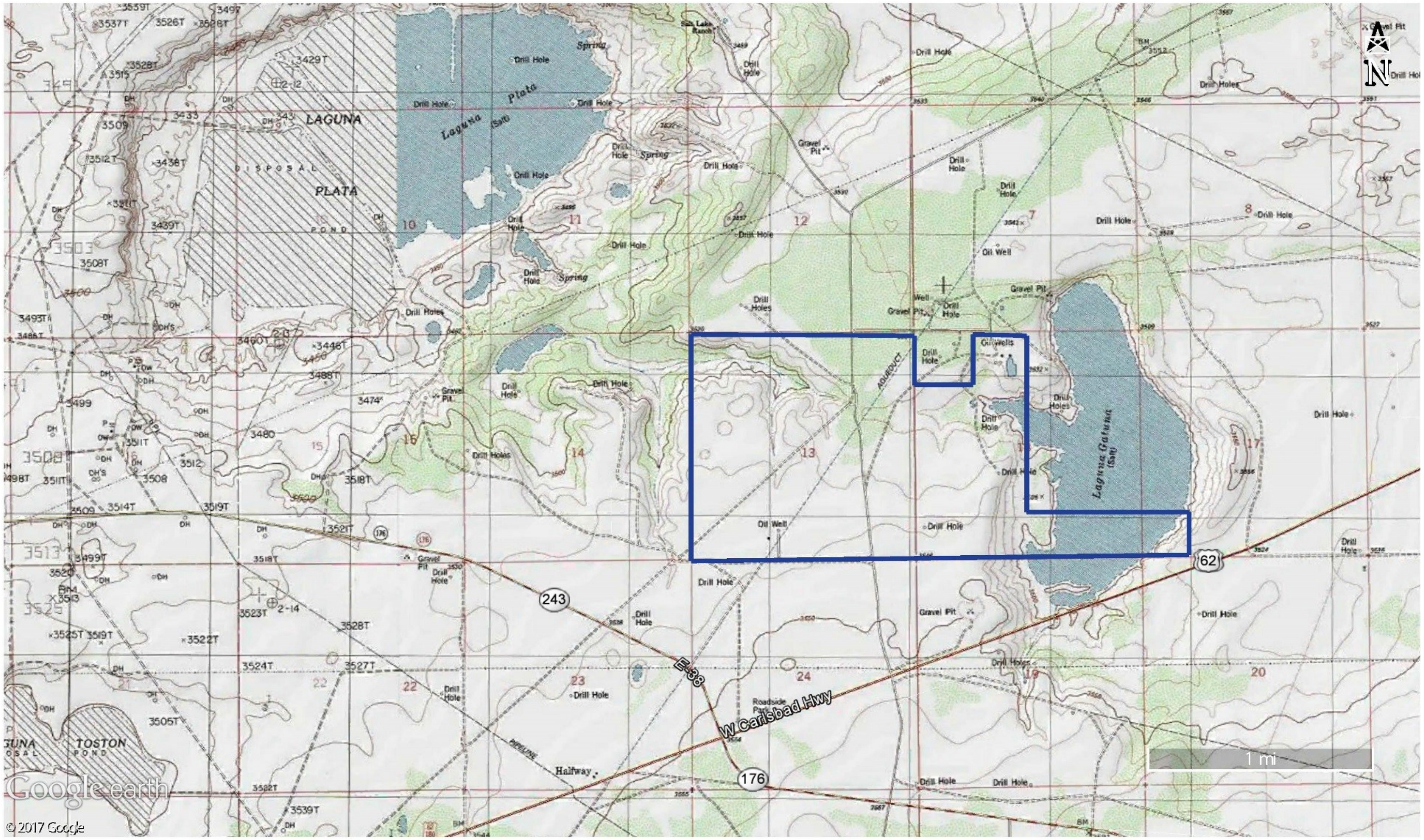


Figure 2.1.9: Topography of Site and Surrounding Area [2.1.3]

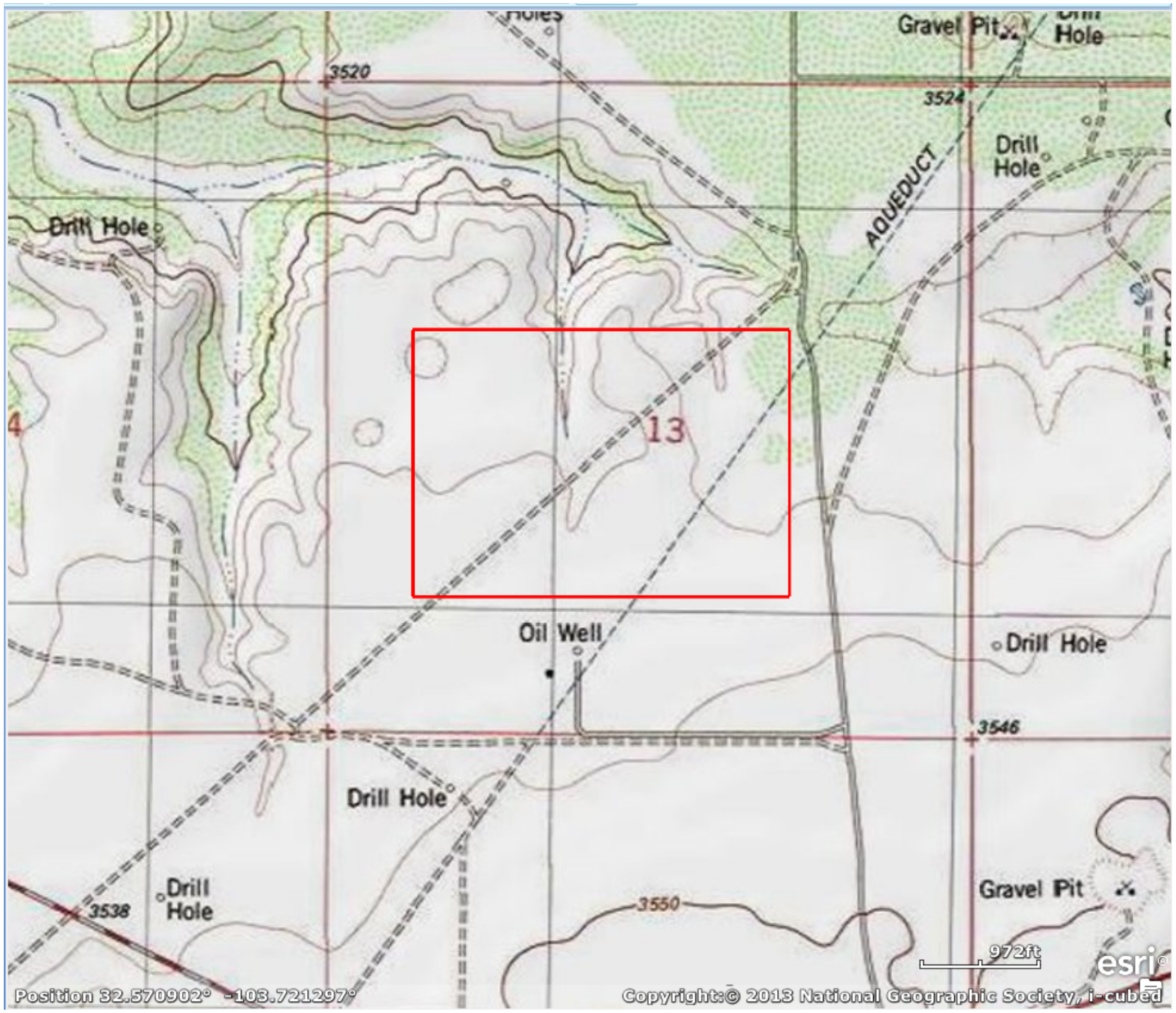


Figure 2.1.10: Topography of Site and Surrounding Area [2.1.3]

Figure 2.1.11: Topography of Site and Surrounding Area [2.1.3]

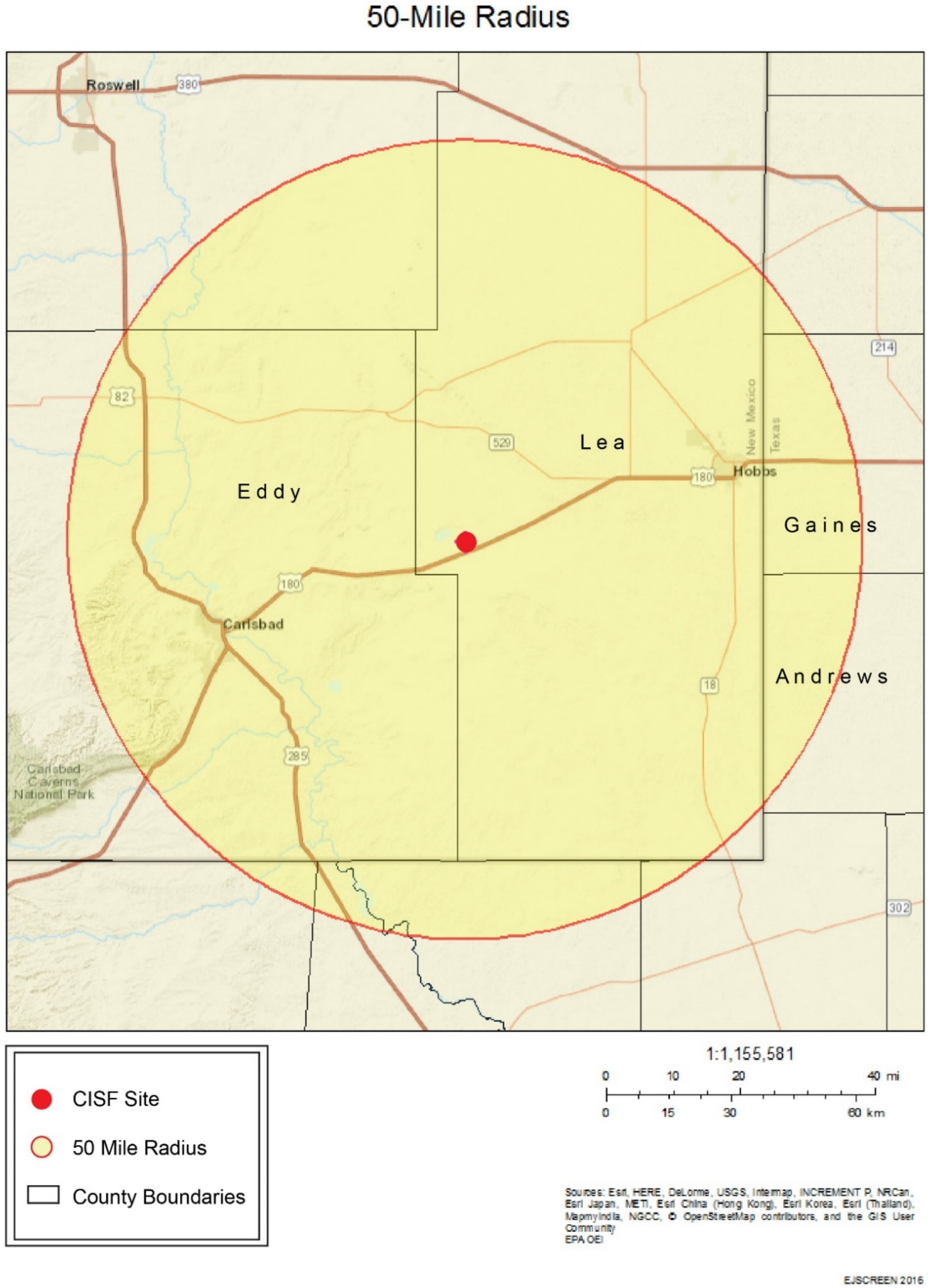


Figure 2.1.12: Region of Influence with a 50-Mile Radius of the Site [2.1.13]

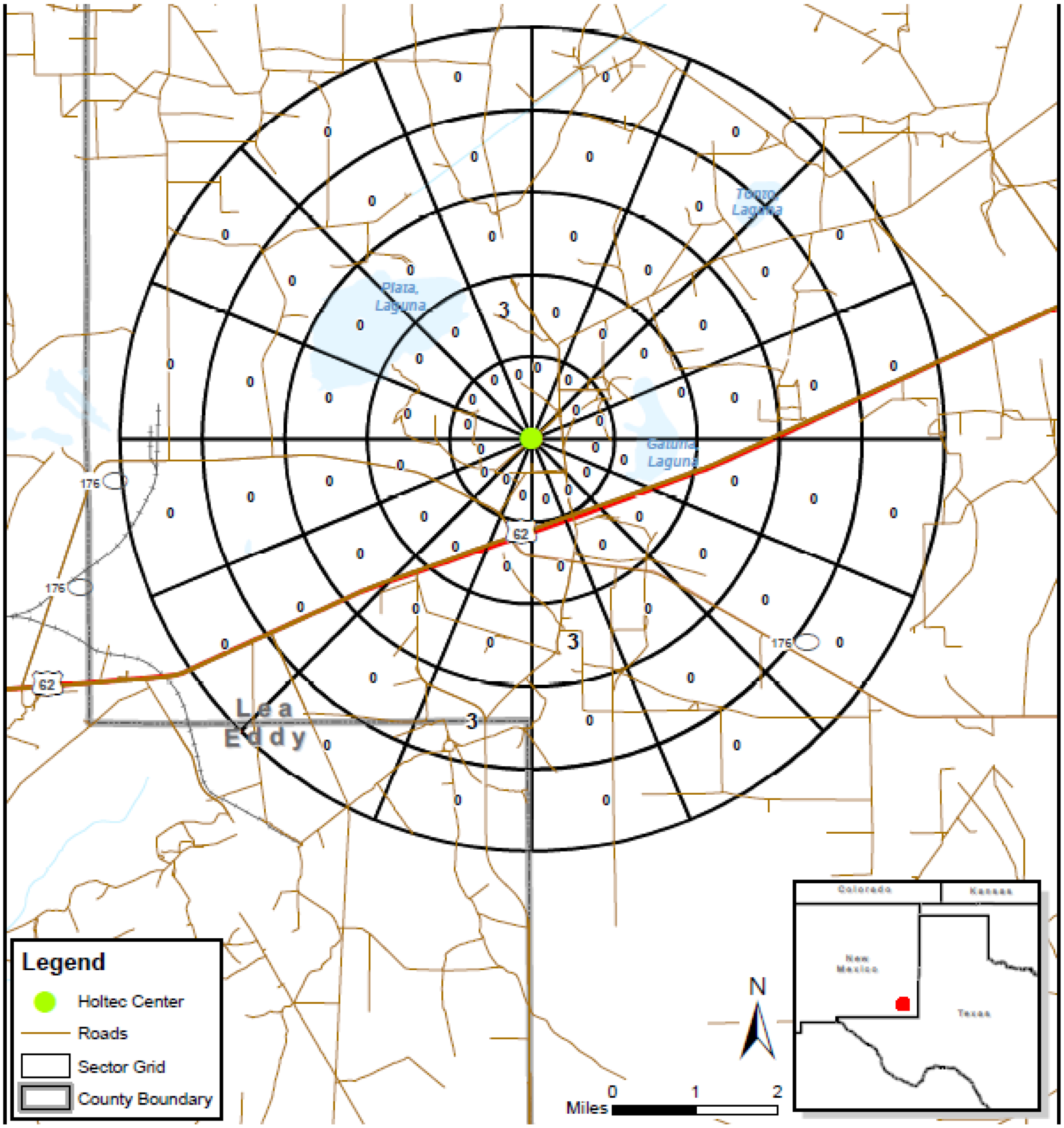


Figure 2.1.13: Sector Population Map

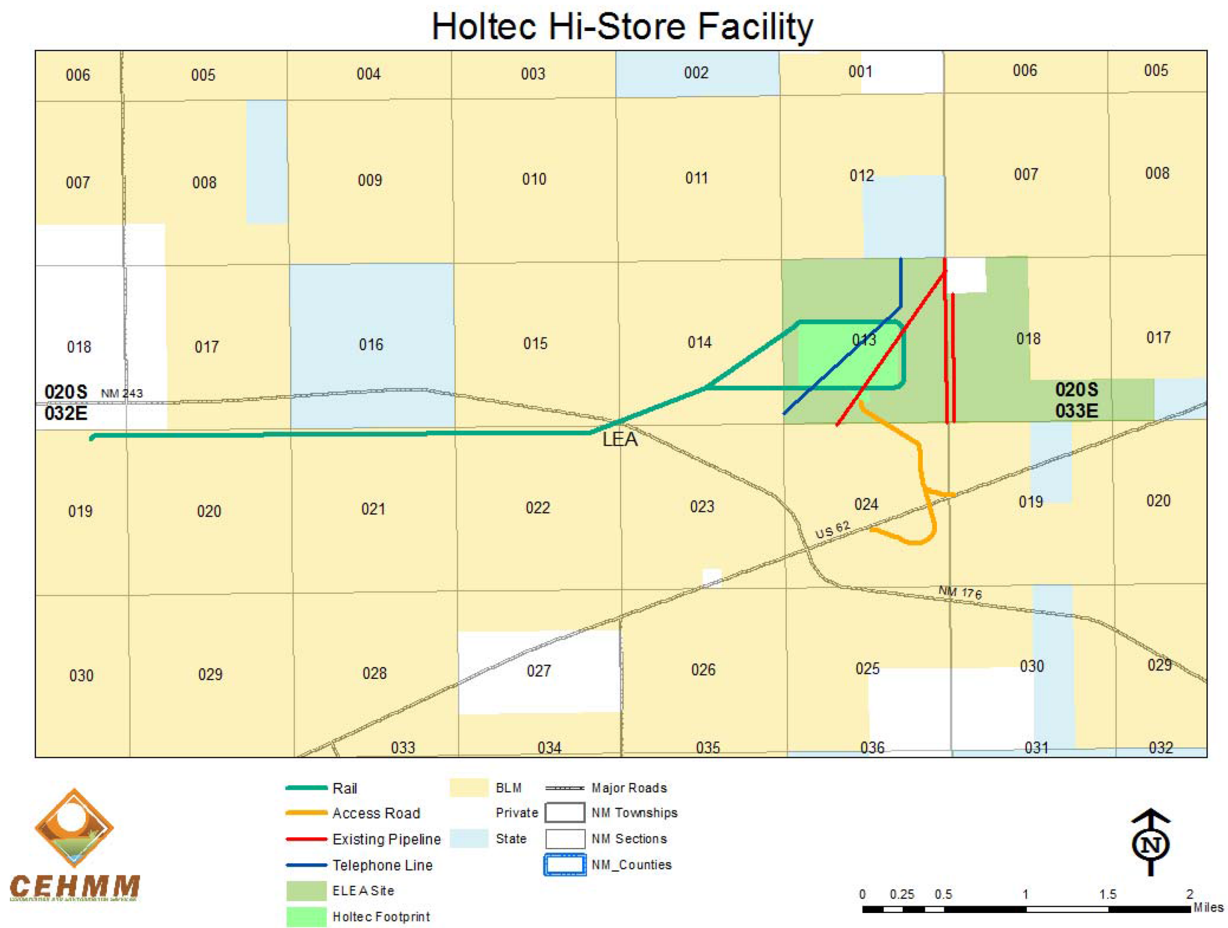


Figure 2.1.14: Surface Land Ownership in the Vicinity of the Site [2.1.23]

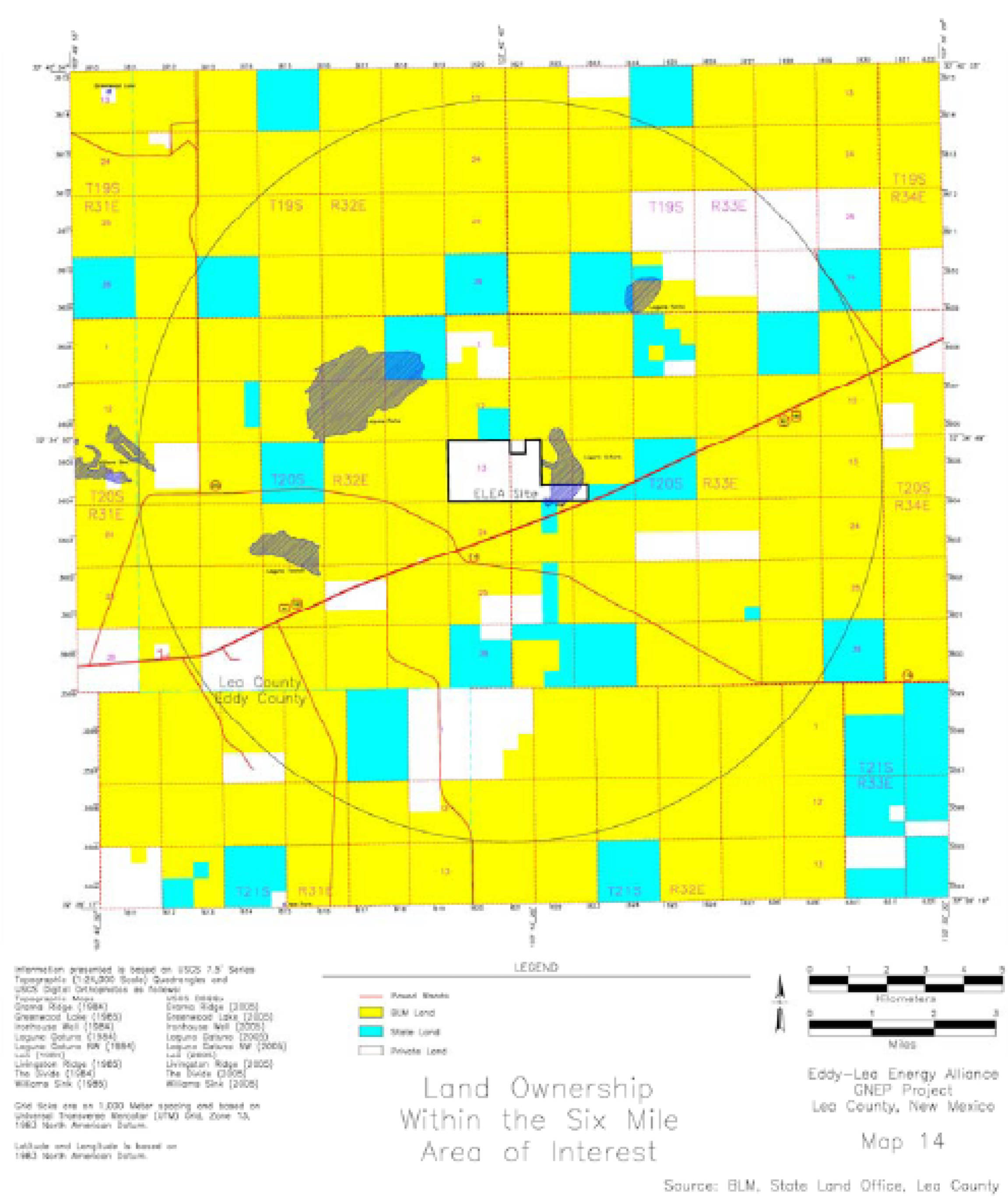


Figure 2.1.15: Land Ownership near the CIS Facility Site

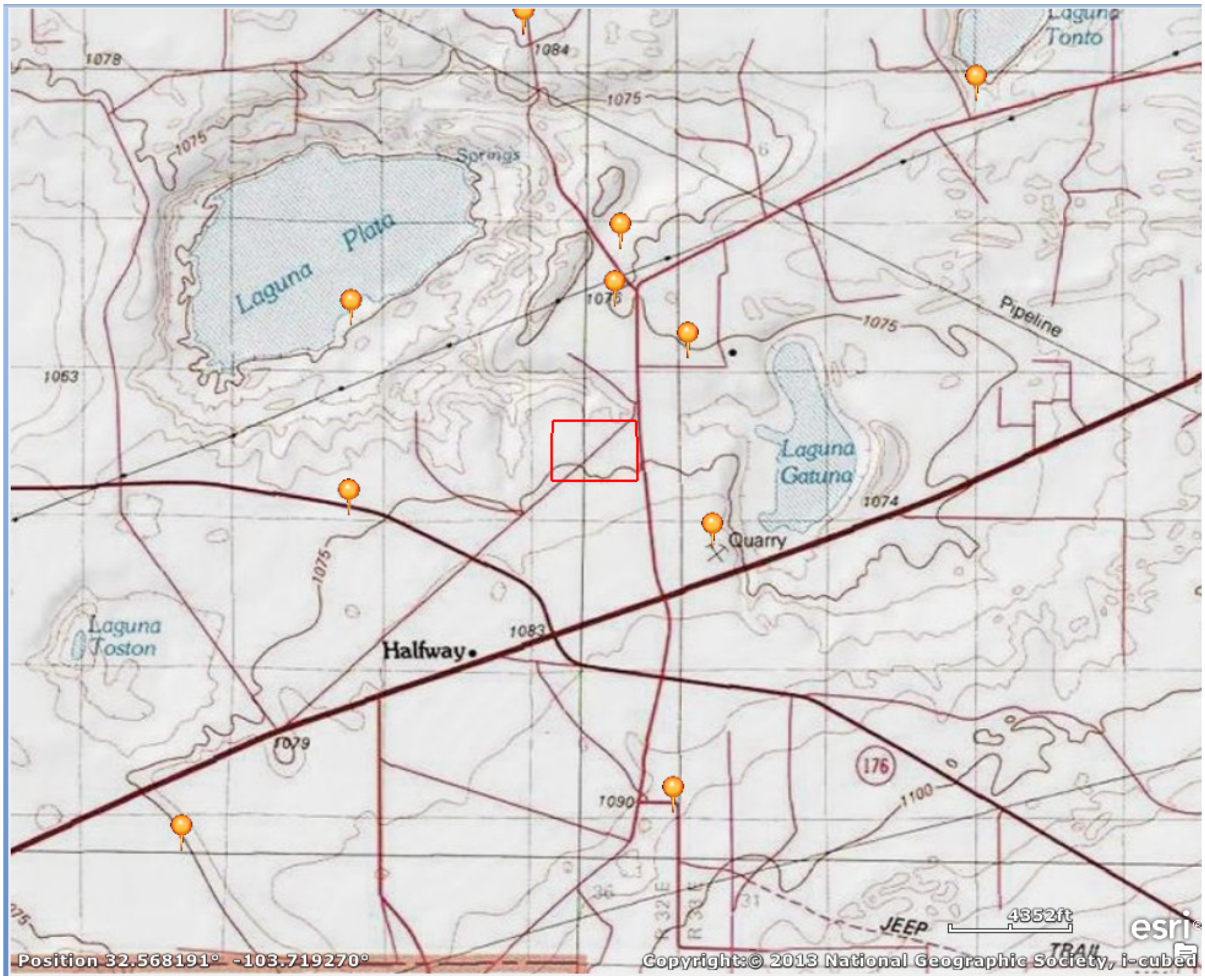


Figure 2.1.16: Mineral Resources near the Site

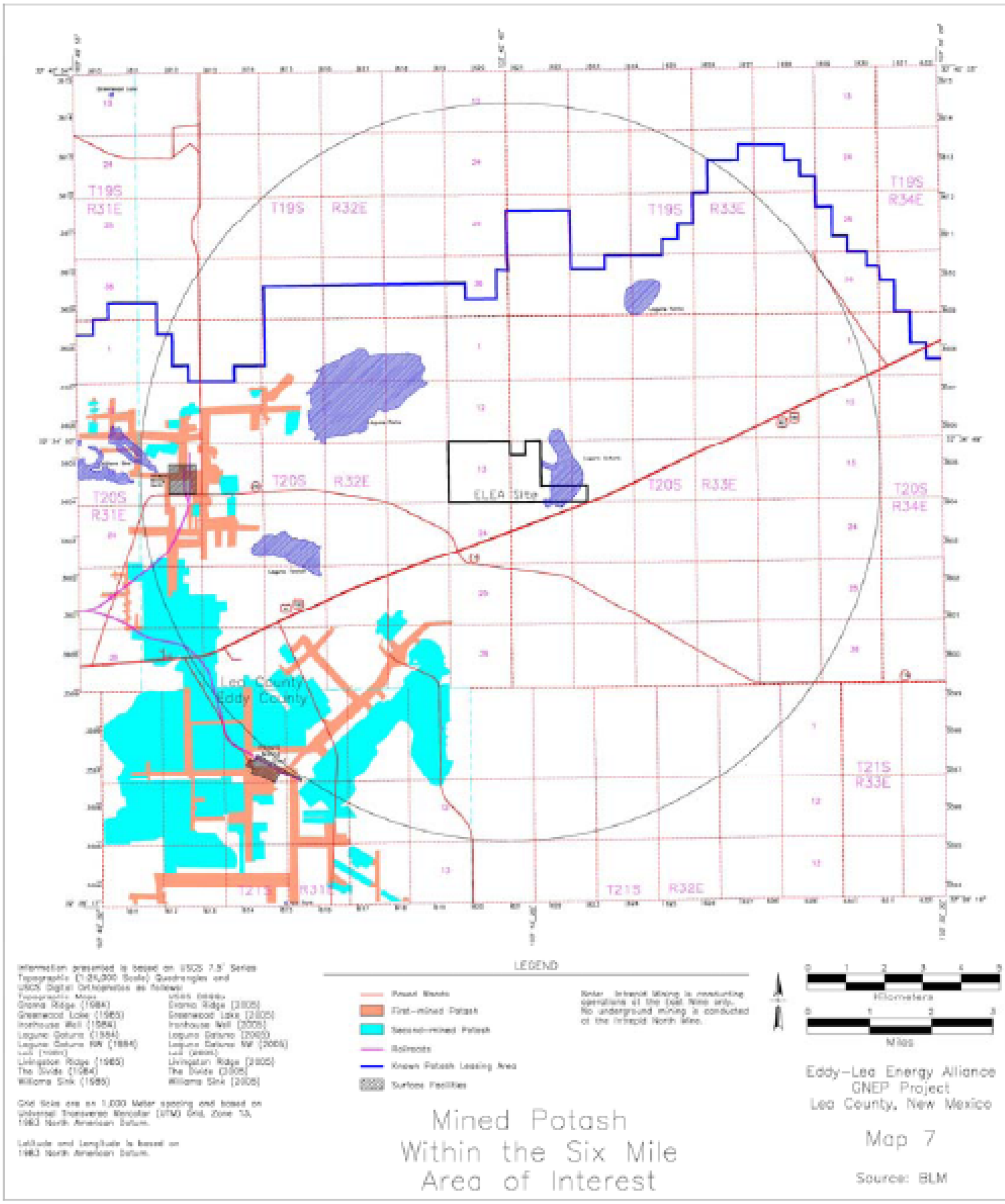


Figure 2.1.17: Mined Potash near the CIS Facility Site

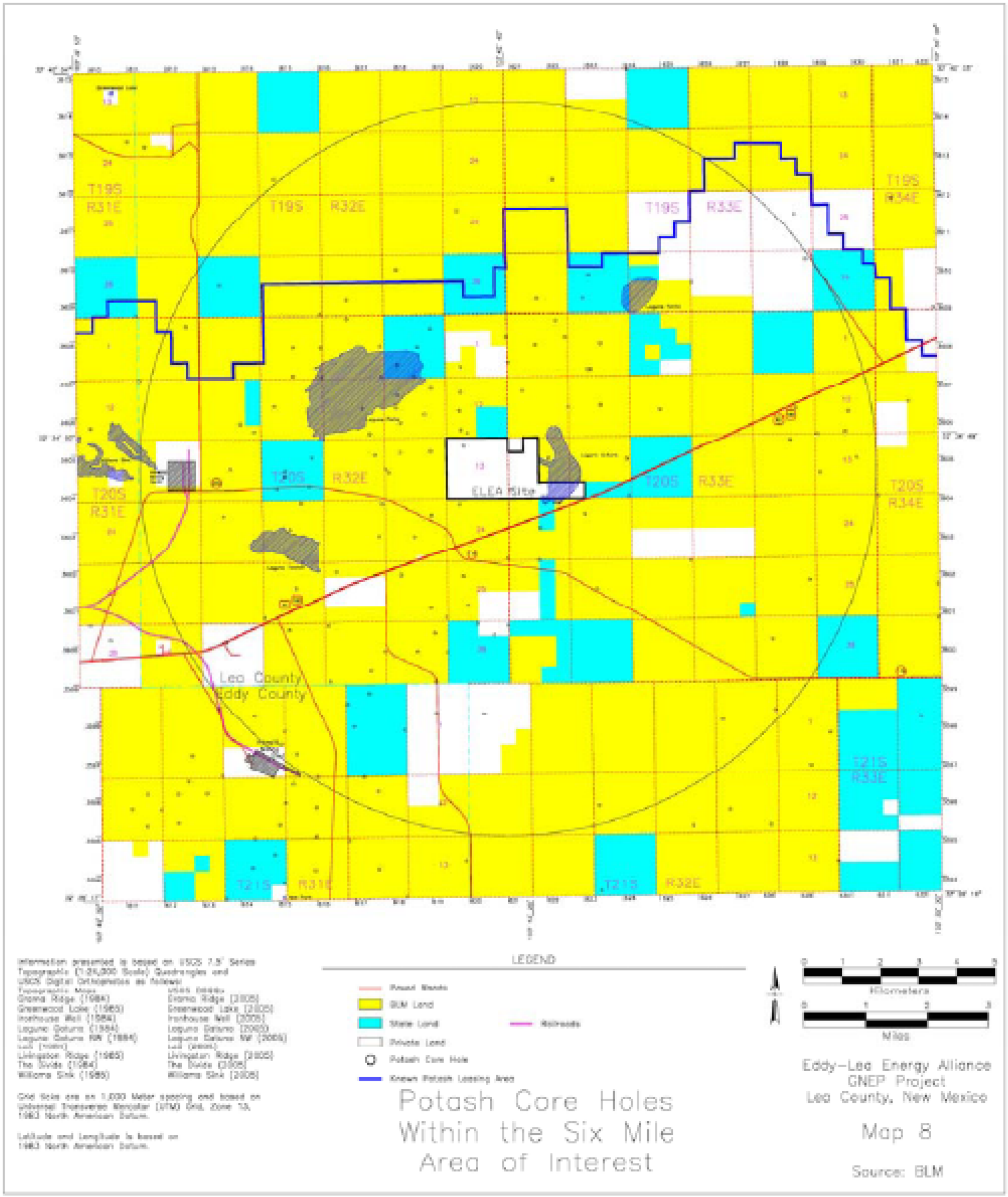


Figure 2.1.18: Potash Core Holes near the CIS Facility Site

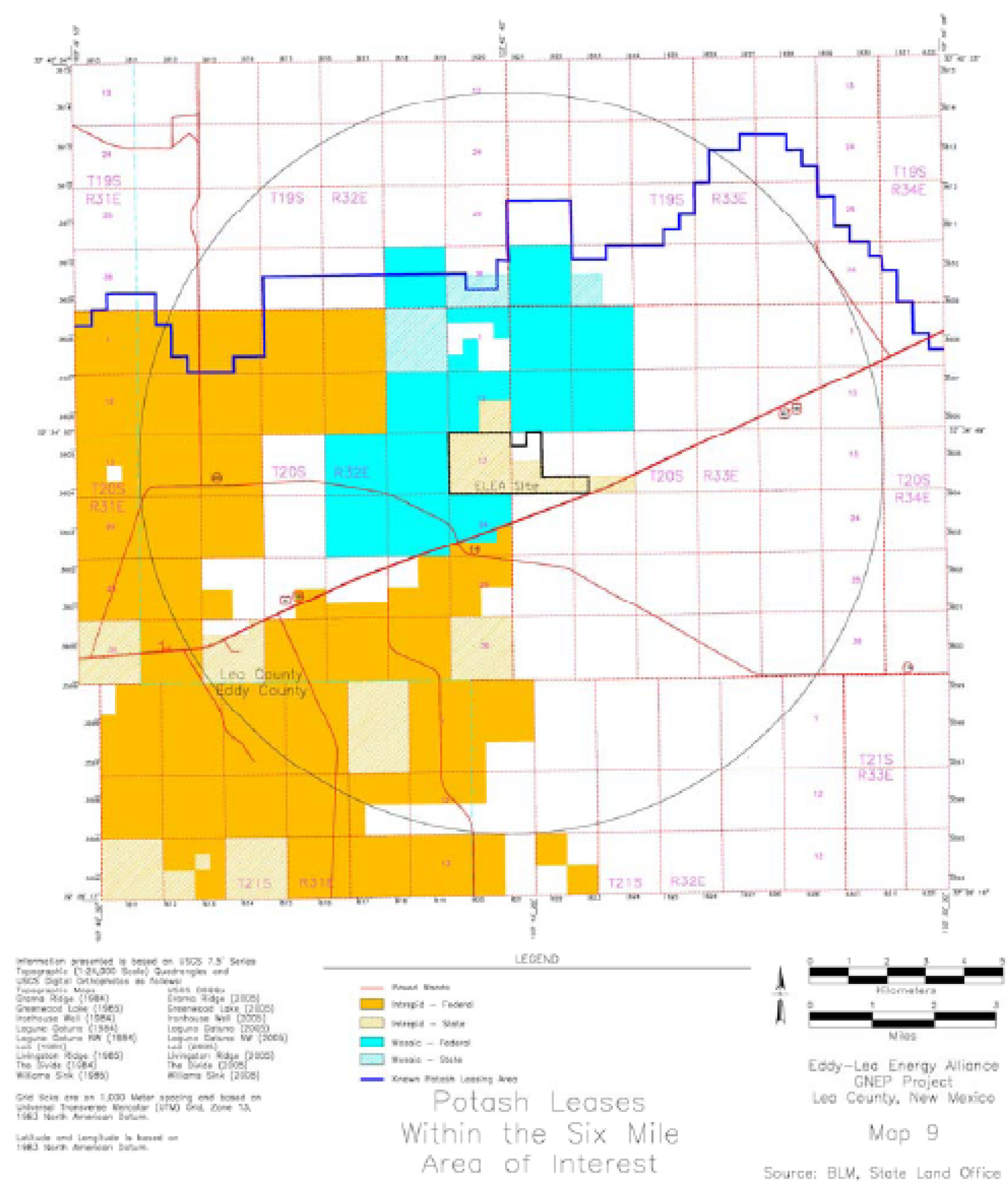


Figure 2.1.19: Potash Leases near the CIS Facility Site

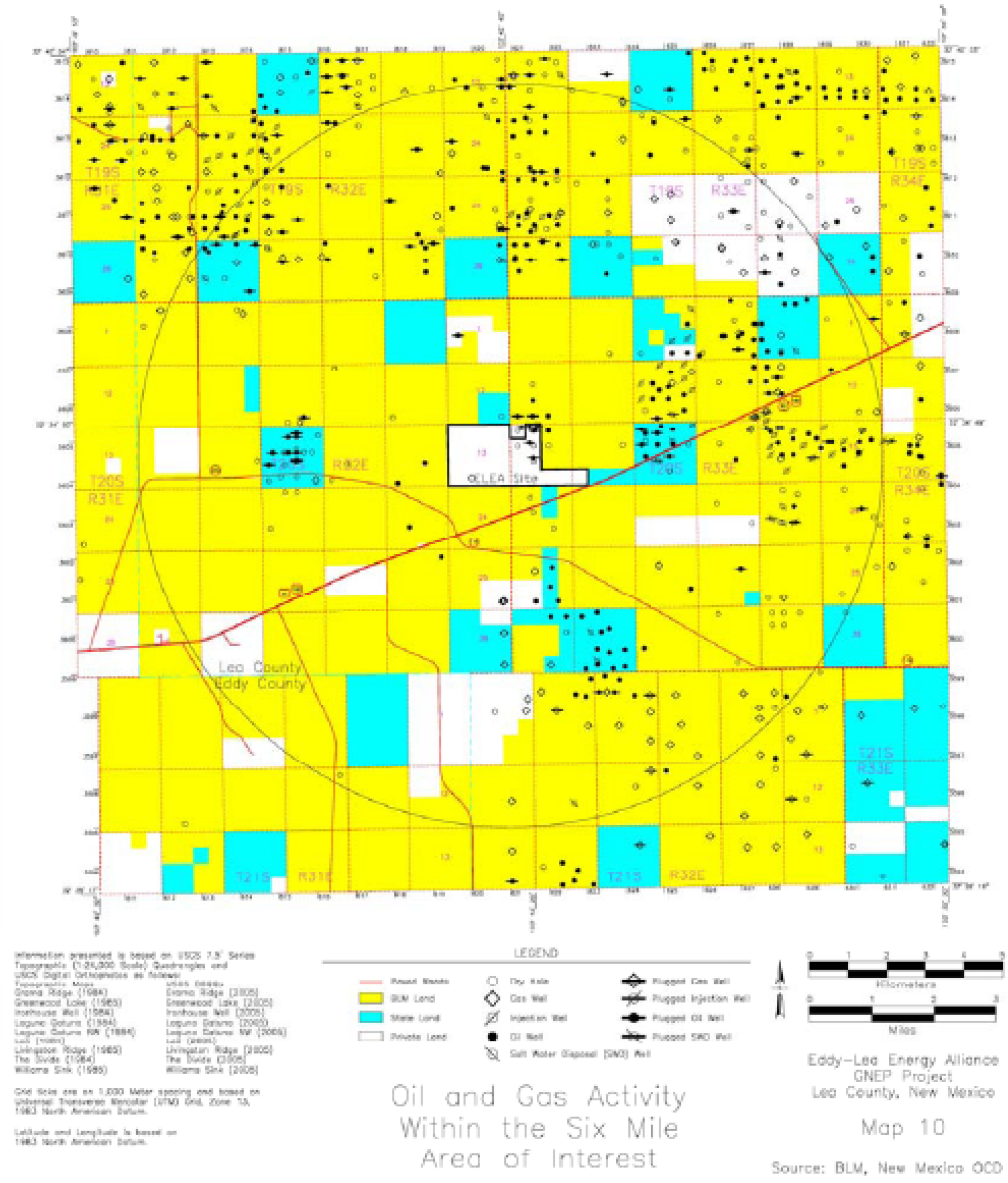
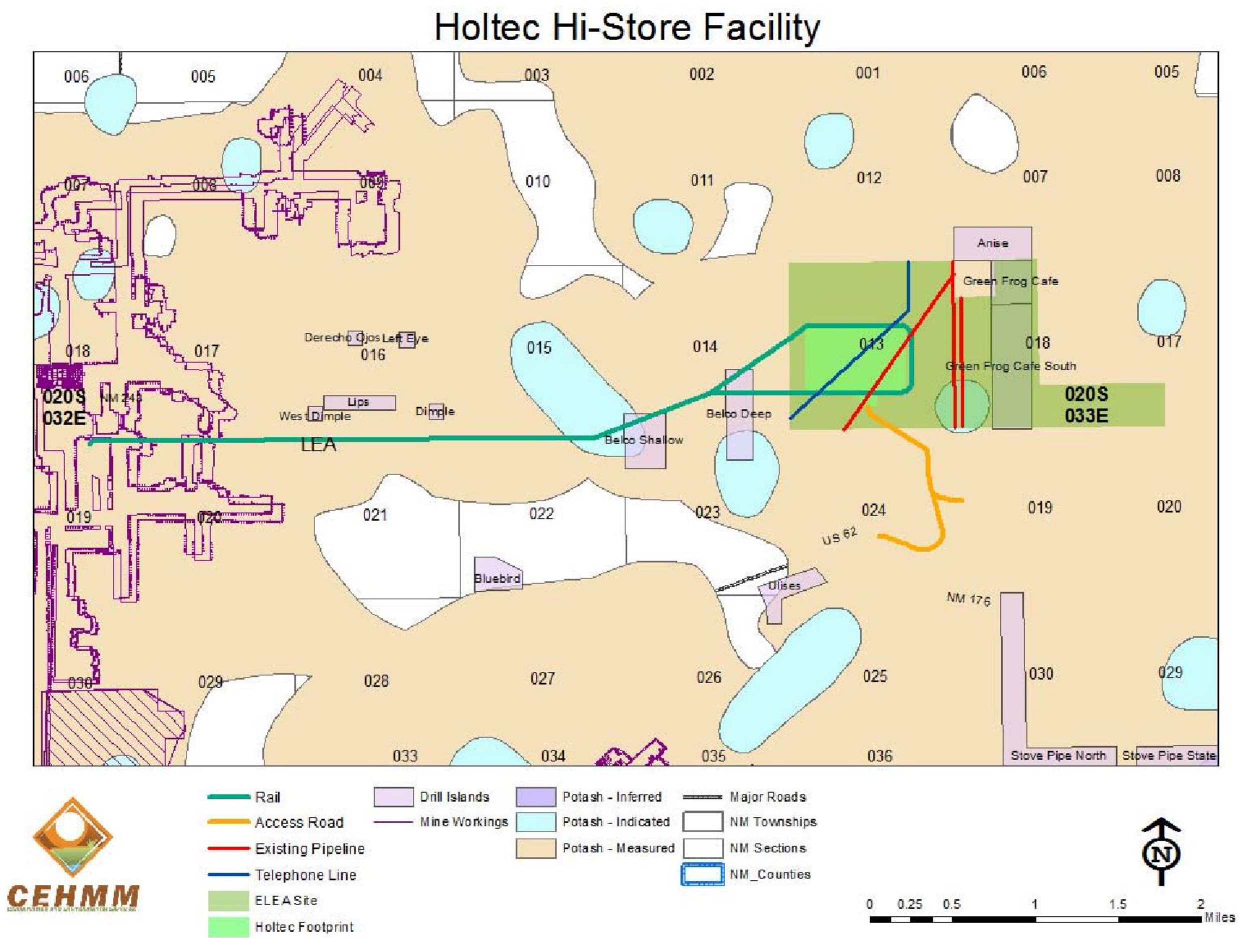


Figure 2.1.20: Oil and Gas Activity near the CIS Facility Site



Map of Potash Conflicts

Figure 2.1.21: Potash Resources near the Site

2.2 NEARBY INDUSTRIAL, TRANSPORTATION, MILITARY, AND NUCLEAR FACILITIES

2.2.1 Industrial Facilities

Figure 2.2.1 identifies industrial facilities located within approximately 5 miles of the Site. These facilities are:

1. Land Farm — oilfield waste management company that remediates contaminated soil from oil and gas operations. Located 1.9 miles southwest of the Site, contaminated soils are trucked to the facility and remediated using microbial degradation of the hazardous compounds.
2. Potash Facility — National Potash Mine, located approximately 4.2 miles west of the Site. This mine first began operations in 1957. Potassium (mainly) is mined below surface with boring machines and lifted to the surface through shafts using hoists.
3. Transwestern — gas pipeline compressor station located approximately 5.2 miles southwest of the Site. This station consists of a small building with compressors used to compress natural gas, transporting it through the gas pipeline.
4. Caliche — mining operation located approximately 4 miles southwest of the Site. Caliche generally occurs on or near the surface or at depths of 10-20 feet. Caliche is mined using traditional excavation machinery and is used in construction applications.

None of the facilities located within 5 miles of the Site are engaged in operations that would pose a hazard to the Site or affect the design basis of the Site.

2.2.2 Pipelines

There are approximately 27,000 miles of energy-related pipelines in New Mexico that are regulated by the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA). Three pipelines are currently near the CIS Facility Site: (1) a Transwestern (TW) 20-inch diameter natural gas pipeline located approximately 0.8 miles from the western boundary of the Site, and (2) a DCP Midstream (DCP) 20-inch diameter natural gas pipeline located approximately 0.16 miles east of the eastern boundary of the Site; and (3) a DCP 10-inch diameter natural gas pipeline located approximately 0.17 miles east of the eastern boundary of the Site. The two 20-inch pipelines are classified as high-pressure pipelines rated for a pressure of 1,180 pounds per square inch (psi). They are normally operated at a pressure of approximately 680 psi. A fourth pipeline is proposed to be constructed near the two DCP pipelines east of the CIS Facility Site. That pipeline would be a 10.75-inch diameter low-pressure natural gas pipeline and would run south-to-north between the two existing pipelines which are east of the CIS Facility [2.2.1].

PHMSA has collected pipeline incident reports since 1970. Although the reporting regulations and incident report formats have changed several times over the years, PHMSA merged the various report formats to create pipeline incident trend lines going back 20 years. PHMSA defines significant incidents based on any of the following conditions:

- Fatality or injury requiring in-patient hospitalization;
- $50,000 or more in total costs, measured in 1984 dollars; or
- Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more [2.2.4].

Tables 2.2.1 and 2.2.2 identify significant incidents over the past 20 years involving PHMSA-regulated pipelines in the U.S. and in New Mexico, respectively.

The most significant incident in New Mexico occurred on August 19, 2000, when a 30-inch diameter El Paso Natural Gas pipeline ruptured near Carlsbad, New Mexico. That incident killed 12 members of an extended family camping over 600 feet from the rupture point. The force of the escaping gas created a 51-foot-wide crater about 113 feet along the pipe. A 49-foot section of the pipe was ejected from the crater, in three pieces measuring approximately 3 feet, 20 feet, and 26 feet in length. The largest piece of pipe was found about 287 feet northwest of the crater. The cause of the failure was determined to be severe internal corrosion of that pipeline [2.2.3].

In order to determine whether the potential failure of a pipeline could have significant impact on people or property, the PHMSA has developed a calculation that accounts for the size of the pipeline and the maximum allowable operating pressure. The term "PIR" means the radius of a circle within which the potential failure of a pipeline could have significant impact on people or property. The PIR is determined by the following formula:

$$r = 0.69 \cdot \sqrt{p \cdot d^2}$$

where:

r = the PIR in feet,
p = the pipeline maximum operating pressure in pounds per square inch (psi), and
d = the nominal pipeline diameter in inches [2.2.2].

Figure 2.2.2 depicts a graphic representation of the results of that formula. As can be seen from that figure, for the maximum expected diameter pipeline (42-inch) operating at the maximum pressure (1450 psi), the hazard area radius is not expected to exceed approximately 1,100 feet from the explosion. For the CIS Facility, there are no pipelines in the vicinity greater than 20-inch diameter or with operating pressures greater than 1,180 psi. As shown on Figure 2.2.2, for a 24-inch diameter pipeline with an operating pressure of approximately 1,180 psi, the hazard area radius is not expected to exceed approximately 600 feet from the explosion. All pipelines near the CIS Facility are located more than 600 feet from the Site boundary, and more than 1 mile from the ISFSI.

Table 2.2.3 presents a summary of some of the most relevant pipeline explosions that have occurred in the U.S. since approximately 1969. As can be seen from that table, impacts occurred within 1,000 feet of all explosions. Given that there are no pipelines within one-half mile of the proposed operations at the CIS Facility, it would be extremely unlikely for a pipeline rupture to impact operations at the facility.

With regard to past operations at the site involving an oil recovery facility with tanks within the CIS Facility Site boundary, it should be noted that there are no oil recovery operations presently occurring on the Site and none are reasonably foreseeable. There are 7 aboveground storage tanks (ASTs) associated with past brine disposal activities on the site. These ASTs are holding tanks that were used for storing brine and settling solids and separating residual oil from oil-field brines. 'The tanks range in size from 150 barrels to 250 barrels. These holding tanks or ASTs are not in use. No containers of hazardous substances have been noted in prior site visits (2007) or most recent site visits (2016). Within Section 13, which is where the CIS Facility would be located, two additional tanks (250 gallon barrels) are present at the well location in the southwest portion of the Site. One active oil/gas well on the southwest portion of Section 13 operates at minimum production to maintain mineral rights.

2.2.3 Air Transportation

The airspace surrounding the CIS Facility is unrestricted and at any given time there would be the potential for commercial aircraft, military aircraft, and civilian aircraft to be flying in that airspace at various altitudes and at various speeds. Commercial aircraft would fly in accordance with flight plans filed with the Federal Aviation Administration (FAA) and would be controlled by the national air traffic control system [2.2.5].

Because airspace above the United States from the surface to 10,000 feet above sea level is limited to 250 knots (indicated airspeed) by FAA regulations, any aircraft below 10,000 feet would be travelling at speeds of less than 250 knots. There is a military exception to this requirement, however. The Military Training Route Program is a joint venture by the FAA and the Department of Defense (DOD), developed for use by military aircraft to gain and maintain proficiency in tactical "low-level" flying. These low-level training routes are generally established below 10,000 feet for speeds in excess of 250 knots. Military training routes do not constitute an official airspace, and are all open to civilian traffic [2.2.9].

There are four designated military training routes in the vicinity of the proposed CIS Facility: (1) Instrument Route (IR) 180; (2) IR 192; (3) Visual Route (VR) 291; and (4) VR 102. The routes are individually operated by the military, which schedule and 'own' the route. The FAA requires the military to provide advance notice to other aircraft that the military training routes will be used to allow for civilian traffic to de-conflict if needed. IR 180 is located approximately 10 miles east of the CIS Facility; IR 192 is located approximately 10 miles west of the CIS Facility; VR 291 is located approximately 30 miles north of the CIS Facility; and VR 102 is located above the CIS Facility. Military training routes are usually limited to 420 knots, and in no case are aircraft allowed to exceed Mach 1 within United States sovereign airspace, except in designated Military Operation Areas. While on the route, military aircraft squawk a Mode C Transponder code of '4000', which informs controllers that they are 'speeding' on a route. This squawk however is only legal by military aircraft, while inside a properly scheduled route corridor.

The closest Military Operation Area to the CIS Facility is approximately 30 miles to the west, just north of Carlsbad. A Military Operation Area is airspace designated to separate or segregate certain nonhazardous military activities from non-military traffic [2.2.9].

As discussed below, most of the commercial airline operations at airports in the area of the CIS Facility involve regional jets. The largest commercial planes (Boeing 737s) are flown in and out

of Midland International Air and Space. A summary of the airplane operations at airports near the CIS Facility are provided below.

Cavern City Air Terminal is a public use airport in Eddy County, New Mexico, United States. It is owned by the city of Carlsbad and located five nautical miles southwest of its central business district, approximately 35 miles from the CIS Facility. The airport is served by one commercial airline. In 2015, the airport had approximately 6,900 aircraft operations, an average of 18 per day: 53 percent general aviation, 39 percent scheduled commercial, 4 percent air taxi, and 4 percent military. There are approximately 24 aircraft based at this airport: 67 percent single-engine, 21 percent multi-engine, and 12 percent helicopter [2.2.6].

Lea County Regional Airport is 4 miles west of Hobbs, approximately 30 miles from the CIS Facility. The airport covers 898 acres and has three runways. It is an FAA certified commercial airport served by United Airlines' affiliate with daily regional flights. Lea County Regional Airport is the largest of the three airports owned and operated by Lea County Government. Lea County also owns and operated two general aviation airports in Lovington and Jal, New Mexico. For the 12 month period ending April 30, 2017, the Lea County Regional Airport had approximately 12,745 aircraft operations, an average of 35 per day: 77 percent general aviation, 16 percent air taxi and 7 percent military. There are 47 aircraft based at this airport: 83 percent single-engine, 8 percent multi-engine, 8 percent jet, and 3 percent helicopter [2.2.7].

Midland International Air and Space is located approximately midway between the Texas cities of Midland and Odessa. It is owned and operated by the City of Midland. In September 2014 it became the first US facility licensed by the FAA to serve both scheduled airline flights and commercial human spaceflight. Midland International Air and Space Port is ranked eighth in Texas for primary commercial service airports. For the 12 month period ending April 30, 2017, the airport has approximately 63,000 aircraft operations, averaging 173 per day: 25 percent military, 42 percent general aviation, 15 percent air taxi and 18 percent airline. Approximately 78 aircraft are then based at the airport: 39 percent single-engine, 47 percent multi-engine, 12 percent jet and 2 percent helicopter The airport has three airlines, two serving hubs with regional jets and one (Southwest) flying mainline jets (Boeing 737s) [2.2.8].

2.2.4 Ground Transportation

U.S. Highway 62/180, approximately 1 mile south of the proposed CIS Facility is the closest and most trafficked public road. It provides a route from the state of Texas to Carlsbad, New Mexico and points further west. It is a divided highway with a maximum speed limit of 70 miles per hour in the area near the proposed CIS Facility. This, in addition to other transportation infrastructure near the site, can be seen in Figure 2.2.4. This highway is on the National Hazardous Materials Route Registry (79 FR 40844, July 14, 2014) and can be used for the transportation of radioactive waste materials to WIPP [2.2.10] (Note: as shown on Figure 2.2.5, the WIPP route is approximately 5 miles southwest of the CIS Facility. There have been instances where transuranic wastes associated with WIPP have been transported along U.S. Highway 62/180 within approximately 1 mile of the proposed CIS Facility).

Like similar roads, commercial shipments of hazardous materials are also transported over U.S. Highway 62/180. Such shipments could include a wide range of hazardous materials, including,

but not limited to: gasoline, diesel fuel, acids, carbon dioxide (CO_2), nitrogen (N_2), liquid nitrogen (LN_2), chlorine (Cl) gas, refrigerants, fuel gases, oxygen (O_2), explosives, and low-level radioactive materials. The State of New Mexico does not keep records of hazardous material shipments via roadways or rail. Consequently, specific types and quantities cannot be provided. In 2015, the annual average daily traffic on U.S. Highway 62/180 was 5,696 vehicles per day in the vicinity of the proposed Site (near the Eddy-Lea County line) and approximately 43 percent of these vehicles were associated with commercial trucks [2.2.12]. In 2014, in the entire state of New Mexico, there were 69 Hazardous Material Incidents required to be reported by 49 CFR §§ 171.15 and 171.16 [2.2.11]. While truck shipments in the area are expected to rise over time, this highway is not included in the planning for increasing freight traffic in the "New Mexico Freight Plan" [2.2.13].

The nearest operating railroad is an industrial railroad approximately 3.8 miles west of the proposed CIS Facility and serves the local potash mines to transport ore to the refiners. The potash ore is not a hazardous material. From 2008 to 2012, the annual average of train accidents per 1,000 railroad miles was 10.4, the fatality rate was zero and the injury rate was 0.4 [2.2.13]. As with highway transport, shipments by rail could include a wide range of hazardous materials, including, but not limited to: gasoline, diesel fuel, acids, CO_2, N_2. LN_2, Cl gas, refrigerants, fuel gases, O_2, explosives. However, no specific records are maintained by the state of New Mexico regarding hazardous material shipments via rail. All transportation infrastructure can be seen in Figure 2.2.5.

2.2.5 Nuclear Facilities

With regard to nuclear facilities, Figure 2.2.5 depicts existing or planned nuclear facilities in the vicinity of the Site. As shown on that Figure, all of these facilities would be within 50-miles of the proposed Site. A brief description of these other nuclear facilities follows:

1. **Waste Isolation Pilot Plant (WIPP)**: Located approximately 16 miles southwest of the proposed Site, WIPP is the nation's first underground repository permitted to safely and permanently dispose of transuranic (TRU) radioactive and mixed waste generated through defense activities and programs. WIPP, which has been operational since March 1999, stores TRU in underground salt caverns approximately 2,150 feet deep. From the first receipt of waste in March 1999 through the end of 2014, approximately 90,983 cubic meters of TRU waste has been disposed of at the WIPP facility. The environmental impacts of the WIPP are described in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE/EIS-0026-S2) [2.2.14], as well as the *Waste Isolation Pilot Plant Annual Site Environmental Report for 2014* [2.2.15].
2. **National Enrichment Facility (NEF)**: Located approximately 38 miles southeast of the proposed Site, the NEF is used to enrich uranium for use in manufacturing nuclear fuel for commercial nuclear power reactors. NEF enriches uranium using a gas centrifuge process. The environmental impacts of the NEF are documented in NUREG-1790 [2.2.16].
3. **Fluorine Extraction Process & Depleted Uranium De-conversion Plan (FEP/DUP)**: Located approximately 23 miles northeast of the proposed Site, the FEP/DUP will de-

convert depleted uranium hexafluoride (DUF6) into fluoride products for commercial resale and uranium oxides for disposal. Construction of that facility is expected to begin before the end of 2016. The environmental impacts of the FEP/DUP are documented in NUREG-2113 [2.217].

4. **Waste Control Specialists (WCS) CIS Facility**: In May 2016, WCS submitted a license application to the NRC to construct and operate a CIS Facility in Andrews County, Texas, approximately 39 miles east of the Holtec proposed Site. The WCS CIS Facility would be similar to the Holtec Site, but would utilize AREVA’s horizontal canister storage system (NUHOMS) at the facility. A limited number of vertical canisters supplied by NAC may also be stored. The environmental impacts of the WCS CIS Facility are documented in an ER which WCS submitted to the NRC in May 2016 [2.2.18]. In addition, the NRC is expected to prepare an EIS for the WCS CIS Facility.

Table 2.2.1: Significant Incidents in U.S. Involving Pipelines (1997-2016) [2.2.4]

Calendar Year	Number	Fatalities	Injuries	Total Cost Current Year Dollars
1997	267	10	77	$110,377,793
1998	295	21	81	$174,516,797
1999	275	22	108	$178,313,209
2000	290	38	81	$257,659,464
2001	233	7	61	$79,086,596
2002	258	12	49	$124,067,949
2003	297	12	71	$163,459,897
2004	309	23	56	$314,362,210
2005	336	16	46	$1,476,994,582
2006	257	19	34	$157,117,098
2007	265	15	46	$147,800,810
2008	278	8	54	$592,290,867
2009	275	13	62	$180,360,208
2010	264	19	103	$1,854,123,037
2011	287	12	51	$447,059,777
2012	254	10	54	$233,813,285
2013	304	8	42	$355,213,552
2014	301	19	94	$305,253,746
2015	328	10	49	$338,297,939
2016	306	16	82	$301,612,864
Grand Total	**5,679**	**310**	**1,301**	**$7,791,781,681**

Table 2.2.2: Significant Incidents in New Mexico Involving Pipelines (1997-2016) [2.2.4]

Calendar Year	Number	Fatalities	Injuries	Total Cost Current Year Dollars
1997	4	0	0	$8,575
1998	6	0	1	$411,056
1999	11	0	1	$1,796,066
2000	3	12	0	$2,019,207
2001	6	0	5	$481,449
2002	8	0	0	$366,976
2003	7	1	1	$730,327
2004	6	0	2	$401,852
2005	6	0	1	$478,356
2006	4	0	2	$794,157
2007	6	2	0	$1,023,842
2008	7	0	2	$1,087,684
2009	5	0	4	$320,218
2010	2	0	1	$133,880
2011	5	0	0	$726,725
2012	3	0	1	$577,414
2013	4	0	0	$1,295,874
2014	3	0	0	$250,297
2015	7	0	0	$1,336,314
2016	7	0	0	$825,006
Grand Total	**110**	**15**	**21**	**$15,065,275**

Table 2.2.3: Notable Significant Incidents Involving Pipelines [2.2.2]

Date	Report	Location	Incident	Damage	Maximum Burn Distance	Diameter (in)	Pressure (psi)
1969	NTSB-PAR-71-1	near Houston, Texas	Rupture at 3:40 p.m. on September 9th, explosive ignition 8 to 10 minutes after failure.	Burned area 370 ft long by 300 ft wide (all to one side). Houses destroyed by blast to 250 ft, heat damage to 300 ft, 106 homes damaged, 9 injuries, and 0 fatalities.	300 ft	14	789
1974	NTSB-PAR-75-2	near Bealeton, Virginia		Burned area 700 ft by 400 ft.		30	718
1974	NTSB-PAR-75-3	near Farmington, New Mexico	Rupture at 3:45 a.m. on March 15th, ignition soon after failure.	Earth charred within a 300 ft diameter circle, 3 fatal injuries (within 60 ft offset)		12.75	497
1976	NTSB-PAR-77-1	Cartwright, Louisiana	Rupture at 1:05 p.m. on August 9th, ignited within seconds	Burn area 3 acres (implies a 200 ft radius circle), 6 fatalities (within about 100 ft offset) and 1 injury.		20	770
1982	NTSB-PAR-83-2	Hudson, Iowa		5 fatalities (within 150 ft, less than 50 ft offset).		20	820
1984	NTSB-PAR-86-1	near Jackson, Louisiana	Rupture at 1:00 p.m. on November 25th, ignition soon after failure.	Burned area 1450 ft long by 360 ft wide (furthest fire extent 950 ft), 5 fatalities (within 65 ft, 0 ft offset), and 23 injuries (within 800 ft,180 ft offset).	Offset 180 ft. Distance 950 ft.	30	1016
1985	NTSB-PAR-87-1	near Beaumont, Kentucky	Rupture at 9:10 p.m. on April 27th, ignition soon after failure.	Burned area 500 ft wide by 700 ft long. 2 houses, 3 house trailers and numerous other structures and equipment destroyed. 5 fatalities due to smoke inhalation in house 318 ft from rupture (150 ft offset), 3 people burned running from house 320 ft from rupture (200 ft offset) one hospitalized with 2nd degree burns.	Offset 350 ft. Distance 500 ft.	30	990
1986	NTSB-PAR-87-1	near Lancaster Kentucky	Rupture at 2:05 a.m. on February 21st, ignition soon after failure.	Burned area 900 ft by 1000 ft. 2 houses, 1 house trailer and numerous other structures and equipment destroyed. 3 people burned running from house 280 ft from rupture (requiring hospitalization), 5 others received minor burn injuries running from dwellings between 200 and 525 ft from rupture (250 ft offset).	Offset 700 ft. Distance 800 ft.	30	987
1994	NTSB-PAR-95-1	Edison, New Jersey	Rupture at night on March 23rd, ignition within 1 to 2 minutes after failure.	Burned area 1400 ft long by 900 ft wide. Fire damage to dwelling units up to 900 ft from rupture, dwelling units at 500 ft and beyond caught fire between 7 to 10 minutes after failure, no fatalities but 58 injuries.	Offset 720 ft. Distance 960 ft.	36	970
1994	TSB Report No. P94H0003	Maple Creek, Saskatchewan	Rupture at 7:40 p.m. on February 14th, ignition soon after failure.	Fire burn area 21.0 acres (8.5 hectares).		42	1207
1994	TSB Report No. P94H0036	Latchford, Ontario	Rupture at 7:13 a.m. on July 23rd, ignition soon after failure.	Fire burn area 11.8 acres (4.77 hectares), heat-affected area 18.6 acres (7.52 hectares).		36	1000
1995	TSB Report No. P95H0036	Rapid City, Manitoba	Rupture of 42 inch line at 5:42 a.m. on July 29th, ignition soon after failure leading to rupture and fire on adjacent 36 inch line at 6:34 a.m.	Fire burn area 48.5 acres (19.6 hectares), heat-affected area 198 acres (80 hectares).		42	880

Figure 2.2.1: Industrial Facilities Within Approximately 5 Miles of the Proposed Site

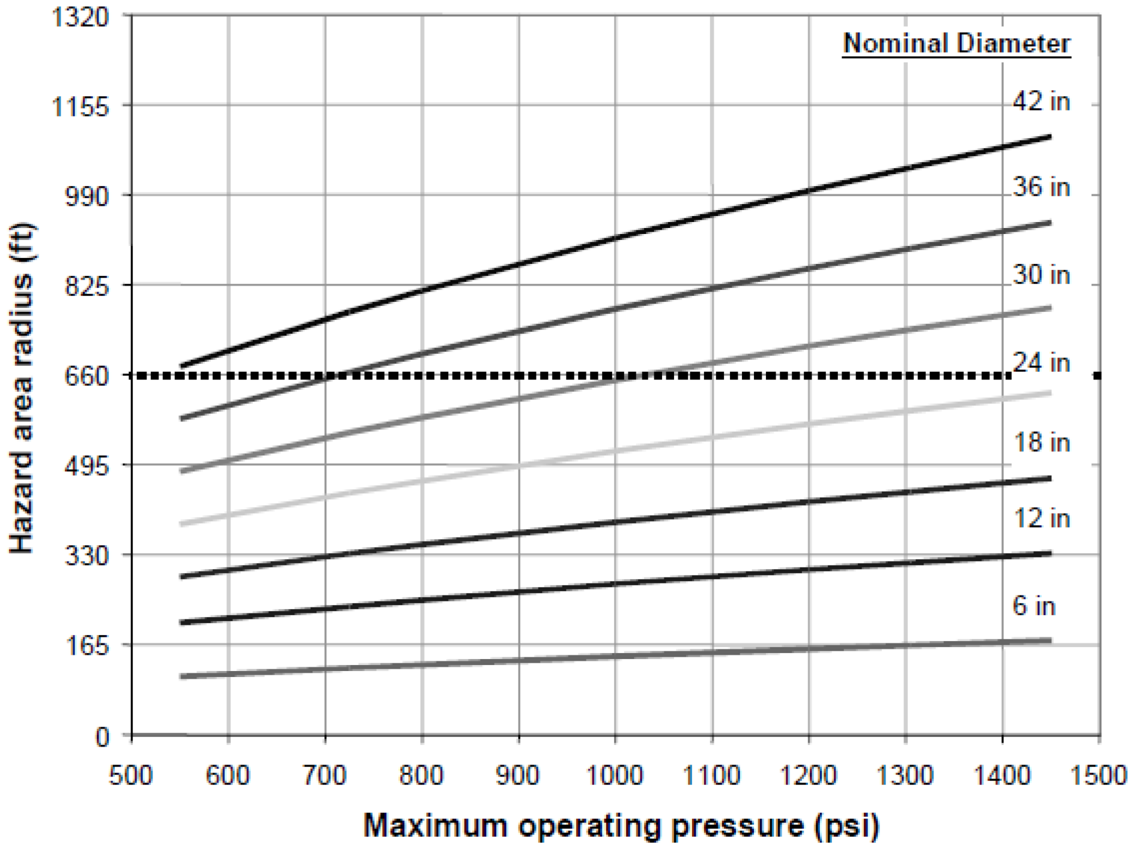


Figure 2.2.2: Hazard Area Radius as Function of Pipeline Pressure and Diameter [2.2.2]

Figure 2.2.3: WIPP Transportation Route.

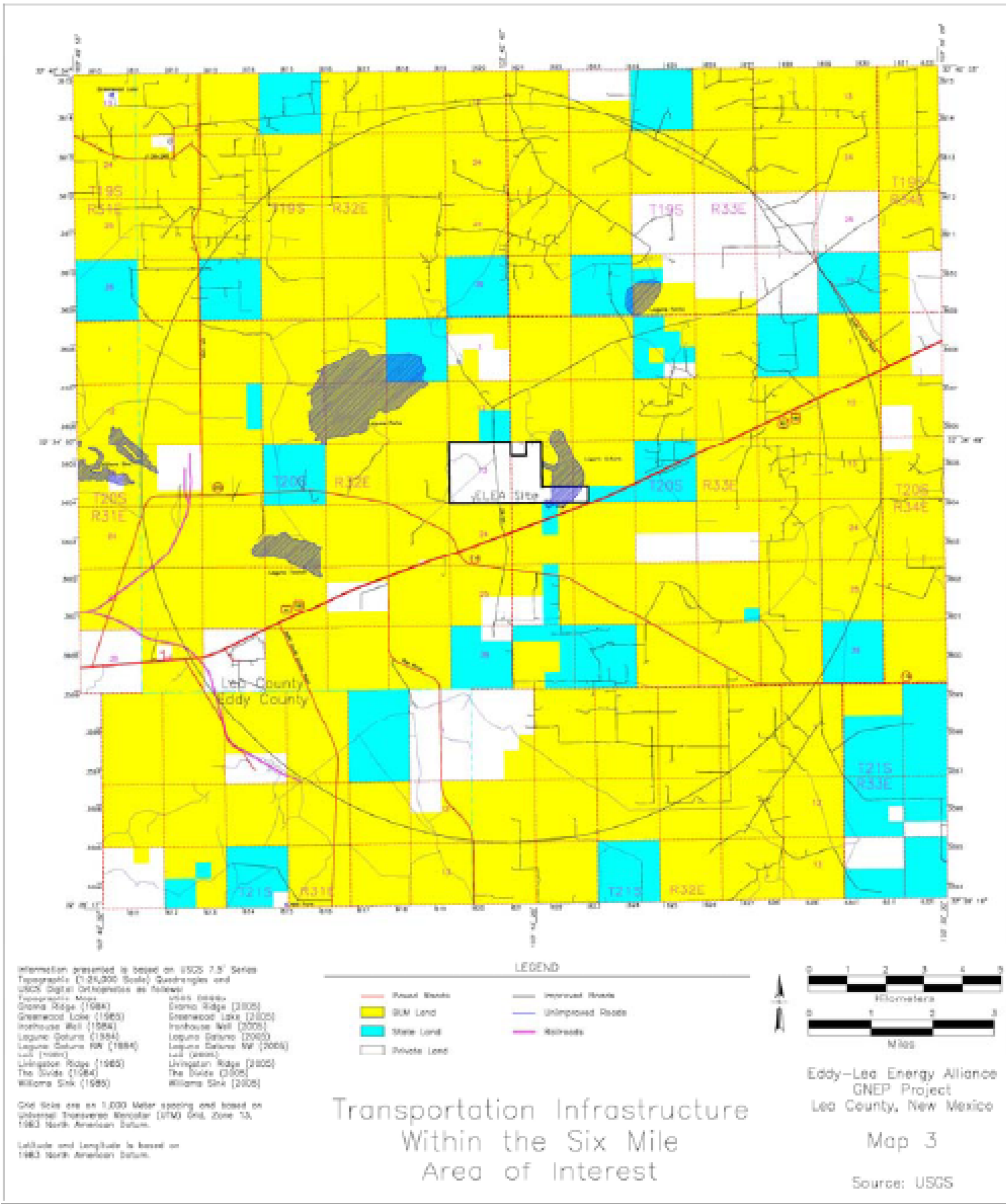


Figure 2.2.4: Transportation Infrastructure near the CIS Facility Site

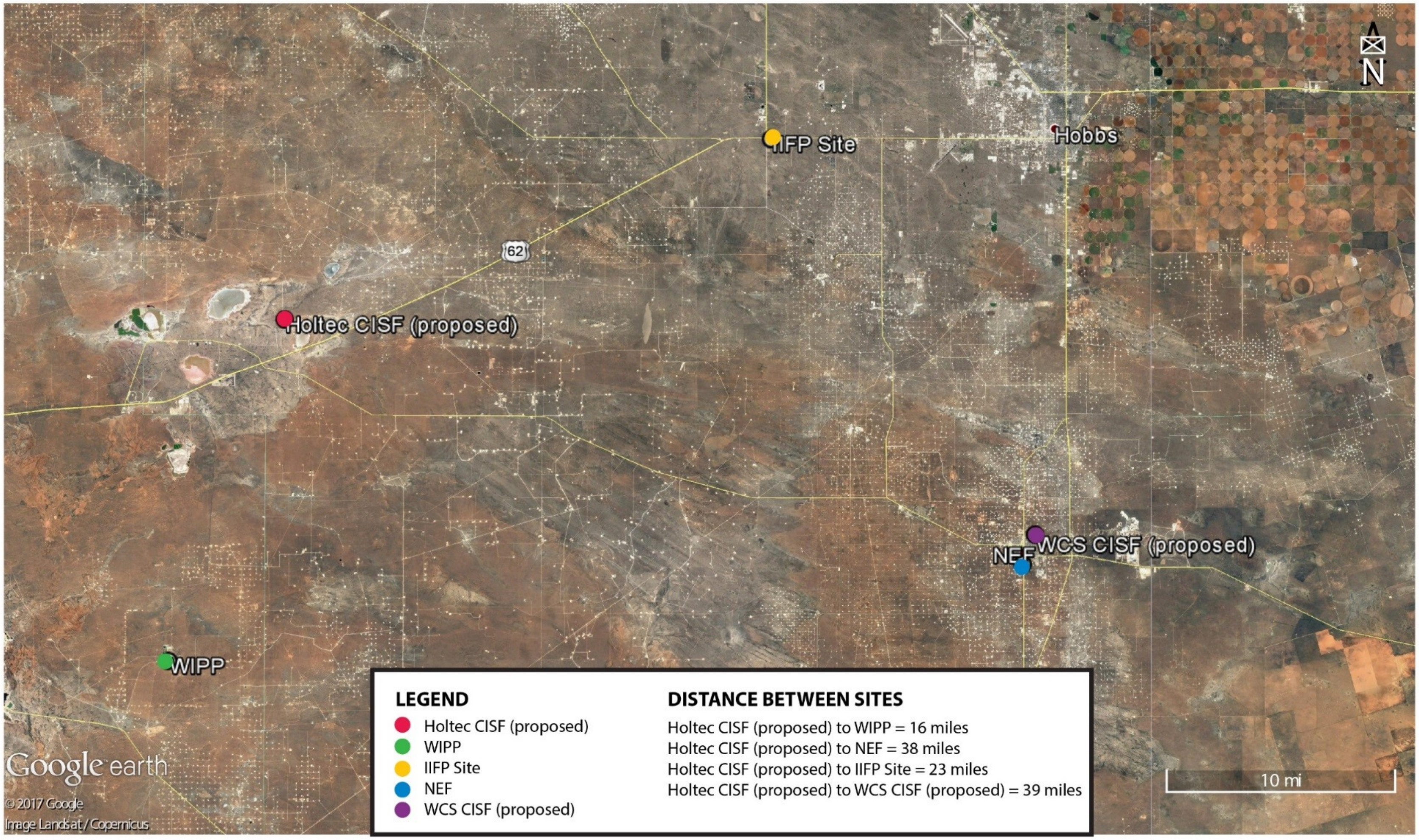


Figure 2.2.5: Existing or Planned Nuclear Facilities in the Vicinity of the Proposed Site

2.3 METEOROLOGY

2.3.1 Regional Climatology

The climate at the Site is typically semi-arid with generally mild temperatures, low precipitation, low humidity, and with a high evaporation rate. The winter weather typically has high pressure systems that are located in the central part of the western U.S. and low pressure systems located in north-central Mexico. In the summer, the region is typically affected by low pressure systems located over Arizona. Overall, precipitation is low and storms are infrequent. Winds during the spring may cause dust during construction periods; however, it is anticipated to be a minimal and temporary impact in comparison to the naturally occurring dust.

Meteorological information was obtained from various sources, including the Western Regional Climate Center (WRCC) and other sources as noted in this section. The use of the data from the WRCC and other sources are appropriate due to proximity to the proposed Site and are expected to have similar climates. The WRCC is a governmental department closely associated with the National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service (NSW). The data from the WRCC is generally considered to be the authoritative source of meteorological data for the region (see Appendix A, Section A.2 of the ER [1.0.4] for additional details regarding the applicability of data from the WRCC).

Temperatures. Data collected over approximately the past 75 years at the Lea County Regional Airport station [2.3.1] is summarized in Table 2.3.1. The temperature data reported in this summary table includes monthly average values for the minimum, average, and maximum temperatures as well as the monthly extreme values for the minimum and maximum temperatures. Additionally, annual values for these temperature parameters are included.

A site-specific 3-day average ambient temperature is defined by evaluating local weather service records for the Lea County in which the site is situated. The results are as follows:

- Location: Lea Regional Airport
- Records Period: 1980 – 2017
- Maximum 3-Day Average Temperature: 90.7°F

Winds. Prevailing wind directions and wind speeds at the Lea County Regional Airport station are presented in Table 2.3.2 and depicted graphically in Figure 2.3.2. The average wind speed is approximately 12 miles per hour (mph) and the prevailing wind direction is from the south. Winds are typically moderate, between 1 mph and 19 mph blowing 84 percent of the time, with calm winds (winds less than 1.3 mph) occurring only approximately 8 percent of the time [2.3.1].

With respect to wind gusts, the average wind speed of all of the maximum gusts is approximately 25 mph. The prevailing wind direction for wind gusts is wind from southwest during 11 percent of the observations; however, the wind gusts are out of the south, south-southeast, and southeast during 30 percent of the observations. Typical gusts range in speed from 13 mph to 32 mph, comprising of 86 percent of the gusts. Gusts range in speed from 32 mph to 47 mph occurred during 13 percent of the observations, and less than 1 percent of the gusts observed were over 47 mph [2.3.1].

Mixing Heights. Mixing height is the height above the ground where the strong, vertical mixing of the atmosphere occurs. G.C. Holzworth developed mean annual morning and afternoon mixing heights for the contiguous United States [2.3.2]. The results of Holzworth's calculation methods for mixing heights include mean annual morning and afternoon mixing heights at the Site of approximately 1,430 feet and 6,854 feet, respectively [2.3.2]. Table 2.3.3 shows the average morning and afternoon mixing heights for Midland-Odessa, Texas, which is the nearest available area with mixing height data, located approximately 100 miles southeast.

Tornadoes. Tornadoes are typically classified by the F-Scale classification. The F-Scale classification of tornadoes is based on the appearance of the damage that the tornado causes. The six classifications range from F0 to F5 with an F0 tornado having winds of 40-72 mph and an F5 tornado having winds of 261-318 mph [2.3.3]. Note that as of February 1, 2007, an enhanced F-scale for tornado damage went into effect in the United States. The switch to the enhanced F-scale involves:

- Changing the averaging interval for wind speed estimates from the fastest quarter-mile wind speed to a maximum three-second average wind speed.
- Changing the minimum tornado wind speed from 40 mph to 65 mph.
- Changing the wind speed intervals associated with each F scale class.

The enhanced F-scale uses three-second wind gusts estimated at the point of damage based on a judgment of eight levels of damage to 28 indicators. The enhanced F-scale has six classifications, EF0 to EF5, with an EF0 tornado having three-second gusts of 65-85 mph and an EF5 tornado having three-second gusts of over 200 mph [2.3.4].

Based on a United States-wide study performed on a state by state basis, the average tornado probability for any F-scale tornado for the Site is between 1×10^{-6} and 2×10^{-4}, as is presented in Figure 2.3.3 [2.1.3]. Ninety two tornados have occurred in Eddy and Lea counties since 1954. The highest number of tornados in any given year was 15 in 1991; of which, 14 occurred over a two day period. The lowest number of tornado in a year has been zero, with a mean average of 1.5 tornados occurring in a year. Most tornados recorded were F0 in scale and occurred in the spring [2.3.5].

Hurricanes. The Site is located over 500 miles from the oceanic coast. Because hurricanes lose their intensity quickly once they pass over land, impacts from a hurricane at the Site are unlikely.

Thunderstorms. Thunderstorms can occur during every month of the year, but generally occur from March through October of each year. Thunderstorms occur an average of 39 days per year in Carlsbad, New Mexico. The seasonal averages are: 2.7 days in spring (March through May); 8.3 days in summer (June through August); 2.3 days in fall (September through November); and less than 1 day in winter (December through February) [2.3.1]. Occasionally, thunderstorms are accompanied by hail [2.1.15].

Precipitation. A summary of precipitation data collected at the Lea County Regional Airport station resulted in an annual mean average total precipitation of 10.2 inches with monthly mean average totals ranging from 0.24 inches in March to 1.9 inches in September. The monthly minimum total is 0.00 inches and the monthly maximum total is 6.2 inches. The highest daily total is 3.6 inches occurring in December of 2015. A summary of this information is presented in

Table 2.3.4 and depicted graphically with monthly average total precipitation in Figure 2.3.4 [2.3.1].

A summary of snowfall data collected at the Lea County Regional Airport station resulted in an annual mean average total precipitation of 5.13 inches with monthly mean average totals ranging from 1.84 inches in February to 0.0 inches from May to October. The monthly minimum total is 0.00 inches and the monthly maximum total is 21.2 inches. The highest daily total is 10.00 inches occurring in February of 1956 [2.3.1].

Based on the season, atmospheric pressure systems can affect temperature and cause cloud formation. Clouds are formed when warm, moist air rises into the atmosphere and the droplets are cooled. When the droplets cool, the water from the air condenses into tiny droplets and forms clouds. This occurs during low pressure system. These low pressure systems typically occur during the spring and summer. Climatology data indicate the relative humidity throughout the year ranges from 45 percent to 61 percent in the region, with the highest humidity occurring during the early morning hours [2.1.15].

2.3.2 Local Meteorology

There are no on-site weather stations, however due to the proximity of the Lea County Regional Airport weather station to the Site (approximately 30 miles away), it is reasonable to say that the data presented in Section 2.3.1 adequately represents the on-site conditions for Local Meteorology. Additional details regarding the applicability of this data can be seen in Appendix A, Section A.2 of the ER [1.0.4].

2.3.3 Onsite Meteorological Measurement Program

There are no on-site weather stations, however due to the proximity of the Lea County Regional Airport weather station to the Site (approximately 30 miles away), it is reasonable to say that the data presented in Section 2.3.1 adequately represents the on-site conditions for Local Meteorology. Additional details regarding the applicability of this data can be seen in Appendix A, Section A.2 of the ER [1.0.4]. After the license is issued for the CIS Facility, Holtec will establish an on-site meteorological data collection system. That system will collect, at a minimum, temperature, precipitation, and wind data.

Table 2.3.1

LEA COUNTY REGIONAL AIRPORT STATION TEMPERATURE DATA (09/01/1941-06/09/2016) [2.3.1]

Month	Average Monthly Minimum Temperature °F	Average Monthly Maximum Temperature °F	Average Monthly Temperature °F	Extreme Minimum Temperature °F	Extreme Maximum Temperature °F
January	27.72	56.25	41.98	4.00	81.00
February	30.68	61.12	45.90	-11.00	84.00
March	35.67	67.32	51.53	14.00	86.00
April	44.32	75.05	59.69	24.00	93.00
May	53.77	84.05	68.91	28.00	103.00
June	63.71	92.90	78.31	51.00	107.00
July	66.73	93.62	80.17	52.00	108.00
August	65.50	92.57	79.04	55.00	104.00
September	58.29	86.47	72.37	41.00	104.00
October	47.82	75.76	61.79	24.00	94.00
November	34.23	64.42	49.33	4.00	85.00
December	28.78	59.04	43.91	7.00	79.00
Annual	46.34	76.03	61.19	-11.00	108.0

Note: The extreme maximum temperature was recorded in July of 2000 and again in July 2001 at 108°F and the extreme minimum temperature was recorded in February of 1951 at -11°F.

Table 2.3.2

LEA COUNTY REGIONAL AIRPORT STATION ALL WIND DATA (12/01/1948-12/31/2014) [2.3.1]

Wind Speed (mph)	N (%)	NNE (%)	NE (%)	ENE (%)	E (%)	ESE (%)	SE (%)	SSE (%)	S (%)	SSW (%)	SW (%)	WSW (%)	W (%)	WNW (%)	NW (%)	NNW (%)	Total (%)
1.3-4	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	2.5
4-8	1	0.8	0.9	0.7	1.8	1.3	1.4	1.4	2.7	1.7	1.3	0.9	0.6	0.5	0.6	0.5	18.2
8-13	2	1.5	1.7	1.5	3	2.8	3.9	4.5	6.2	3.4	2.8	2.3	1.7	1.2	1.1	0.9	40.4
13-19	1.4	1.2	1.1	0.6	1.1	1.2	2.2	2.8	2.9	1.6	1.9	1.8	1	0.7	0.6	0.5	22.7
19-25	0.5	0.4	0.2	0.1	0.1	0.1	0.3	0.6	0.4	0.4	0.7	0.7	0.4	0.3	0.2	0.2	5.6
25-32	0.2	0.1	0.1	0	0	0	0	0.1	0.1	0.1	0.2	0.3	0.1	0.1	0.1	0.1	1.7
32-39	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.4
39-47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1
47+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (%)	5.3	4.1	4.1	3.1	6.2	5.7	7.9	9.5	12.6	7.5	7.2	6.4	3.9	3	2.7	2.3	91.5
Avg. Wind Speed (mph)	12.6	12.4	11.4	10.5	10.0	10.5	11.3	11.9	11.0	11.3	12.9	14.1	12.8	13.4	11.9	12.3	10.8

NOTE: Total Calm Winds (Calm Winds is defined as less than 1.3 mph) is 8.4 percent

Table 2.3.3

AVERAGE MORNING AND AVERAGE AFTERNOON MIXING HEIGHTS [2.3.2]

	Winter (feet)	Spring (feet)	Summer (feet)	Autumn (feet)	Annual (feet)
Morning	951	1,407	1,988	1,375	1,430
Afternoon	4,186	8,035	9,003	6,191	6,854

Table 2.3.4

LEA COUNTY REGIONAL AIRPORT STATION PRECIPITATION DATA (09/01/1941-06/09/2016) [2.3.1]

Month	Monthly Minimum Totals (Inches)	Monthly Maximum Totals (Inches)	Monthly Average Totals (Inches)	Extreme Daily Maximum Totals (Inches)
January	0.00	2.09	0.31	0.68
February	0.00	1.02	0.32	0.68
March	0.00	1.41	0.24	0.52
April	0.00	2.26	0.65	1.40
May	0.00	5.02	1.43	1.72
June	0.00	3.19	0.75	1.77
July	0.00	3.49	1.17	1.98
August	0.04	4.08	1.32	2.28
September	0.05	5.84	1.85	2.13
October	0.00	3.81	1.52	1.73
November	0.00	1.07	0.26	0.95
December	0.00	6.21	0.56	3.63
Annual	2.81	18.66	10.16	3.63

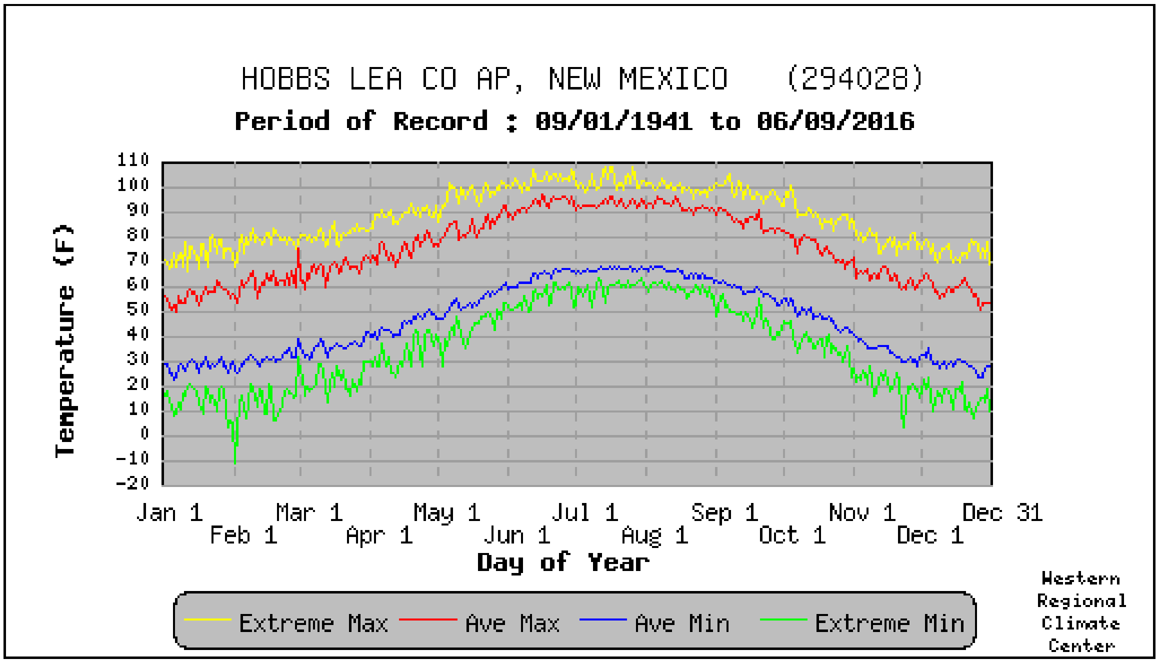


Figure 2.3.1: Lea County Regional Airport Station Temperature Data (09/01/1941-06/09/2016) [2.3.1]

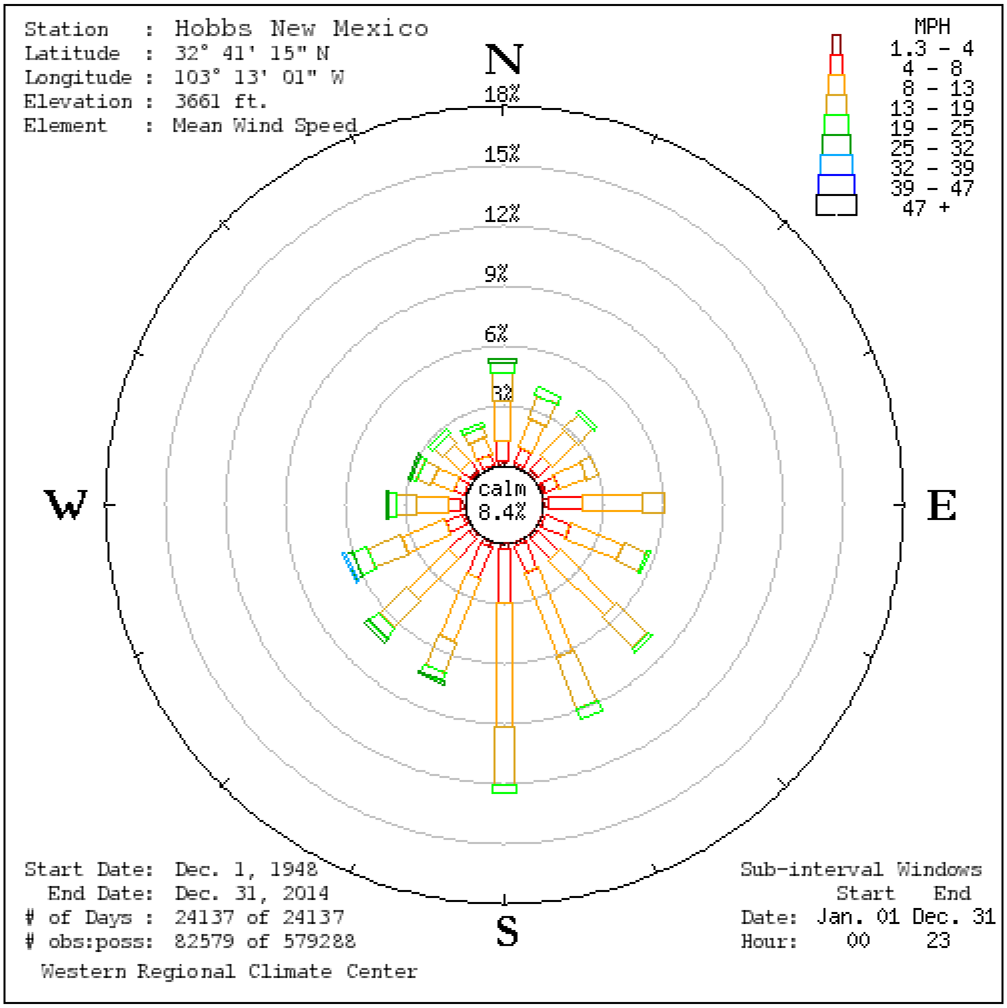


Figure 2.3.2: Lea County Regional Airport Station All Wind Rose (12/01/1948-12/31/2014) [2.3.1]

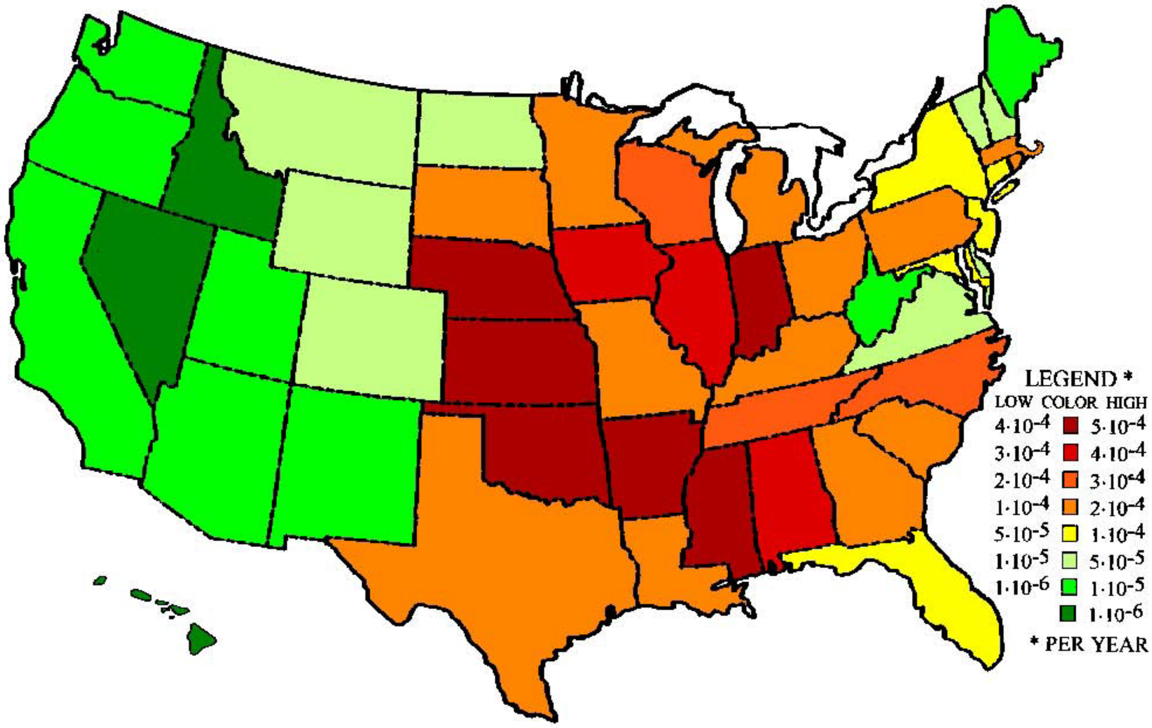


Figure 2.3.3: Tornado Probability Map [2.1.3]

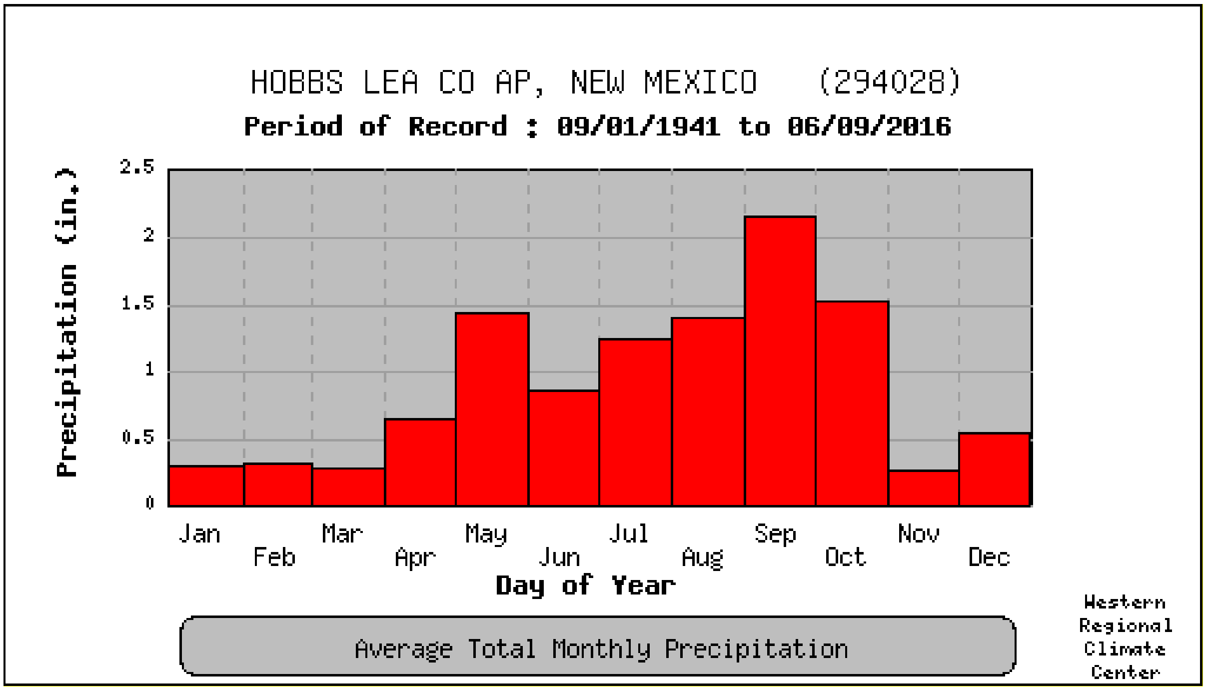


Figure 2.3.4: Monthly Average Total Precipitation Lea County Regional Airport Station (09/01/1941-06/09/2016) [2.3.1]

2.4 SURFACE HYDROLOGY

2.4.1 Hydrologic Description

The Site lies within the Pecos River Basin (see Figure 3.5.1 of the ER [1.0.4]), which has a maximum basin width of 130 miles, and a drainage area of 44,535 square miles. There are no surface-water bodies or surface-drainage features on the proposed CIS Facility Site. The Pecos River is the closest surface water feature to the Site. At its nearest approach, the distance from the Site to the Pecos River is 26 miles. In Lea County neither of the two major drainage basins, the Texas Gulf Basin in the north and east and the Pecos River Basin in the south and west, contain large-scale surface-water bodies or through-flowing drainage systems. The surface water supplies that exist are transitory and limited to quantities of runoff impounded in short drainage ways, shallow lakes, and small depressions, including various playas and lagunas. The Texas Gulf Basin contains a lake, the Llano Estacado, and the Simona Valley. The Pecos River Basin contains the Querecho Plains, the Eunice Plains, and the Antelope Ridge [2.4.1, Section 2.5.1].

The CIS Facility Site is contained within the Upper Pecos-Black watershed; however, there are no freshwater lakes, estuaries, or oceans in the vicinity of the site (Figure 2.4.1). Local surface hydrologic features in the vicinity of the site include a cluster of four saline playas that are located in the Querecho Plain area of the west-central part of the county. These playas, which retain runoff temporarily, are referred to locally as lagunas. Laguna Plata covers the largest area, about 2 square miles. Laguna Toston, the smallest of the four with a surface area of one-quarter square mile, is completely filled with sediments; the other three all contain accumulations of clastic sediments and salts (halite, gypsum) [2.4.5; 2.4.1, Section 2.5.1]. Surface runoff from the Site flows into Laguna Gatuna to the east and Laguna Plata to the northwest [2.1.3]. Surface drainage at the proposed Site is contained within two local playa lakes that have no external drainage. These playas are generally dry, but retain runoff temporarily [2.1.3]. Runoff does not drain to one of the state's major rivers. Figures 2.4.2 and 2.4.3 show hydrologic features in the vicinity of the CIS Facility.

The lagunas help to create shallow saline ground-water which exists under much of the Querecho Plain. Surface water is lost through evaporation, resulting in high salinity conditions in soils associated with the playas. These conditions are not favorable for the development of viable aquatic or riparian habitats. The presence of the shallow saline water has been recognized to the extent that the New Mexico Oil Conservation Commission Order No. R-3221, banning the surface disposal of produced water into unlined pits within the State was amended (OCC Order No. R-3221-B, July 25, 1968) to exclude much of the area [2.4.5; 2.4.6].

Laguna Gatuna is located on the eastern boundary of the Site. Laguna Gatuna is an ephemeral playa that covers a surface area of 0.54 square miles, has an average depth of 10 feet, and a total shore line of 4 miles. The lake, which sits at an elevation of 3,495 feet drains a watershed that covers 170 square miles. Laguna Gatuna was the site of multiple facilities for collection and discharge of brines that were co-produced from oil and gas wells in the entire area; facility permits authorized discharge of almost one million barrels of oilfield brine per month between 1969 and 1992. As a result, saturations of shallow groundwater brine have been created in a number of areas associated with the playa lakes [2.4.1, Section 2.4.2.1].

Laguna Tonto is located approximately 2.5 miles northeast of the Site. Laguna Tonto is an ephemeral playa that covers a surface area of 0.28 square miles, has an average depths of 12 feet, and has a total shore line of 2 miles. The playa, which sits at an elevation of 3,531 feet, drains a watershed that covers 49 square miles.

Laguna Plata is located approximately 1.8 miles northwest of the Site. Laguna Plata is an ephemeral playa that covers a surface area of 2 square miles, has an average depth of 14 feet, and has a total shore line of 6 miles. The playa, which sits at an elevation of 3,432 feet, drains a watershed that covers 254 square miles. Laguna Plata is the largest of the playas in the vicinity of the site with a total water volume of approximately 14,593 acre-feet. Laguna Plata is the topographically lowest point in the area and alluvial groundwater appears to flow toward this site [2.4.1, Section 2.4].

Laguna Toston is the smallest of the playas in the vicinity of the CIS Facility Site with a surface area of one-quarter mile. The playa is a major input point for potash refinery brine and water appears to drain radially away from this location [2.4.1, Section 2.4].

The U.S. Geological Survey (USGS) does not have permanent stream gages in Lea County which measure daily surface flows. However, peak flow rates have been spot measured at Monument Draw (near Monument) and Antelope Draw (near Jal). Each of these Draws can occasionally convey sizable flows. In June of 1972, a flow of 1280 cubic feet per second (CFS) (the highest recorded) occurred at Monument Draw. In July of 1994, a flow of 530 CFS (also the highest recorded) occurred at Antelope Draw. These flows should be considered indicative of flows that can occur at other gullies and swales in Lea County (Lea County 2016, 1999).

The proposed CIS Facility Site is not located near any floodplains. The Site is located in an area of Lea County designated as “Zone D”. The “Zone D” designation is used for areas where there are possible but undetermined flood hazards, as no analysis of flood hazards has been conducted or when a community incorporates portions of another community’s area where no map has been prepared [2.4.3]. A digital version of the map panel for the CIS Facility location in the National Flood Hazard Layer is presented in Figure 2.4.4 [2.4.3]. Other than the playas, the nearest surface water is the Pecos River which is west of the Site. Like most rivers in New Mexico, the Pecos River is described as “extremely variable from year-to-year” due to its dependence on runoff. The principle use of Pecos River water is for agriculture. There are no sensitive or unique aquatic or riparian habitats or wetlands at the Site, nor is there surface water in the vicinity that is potable [2.1.3].

Groundwater within Lea County is provided primarily by the High Plains Aquifer composed of the Ogallala Formation. Cretaceous and Triassic rocks underlying the Ogallala Formation limit downward percolation from the Ogallala Aquifer. The region includes portions of five declared underground water basins (UWBs): Capitan, Carlsbad, Jal, Lea County, and Roswell. (A declared UWB is an area of the state proclaimed by the State Engineer to be underlain by a groundwater source having reasonably ascertainable boundaries. By such proclamation the State Engineer assumes jurisdiction over the appropriation and use of groundwater from the source.) The Jal UWB falls entirely within the Lea County region, but the other four are shared with the Lower Pecos Valley region, although only a small portion of the Lea County UWB extends into the Lower Pecos Valley region, and Lea County overlies only a small extension of the Roswell Basin [2.4.6].

The CIS Facility Site is within the Capitan UWB (Figure 2.4.5) and lies within the Upper Pecos-Black Watershed which is part of the Pecos River Basin (Figure 2.4.6). The Capitan UWB covers approximately 1,100 square miles and occupies the south-central portion of Lea County. The Capitan UWB is located within a geologic province known as the Delaware Basin, a subdivision of the Permian Basin. The Capitan UWB is aerially oriented in a northwest-southeast alignment above an arc shaped section of a formation known as the Capitan Reef Complex. The Capitan aquifer occurs within dolomite and limestone strata deposited as an ancient reef. The ground-water quality of the Capitan in Lea County is very poor. Other aquifers in the Capitan UWB are found in the overlying Rustler Formation4, Santa Rosa Sandstone5, and Cenozoic Alluvium. The primary uses of ground-water from the Capitan UWB are mining, oil recovery, industry, livestock, and domestic use. The towns of Eunice and Jal are located within the Capitan UWB, but currently tap beds of saturated Quaternary alluvium located within the Lea County UWB and Jal UWB respectively [2.4.5].

The site topography is irregular, with a slight slope toward the north, with elevations ranging between about 3,500 and 3,550 feet above mean sea level [2.4.4]. Based on a review of the USGS topographic map, the elevation at the CIS Facility Site is approximately 3,530 feet above mean sea level. Several shallow depressions are shown along the western portions of the Site. Figure 2.4.7 illustrates local topography in the area of the proposed CIS Facility Site. A topographic high is present within the central portion of the property with ephemeral washes draining from this point; one to the west into Laguna Plata and another to the east into Laguna Gatuna. Both of these drainages would be able to accept a one day severe storm total within the 7.5 inch range with excess free board space. The natural drainage of the Site is useful by providing a natural area for impoundment of excess runoff during severe storms [2.4.1].

The Project area is classified as Apacherian-Chihuahuan mesquite upland scrub [2.4.8]. This ecosystem often occurs as invasive upland shrublands such as those that are concentrated in the foothills and piedmonts of the Chihuahuan Desert [2.4.7]. Substrates are typically derived from alluvium, often gravelly without a well-developed argillic or calcic soil horizon that would limit infiltration and storage of winter precipitation in deeper soil layers. Deep-rooted shrubs are able to access the deep-soil moisture that is unavailable to grasses and cacti. Water held in storage in the soil is subsequently subject to evapotranspiration. Historical periods of high temperature and low precipitation in Lea County have resulted in high demands for irrigation water and higher open water evaporation and riparian evapotranspiration [2.4.6]. Evapotranspiration at the Site is five times the precipitation rate, indicating that there is little infiltration of precipitation into the subsurface. Surface drainage at the Site is contained within two local playa lakes that have no external drainage. Runoff does not drain to one of state's major rivers. Essentially all the precipitation that occurs at the Site is subject to infiltration and/or evapotranspiration.

No major surface water supplies are available in Lea County, only intermittent streams, lakes, stock ponds, and small playas that collect runoff during thunderstorms. Intermittent streams that channel runoff include Lost Draw, Sulfur Springs Draw, and Monument-Seminole Draw in the northern half of Lea County, which is part of the Texas Gulf Basin, and Landreth-Monument Draw in the southern portion of the county, which flows to the Pecos River. The Site lies within the Pecos River Basin as depicted in Figure 2.4.8, which has a maximum basin width of 130 miles, and a drainage area of 44,535 square miles. The Pecos River generally flows year-round.

The main stem of the Pecos River and its major tributaries have low flows, and the tributary streams are frequently dry. Seventy-five percent of the total annual precipitation and 60 percent of the annual flow result from intense local thunderstorms between April and September. Due to the seasonal nature of the rainfall, most surface drainage is intermittent. There are no surface-water bodies or surface-drainage features on the proposed CIS Facility Site. The intermittent surface drainages, lakes, and watersheds in Lea County are shown on Figure 2.4.8 [2.4.6].

The USGS does not have permanent stream gages in Lea County which measure daily surface flows. However, peak flow rates have been spot measured at Monument Draw (near Monument) and Antelope Draw (near Jal). Each of these Draws can occasionally convey sizable flows. In June of 1972, a flow of 1,280 cubic feet per second (cfs) (the highest recorded) occurred at Monument Draw. In July of 1994, a flow of 530 cfs (also the highest recorded) occurred at Antelope Draw. These flows should be considered indicative of flows that can occur at other gullies and swales in Lea County [2.4.5; 2.4.6].

The proposed CIS Facility Site is not located near any floodplains. The Site is located in an area of Lea County designated as "Zone D". The "Zone D" designation is used for areas where there are possible but undetermined flood hazards, as no analysis of flood hazards has been conducted or when a community incorporates portions of another community's area where no map has been prepared [2.4.3]. A digital version of the map panel for the CIS Facility location in the National Flood Hazard Layer is presented in Figure 2.4.9 [2.4.3].

There are no wetlands on the proposed CIS Facility Site. Wetlands in the vicinity of the CIS Facility are shown on Figure 2.4.10.

As further discussed in sections 2.4.2 and 2.4.3, the Site can be considered "flood-dry" and therefore it can be concluded that none of the facilities important to safety structures will be affected by the Site's hydrologic features. Additionally, there are no surface water bodies on the Site and groundwater resources are at depths of approximately 300 to 400 feet, therefore no population groups are affected by normal Site operations.

2.4.2 Floods

Floodplains are areas of low-level ground present along rivers, stream channels, or coastal waters subject to periodic or infrequent inundation due to rain or melting snow. Risk of flooding typically depends on local topography, the frequency of precipitation events, and the size of the watershed above the floodplain. Flood potential is evaluated by the Federal Emergency Management Agency (FEMA), which defines the 100-year floodplain as an area that has a one percent chance of inundation by a flood event in any given year. Federal, state, and local regulations often limit floodplain development to passive uses such as recreational and preservation activities to reduce the risks to human health and safety. Floodplain ecosystem functions include natural moderation of floods, flood storage and conveyance, groundwater recharge, nutrient cycling, water quality maintenance, and diversification of plants and animals.

The proposed Site or Lea County has no floodplain identified or mapped for Lea County, New Mexico [2.1.6, 2.1.7]. Elevations in Lea County vary from 2,900 feet in the southeast to 4,400 feet in the northwest. This relief provides two surface water drainage basins in the county. The Texas Gulf Basin, located in the northern portion of Lea County, and the Pecos River Basin,

located in the southern portion of the county, is separated by the Mescalero Ridge and its extended escarpment [2.1.3].

In Lea County neither of the two major drainage basins, the Texas Gulf Basin in the north and east and the Pecos River Basin in the south and west, contain large-scale surface-water bodies or through-flowing drainage systems. The surface water supplies that exist are transitory and limited to quantities of runoff impounded in short drainage ways, shallow lakes, and small depressions, including various playas and lagunas [2.1.3].

The topography of the Site shows a high point located on the southern border of the Site and gentle slopes leading to the two drainages (Laguna Plata and Laguna Gatuna). Both of these drainages would be able to accept a one day severe storm total within the 7.5 inch range with excess free board space. The natural drainage of the Site is useful by providing a natural area for impoundment of excess runoff during severe storms [2.1.3].

A site-specific flood analysis of the maximum precipitation event was prepared. The objective of this study was to determine the amount of flooding that would occur at the project site (as seen in Figure 2.4.11) with 7.5 inches of rain during a 24-hour period using publicly available GIS data.

The boundary of the site (defined as Area of Interest (AOI)) was provided. All other GIS data for the analysis were identified, derived, and/or acquired from publicly available data sources. This data included a Digital Elevation Model (DEM) of the AOI, one foot contours of the area (derived from the DEM), hydrologic unit boundary for the 12-digit sub-watersheds (HUC-12), and the NRCS soils present in the AOI [2.4.9; 2.4.10; 2.4.11]. Also derived from the DEM was a Triangular Interpolated Network (TIN) layer used in the polygon volume calculations. All data were projected into the NAD83, UTM Zone 13N coordinate system.

The flooding analysis was conducted with ESRI ArcGIS for Desktop software, version 10.2.2, with 3D and Spatial Analyst extensions. The HUC-12 sub-watersheds layer was assessed for proximity to the site, and two sub-watersheds were identified as relevant basins (i.e., Laguna Grande and Laguna Plata Watersheds). The Laguna Gatuna and Laguna Plata wetlands both were the downslope point of catchment for their respective watersheds. Acreage was calculated for each of these watersheds, and the watersheds were buffered to eliminate edge effects of contour creation. Two DEMs (east and west, corresponding to Laguna Grande and Laguna Plata, respectively) were extracted from the buffered layers and contours were created at one foot intervals.

The NRCS soils layer was clipped to the watershed boundaries. The soil attributes of concern, Depth to Restrictive Layer (depth to impermeable bedrock in centimeters, “Dep2ResLyr”) and Saturated Hydraulic Conductivity (Ksat in μm/second) were extracted and consolidated into one layer. The Ksat values were used from the top 0-80 inch active soil zone. The infiltration level (Ksat) was converted into inches of water absorbed per 24 hour period, and the Dep2ResLyr converted to inches. The restrictive depth was then halved to add conservatism, and 7.5 inches was subtracted from this value. Area where saturation and run-off occurred within the 24-

hour/7.5 inch rain event were calculated for these soil types, normalized for feet, and multiplied by the acreage for the respective watersheds, yielding acre-feet of runoff that were converted to cubic feet of runoff. These values were 23,379,663.14 ft^3 (Laguna Gatuna eastern wetland basin) and 15,508,872.72 ft^3 (Laguna Plata western wetland basin). These volumes were used to determine the level of flooding in each watershed.

A TIN was created from watershed's DEM. This provided a 3D functional surface representing elevations over the watershed and was used as an input for polygon volume calculation. From the contour layers, polygons were created in an ascending order of elevations from the lowest level in each laguna. The Polygon Volume tool was run iteratively on these polygons, calculating the volume between the polygon and the TIN surface. Based on the watershed and hydrologic modeling the results of the analysis show the volume of flooding in the eastern Laguna Gatuna would rise 5 feet from 3,500 feet to an elevation of 3,505 feet. The volume of flooding in the western Laguna Plata would rise 2 feet from 3,427 feet to an elevation of 3,429 feet. The Project site is bisected by the two sub-watersheds. The lowest elevation of the Project site on the west side is 3,501 feet which is 72 feet above the modeled flood elevation, and the east side is 3,523 feet which is 18 feet above the modeled flood elevation. In summary, this analysis indicates that the Project site will not flood during a 24-hour/7.5 inch rain event even with 50% reduction in the soil saturation capacity/depth to restriction which was added into this model as a conservative measure. It should be noted that the model assumes that the playas were dry prior to the 24-hour/7.5 inch rain event.

2.4.3 Probable Maximum Flood (PMF)

Because there are no significant bodies of water or rivers within 50 miles of the Site, the only plausible flooding hazard to the Site is from stormwater runoff during rain events. To estimate the potential effects of rainfall-induced stormwater runoff, Holtec reviewed precipitation data for the area spanning more than 50-years (see Paragraph 3.6.1.7 of the ER [1.0.4]), as well as other available data developed for other nuclear facilities in the area. The highest daily precipitation in the area was 3.6 inches, which occurred in December of 2015 [1.0.4].

The topography of the CIS Facility Site is irregular, with a slight slope toward the north. A topographic high is present within the central portion of the property with ephemeral washes draining from this point; one to the west into Laguna Plata and another to the east into Laguna Gatuna. Based on a review of the USGS topographic map, the elevation at the Site is approximately 3,530 feet above mean sea level. Several shallow depressions are shown along the western portions of the Site. The Site is not within the 100-year and 500-year floodplains. Table 2.4.1 provides estimates of the 24-hour 100-year rain event for the Hobbs, New Mexico.

As discussed in Section 2.4.2, drainages on the Site would be able to accept a one day severe storm total within the 7.5 inch range with excess free board space. Because the Site's drainage areas can handle a greater maximum flood height than what the PMF has been determined to be, the site can be considered to be "flood-dry".

Per Table 2.3.1 of the HI-STORM UMAX FSAR [1.0.6], the HI-STORM UMAX System is able to withstand a maximum flood height of 125 ft. Therefore, all ITS components of the system can be considered safe from flooding concerns.

With regard to the potential for surface erosion from flooding at the Site, as discussed in Section 4.3 of the ER [1.0.4], soils at the Site are considered to be only slightly susceptible to water erosion.

2.4.4 Potential Dam Failures (Seismically-Induced)

The nearest dams are Brantley Dam, approximately 38 miles, and Avalon Dam, approximately 31 miles from the proposed Site. Both dams are at an elevation more than 500 feet below the Site. As a result of the large distances to the nearest bodies of water, these bodies of water do not present a credible disruptive event for the proposed Site.

2.4.5 Probable Maximum Surge and Seiche Flooding

There are no significant bodies of water or rivers within 50 miles of the Site and seiche flooding is excluded as a potential flood hazard.

2.4.6 Probable Maximum Tsunami Flooding

The Site is approximately 500 miles from any coastal area and tsunamis are excluded as a potential flood hazard.

2.4.7 Ice Flooding

The mean annual snowfall is 5.1 inches recorded at the Hobbs weather station. The maximum recorded snow accumulation for Hobbs, NM, is 12.2 inches, and a 100-year, 2-day snowfall is 12.1 inches [2.4.14]. The Site is not subject to flooding caused by ice jams. In the winter, during those periods when the playas are retaining temporary runoff, freezing of the retained water can occur.

2.4.8 Flood Protection Requirements

Because the flooding analyses do not indicate that the Site would be subject to flooding, there are no flood protection requirements.

2.4.9 Environmental Acceptance of Effluents

As stated in Chapter 14, the canister storage system does not create any radioactive materials or have any radioactive waste treatment system and thus provides assurance that there are no radioactive effluents from the spent fuel storage system. Additionally, surface drainage at the proposed Site is contained within two local playa lakes that have no external drainage. Evapo-transpiration at the Site is five times the precipitation rate, indicating that there is little infiltration of precipitation into the subsurface. The near surface water table is approximately 35-50 feet deep, where present and is likely controlled by the water level in the playa lakes. Therefore, there is little to no risk of effluents of any kind being accepted by the environment.

Table 2.4.1: Estimates of the 24-hour 100-year Rain Event for the Hobbs, New Mexico [2.4.13]

Location	Mean (90% Confidence Interval)	Lower Limit (90% Confidence Interval)	Upper Limit (90% Confidence Interval)
Hobbs 4030	6.43 inches	5.73 inches	7.03 inches

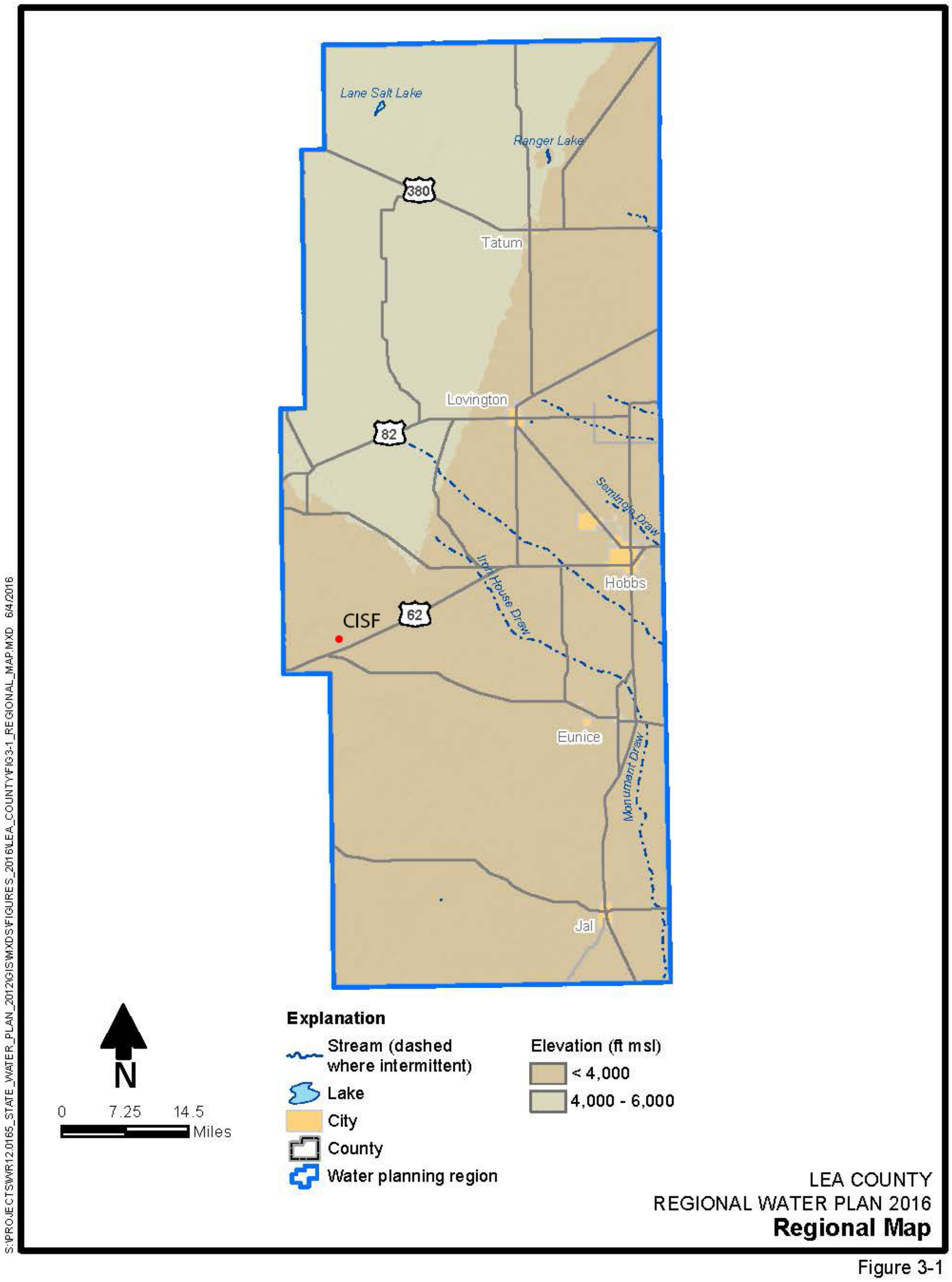


Figure 2.4.1: Regional Map [2.4.6]

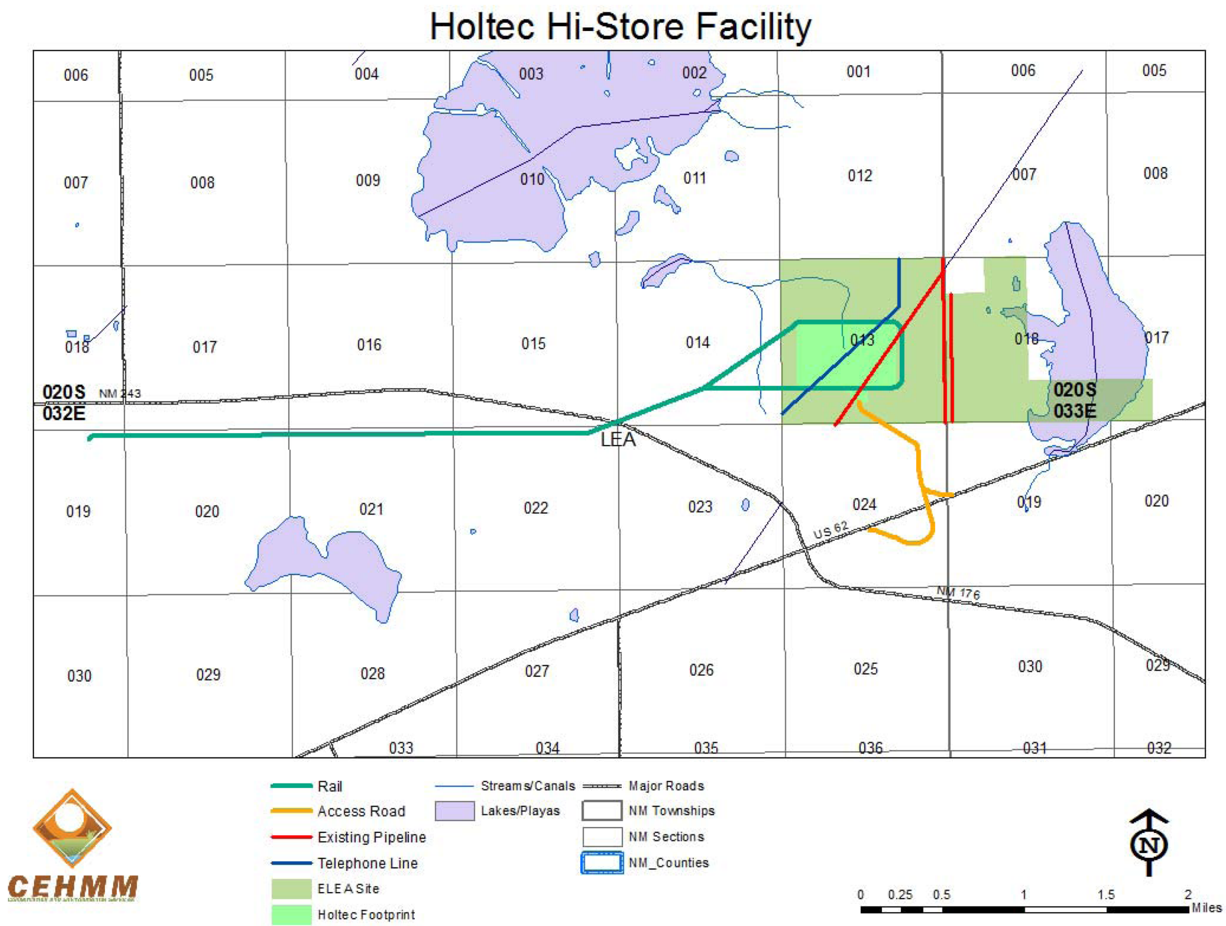


Figure 2.4.2: Location of Hydrologic Features in the Vicinity of the CIS Facility Site [2.4.2]

Figure 2.4.3: Lakes/Playas in the Vicinity of the CIS Facility [2.4.4]

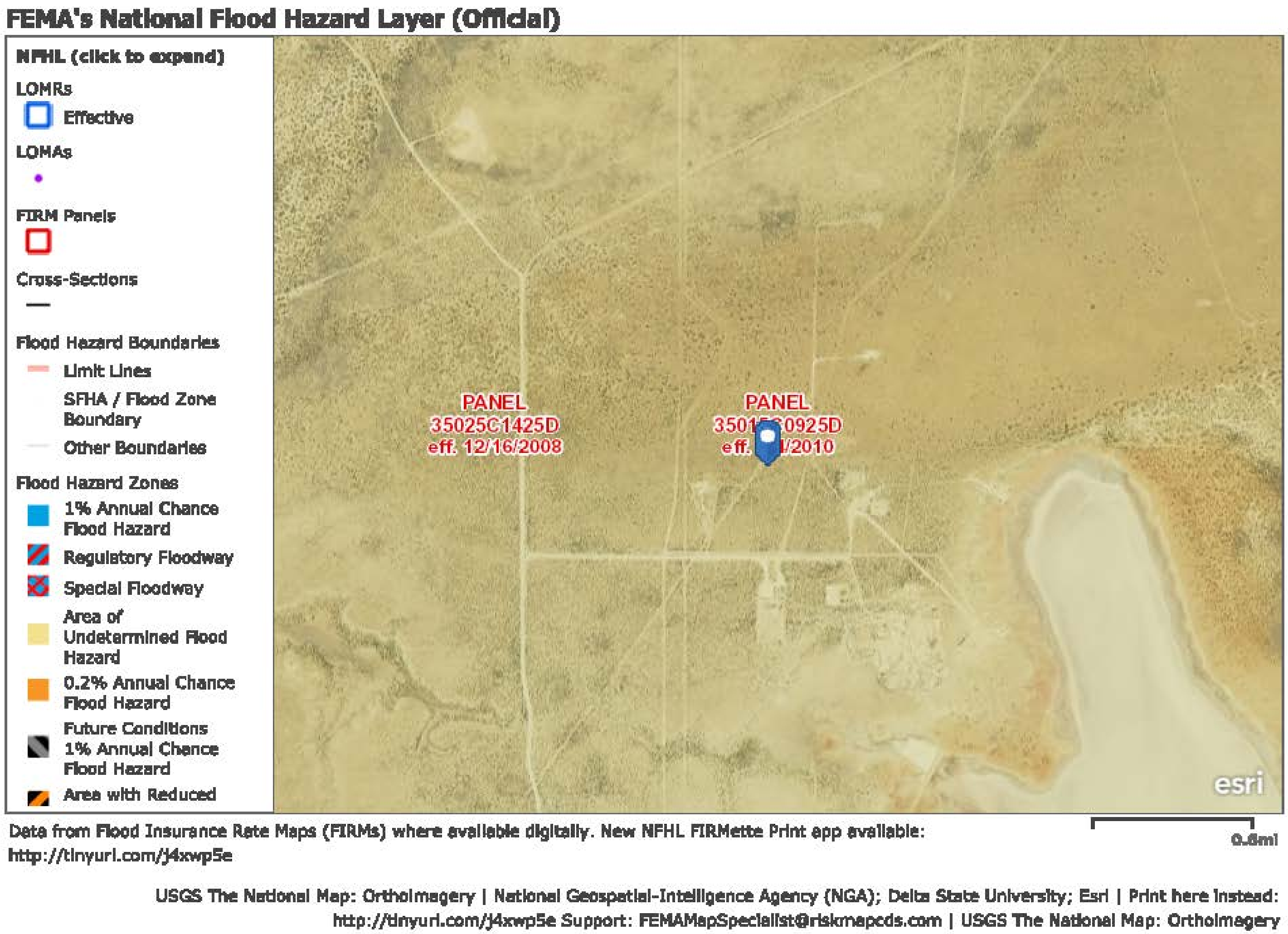


Figure 2.4.4: FEMA's National Flood Hazard Layer for the CIS Facility Site [2.4.3]

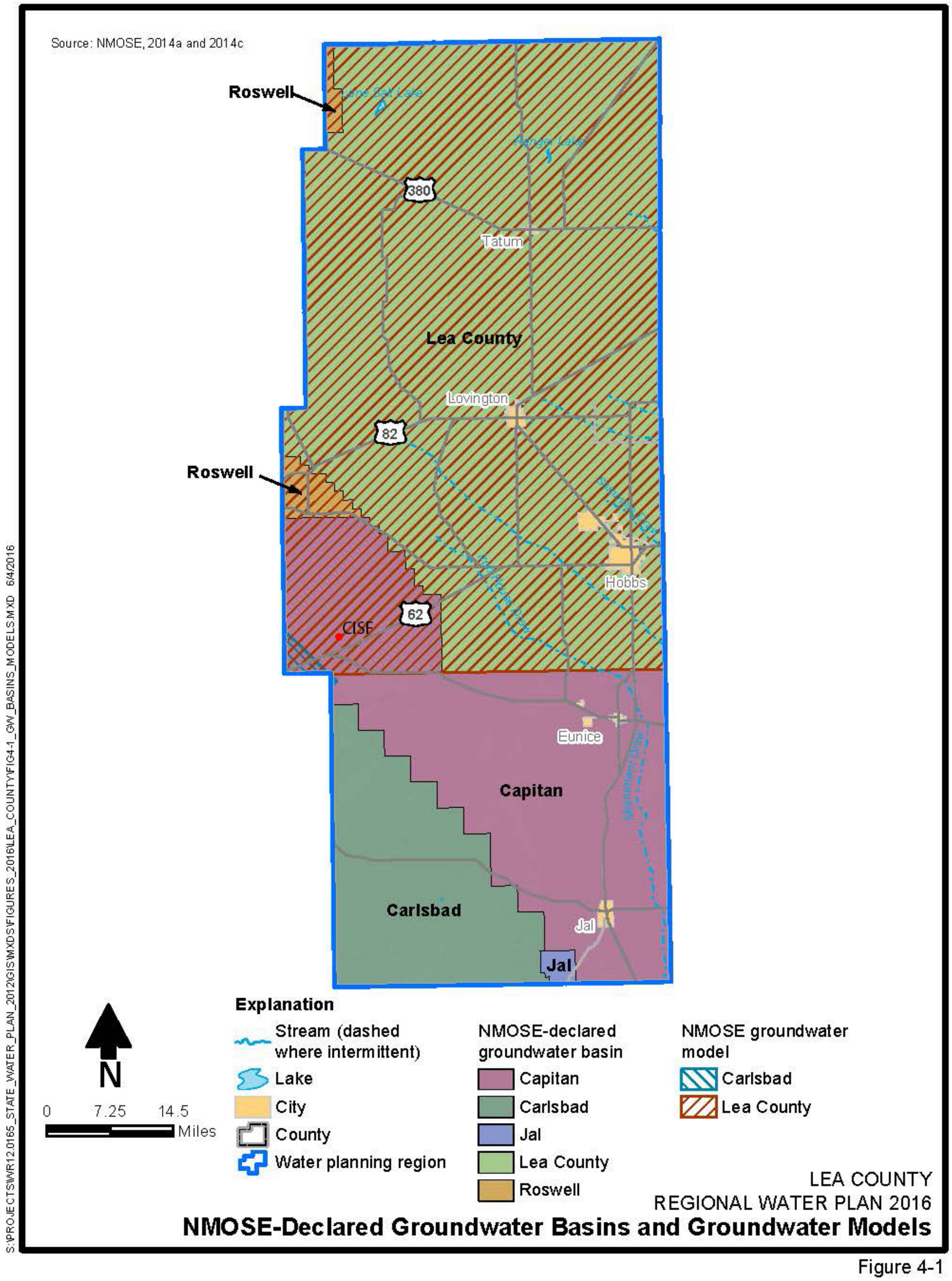


Figure 2.4.5: MNOSE-Declared Groundwater Basins and Groundwater Models [2.4.6]

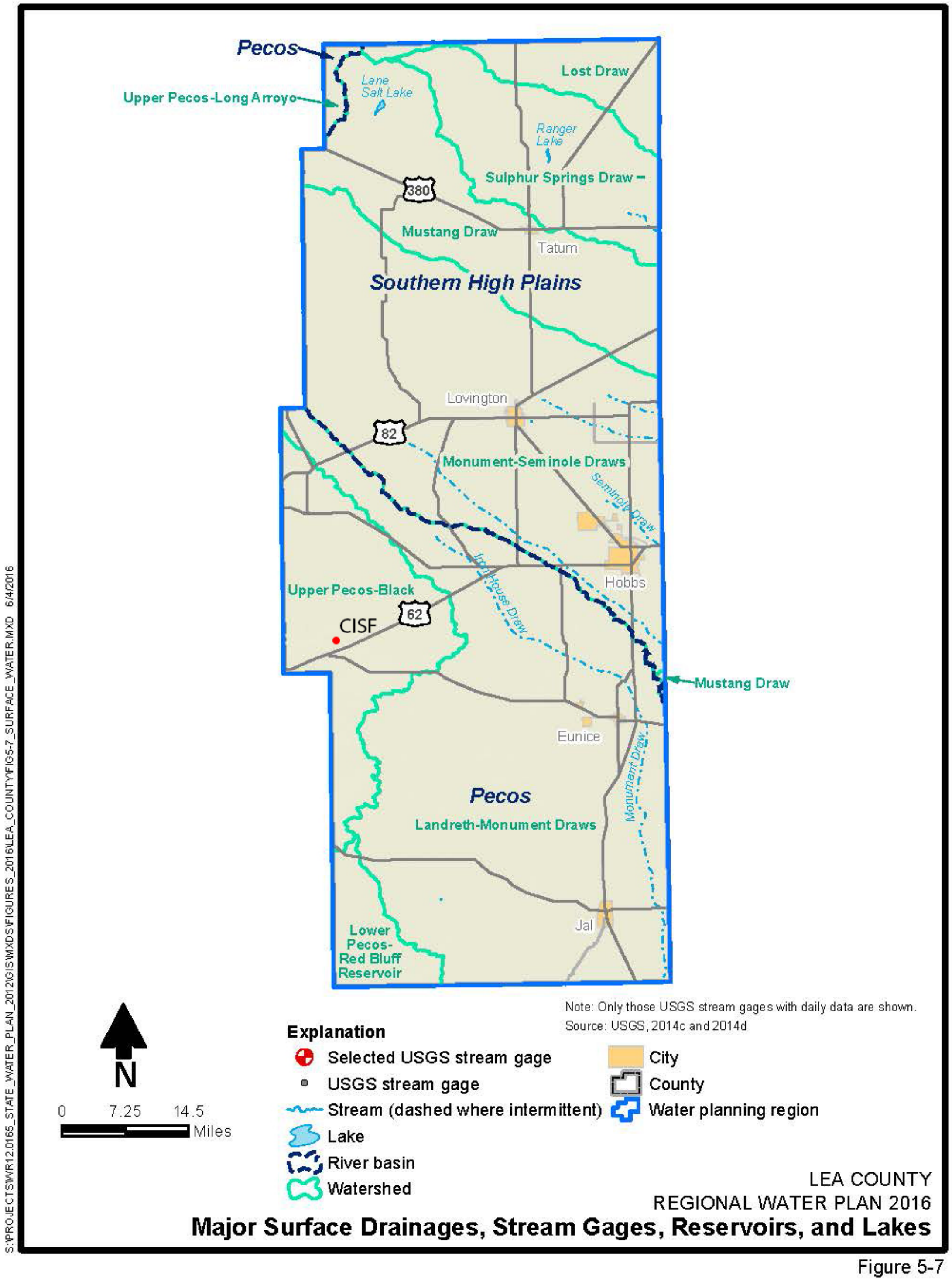


Figure 2.4.6: Major Surface Drainages, Stream Gages, Reservoirs, and Lakes [2.4.6]

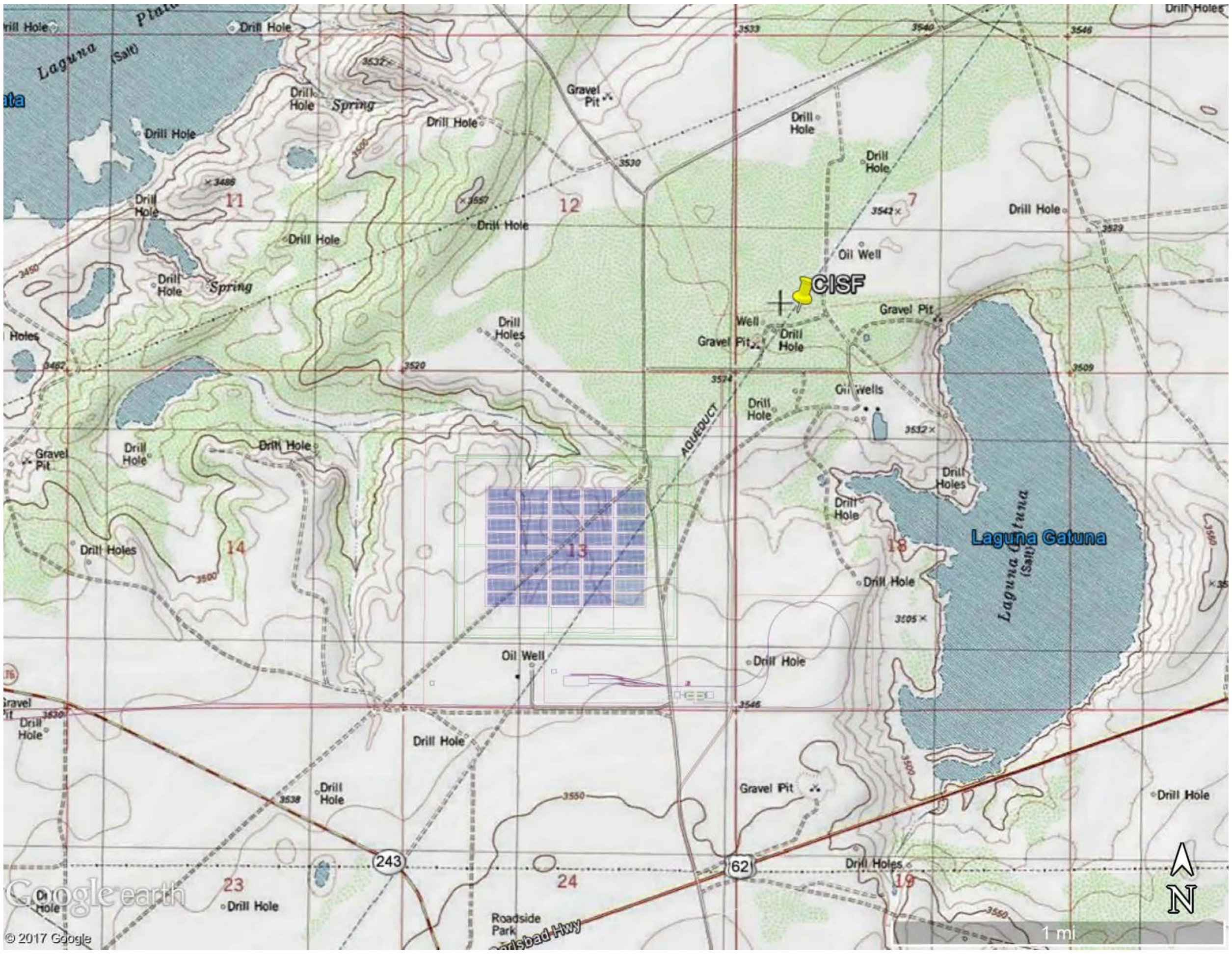


Figure 2.4.7: General Topography around the Proposed CIS Facility Site [2.4.4]

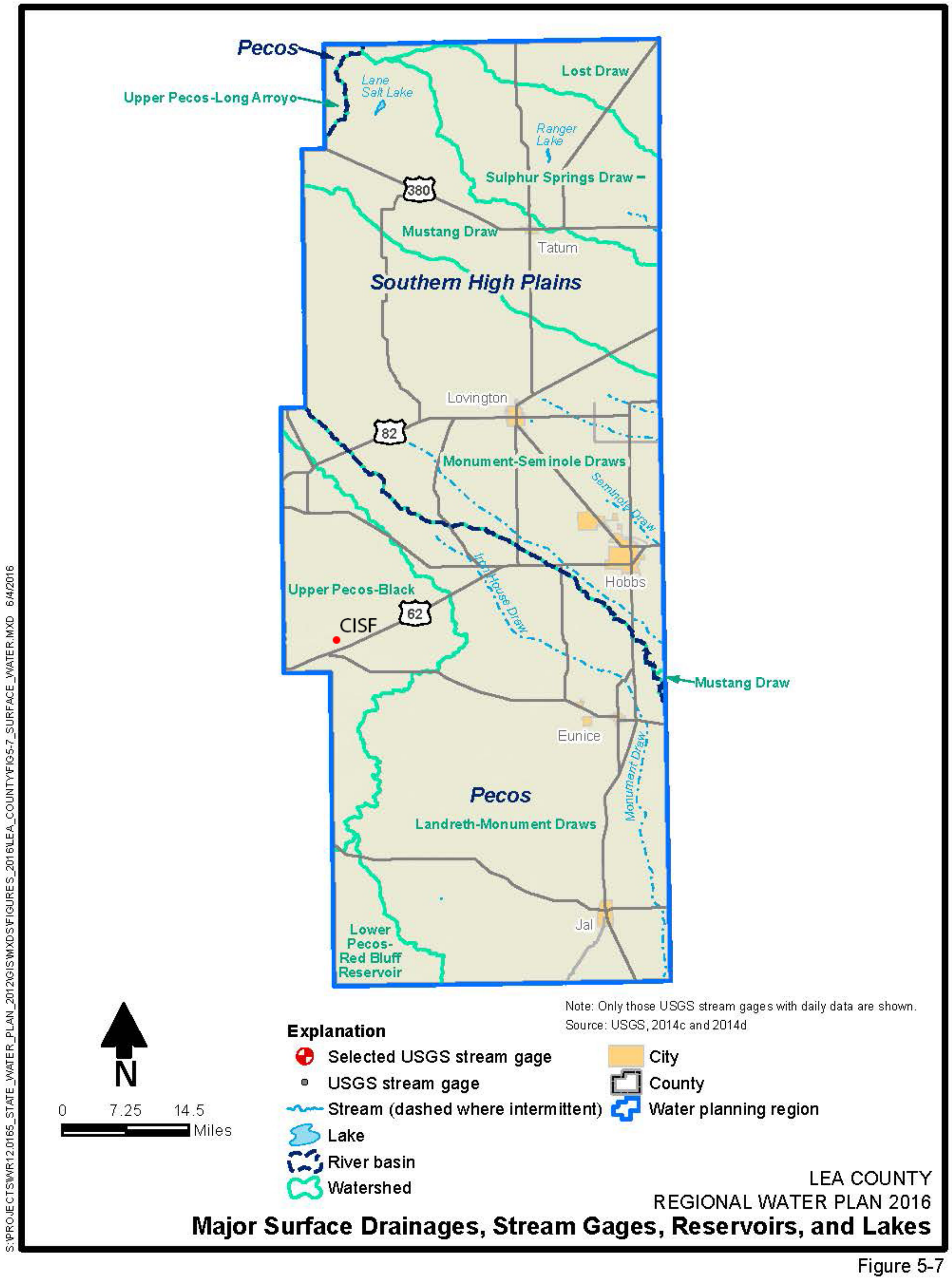


Figure 2.4.8: Major Surface Drainages, Stream Gages, Reservoirs, and Lakes [2.4.6]

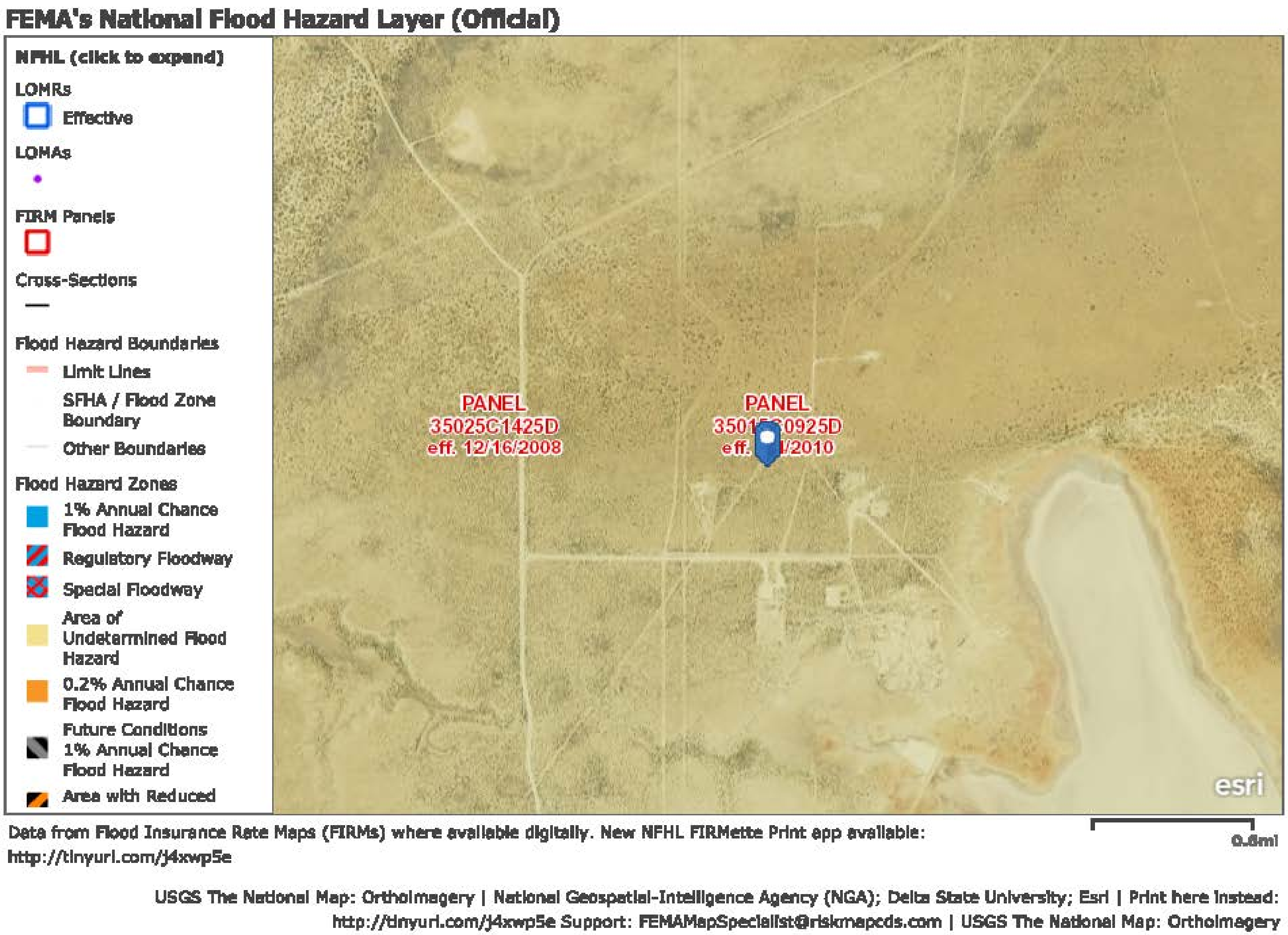


Figure 2.4.9: FEMA's National Flood Hazard Layer for the CIS Facility Site [2.4.3]

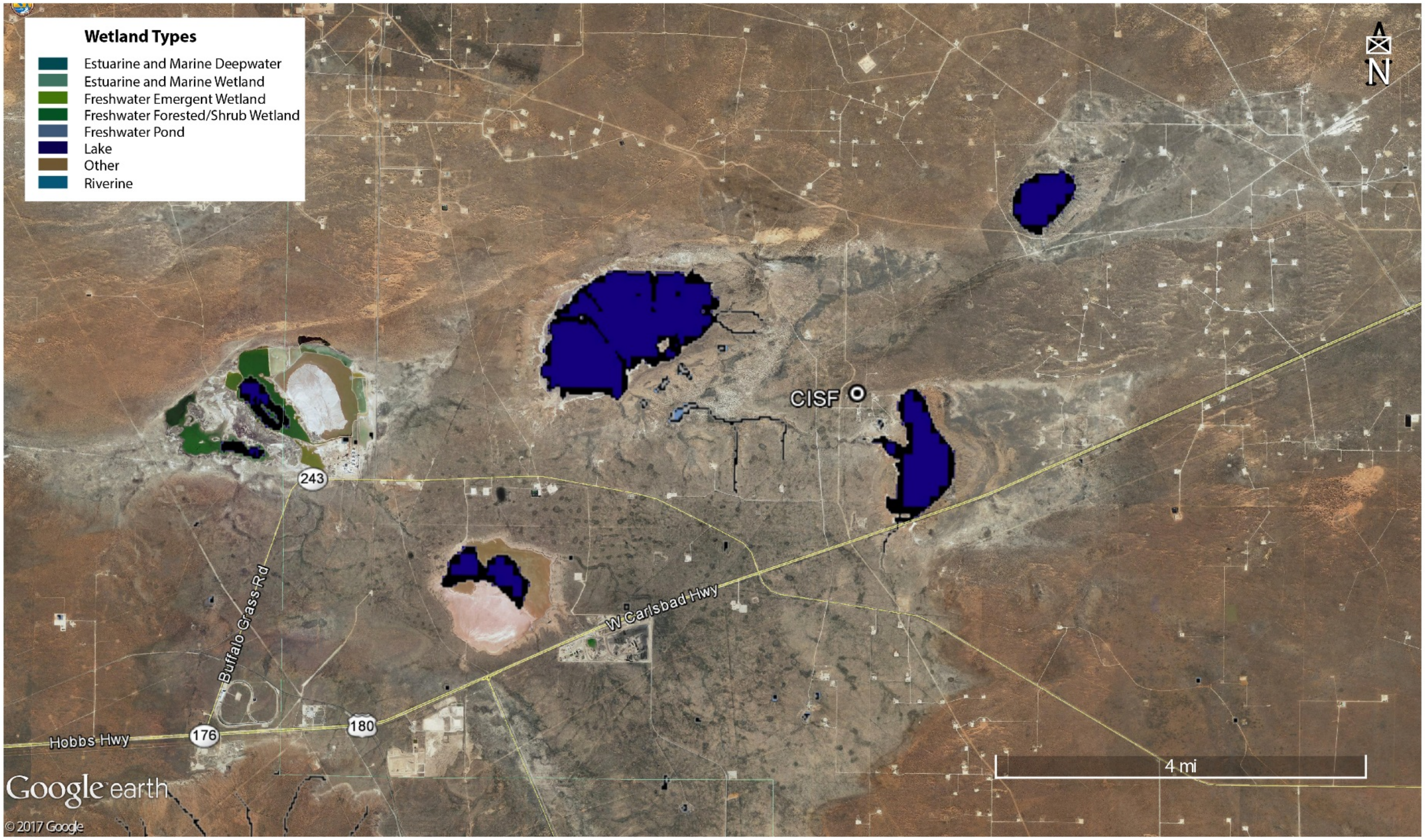


Figure 2.4.10: Wetlands in the vicinity of the CIS Facility Site [2.4.12]

2.5 SUBSURFACE HYDROLOGY

The Site is located in the Capitan Underground Water Basin (UWB) as shown in Figure 2.5.1 [2.5.1]. A declared groundwater basin is an area of the state proclaimed by the State Engineer to be underlying a groundwater source having reasonably ascertainable boundaries. By such proclamation, the State Engineer assumes jurisdiction over the appropriation and use of groundwater from the source. The Capitan UWB covers approximately 731,500 acres in the south-central portion of Lea County. It is located within a geologic province known as the Delaware Basin, a subdivision of the Permian Basin. The Capitan UWB is oriented in a northwest-southeast alignment above an arc-shaped section of a formation known as the Capitan Reef Complex. The Capitan aquifer occurs within dolomite and limestone strata deposited as an ancient reef. The groundwater quality of the Capitan in Lea County is very poor, with total dissolved solids ranging from 10,065 to 165,000 milligrams per liter (mg/L).

Other aquifers in the Capitan UWB are found in the overlying Rustler Formation, Santa Rosa Sandstone, Ogallala Formation, and Cenozoic alluvium and are important sources of groundwater in the Capitan UWB. The depth to the top of the Rustler Formation ranges from 900 to 1,100 feet.

Potable groundwater is available from three geologic units in southern Lea County; the Triassic Dockum shale, the Tertiary Ogallala, and Quaternary alluvium [2.5.2]. No potable groundwater is known to exist in the immediate vicinity of the Site. Shallow groundwater is present in a number of locations in the area, but water quality and quantity are marginal at best and most, if not all, shallow wells that have been drilled in the area are either abandoned or not currently in use. Potable water for the area is generally obtained from potash company pipelines that convey water to area potash refineries from the Ogallala High Plains aquifer on the caprock area of eastern Lea County. At present, water is generally obtained from these pipelines for other area users.

Much of the shallow groundwater near the Site has been directly or indirectly influenced by brine discharges from potash refining or oil and gas production. Potash mines have discharged thousands of acre-feet of near-saturated refinery process brine to Laguna Plata and to Laguna Toston for many years. But discharges ceased in Laguna Plata in the mid-1980s and in Laguna Toston by 2001. Laguna Gatuna was the site of multiple facilities for collection and discharge of brines that were co-produced from oil and gas wells in the entire area; facility permits authorized discharge of almost one million barrels of oilfield brine per month between 1969 and 1992. As a result, saturations of shallow groundwater brine have been created in a number of areas associated with the playa lakes [2.1.3].

Evapo-transpiration at the Site is five times the precipitation rate, indicating that there is little infiltration of precipitation into the subsurface. There are numerous low permeability layers between the surface and the expected groundwater level [2.1.3]. Because of the depth of groundwater, excavation during construction would not reach the groundwater. Groundwater at the Site would also not likely be impacted by any potential releases; therefore, groundwater would be unaffected by the proposed activities. The near surface water table appears to be 35-50 feet deep, where present, and is likely controlled by the water level in the playa lakes. No groundwater was encountered in the test boring on the west side of the Site in the vicinity where the ISFSI would be located [2.1.3]. Consequently, no impacts from the near surface water table

would be expected. Additional information regarding groundwater can be found in Sections 3.5.2 and 4.5 of the ER [1.0.4].

Well drilling was conducted at the Site in 2007. Two wells, ELEA-1 and ELEA-2 were drilled on the Site to identify the depth and character of water-bearing rocks. The goals of the drilling investigation were to identify the potential for thin groundwater saturation in lower alluvium perched on the Triassic shale, or deeper groundwater saturation in the Triassic shale. Locations of these wells and other wells in the vicinity are shown on the well location map in Figure 2.5.2.

Piezometer ELEA-1. A small amount of water was initially detected in the well; however the water has steadily declined to within a few inches of the bottom of the well and is attributed to the small amount of bentonite hydration water that was placed in the well to seal the upper annulus during completion. Based on the data obtained from ELEA-1, no shallow groundwater saturation is present at the top of the Triassic shale at the location [2.1.3].

Piezometer ELEA-2. Water level in this well rose slowly over several days to a static depth of 34 feet below land surface (3,497 feet above mean sea level). The water-bearing zone in this well consists of either fractures or tight sandy zones between the depths of 85 and 100 feet; water in this zone is under artesian head of 50 feet. Laboratory analyses of water samples from the well indicate that the water is highly mineralized brine [2.1.3].

From the data collected from the onsite drilling, shallow alluvium is likely non water-bearing at the Site. Groundwater saturation in the Triassic shale appears to be limited to small amounts of highly mineralized water likely associated with the brine in Laguna Gatuna, where the brine is 3,500 feet above mean sea level [2.1.3].

Additional well drilling was conducted at the ISFSI site in Fall of 2017. Three monitoring wells were drilled next to borings numbered B101, B106, and B107 during the geotechnical field survey to determine the groundwater depth and elevation. The locations of these monitoring wells are shown in Figure 2.1.8. Figures 2.5.3 through 2.5.5 show Subsurface Profiles of the four soil and rock layers that were tested (details of these layers are further explained in Section 2.6.1). Monitoring well B101 (MW) was screened at the Santa Rosa foundation) while wells B106 (MW) and B107 (MW) were screened at the Chinle Foundation. Groundwater was encountered from elevations 3272 to 3282 and 3430 to 3437 at wells B101 (MW) and B107 (MW), respectively. No groundwater was found in well B106 (MW) after water was removed after drilling and wall installation. These measurements, along with the measurements present from aforementioned ELEA-2, were analyzed and tabulated in Table 2.5.1.

After field testing, it was determined that the measurement provided by well B101 (MW) is indicative of the primary groundwater aquifer at the site, whereas well B107 (MW) and ELEA-2 indicate the presence of isolated pockets of water in discontinuous aquifers above the lower permeability zones in the Chinle layer [2.1.24]. Therefore, the primary groundwater table depth is approximately 253 to 263 feet below the ground surface at the ISFSI site.

Based on this information presented in this section and the fact that there are no radioactive effluents from the proposed spent fuel storage system, it can be concluded that no buildup of radionuclides will occur in the subsurface hydrologic system.

Table 2.5.1: Groundwater Elevation Data from Monitoring Wells [2.1.24]

Monitoring Well Number		B101 (MW)		B106 (MW)		B107 (MW)		ELEA-2	
		Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
Sanded and Screened Interval[1]		377.7 - 414.4	3157.78 - 3121.08	174.3 - 203	3357.08 - 3328.38	82.4 - 107.5	3447.56 - 3422.46	53 - 98	3480.49 - 3435.49
Water Level Measurements	10/15/2017	NA	NA	199.5	3331.9	102.6	3427.4	NM	NM
	10/16/2017	NA	NA	199.5	3331.9	102.0	3428.0	NM	NM
	10/18/2017	NA	NA	199.5	3331.9	100.8	3429.2	NM	NM
	10/19/2017	NA	NA	199.5	3331.9	100.5	3429.5	NM	NM
	10/24/2017	NA	NA	199.4	3332.0	98.0	3432.0	NM	NM
	10/26/2017	263.7	3271.8	NM	NM	NM	NM	NM	NM
	10/31/2017	253.4	3282.1	NE	NE	100.0	3430.0	NM	NM
	11/1/2017	253.4	3282.1	NE	NE	99.6	3430.4	37.6	3495.9
	11/16/2017	253.6	3281.9	NE	NE	93.1	3436.9	37.7	3495.8

Notes:
1. The sanded and screened interval corresponds to the upper and lower limits of the sanded zone.
2. Depth refers to depth below the ground surface.
3. Elevations are based on the North American Vertical Datum of 1988 (NAVD88).
4. "NA" indicates Not Applicable. Monitoring well was not installed by those dates.
5. "NM" indicates Not Measured.
6. "NE" indicates Not Encountered.
7. B107(MW) was bailed dry after 10/24/2017 water level measurement.
8. Data for B106(MW) from Oct15 to Oct24 indicate water levels below bottom of screen section, within the silt trap. These readings indicate groundwater at this
9. ELEA-2 sanded and screened interval information is based on the Drillhole Log ELEA-2 from the GNEP Eddy Lea Siting Study (2007).

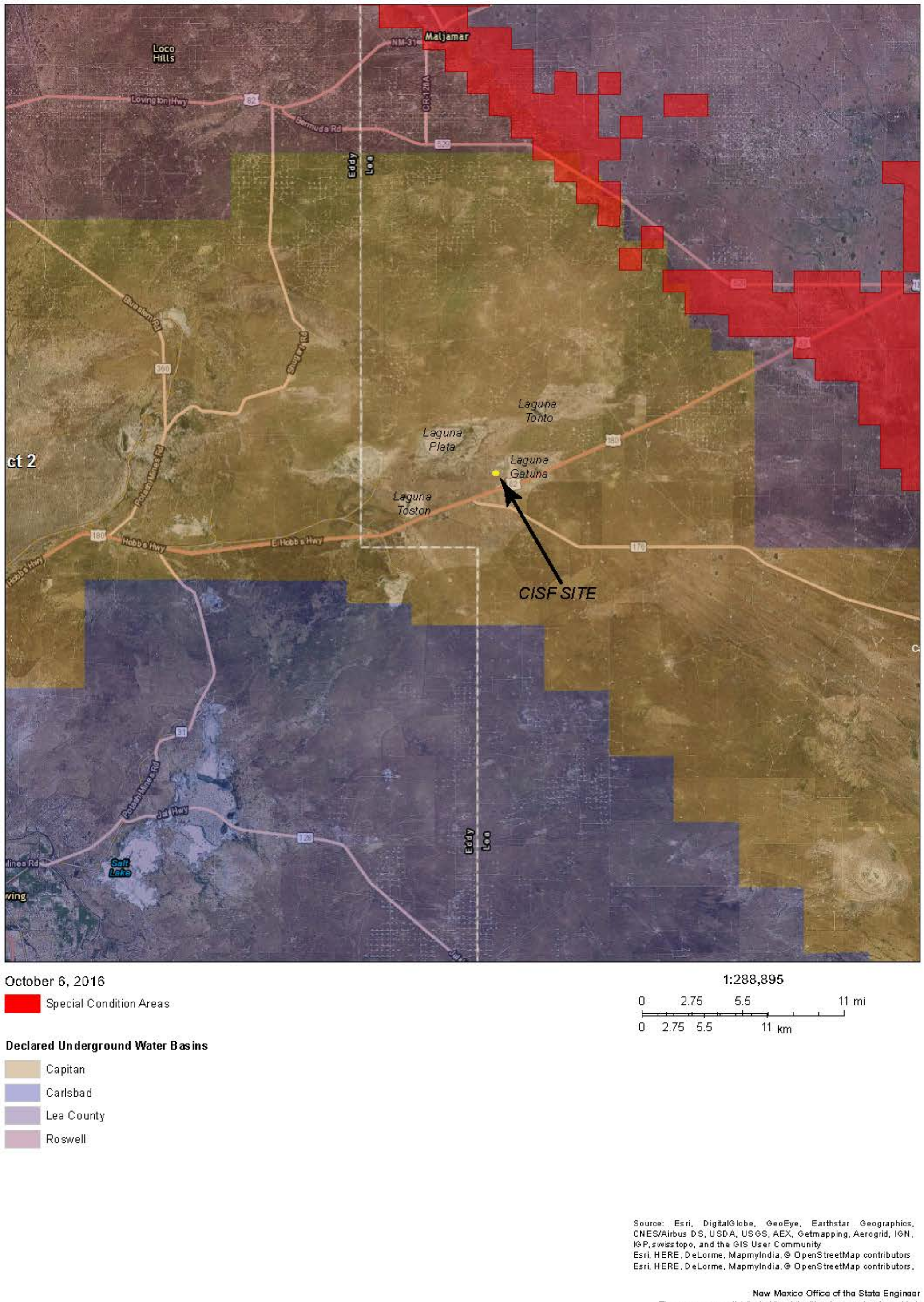


Figure 2.5.1: Administrative Underground Water Basins in the State of New Mexico [2.5.1]

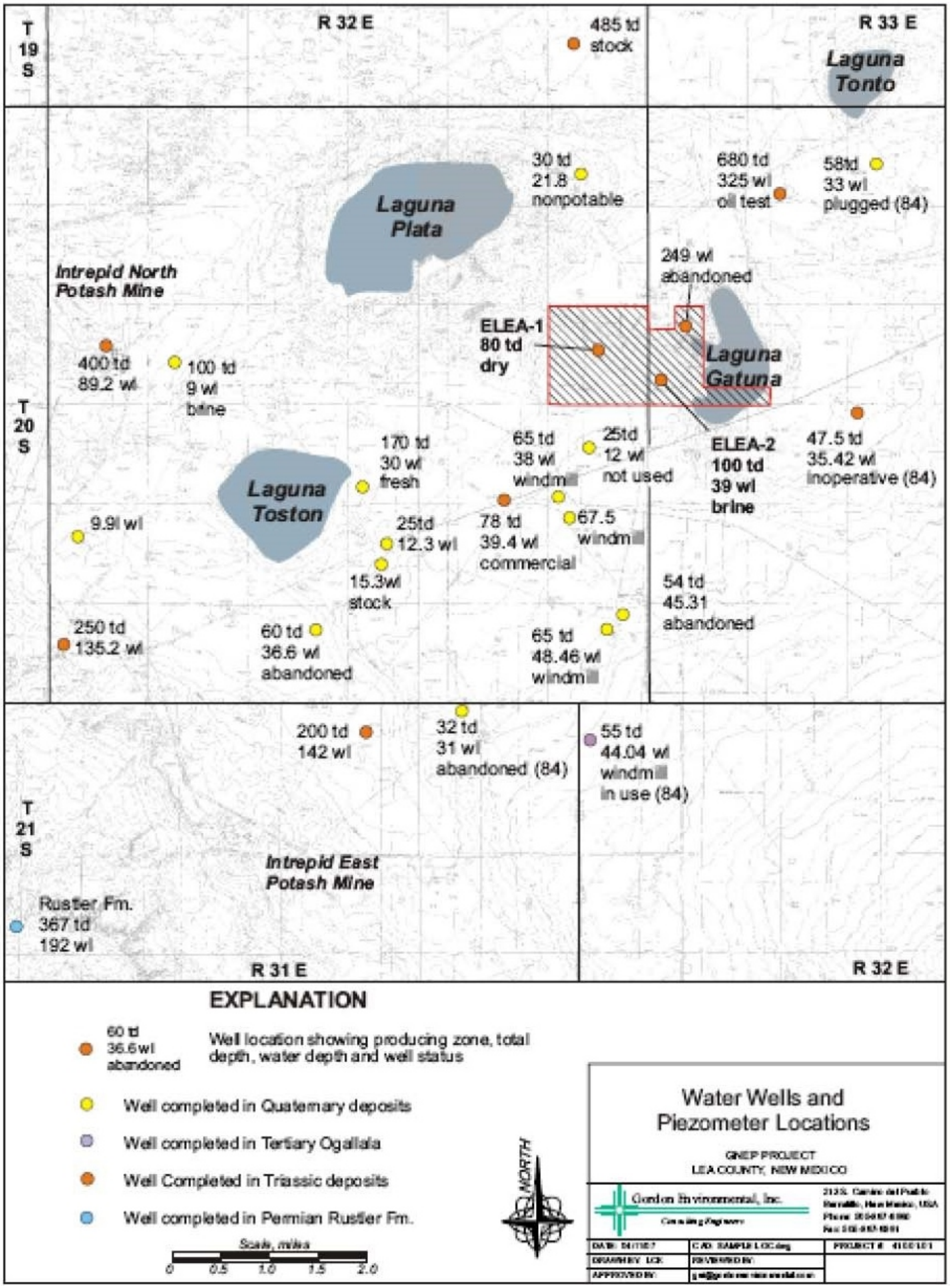


Figure 2.5.2: Water Wells and Piezometer Locations [2.1.3]

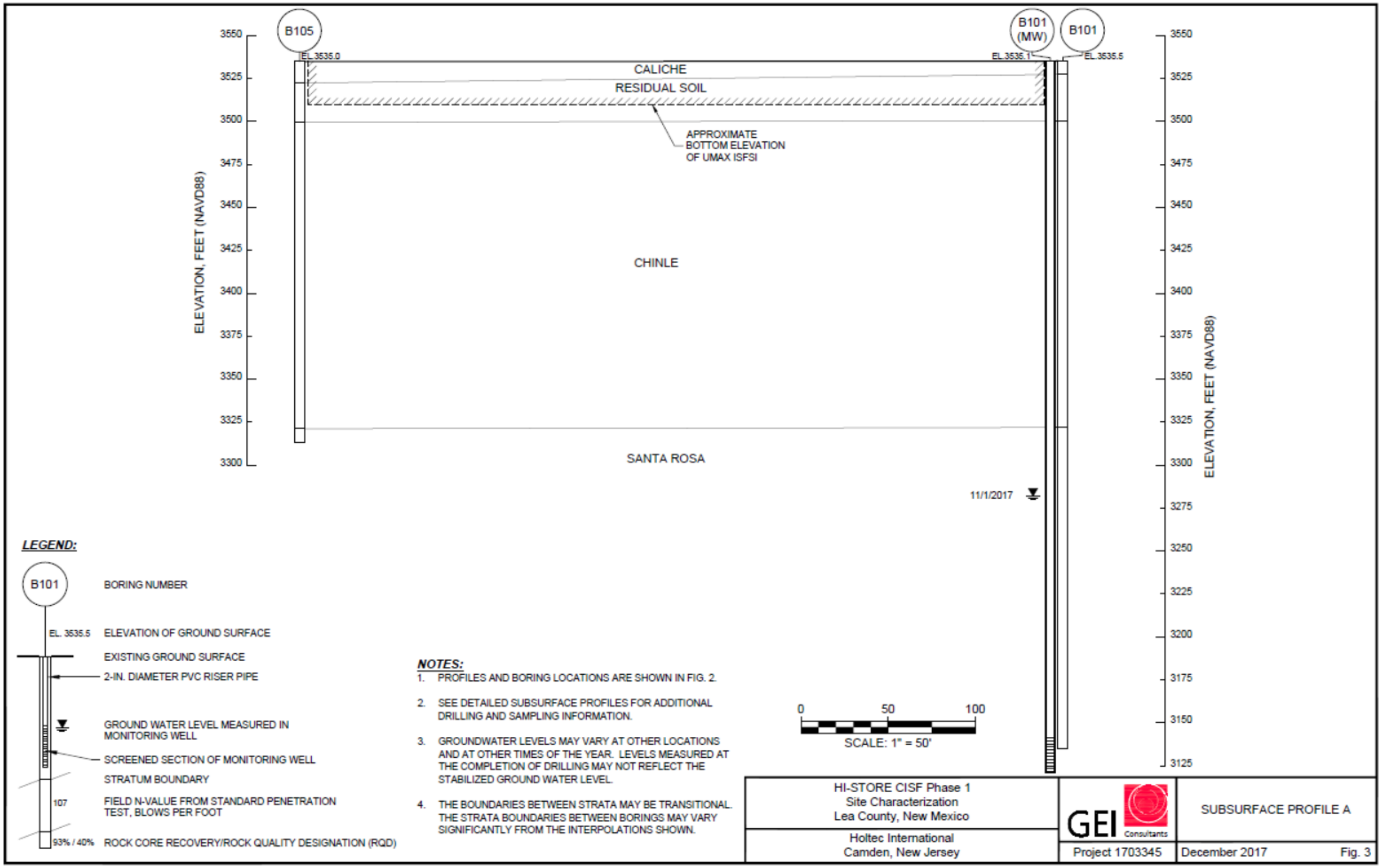


Figure 2.5.3: Subsurface Profile A [2.1.24]

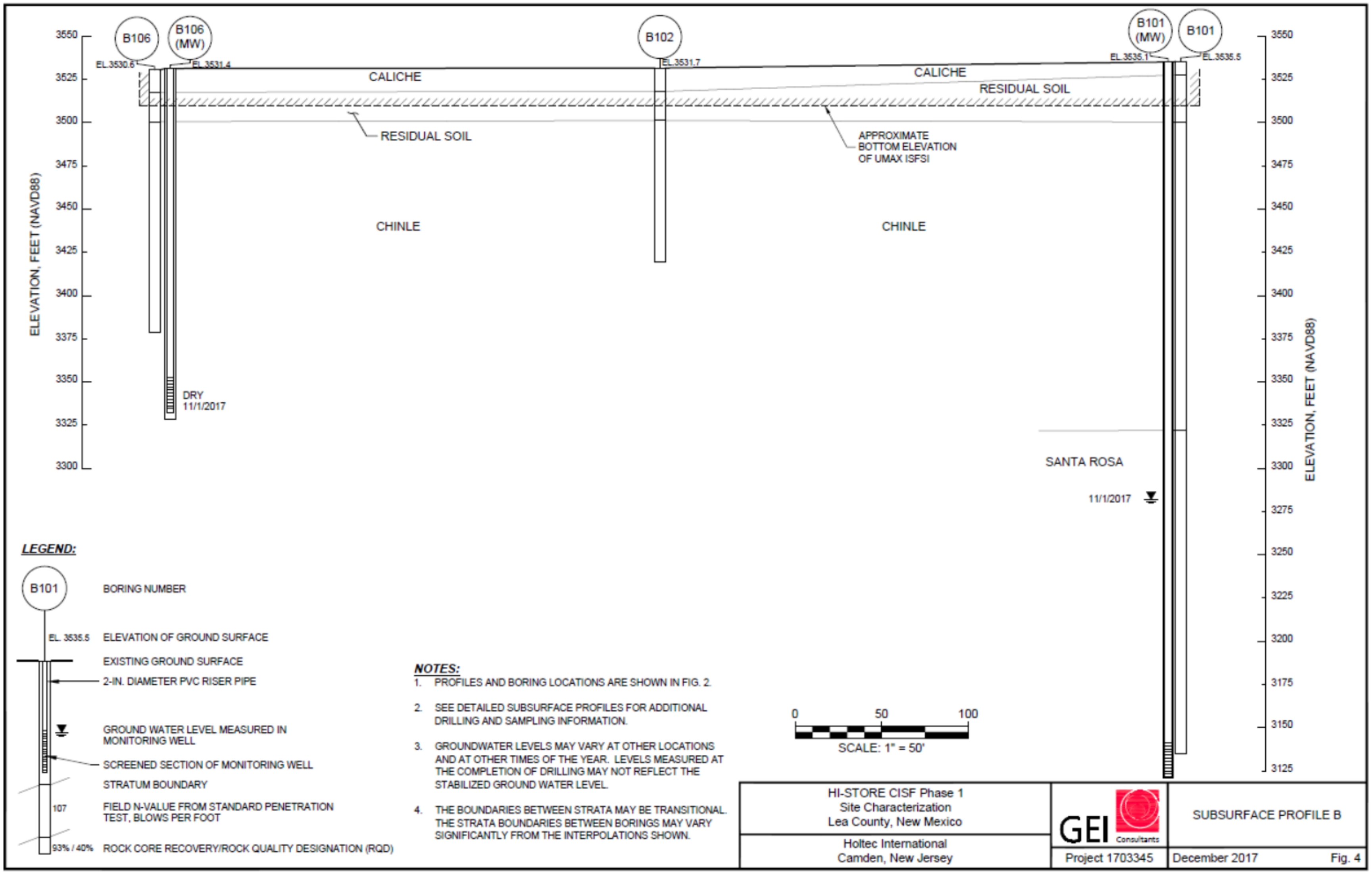


Figure 2.5.4: Subsurface Profile B [2.1.24]

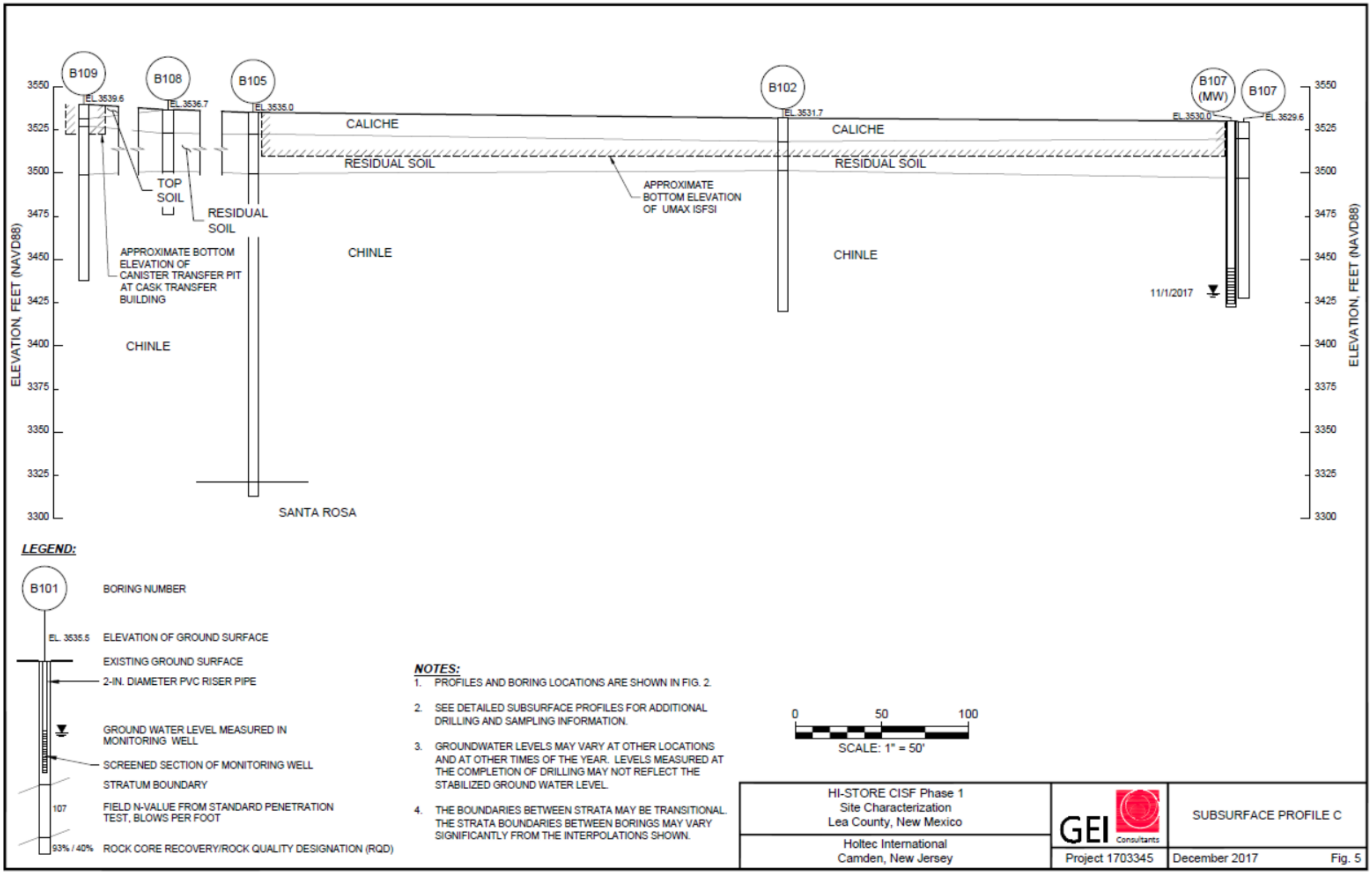


Figure 2.5.5: Subsurface Profile C [2.1.24]

2.6 GEOLOGY AND SEISMOLOGY

This section identifies the geological and seismological characteristics of the Site and its vicinity. The location for the proposed Site, and sites in the vicinity including the WIPP (located 16 miles southwest), and the NEF (located 38 miles southeast), have been thoroughly studied in recent years in preparation for construction of other facilities. Data are available from these investigations in the form of various reports [2.1.3, 2.1.24, 2.6.1, 2.6.2]. These documents and related material provide a substantial database and description of regional and site-specific geological conditions at the proposed Site.

2.6.1 Basic Geologic and Seismic Information

The Site is located in the northern portion of the Delaware Basin, a northerly-trending, southward plunging asymmetrical trough with structural relief of greater than 20,000 feet on top of the Precambrian basement rock. The Basin was formed by early Pennsylvanian time, followed by major structural adjustment from Late Pennsylvanian to Early Permian time. During the Triassic period, the area was uplifted, resulting in deposition of clastic continental shales (redbeds). Continuing uplift resulted in erosion and/or nondeposition until the middle to late Cenozoic period, when regional eastward tilting completed structural development of the basin as it exists today. Shallow subsurface structure at the Site consists of gently east sloping beds of Triassic age redbeds, dipping two degrees to the east. Faulting has not occurred in the northern Delaware Basin in the area of the Site. The regional geology suggests that there have been no recent, dramatic changes in geologic processes and rates in the vicinity of the Site [2.1.3].

During most of the Permian period, the Delaware Basin was the site of a deep marine canyon that extended across southeastern New Mexico and west Texas. Major structural elements of the Delaware Basin area are shown in Figure 2.6.1. The major structures of the basin include the Guadalupe Mountains on the west side, the Central Basin Platform on the east side, and the Capitan Reef Complex on the west and north sides of the basin. The reef created steep slopes toward the basin and the thickness of sediments grows precipitously toward the center of the basin from the margin of the reef. The Central Basin Platform forms an abrupt eastern terminus to the Delaware Basin; it is a steeply fault-bound uplift of basement rocks that grew through the early and middle Paleozoic period such that most of the pre-Permian sedimentary section is missing from its apex. Great thickness of organic-rich marine deposits in the basin and the presence of abrupt structures in the Capitan Reef Complex and Central Basin Platform combined to produce a prolific oil and gas province. These areas have been the focus of intense petroleum exploration and development activities since approximately 1920. Surficial geology and subsurface structure across the Delaware Basin are depicted in the maps and cross section in Figures 2.6.2 through 2.6.4. Thickness of sediments in the basin exceeds 20,000 feet, and Permian strata alone account for more than 13,000 feet of sedimentary materials [2.1.3].

The geologic formations of concern beneath the Site comprise, from oldest to youngest, consist of Permian-aged rocks (Wolfcamp series, Leonard series, Guadalupe series, Ochoa series); Triassic-aged rocks (Dockum Group); and Tertiary and Quaternary rocks (Lower Gatuna Formation, Upper Gatuna Formation); and alluvium. A stratigraphic column for the above units in provided in Figure 2.6.5.

The entire Site is underlain by Triassic bedrock consisting of shale, siltstone, and minor, fine-grained, poorly sorted sandstone. Most of the proposed operational area is relatively flat and the shale bedrock is covered by a laterally extensive veneer of 25 feet of Quaternary pediment deposits consisting of well sorted eolian sand and sandy-gravelly materials near the bedrock interface. The Mescalero Caliche unit is near the surface and is about 10 feet thick at the Site.

Most of the proposed operational area is relatively flat ranging from 3,520 feet above mean sea level (AMSL) on the northern end to 3,535 feet AMSL on the southern end. The surficial geology consists of Quaternary Pediment deposits (25 feet thick) overlying Triassic-age shale bedrock. The different soil/geologic layers are described as follows:

- Surface Soil: sandy and well-drained (0 to 2 feet below grade);
- Mescalero Caliche: well developed, naturally cemented calcium carbonate, laterally extensive, tightly bound and erosion resistant (2 to 12 feet below grade);
- Quaternary Sands: well sorted eolian sand and sandy-gravelly materials near the bedrock interface (12 to 25 feet below grade);
- Dockum Group: Triassic-age, predominantly shale, siltstone, and minor, fine-grained, poorly sorted sandstone (25 to greater than 100 feet below grade).

To determine the subsurface profile at the CIS Facility, a geotechnical survey was conducted. Nine borings, labeled B101 through B109, were drilled throughout the area: seven at the ISFSI pad, one along the haul path (B108), and one at the cask transfer building (B109). The location of each of these borings can be found in Figure 2.1.8. A summary of the boring exploration data including drilling, sampling, and field test notes, is located in Table 2.6.1. Subsurface profiles produced based on the subsurface exploration results are located in Figures 2.5.4 through 2.5.6, with more detailed subsurface profiles located in Figures 2.6.6 through 2.6.8. In addition, boring logs were developed to provide details of the subsurface geology encountered during the testing process. These boring logs can be found in Appendix C of the referenced geotechnical report [2.1.24].

At the ISFSI location (B101-B107), five primary subterranean layers were observed, Figures 2.6.6 through 2.6.8:

- Top Soil layer, which consists of clayey sand with gravel on the south corners or lean clay with sand in the center and north corners of the ISFSI site.
- Caliche layer, which consists of silty sand with gravel for all borings, along with additional layers of narrowly graded gravel with sand and widely graded sand with silt and gravel for the northwest and southwest corners, respectively.
- Residual layer, which consists of various layers of clayey sand and sandy lean clay at all borings, except the northeast corner, which only included clayey sand. The center has an additional layer of clayey sand with gravel.
- Chinle layer, which consists of various layers of lean clay, sandy lean clay, lean clay with sand, and clayey sand. Mudstone was encountered at this layer for all borings.
- Santa Rosa layer, which consists of various layers of mudstone and sandstone. Only borings B101 and B105 at the southern corners encountered this layer.

These borings describe the subgrade and under-grade space makeup of Spaces B, C, and D beneath the ISFSI pad in Figure 4.3.1.

At the haul path (B108), four primary subterranean layers were tested:

- Top Soil layer which consists of clayey sand.
- Caliche layer which consists of silty sand with gravel.
- Residual layer which consists of various layers of clayey sand, sandy lean clay, and clayey sand with gravel.
- Chinle layer which consists of various layers of lean clay with sand, and then sandy lean clay before the end of boring.

At the CTF site (B109), four primary subterranean layers were tested:

- Top Soil layer which consists of lean clay with sand and sandy lean clay with gravel.
- Caliche layer which consists of clayey sand and sandy lean clay layers.
- Residual layer which consists of various layers of sandy lean clay, clayey sand, and lean clay with sand.
- Chinle layer which consists of various layers of lean clay, sandy lean clay, lean clay with sand, and clayey sand. Mudstone was encountered at this layer.

Soil properties, such as grain size, specific gravity, density, Atterberg limits, shear velocity, and water content were determined and are tabulated in Tables 2.6.2 through 2.6.4. The graphical Atterberg limit results and shear wave velocities are shown in Figures 2.6.9 and 2.6.10, respectively. All of the testing deliverables are defined in the geotechnical report [2.1.24] and are summarized in Tables 2.6.2 and 2.6.3 below. Table 2.6.5 provides locations of applicable data in the geotechnical report [2.1.24].

The Top Soil layer ranges from 3 to 4 inches deep, but was 8.1 feet thick at the CTF. The soil consists of varying loose-to-medium dense amounts of sand and clay. Next, the Mescalero Caliche layer ranges from 4.4 to 13.5 feet thick. The soil consists of varying dense-to-very dense amounts of sand and gravel with silt, with unit weights between 84.5 to 94.2 pounds per cubic foot. Finally, the Residual Soil layer ranges from 17 to 28 feet thick. The soil consists of varying very hard or very dense amounts of clayey sand or sandy clay with traces of gravel, with unit weights between 98.6 to 126.4 pounds per cubic foot [2.1.24].

The Chinle Formation layer is the first bedrock layer encountered, from a depth of 27.5 to 40.5 feet. The rock consists of varying layers of lean clay or clayey sand, classified from the SPT N-values as very dense soil to soft rock. Lastly, the Santa Rosa Formation is the last tested bedrock layer, where samples were collected at depths of 401 and 222 feet from two separate borings. The rock consists of varying ranges of fine-to-coarse grained sandstone, with minor reddish-brown siltstones and conglomerate. Details of the soil and rock layers are included in Section 5.2 of the geotechnical report [2.1.24].

Monitoring wells were drilled next to borings B101, B106, and B107 to determine the groundwater elevation at the ISFSI site. Laboratory testing was conducted on the soil and rock extracted from these borings. As stated in Section 2.5, the primary groundwater table is at 253-

263 feet below grade. Excavation to a depth of 25 feet below grade is expected for facility construction; thus, the construction activity will not be in contact with the groundwater table.

2.6.2 Vibratory Ground Motion

Earthquakes of low to moderate magnitude have been documented within a 200 mile radius of the Site. The vast majority of the earthquake activity is located southeast of the Site in west Texas, and west/northwest of the Site in central New Mexico. The U.S. Geological Survey (USGS) earthquake database was used to query historical earthquakes within a 200 mile radius of the Site [2.6.3]. Results of the search of the 200 mile radius yielded a total of 244 historical earthquakes with magnitude 2.5 or greater between 1900 and the most recent update of the database in 2016. The results indicate the closest earthquake to the Site was 24 miles southwest with a magnitude of 3.1 that occurred on March 18, 2012. Two earthquakes with magnitudes greater than 5.0 were recorded within 200 miles of the Site. An earthquake with magnitude 6.5 occurred on August 16, 1931, located 140 miles southwest of the Site; and an earthquake with magnitude 5.7 occurred on April 14, 1995, located 165 miles south of the Site. The Eunice earthquake of January 2, 1992, located 39 miles east of the Site had a magnitude of 4.6. The results of the USGS earthquake search are plotted on a regional map in Figure 2.6.11.

There are three seismic source zones within a 200 mile radius of the Site: the northern and southern regions of the Southern Basin and Range – Rio Grande rift zone located west and southwest of the Site; and the Central Basin Platform zone located east of the Site. The most active seismic area within 200 miles of Site is the Central Basin Platform east of the Site. Large magnitude earthquakes are not occurring or have not occurred within the recent geologic past along the Central Basin platform due to the absence of Quaternary faults. The seismicity in west Texas, southeast of the Site, is hypothesized as being a result of fluid pressure build-up from fluid injection, and consequential reduction in effective stress across pre-existing fractures and associated decrease in frictional resistance to sliding. Similarly, recent records (1998 through 2005) from the WIPP seismic monitoring network indicate that the strongest events recorded annually in 1999, 2000, and 2002 through 2005 (typically of 2.5 to 4.0 magnitude during this time period) have been located about 50 miles west of the Site. This seismic activity is suspected to be induced by injection of waste water from natural gas production into deep well or wells [2.1.3].

A review of the seismic risk was based on USGS Geologic Hazards Science Center's 2009 Earthquake Probability Mapping [2.6.4], which generates maps that show the probability of a magnitude 5.0 or higher earthquake within a 30-mile radius of any location within the next 50 years. On a scale of 0.00 (the lowest probability of earthquake) to 1.00 (the highest probability), all Project facilities are within the low probability range of 0.01 to 0.02 as shown in Figure 2.6.12. Earthquake probability is dominated by seismic activity within the Central Basin Platform south and east of the Site.

Probabilistic ground motion for the Site was determined using information from the USGS [2.6.5]. Figure 2.6.13 is a probabilistic ground motion map of the Site, illustrating peak horizontal acceleration with a 2 percent probability of exceedance in 50 years (2,500 year return interval). The Peak Horizontal Ground Acceleration (PGA) value of 0.04 of the acceleration due to gravity (g) to 0.06g estimated by the regional USGS algorithm is similar to values suggested by several site-specific studies for nearby locations. The Geological Characterization Report (GCR) for the WIPP Site [2.6.1] determined acceleration of ≤0.06g for a return interval of 1,000

years, and ≤0.1g for a return interval of 10,000 years (WIPP is located approximately 16 miles southwest of the Site); the results of the GCR were reviewed and confirmed by Sanford et al. [2.6.5]), which estimated a maximum expected acceleration of 0.1g for the WIPP, and again in the Safety Evaluation Report for the WIPP [2.6.6], which describes the GCR results as conservative. The seismic hazard for the National Enrichment Facility (NEF) uranium enrichment facility predicts 0.15g for a return interval of 10,000 years [2.6.2]. The NEF facility is about 38 miles southeast of the Site [2.1.3].

Quaternary-age faulting (exhibiting movement in the past 1.6 million years) is not present in the vicinity of the Site. The nearest Quaternary-age fault is located 85 miles southwest of the Site [2.6.7]. Little is known about this fault except that it is a normal fault, 3.6 miles in length, and has a slip rate of less than 0.01 in/yr. The Guadalupe fault forms a scarp on unconsolidated Quaternary deposits at the western base of the Guadalupe Mountains in the Basin and Range physiographic province. The same USGS database shows numerous other Quaternary-age faults within a 200-mile radius of the Site, located to the west and southwest, most of which are at the distal end of the radius and are near the Rio Grande Rift of central New Mexico. Figure 2.6.14 is a map of New Mexico and West Texas showing Quaternary-age faulting as cataloged by the USGS, and as down-loaded from the database referenced above. The database contains locations and information on faults and associated folds that have been active during the Quaternary.

In all, there are a total of 27 Quaternary faults or fault zones within a 200-mile radius of the Site. A total of four "capable" faults were identified, the closest being the Guadalupe fault (85 miles to the southwest). A "capable" fault is one that has exhibited one or more of the following characteristics (10 CFR 100 [2.6.10] Appendix A.III, Definitions):

- Movement at or near the ground surface at least once within the past 35,000 years or movement of a recurring nature within the past 500,000 years.
- Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
- A structural relationship to a capable fault according to the previous two characteristics such that movement on one could be reasonably expected to be accompanied by movement on the other.

For the purposes of this assessment, capable faults were identified based solely upon the first characteristic above.

2.6.3 Surface Faulting

There are no surface faults at the Site. Tectonic activity in the Delaware Basin is characterized by slow uplift relative to surrounding areas which has resulted in erosion and dissolution of rocks in the Basin. Faulting has not occurred in the northern Delaware Basin in the area of the Site. The regional geology suggests that there have been no recent, dramatic changes in geologic processes and rates in the vicinity of the Site [2.1.3].

2.6.4 Stability of Subsurface Materials

The entire Site is underlain by Triassic bedrock consisting of shale, siltstone, and minor, fine-grained, poorly sorted sandstone. Most of the proposed operational area is relatively flat and the shale bedrock is covered by a laterally extensive veneer of 25 feet of Quaternary pediment

deposits consisting of well sorted eolian sand and sandy-gravelly materials near the bedrock interface. The Mescalero Caliche unit is near the surface and is about 10 feet thick at the Site.

Comparison of conditions at the Site with those conditions favorable to karst development indicates that conditions at the Site are not conducive to karst development. No thick sections of soluble rock are present at or near land surface; the shallowest soluble bedrock materials are gypsum and halite beds in the Rustler Formation, which is located at least 1,100 feet below land surface at the Site. Additionally, rainfall rates in the area are low. Mescalero caliche is soluble and situated at or near land surface; however this unit is no more than 10 feet in thickness. Local dissolution of this unit may have resulted in the development of a number of small shallow depressions in the area; however this is not regarded as an active or significant karst process at the Site [2.1.3].

During site reconnaissance, detailed inspection of the areas around the margins of Laguna Gatuna and tributary drainages was performed to identify any tension cracks, disrupted soils, tilting, or other evidence of rapid earth displacement. No tension cracks or other evidence of displacement was observed. Additionally, older cultural features in the area were inspected to identify evidence of tilting, offset, or displacement that could indicate recent land movement. A number of oil wells were drilled along the west flank of Laguna Gatuna beginning in the early 1940’s. Most of the wells were abandoned by 1975 and well monuments were installed; several of the well monuments were identified during site reconnaissance. None of the monuments displayed evidence of tilting that might be associated with local earth movements [2.1.3].

A halite preservation and stability assessment entitled, *Report on Evaporite Stability in the Vicinity of the Proposed GNEP Site, Lea County, NM* was performed for the Site as part of the GNEP siting study [2.1.3]. This study was conducted in order assess existing data on the continuity and stability of evaporites under the Site, with special attention to data within, or adjacent to the boundaries of nearby lakes or playas. The main data sources for the project area include potash exploration drillholes and oil and gas drillholes.

Lithologic logs from potash exploration and geophysical logs from oil and gas exploration around the Site in southwestern Lea County, New Mexico, provide evidence of the extent and stability of evaporites and their possible relationship to the formation of playas in the vicinity.

An elevation map on the uppermost evaporite-bearing bed (top of Permian Rustler Formation) shows continuity across the area. General northeast slopes are revealed, with some flattened slopes associated with Laguna Plata. There are no indications of lowering of the surface by dissolution; the top of Rustler under most of Laguna Plata is actually elevated above the general trend. The surface varies locally due to variable reporting for potash drillholes of the first encounter with the uppermost sulfate bed of the Rustler.

There are no surface, drillhole, or mining indications that subsidence and collapse chimneys occur at the Site or surrounding area. These features are associated with the front of the Capitan reef, which is south of the Site, and with a hydraulic environment that is not known to exist at the Site.

Geophysical logs indicate that halite in the Rustler persists across the Site area. Dissolution from above to create lows on the uppermost Rustler is not a practical process. There is neither subsurface drillhole data nor surface features indicating a dissolution front in the vicinity of the

Site. There is no evidence for either past or continuing natural processes that would cause Site instability due to halite dissolution in the near future [2.1.3].

With regard to potential future drilling on the Site, Holtec has an agreement [2.6.9] with Intrepid Mining LLC (Intrepid) such that Holtec controls the mineral rights on the Site and Intrepid will not conduct any potash mining on the Site. Additionally, any future oil drilling or fracking beneath the Site would occur at greater than 5,000 feet depth, which ensures there would be no subsidence concerns [2.1.8].

Based on the data from the borings and analyses, the soils at the site are not susceptible to liquefaction. The soils encountered at the site were evaluated for liquefaction potential using the methods described in Youd, et al., 2001 [2.6.12] as prescribed by Regulatory Guide 1.198 [2.6.11]. Corrected N-values greater than 30 blows per foot are too dense to liquefy in an earthquake of any size, and are therefore classified as non-liquefiable. In addition, soils above the groundwater table are not susceptible to liquefaction [2.6.12].

2.6.5 Slope Stability

The site terrain ranges in elevation from 3,520 to 3,540 feet above mean sea-level sloping gently downward from south to north. Most of the site is flat with slopes ranging from 0 to 3 percent, as shown in Figure 2.6.15. Therefore, there is no risk from slope instability (i.e. landslides) in the vicinity of the Site.

Table 2.6.1: Boring Exploration Data [2.1.24]

Boring Number	As-Drilled Coordinates		Ground Surface Elevation (feet)	Boring Depth (feet)	Drilling, Sampling, and Field Test Notes (1)	Purpose
	Northing (feet)	Easting (feet)				
B101	571,880.4	731,795.0	3535.5	400.6	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B101A	571,899.0	731,779.8	NM	30.9	SPT	Hammer energy measurement.
B101B	571,906.7	731,791.6	3535.1	414.4	Not sampled	Installed monitoring well B101(MW).
B102	572,097.9	731,585.2	3531.7	112.0	Bulk Sampling, SPT, Rock Coring	Characterize soil and rock for ISFSI Pad.
B102A	572,088.4	731,581.4	3531.4	107.9	Not sampled	Installed inclinometer casing for crosshole seismic velocity testing.
B103	572,091.3	731,567.4	3531.2	107.6	Not sampled	Installed inclinometer casing for crosshole seismic velocity testing.
B104	572,094.6	731,552.0	3531.6	107.8	Not sampled	Installed inclinometer casing for crosshole seismic velocity testing.
B105	571,879.9	731,356.8	3535.0	221.7	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B105A	571,865.2	731,338.5	3534.9	30.4	SPT	Hammer energy measurement.
B106	572,280.0	731,356.3	3530.6	152.0	SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B106A	572,270.0	731,364.2	3531.4	203.0	Not sampled	Installed monitoring well B106(MW).
B107	572,282.3	731,792.4	3529.6	102.0	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for ISFSI Pad.
B107A	572,282.4	731,782.1	3530.0	107.5	Not sampled	Installed monitoring well B107(MW).
B108	571,660.2	731,344.9	3536.7	60.9	SPT	Characterize soil for HHP.
B109	570,681.2	730,773.3	3539.6	102.0	Bulk Sampling, SPT, Rock Coring, Packer Testing	Characterize soil and rock for CTB.

Notes:
1. Modified California samples were collected as appropriate in SPT borings.
2. Northing and Easting are based on the Modified U.S. State Plane of 1983 (NAD83), New Mexico East Zone 3001.
3. Elevations are based on the North American Vertical Datum of 1988 (NAVD88).
4. "SPT" indicates Standard Penetration Test.
5. "NM" indicates not measured.

Table 2.6.2: Soil Index Properties [2.1.24]

Sample Identification				Index Properties											Unit Weight		
					Grain Size Tests				Atterberg Limits Tests								
Boring Number	Sample Number	Sample Depth (ft)	Formation	Water Content (%)	Water Content (%)	Gravel (%)	Sand (%)	Fines (%)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Specific Gravity	Water Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)
B101	MC1	10.0 - 11.0	Residual Soil	--	--	--	--	--	--	--	--	--	--	15.8	--	--
B101	MC2	20.0 - 21.0	Residual Soil	--	--	--	--	--	--	--	--	--	--	9.4	--	--
B101	MC3	30.0 - 30.4	Residual Soil	--	--	--	--	--	--	--	--	--	--	15.4	126.4	109.5
B101	S11	35.0 - 36.8	Chinle	--	8.7	0.0	3.6	96.4	--	--	--	--	--	--	--	--
B101	S13	45.0 - 46.8	Chinle	--	15.0	0.0	46.8	53.2	--	--	--	--	--	--	--	--
B101	S15	55.0 - 56.4	Chinle	--	13.0	0.0	35.2	64.8	--	--	--	--	--	--	--	--
B101	S19	75.0 - 76.2	Chinle	10.4	10.2	0.0	30.6	69.4	--	33	16	17	--	--	--	--
B101	S20	80.0 - 81.3	Chinle	10.4	10.8	0.0	19.4	80.6	--	--	--	--	--	--	--	--
B101	S22	90.0 - 91.4	Chinle	--	14.2	0.0	29.3	70.7	--	--	--	--	--	--	--	--
B101	S23	95.0 - 96.8	Chinle	15.9	13.9	0.0	42.1	57.9	--	40	20	20	--	--	--	--
B102	G1	0.0 - 10.0	Caliche	--	--	--	--	--	5.0	NP	NP	NP	2.67	--	--	--
B102	S13(5-17")	30.0 - 32.0	Chinle	13.6	8.6	0.0	27.6	72.4	--	--	--	--	--	--	--	--
B102	S14	35.0 - 36.3	Chinle	9.9	--	--	--	--	--	--	--	--	2.78	--	--	--
B102	S15	40.0 - 41.4	Chinle	8.0	6.6	0.0	14.7	85.3	--	--	--	--	--	--	--	--
B102	S16	45.0 - 45.9	Chinle	14.6	--	--	--	--	--	--	--	--	2.81	--	--	--
B105	MC1	10.0 - 11.0	Caliche	--	--	--	--	--	--	--	--	--	--	16.0	--	--
B105	MC2	20.0 - 20.9	Residual Soil	--	--	--	--	--	--	--	--	--	--	10.3	--	--
B105	S9	25.0 - 26.8	Residual Soil	11.5	--	--	--	--	--	--	--	--	2.74	--	--	--
B105	MC3	40.0 - 41.0	Chinle	--	--	--	--	--	--	--	--	--	--	15.8	124.2	107.3
B105	S14	50.0 - 51.4	Chinle	15.7	--	--	--	--	--	--	--	--	2.81	--	--	--
B105	S15	55.0 - 56.4	Chinle	15.0	12.9	0.0	48.8	51.2	--	--	--	--	--	--	--	--
B106	S5	10.0 - 12.0	Caliche	12.7	13.0	49.2	42.0	8.8	--	43	34	9	--	--	--	--
B106	S7(6-24")	15.0 - 17.0	Residual Soil	11.5	10.7	0.3	80.2	19.5	--	40	15	25	--	--	--	--
B106	S9	20.0 - 21.9	Residual Soil	9.6	9.2	0.0	38.3	61.7	--	40	12	28	--	--	--	--
B106	S10	22.5 - 24.5	Residual Soil	10.8	9.2	0.0	55.9	44.1	--	41	14	27	--	--	--	--
B106	S13	30.0 - 31.1	Chinle	11.0	9.9	0.0	34.3	65.7	--	40	18	22	--	--	--	--
B107	G1	0.0 - 10.0	Caliche	--	--	--	--	--	--	NP	NP	NP	2.65	--	--	--
B107	S7	15.0 - 16.9	Residual Soil	--	8.3	0.0	60.1	39.9	10.9	42	20	22	--	--	--	--
B107	S13	30.0 - 32.0	Chinle	--	11.6	0.0	10.5	89.5	12.1	45	18	27	--	--	--	--
B107	S15	40.0 - 42.0	Chinle	--	10.9	0.0	31.8	68.2	16.5	41	20	21	--	--	--	--
B107	S17	50.0 - 51.3	Chinle	--	13.3	0.0	42.7	57.3	14.9	40	21	19	--	--	--	--
B108	MC1	10.0 - 11.0	Caliche	--	--	--	--	--	--	--	--	--	--	13.3	94.2	83.2
B108	MC2	40.0 - 40.9	Chinle	--	--	--	--	--	--	--	--	--	--	14.7	123.9	108.1
B108	S14	45.0 - 47.0	Chinle	5.5	14.1	0.0	47.0	53.0	--	--	--	--	--	--	--	--
B109	MC1	10.0 - 11.0	Caliche	--	--	--	--	--	--	--	--	--	--	15.9	84.5	72.9
B109	MC2	20.0 - 20.3	Residual Soil	--	--	--	--	--	--	--	--	--	--	7.5	98.6	91.7

Notes:

1. "--" Indicates test was not assigned or performed.
2. "NP" Indicates the sample is nonplastic.
3. Total Unit Weight and Dry Unit Weights from modified california samples.
4. "ft" Indicates feet.
5. "pcf" Indicates pounds per cubic foot.
6. MC = Modified california sample; S = Standard SPT; G = Bulk sample.

Table 2.6.3: Rock Core Test Results [2.1.24]

Sample Identification			Formation	Test No.	Water Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (ksf)	Strain at Failure (%)	Elastic Modulus (ksf)
Boring Number	Sample Number	Sample Depth (ft)								
B107	C6	84.0 - 85.0	Chinle	UC-1	15.2	126.5	109.8	17.4	0.75 (6)	2,727
B107	C6	84.0 - 85.0	Chinle	UC-2	16.8	136.9	117.2	5.3	0.90	900
B107	C4	73.9 - 74.6	Chinle	UC-3	15.4	137.8	119.5	25.7	0.80	4,545
B101	C28	226.3 - 226.7	Santa Rosa	NA	NM	159	NM	293	1.50	28,800
B101	C31	244.5 - 244.9	Santa Rosa	NA	NM	163	NM	938	0.45	227,500
B101	C39	283.4 - 283.8	Santa Rosa	NA	NM	160	NM	696	0.74	128,300
B101	C45	309.8 - 310.2	Santa Rosa	NA	NM	156	NM	699	0.62	95,040
B101	C48	324.5 - 325.9	Santa Rosa	NA	NM	163	NM	594	0.60	124,560
B101	C55	360.7 - 361.4	Santa Rosa	NA	NM	157	NM	766	0.56	181,440
B101	C63	399.8 - 400.3	Santa Rosa	NA	NM	164	NM	1003	0.50	263,520

Notes:

1. "ft" Indicates feet.
2. "pcf" Indicates pounds per cubic foot.
3. "ksf" indicates kips per square foot
4. NM indicates not measured.
5. NA indicated not applicable.
6. Strain at failure for UC-1 adjusted to remove initial seating strain

Table 2.6.4: Shear Wave Velocities [2.1.24]

Depth (ft)	Measurement Elevation (ft)	Shear Wave Velocity (ft/sec)	Formation
2	3529.4	1092	Caliche
5	3526.4	1057	Caliche
10	3521.4	1019	Caliche
15	3516.4	1087	Residual Soil
20	3511.4	1906	Residual Soil
25	3506.4	1703	Residual Soil
30	3501.4	2005	Residual Soil
35	3496.4	1243	Chinle
40	3491.4	1500	Chinle
45	3486.4	1588	Chinle
50	3481.4	1637	Chinle
55	3476.4	2041	Chinle
60	3471.4	2274	Chinle
65	3466.4	2240	Chinle
70	3461.4	1867	Chinle
75	3456.4	1849	Chinle
80	3451.4	1831	Chinle
85	3446.4	1877	Chinle
90	3441.4	1812	Chinle
95	3436.4	2220	Chinle
100	3431.4	2539	Chinle
105	3426.4	2761	Chinle

Note: Shear wave velocities were measured by crosshole testing at B102A, B103, and B104.

Table 2.6.5: Testing Deliverable and Reference in SAR and Geotechnical Report [2.1.24]

Deliverable	Reference
Lab Testing Procedures	
No. and Locations of Borings	Table 2.6.1. *Boring Exploration Data* Figure 2.1.8. *Boring Location Plan*
Method of Sample Collection	Table 2.6.1. *Boring Exploration Data*
Types of Field & Lab Testing	Section 3.2. *In-Situ Soil Testing* in GEI Report Section 4.1. *Geotechnical Laboratory Testing of Soil and Rock* in GEI Report [2.1.24]
Soil Properties	
Grain Size Classification	*Grain Size Analysis* in Attachment H in GEI Report [2.1.24]
Atterberg Limits	Table 2.6.2. *Soil Index Properties* Figure 2.6.9. *Atterberg Limit Results* *Atterberg (Liquid and Plastic) Limits* in Attachment H in GEI Report [2.1.24]
Water Content	Table 2.6.2. *Soil Index Properties* Table 2.6.3. *Rock Core Test Results* *Water Content Measurement (Soil)* in Attachment H in GEI Report[2.1.24]
Unit Weight	Table 2.6.2. *Soil Index Properties* Table 2.6.3. *Rock Core Test Results* *Unit Weigh of Soil* in Attachment H in GEI Report [2.1.24]
Specific Gravity	Table 2.6.2. *Soil Index Properties* *Specific Gravity Measurement* in Attachment H in GEI Report [2.1.24]
Soil Classification	*Particle Size Analysis* in Attachment J in GEI Report in GEI Report [2.1.24]
Shear Strength	*Unconfined Compression Test* in Attachment I in GEI Report [2.1.24]
Shear [Young's] Modulus	Table 2.6.2. *Soil Index Properties* *Compressive Strength and Elastic Moduli of Rock* in Attachment K in GEI Report [2.1.24]
Poisson's Ratio	Table 2.6.2. *Soil Index Properties* *Compressive Strength and Elastic Moduli of Rock* in Attachment K in GEI Report [2.1.24]
Seismic Wave Velocities	Figure 2.6.10. *Shear Wave Velocities* Table 2.6.4. *Shear Wave Velocities*
Blow Count	*Boring Logs* in Attachment C in GEI Report [2.1.24]
Groundwater	
Groundwater El.	Table 2.5.1. *Groundwater Elevation Data from Monitoring Wells*

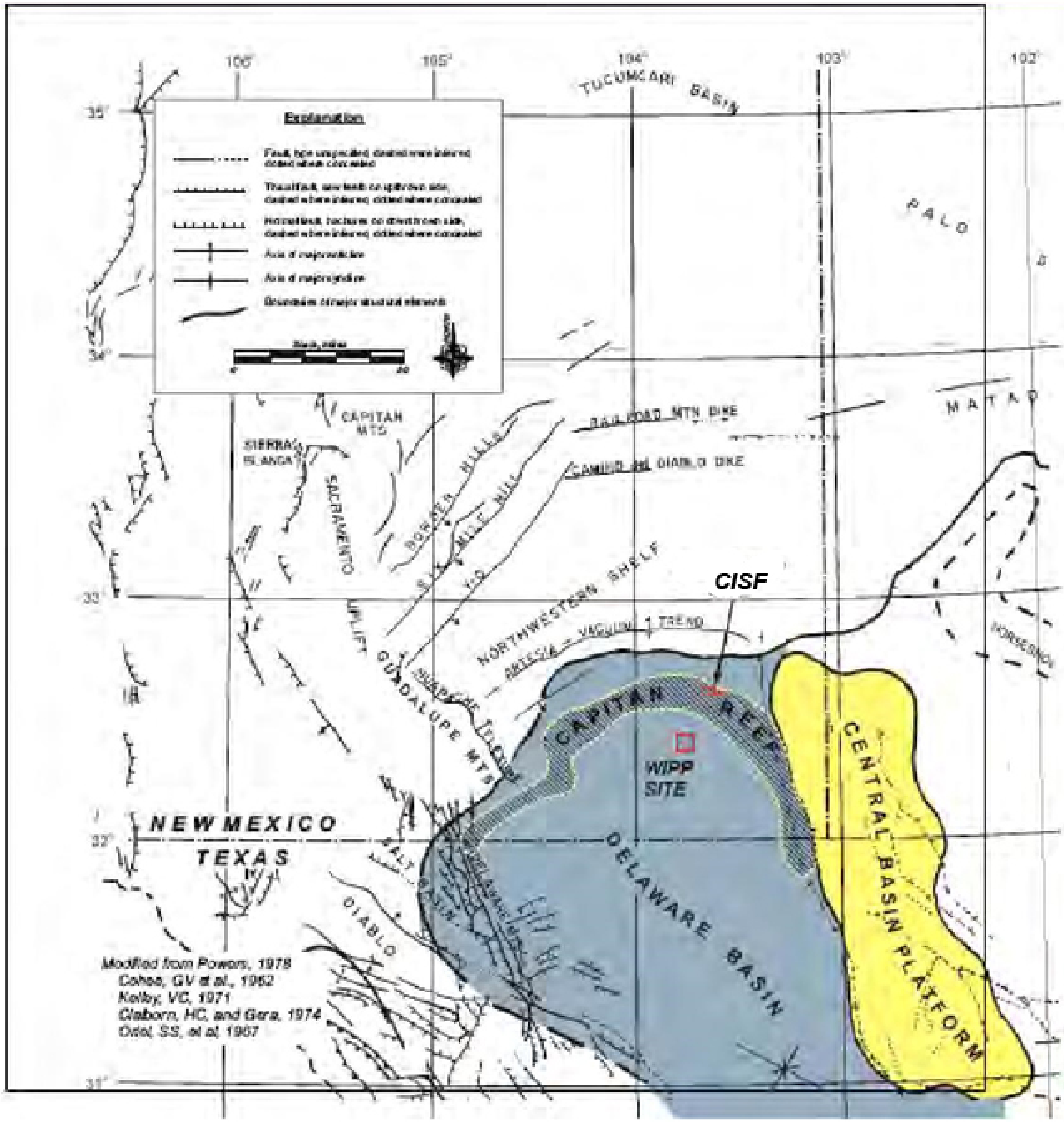


Figure 2.6.1: Major Regional Geological Structures near the Site [2.1.3]

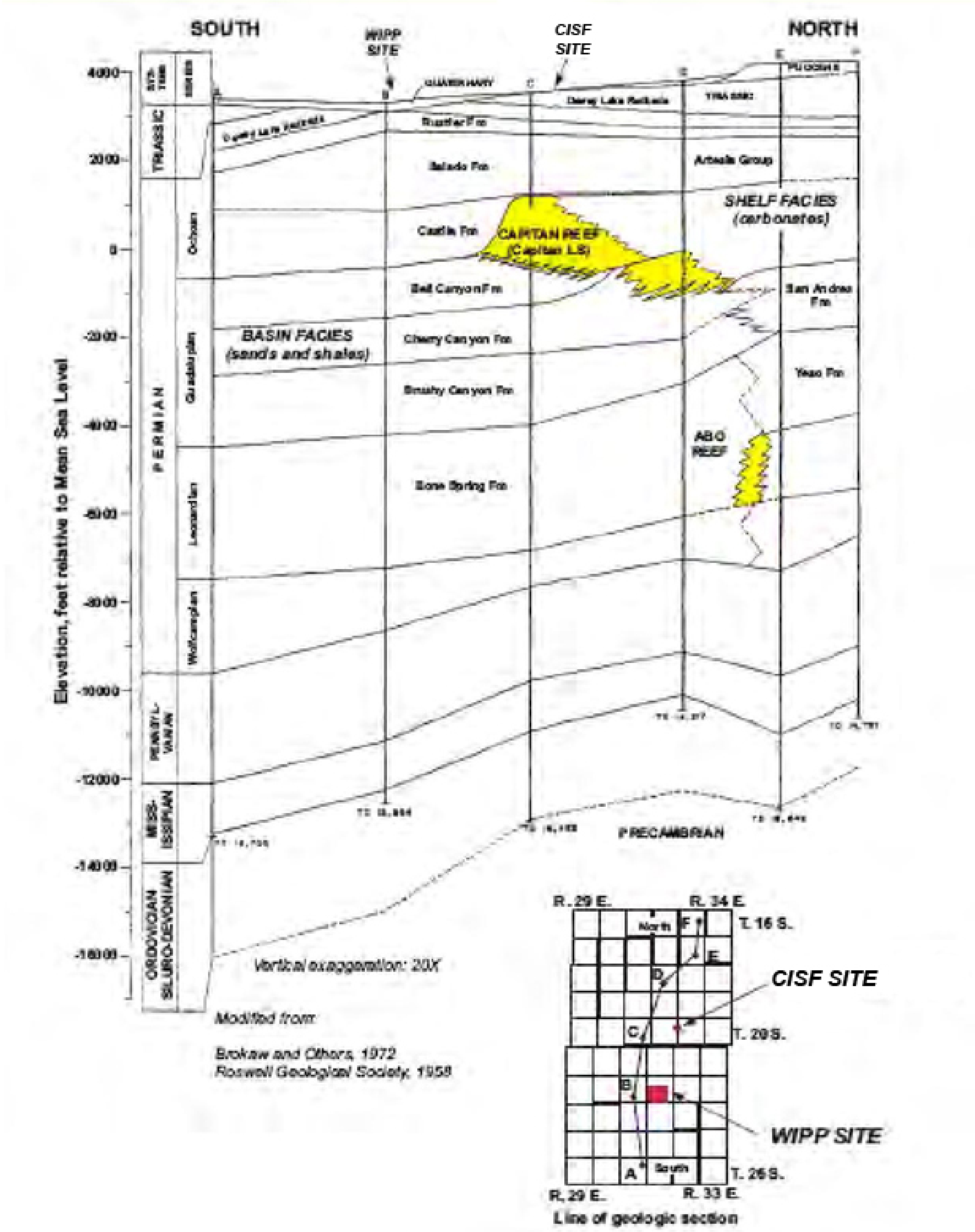


Figure 2.6.2: Geologic Cross Section through the Capitan Reef Area, Eddy and Lea Counties, NM [2.1.3]

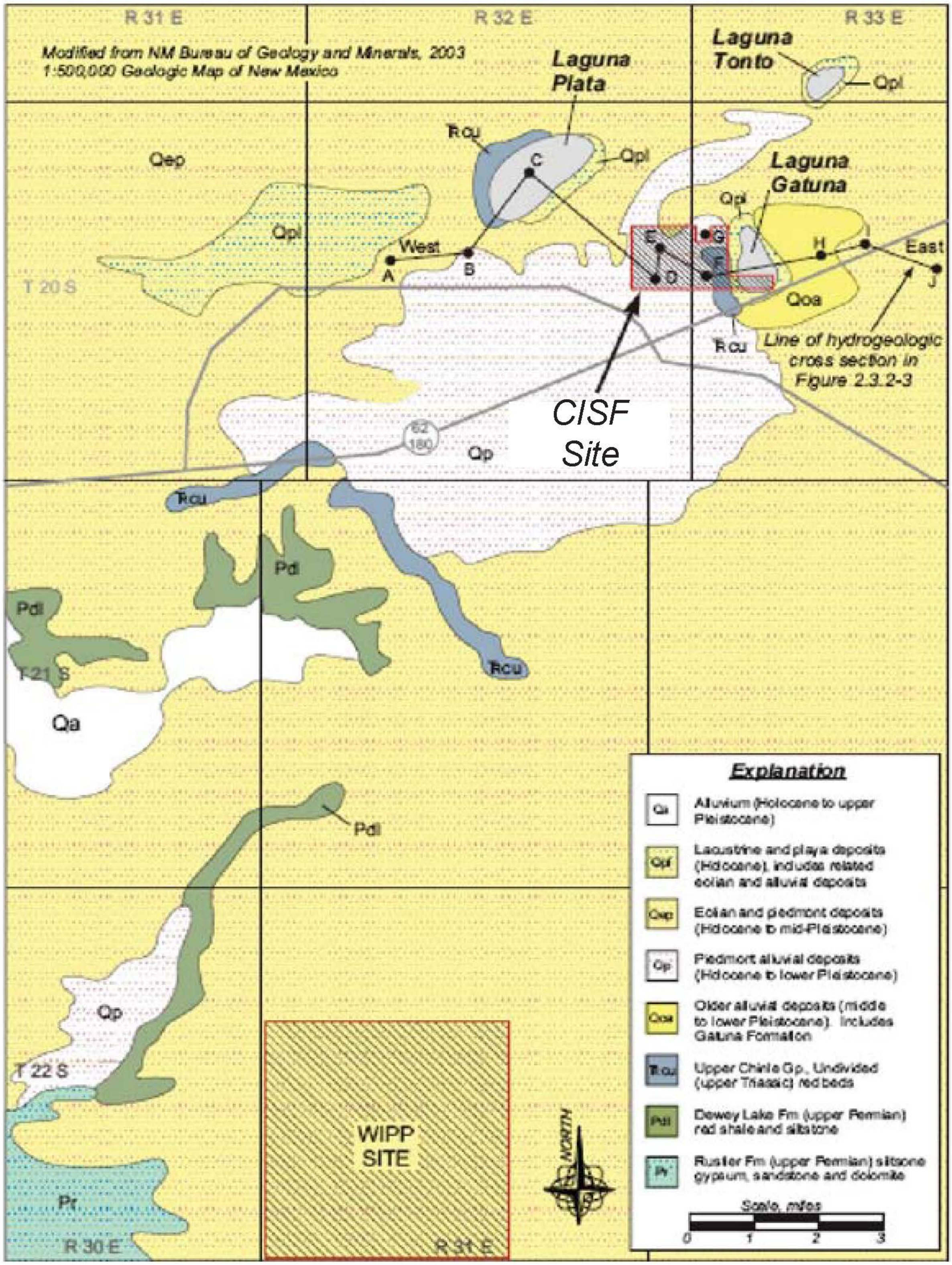


Figure 2.6.3: Surficial Geology in the Vicinity of the Site [2.1.3]

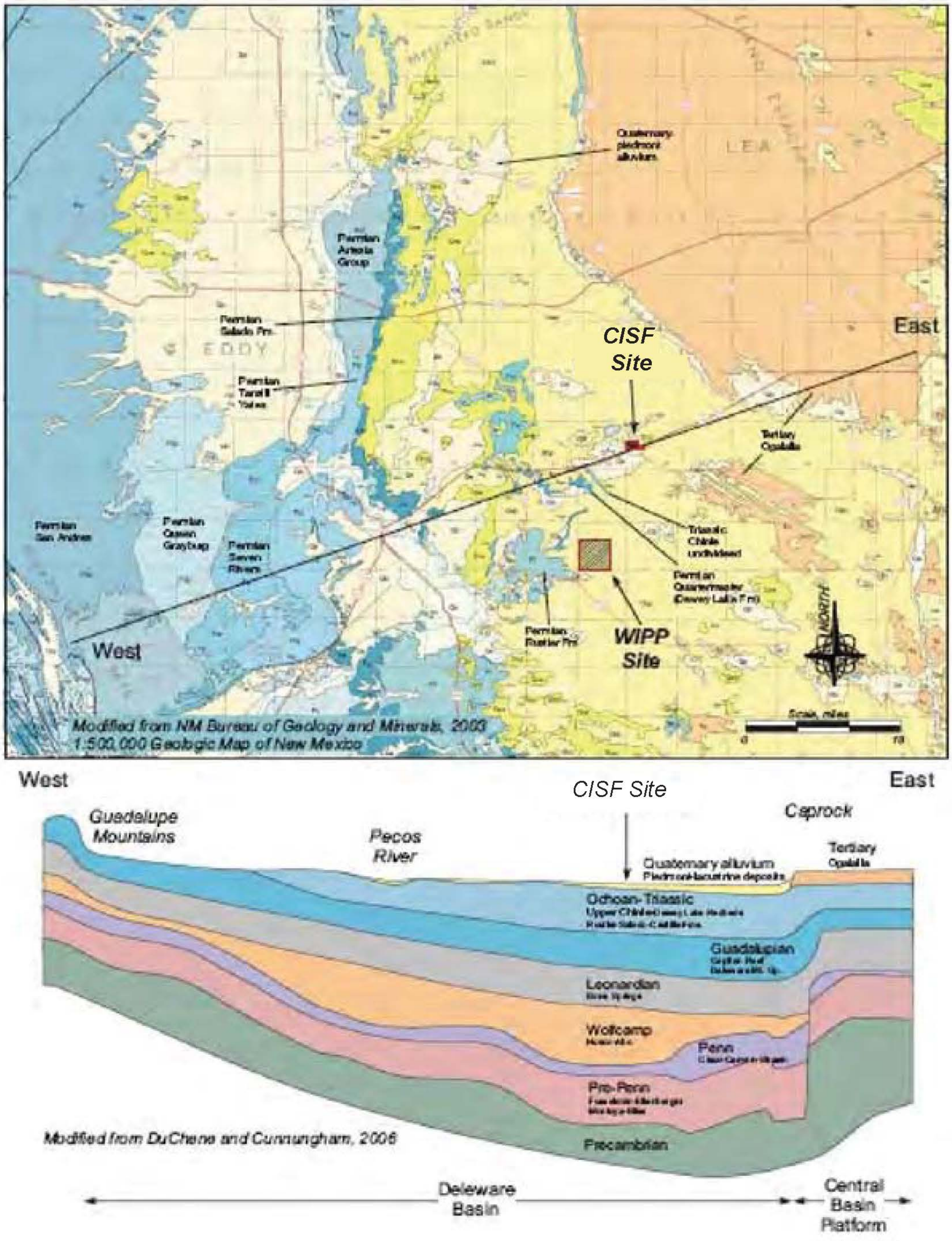


Figure 2.6.4: Regional Surficial Geology and Generalized Cross Section Through the Site [2.1.3]

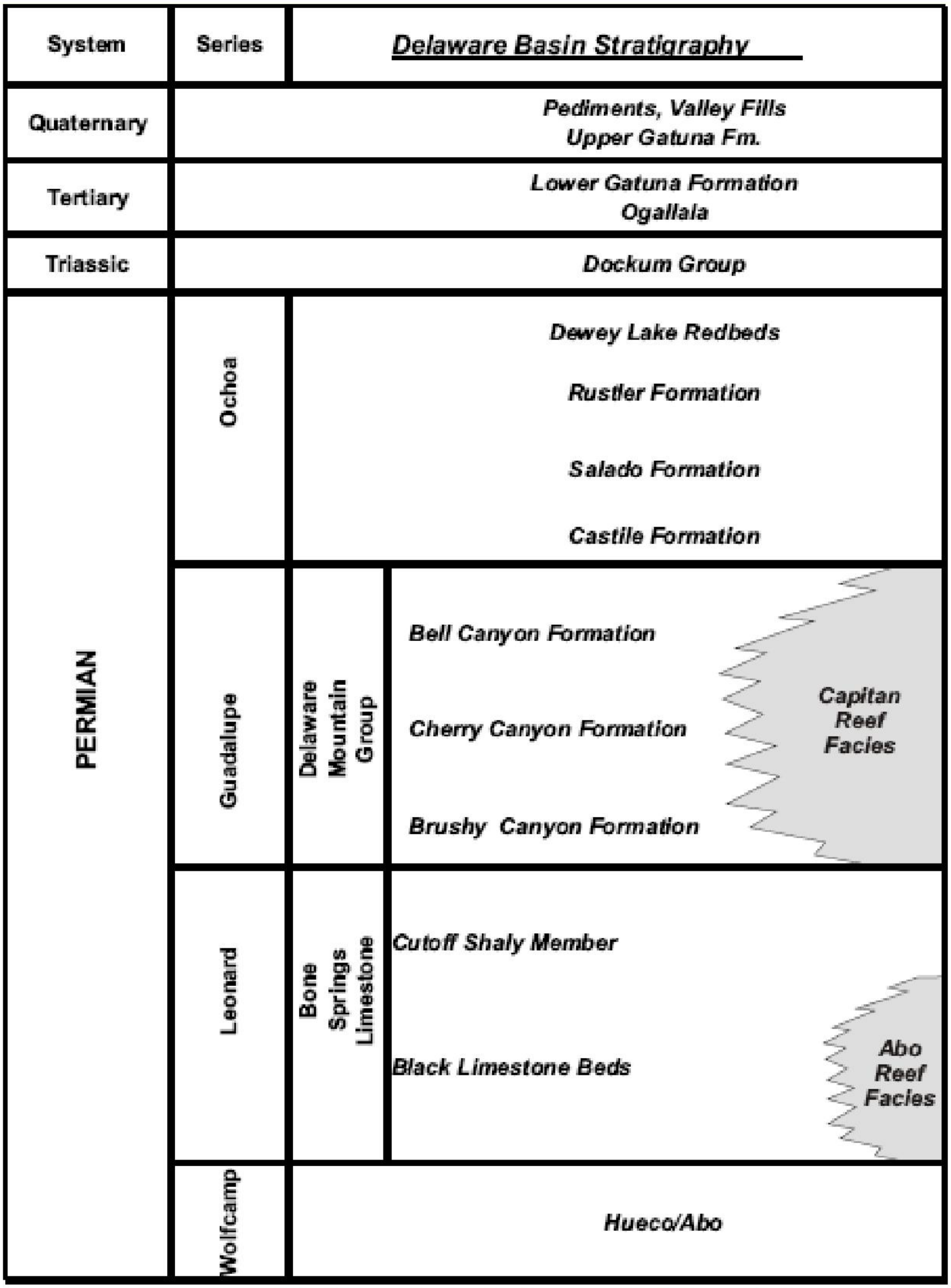


Figure 2.6.5: Permian to Quaternary-aged Stratigraphy of the Delaware Basin [2.1.3]

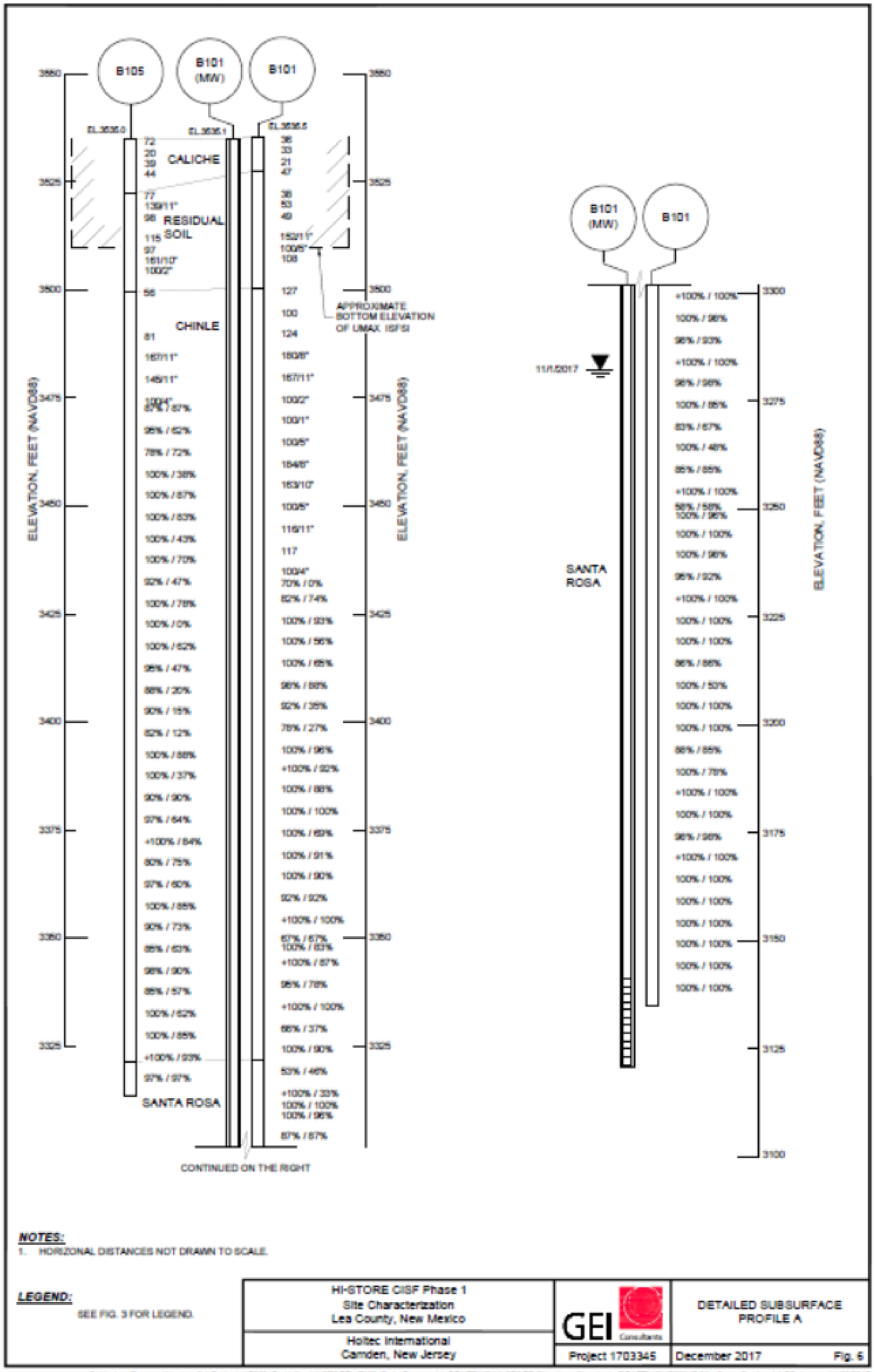


Figure 2.6.6: Phase 1 Detailed Subsurface Profile A [2.1.24]

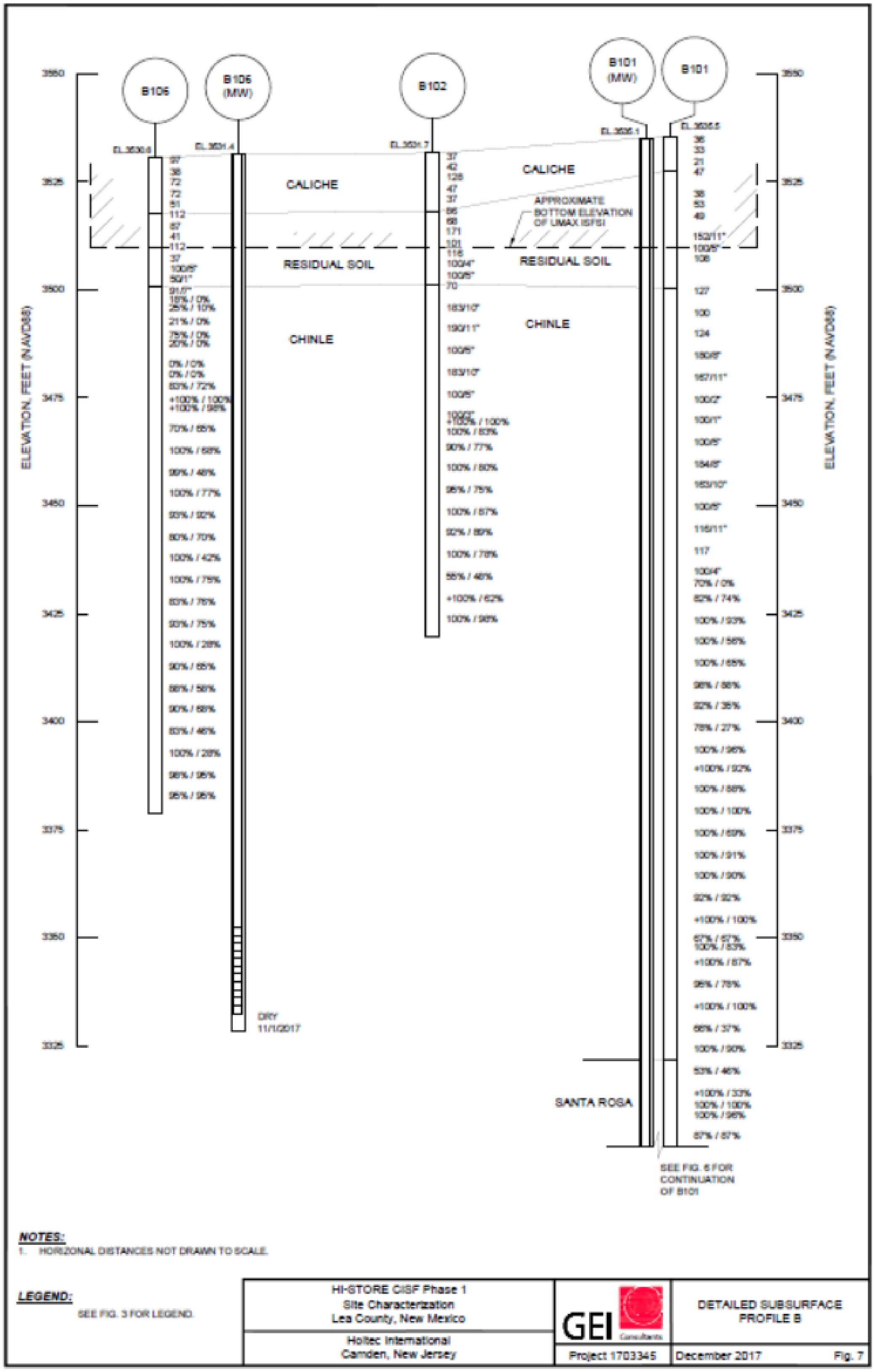


Figure 2.6.7: Phase 1 Detailed Subsurface Profile B [2.1.24]

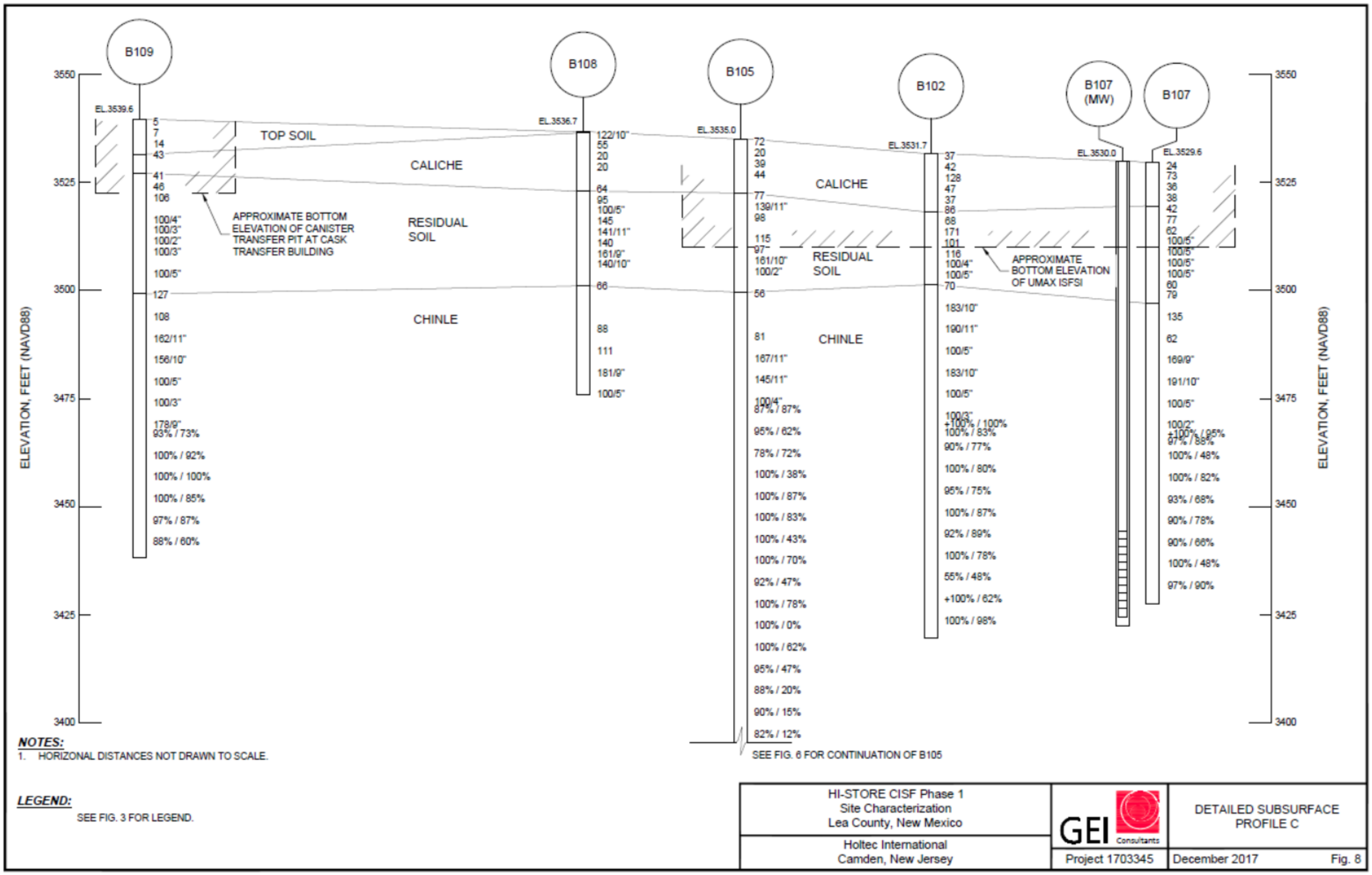


Figure 2.6.8: Phase 1 Detailed Subsurface Profile C [2.1.24]

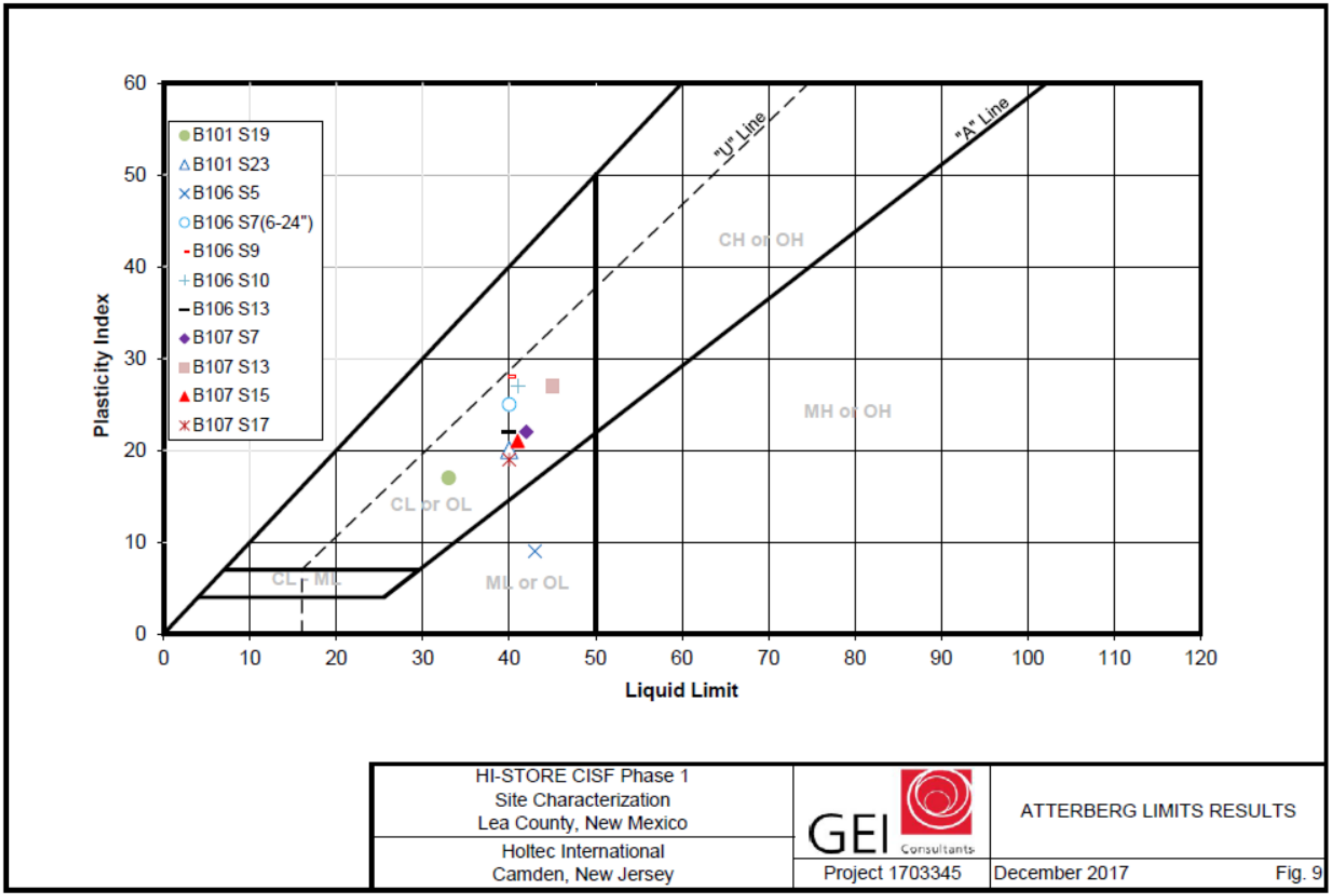


Figure 2.6.9: Phase 1 Atterberg Limit Results [2.1.24]

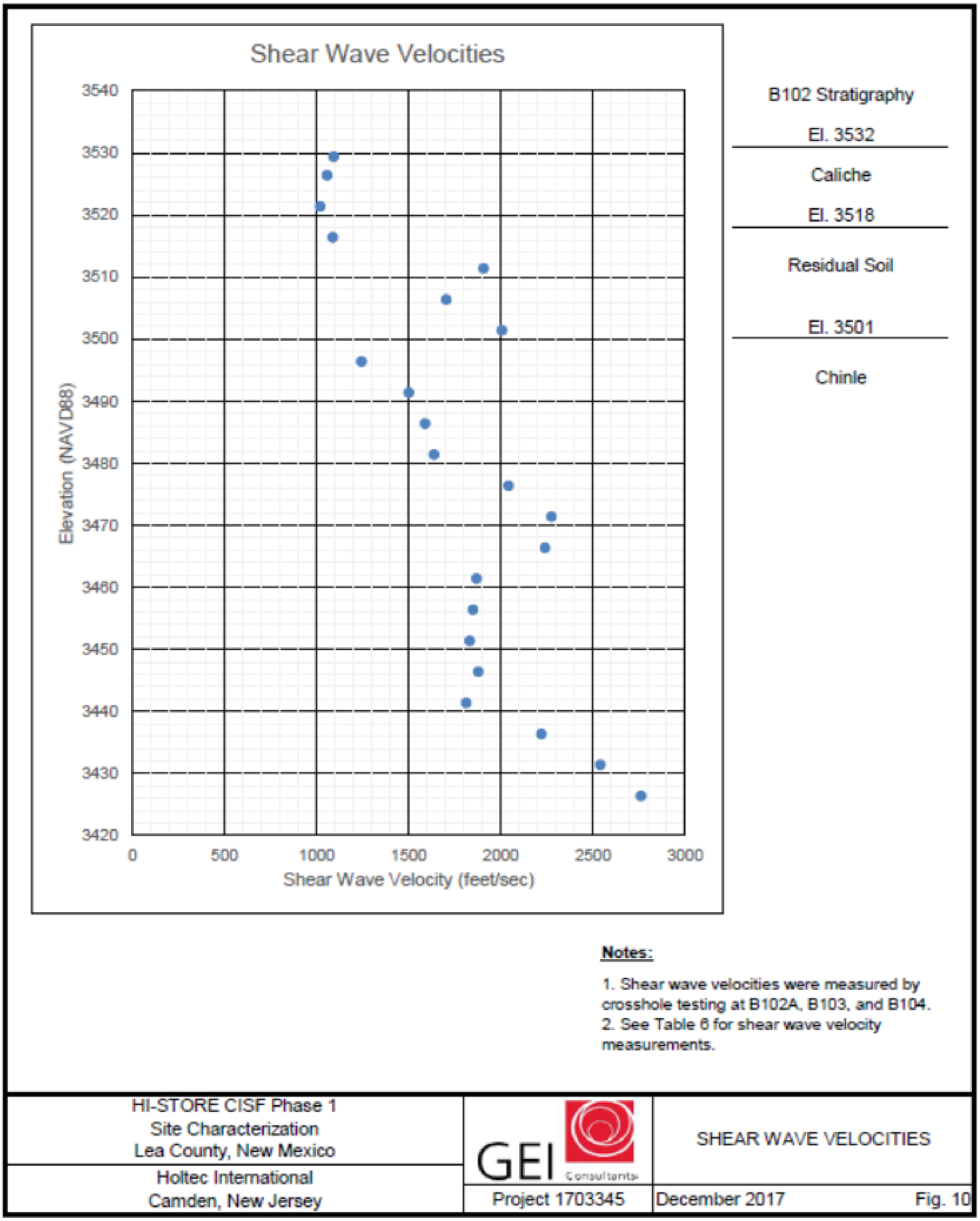


Figure 2.6.10: Phase 1 Shear Wave Velocity Results [2.1.24]

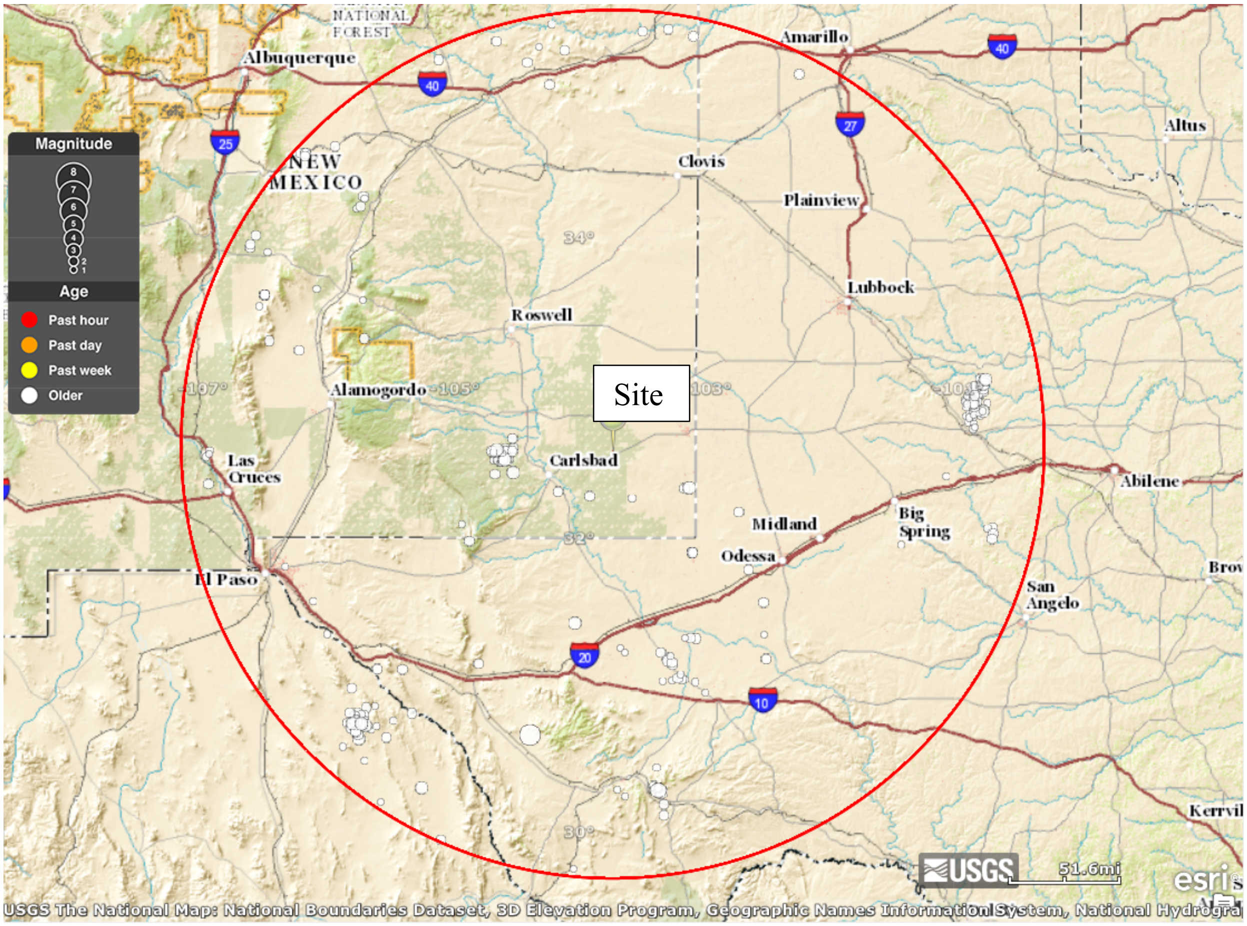


Figure 2.6.11: Earthquakes (Magnitude 2.5 or greater) within 200 miles of the Site [2.6.3]

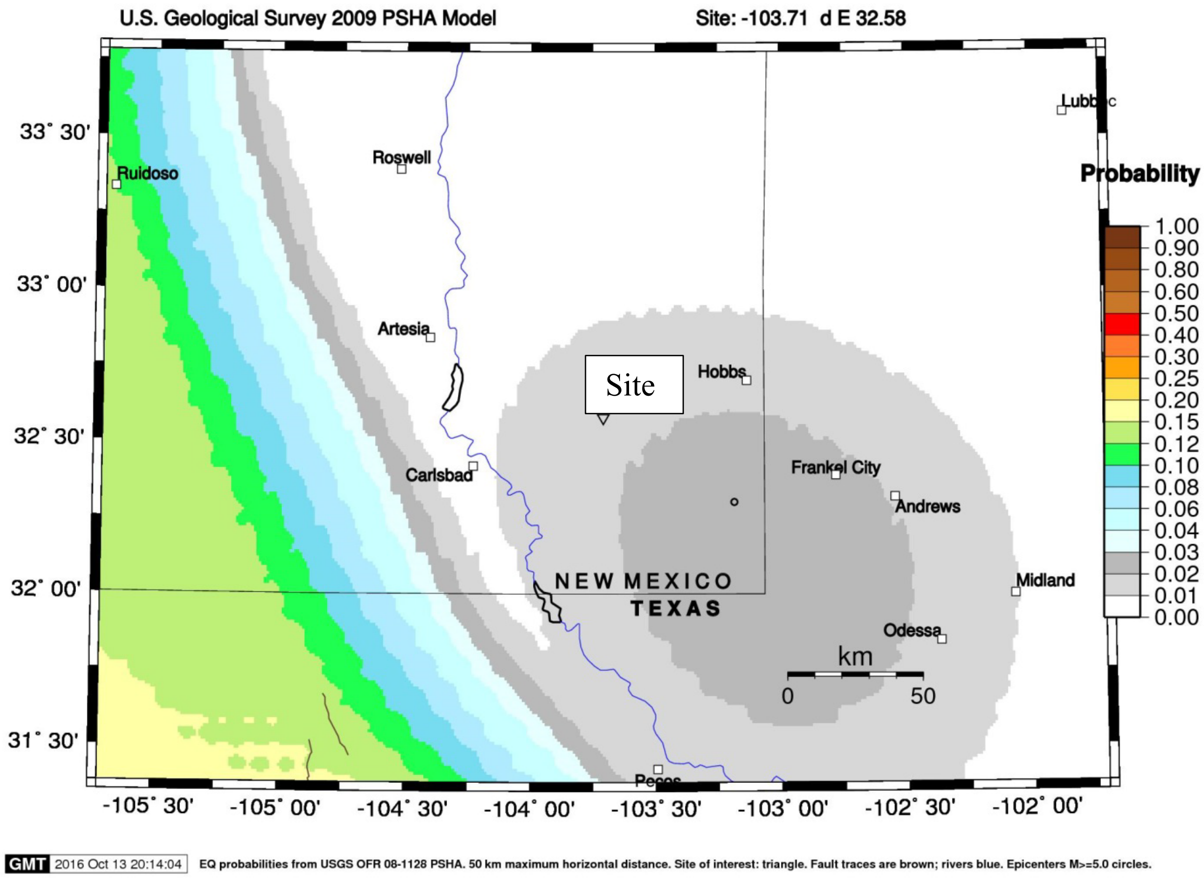


Figure 2.6.12: Probability of earthquake with Magnitude greater than 5.0 within 50 years and 30 miles of the site [2.6.4]

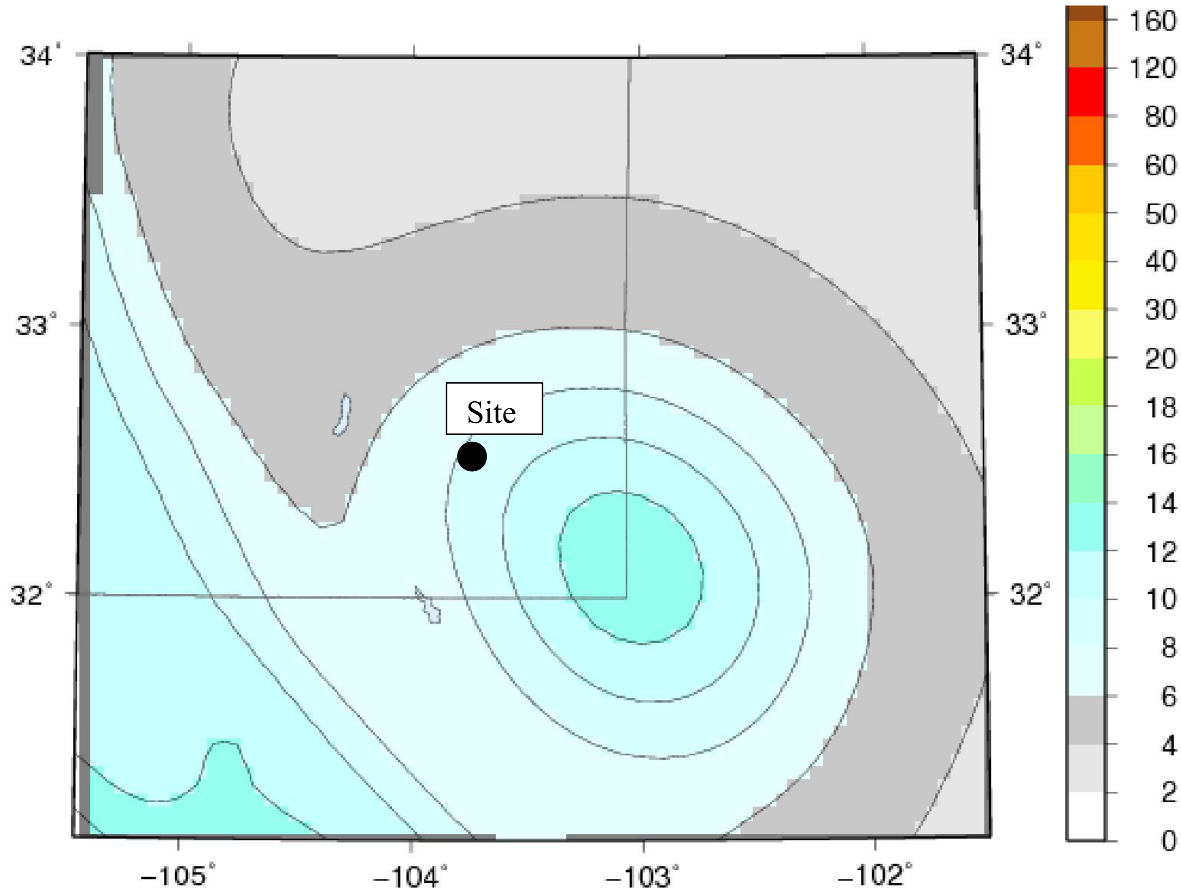


Figure 2.6.13: Peak Ground Acceleration (percent of gravity) (2,500 year return interval) [2.6.4]

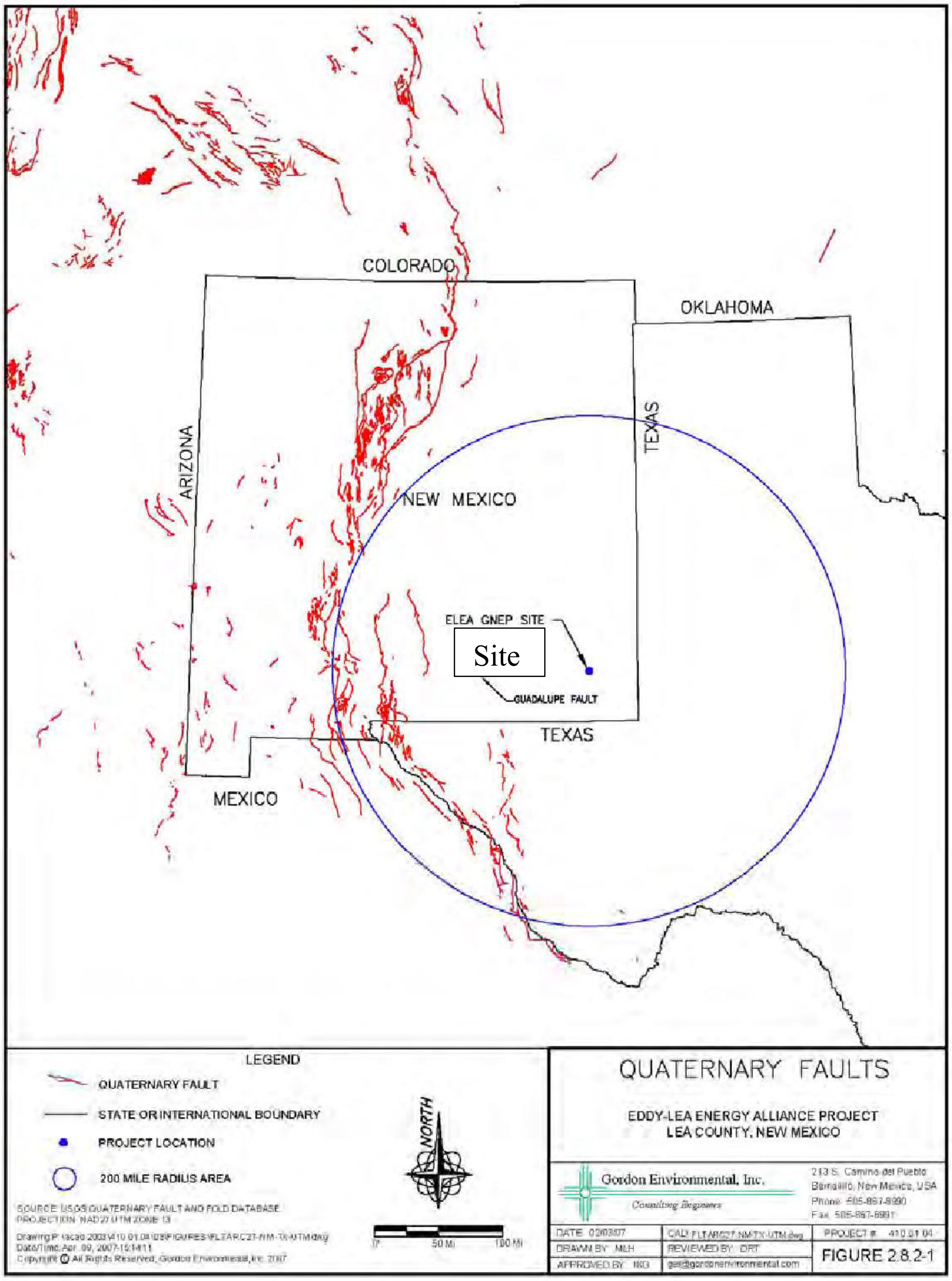


Figure 2.6.14: Quaternary faults within 200-mile radius of the site [2.6.8]

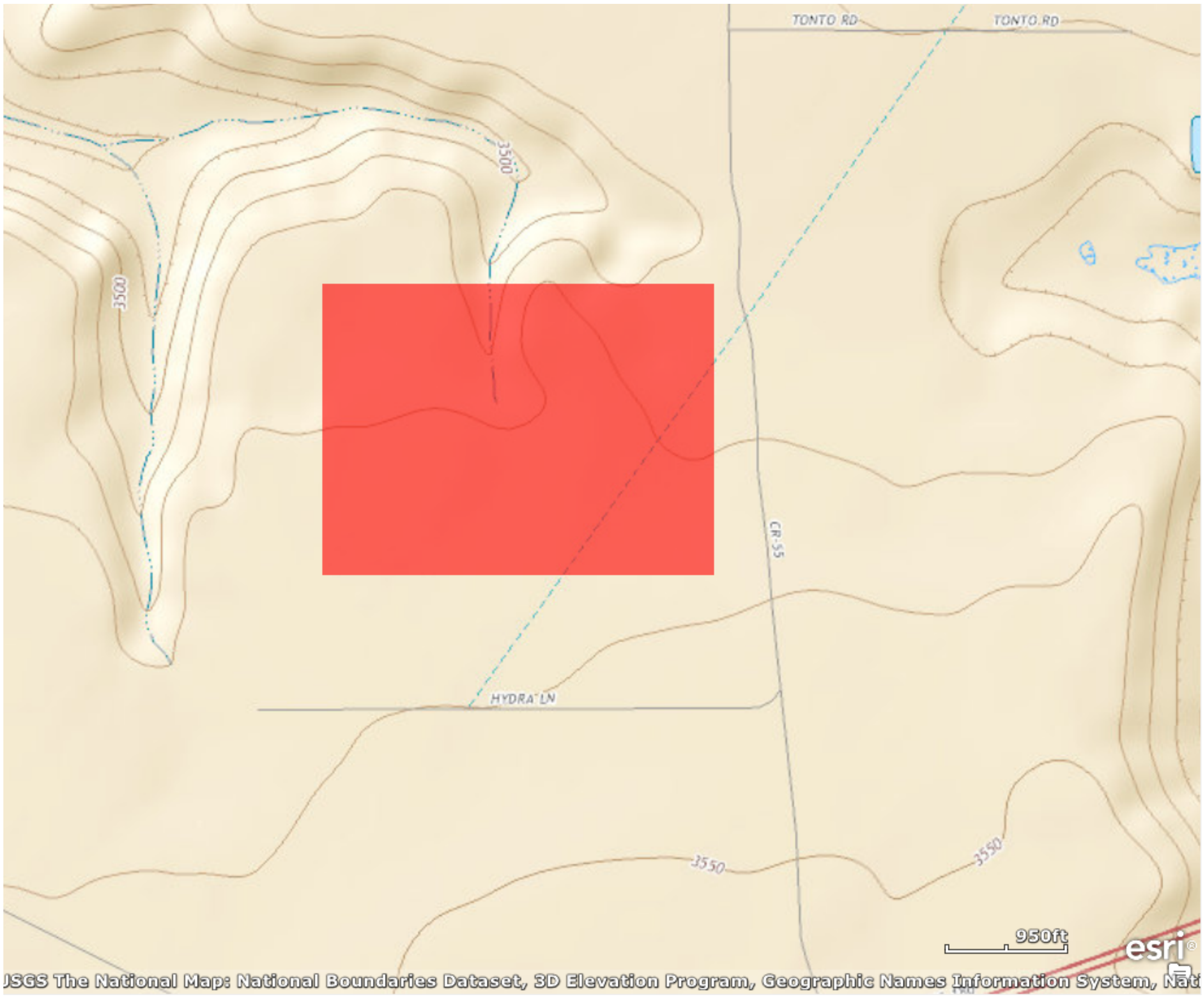


Figure 2.6.15: Elevation Contours at the Site

2.7 SITE SPECIFIC DATA FOR THERMAL AND STRUCTURAL ANALYSES

The site characterization effort, summarized in this chapter, enables a conservative set of parameters important to thermal and structural analyses to be established. These parameters are summarized in Table 2.7.1 and are used in Chapter 5 (Structural) and Chapter 6 (Thermal). The ambient temperature in Table 2.7.1 is based on the meteorological data for the site with a small margin added for conservatism.

The 10,000-year return earthquake, adopted as the Design Basis Earthquake (DBE) for the HI-STORE facility, is bounded by the classical Reg. Guide 1.60 response spectrum with its ZPAs denoted in Table 2.7.1. Likewise, the assumed bounding tornado missiles considered for the Site are based on the regulatory guidance and a national standard [2.7.1, 2.7.2]. These are the same missiles considered for the HI-STORM FW MPC Storage System in Docket 72-1032 and the HI-STORM UMAX Canister Storage System in Docket 72-1040.

Table 2.7.1

SITE SPECIFIC DATA FOR THERMAL AND STRUCTURAL ANALYSIS

Parameter	Conservatively assumed value for analysis based on site data	Comment
Normal Ambient Temperature (°F)	62	Bounding Annual Average at the Site
Normal Soil Temperature (°F)	62	Conservatively assumed to be equal to the Normal Ambient Temperature
Off-Normal Ambient Temperature (°F)	91	This temperature is based on 3-day average ambient temperature defined by evaluating local weather service records for the Lea County in which the Site is situated
Extreme Accident Level Ambient Temperature (°F)	108	This temperature value is the extreme maximum ambient temperature recorded at the Site
Reference temperature for short term operations (°F)	0 (min) and 91 (max)	This temperature is based on 3-day average ambient temperature defined by evaluating local weather service records for the Lea County in which the Site is situated
Extreme Minimum Ambient Temperature recorded in the region (°F)	See Table 2.3.1	This temperature value is used in the stress analysis of the site specific ancillaries
Extreme Maximum Ambient Temperature recorded in the region (°F)	See Table 2.3.1	This temperature value is used in the stress analysis of the site specific ancillaries
Site Elevation (feet above mean sea level)	3,520 (min) to 3,540 (max)	
Design Basis Earthquake (DBE) ZPAs in the two horizontal (X and Y) and vertical (Z) directions	See Table 4.3.3	
Design Basis Missiles and their incident velocity	See Table 2.7.2	Data is bounding for the Contiguous United States

TABLE 2.7.2; TORNADO GENERATED MISSILES		
Missile Description	**Mass (kg)**	**Velocity (mph)**
Automobile	1800	126
Rigid solid steel cylinder(8 in. diameter)	125	126
Solid sphere (1 in. diameter)	0.22	126

2.8 SAFETY-RELEVANT ENVIRONMENTAL DETERMINATIONS

The geotechnical information on the proposed HI-STORE CIS Facility presented in this chapter may be summarized in the following points:

- The facility will be located in one of the most sparsely populated areas in the continental United States. The nearest population centers are the cities of Carlsbad (32 miles away) and Hobbs (34 miles away).
- The topography of the land is relatively flat lending to effective intrusion detection by camera surveillance.
- The water table is sufficiently below the bottom of the subterranean HI-STORM UMAX system to preclude the possibility of any ground water intrusion in the storage cavity spaces.
- The land is fallow with limited vegetation to support cattle herds.
- The annual rainfall is meager requiring a modest water drainage infrastructure.
- The tornadic activity in the region is infrequent. The strength of the tornadoes is bounded by the national meteorological tornadic data which has been used to define the Design Basis Missiles for both the HI-STORM FW system and the HI-STORM UMAX system. Therefore, the storage system's ability to withstand the site specific tornados is axiomatically satisfied.
- There are no active volcanoes in the area.
- The area has a stable tectonic plate profile. As a result, the 10,000 year-return earthquake for the site is quite modest and well below the range for which HI-STORM UMAX as licensed in Docket 72-1040.
- There are no chemical plants in the area that would spew aggressive species into the environment. As a result, the ambient air is non-aggressive and a long service life of the stored stainless steel canisters can be predicted with confidence.
- There is no air force base or a major civilian airport in the vicinity of the site and the area is ostensibly not used for any aerial training exercises by the US military.
- The local area has a well-developed rail road infrastructure. The length of additional rail spur required for the site in less than 10 miles.
- By agreement with the applicable third parties, the oil drilling and phosphate extraction activities have been proscribed at and around the site.

The above considerations lead to the conclusion that the proposed Site is suitable for its intended purpose.

2.9 REGULATORY COMPLIANCE

Pursuant to the guidance provided in NUREG-1567, the foregoing material in this Chapter provides:

i. A complete description of the Geography and Demography of the Site as mandated by 10 CFR 72.24, 72.90, 72.96, 72.98, and 72.100;

ii. A complete identification and description of key characteristics of Nearby Facilities as mandated by 10 CFR 72.24, 72.40, 72.90, 72.94, 72.96, 72.98, 72.100, and 72.122;

iii. A complete description of the Meteorology and Surface Hydrology of the Site as mandated by 10 CFR 72.24, 72.40, 72.90, 72.92, 72.98, and 72.122;

iv. A complete description of the Subsurface Hydrology of the Site as mandated by 10 CFR 72.24, 72.98, and 72.122;

v. A complete description of the Geology and Seismology of the Site as mandated by 10 CFR 72.24, 72.40, 72.90, 72.92, 72.98, 72.102, and 72.122;

Therefore, it can be concluded that this SAR provides adequate description and safety assessment of the site which this ISFSI Facility is to be located, in accordance with 10 CFR 72.24(a). Additionally, it can be concluded that the proposed site complies with the criteria of 10 CFR 72 Subpart E, as required by 10 CFR 72.40(a)(2).

CHAPTER 4: DESIGN CRITERIA FOR THE HI-STORE CIS SYSTEMS, STRUCTURES AND COMPONENTS*

4.0 INTRODUCTION

This chapter contains safety-relevant information on the HI-STORE CIS facility in the following topical areas:

a. Spent fuel or other high-level radioactive waste containers (canisters) authorized to be stored,

b. Classification of structures, systems and components (SSCs) according to their *importance –to-safety*, and

c. Design criteria and design bases for the HI-STORE CIS facility and associated SSCs during all operational modes, including normal and off-normal operations, Short Term Operations, accident conditions and extreme natural phenomena events.

Unlike the generic HI-STORM UMAX system, the Short-Term Operations at the HI-STORE facility do not involve any activity related to loading fuel into canisters: the canisters arrive at the HI-STORE CIS facility in a NRC-certified transport cask such as HI-STAR 190 (NRC docket # 71-9373). The Short Term Operations begin at the point the transport package is received at the site and end at the point the canister is placed in a HI-STORM VVM for interim storage.

As stated in Chapter 1, the HI-STORM UMAX system (NRC Docket # 72-1040) [1.0.6] is the sole storage system designated to be employed at the HI-STORE CIS facility. As the canisters certified for use in the HI-STORM UMAX system are qualified in the HI-STORM FW system (NRC Docket # 72-1032) [1.3.7], there is a direct nexus between the site specific safety analyses for HI-STORE CIS facility and the analyses that undergird the general certification in [1.0.6] and [1.3.7]. As documented in this chapter, the loadings and conditions for which the HI-STORM UMAX VVM and its canisters are certified in [1.0.6] substantially exceed their counterparts for the HI-STORE CIS facility. This safety analysis reports mandates that only those canisters that are authorized for storage in HI-STORM UMAX under its general certification can be stored at the HI-STORE CIS facility. Furthermore, even among the population of canisters authorized by the HI-STORM UMAX CoC, only those that meet the heat load limit of the transport cask can be transported to the site will be available for storage at the site. Because the transport cask has a much lower heat load capacity than the HI-STORM UMAX ventilated storage system, the limitation imposed by the transport cask winnows the number of canisters eligible for storage at the HI-STORE CIS facility significantly. It is evident that those canisters that meet the heat load limitation of the transport cask, because of the greater innate heat rejection capacity of ventilated systems, will be subject to a less severe thermal state at the HI-STORE CIS facility than that permitted under ISG-11 Rev. 3 [4.0.1] under long term storage.

The HI-STORE facility must be qualified to withstand all credible environmental or operation-related loadings without exceeding its applicable safety limits. To make this safety

* All references are placed within square brackets in this report and are compiled in Chapter 19 of this report.

determination, the credible loadings under all normal, off-normal and faulted states are compared with those that have been qualified in the HI-STORM UMAX FSAR [1.0.6]. Any load that is found to exceed the pre-certified limit in the HI-STORM UMAX FSAR [1.0.6] is so identified in this chapter for further analysis.

As noted subsequently in this chapter, the site specific environmental and accident loads are fewer in number and less severe than those treated in the HI-STORM UMAX FSAR [1.0.6]. This statement applies to the Design Basis Earthquake (DBE) also where the 10,000-year return earthquake is shown to be bounded by the DBE for which the HI-STORM UMAX system is pre-certified. Much of the safety analysis material in this chapter pertains to confirming that each HI-STORE site specific loading is bounded by its counterpart treated in the HI-STORM UMAX FSAR.

Many of the Design Criteria pertaining to the loadings and components common to the HI-STORM UMAX and the HI-STORE CIS systems, such as the MPC and VVM, are incorporated by reference in this SAR, as appropriate, to the HI-STORM UMAX FSAR [1.0.6]. To facilitate convenient access to the referenced material, a list of HI-STORM UMAX FSAR sections germane to this chapter is provided in Table 4.0.1.

TABLE 4.0.1: HI-STORM UMAX FSAR MATERIAL INCORPORATED IN THIS FSAR BY REFERENCE			
Location in HI-STORE SAR	**Subject of the Reference**	**Location in HI-STORM UMAX FSAR [1.0.6]**	**Justification**
Subsection 4.1.1	Spent Fuel to be stored	Section 2.1, with exceptions as described in Subsection 4.1 of this SAR	MPCs to be stored at HI-STORE site are limited to those included in the HI-STORM UMAX FSAR [1.0.6]; exceptions for maximum heat loads and backfill pressure imposed by transport cask are made, but are bounded by HI-STORM UMAX FSAR requirements.
Subsection 4.3.1	MPCs to be stored		
Subsection 4.3.2	Design criteria for HI-STORM UMAX VVM and ISFSI	Section 2.2, with exceptions as described in Subsection 4.3.2.1 of this SAR	Design criteria for HI-STORM UMAX VVM and ISFSI are bounded by HI-STORM UMAX FSAR, except as noted.
Table 4.3.1	MPC Internal Design Pressure	Section 2.3.2.1	Due to the lower heat load limit of the transport cask, the associated internal MPC pressure shall always be less than the MPC design basis pressure in the HI-STORM UMAX FSAR [1.0.6]
Table 4.3.1	High Winds	Section 2.3.2.7	The wind conditions at the ELEA site are bounded by the HI-STORM UMAX FSAR Design Basis Wind.
Table 4.3.1	Design Basis Flood	Section 2.4.7	The Design Basis Flood used to qualify the VVM in the HI-STORM UMAX FSAR exceeds the most severe projection of flood at the ELEA site.
Subsection 4.3.1	MPC (including fuel) temperature limits	Table 2.3.7	HI-STORM UMAX FSAR temperature limits adopted.

Subsection 4.3.2	VVM temperature limits	Table 2.3.7	HI-STORM UMAX FSAR temperature limits adopted.

4.1 MATERIALS TO BE STORED

4.1.1 Spent Fuel Canisters

The SNF-bearing canisters that will be stored at the HI-STORE CIS facility are limited to those included in the HI-STORM UMAX FSAR [1.0.6]. No canister that is not included in the HI-STORM UMAX FSAR can be stored at the HI-STORE CIS Facility. Therefore all canisters (and the SNF specified as acceptable for storage in said canisters) to be stored at the facility are incorporated by reference herein, as follows:

- Authorized contents are incorporated by reference from Section 2.1 of the HI-STORM UMAX FSAR [1.0.6], with the following exceptions:
  - i. Maximum permissible heat loads specified in Subsection 2.1.9 of the HI-STORM UMAX FSAR [1.0.6], are replaced by more restrictive heat load imposed by the transport cask heat load requirements;
  - ii. The helium backfill pressure options of Tables 2.1.8 and 2.1.9 of the HI-STORM UMAX FSAR [1.0.6], which relate to the establishment of the permissible aggregrate heat load, are supplanted by the requirements of this chapter.

Canisters to be stored at the HI-STORE CIS Facility must meet the maximum heat loads shown in Tables 4.1.1 and 4.1.2 of this SAR, in accordance with the regional loading patterns shown in Figures 4.1.1 and 4.1.2 of this SAR (item i).

Requirements for the helium backfill of all canisters to be stored at the HI-STORE CIS are in Table 4.1.3 and 4.1.4 of this SAR (item ii). Although canisters will not be backfilled at site, received canisters will be verified to meet these helium backfill requirements as a condition of acceptance.

4.1.2 High Level Radioactive Waste

This SAR does not consider safety analysis of any canister that is not certified in the HI-STORM UMAX docket [1.0.6]. Accordingly, it does not at the present time include any canister containing non-fissile High Level Radioactive Waste at the HI-STORE CIS facility.

Table 4.1.1: Maximum Decay Heat Load for MPC-37 (PWR Fuel Assembly)

Pattern	Region (Note 1)	Maximum Decay Heat Load per Assembly (kW) (Note 2)	Total Heat Load for Each Pattern (kW)
1	1	0.38	31.82
	2	1.7	
	3	0.50	
2	1	0.42	32.02
	2	1.54	
	3	0.61	
3	1	0.61	32.09
	2	1.23	
	3	0.74	
4	1	0.74	32.06
	2	1.05	
	3	0.8	
5	1	0.8	32.04
	2	0.95	
	3	0.84	
6	1	0.95	31.43
	2	0.84	
	3	0.8	

Note 1: For basket region numbering scheme refer to Figure 4.1.1

Note 2: These maximum fuel storage location decay heat limits must account for decay heat from both the fuel assembly and non-fuel hardware.

Table 4.1.2: Maximum Decay Heat Load MPC-89 (BWR Fuel Assembly)

Pattern	Region (Note 1)	Maximum Decay Heat Load per Location (kW) (Note 2)	Total Heat Load for Each Pattern (kW)
1	1	0.15	32.15
	2	0.62	
	3	0.15	
2	1	0.18	32.02
	2	0.58	
	3	0.18	
3	1	0.27	32.03
	2	0.47	
	3	0.27	
4	1	0.32	32.08
	2	0.41	
	3	0.32	
5	1	0.35	31.95
	2	0.37	
	3	0.35	

Note 1: For basket region numbering scheme refer to Figure 4.1.2.

Note 2: These maximum fuel storage location decay heat limits must account for decay heat from both the fuel assembly and non-fuel hardware.

Table 4.1.3: MPC Backfill Pressure Requirements (Note 1)

MPC Type	Pressure Range
MPC-37	≥ 39.0 psig and ≤ 46.0 psig
MPC-89	≥ 39.0 psig and ≤ 47.5 psig

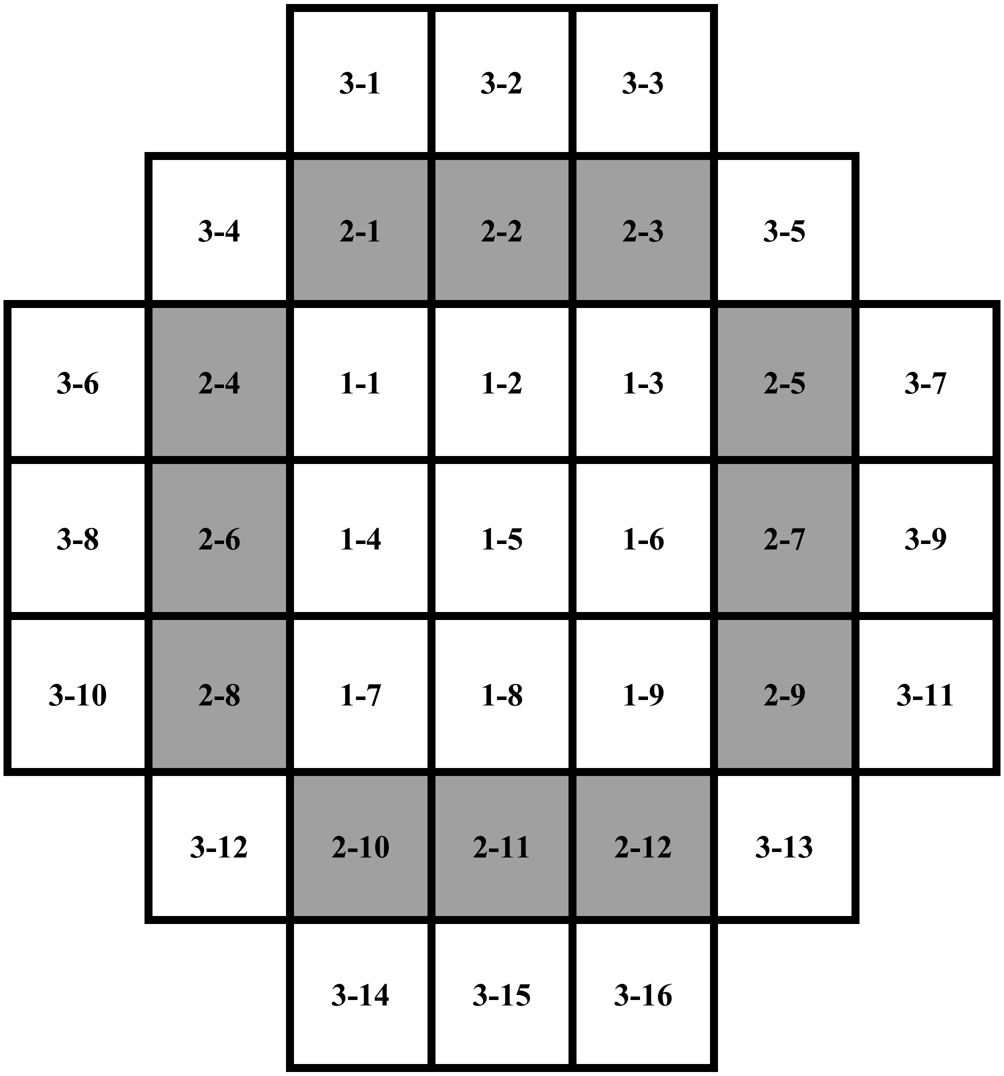
Note 1: Helium used for backfill of MPC shall have a purity of ≥99.995%. The pressure range is based on a reference temperature of 70^{o}F.

Table 4.1.4: MPC Backfill Pressure Requirements for Sub-Design Basis Heat Load (Note 1)

MPC Type	Pressure Range (Note 2)
MPC-37	≥ 39.0 psig and ≤ 50.0 psig
MPC-89	≥ 39.0 psig and ≤ 50.0 psig

Note 1: Sub-Design Basis Heat Load is defined as 80% of the design basis heat load in every storage location defined in Tables 4.1.1 and 4.1.2 for MPC-37 and MPC-89 respectively.

Note 2: Helium used for backfill of MPC shall have a purity of >99.995%. The pressure range is based on a reference temperature of 70^{o}F.



Legend

Region-Cell ID

Figure 4.1.1: MPC-37 Regional-Cell Identification

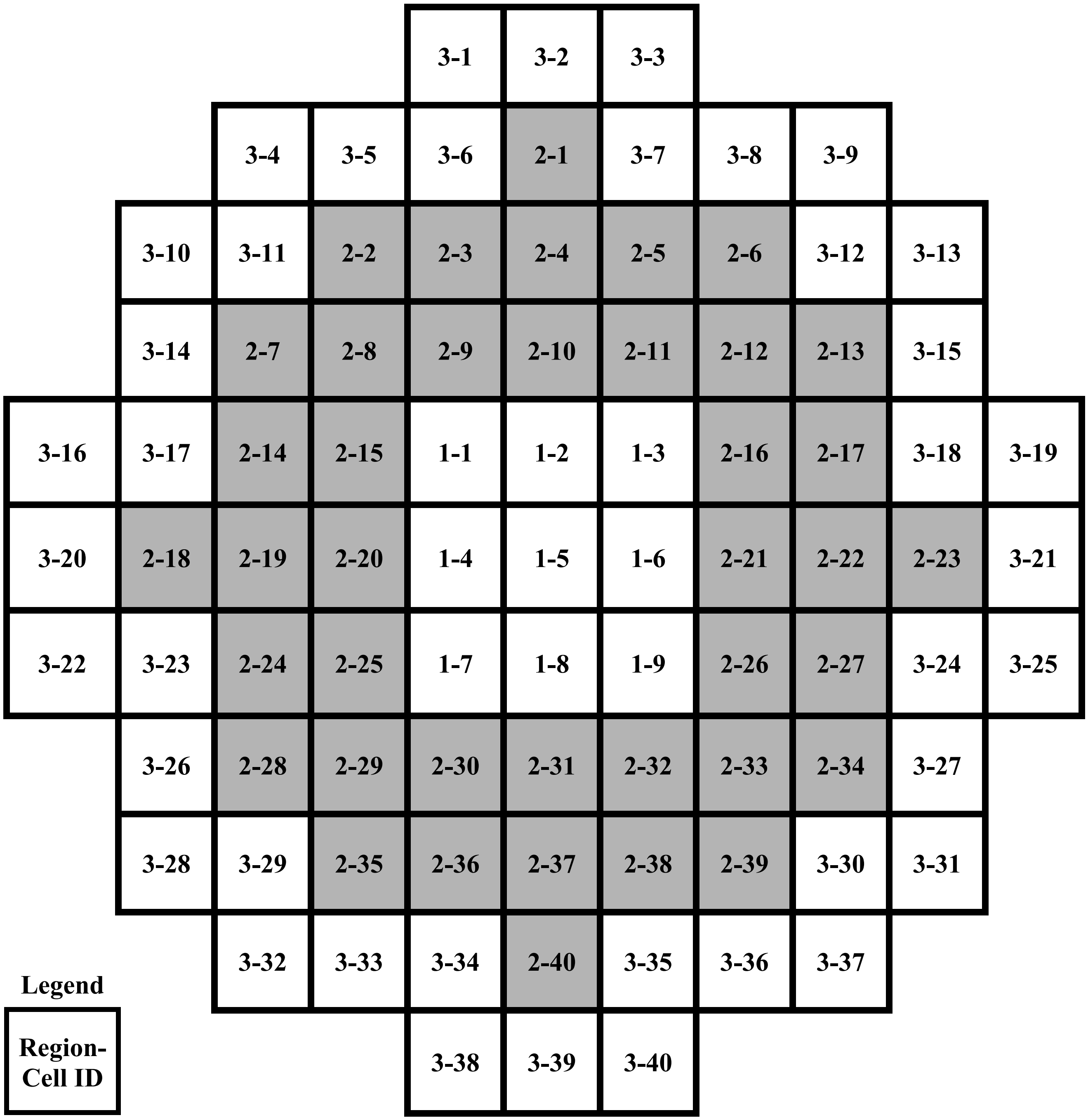


Figure 4.1.2: MPC-89 Regional-Cell Identification

4.2 CLASSIFICATION OF STRUCTURES, SYSTEMS, AND COMPONENTS

The systems, structures and components (SSCs) for the HI-STORE CIS facility are designed and analyzed to ensure that they will perform their intended functions under normal, off-normal, and accident conditions to meet all regulatory requirements delineated in 10 CFR Part 72 [1.0.5]. These intended functions include:

i. Providing radionuclide confinement/containment

ii. Enabling heat rejection from cask components and contents to maintain their temperatures within specified regulatory limits

iii. Attenuating emission of radiation to acceptable levels

iv. Maintaining sub-criticality of fissile contents

References [4.2.1] & [4.2.2] provide the guidelines to determine the Important to Safety significance category in accordance with NUREG/CR-6407 [1.2.2] which are:

Category A: The failure or malfunction of a structure, component, or system could directly result in a condition adversely affecting public health and safety.

Category B: The failure or malfunction of a structure, component, or system could indirectly (i.e., in conjunction with the failure of another item) result in a condition adversely affecting public health and safety.

Category C: The failure or malfunction of a system, structure or component (SSC) that would have some effect on the packaging, but would not significantly reduce the effectiveness of the packaging and would not be likely to create a situation adversely affecting public health and safety.

Not-Important-to-Safety: The failure or malfunction of an SSC would not reduce the effectiveness of the system or packaging and would not create a situation adversely affecting public health and safety.

Thus each SSC that constitutes the HI-STORE CIS facility is classified into one of above four categories depending on the severity of consequence in the event of its failure or malfunction due to a credible adverse event.

Chapter 1 contains the description of the SSCs that comprise the HI-STORE CIS facility. The SSCs in Table 4.2.1 can be subdivided in two types, namely

i. Those that are designed and built to meet the requirements of the HI-STORE CIS facility or are assembled at the site (HI-STORE Specific or "HS")

ii. Those that are pre-qualified and delivered to the site pursuant to the safety requirements in the HI-STORM UMAX docket and arrive at the site ready-for-deployment (UMAX Generic or "UG")

The ITS category for UG SSCs is defined by their classification in their native docket, principally the HI-STORM UMAX docket [1.0.6]. Those SSCs whose safety classification is not defined in other dockets (HS SSCs) are classified using [4.2.1] & [4.2.2]. Table 4.2.1 provides a compilation of the ITS classification information on *all* of the principal SSCs that are envisaged to be used at the HI-STORE CIS facility including both the "HS" and "UG" types; the latter directly excerpted from the HI-STORM UMAX FSAR [1.0.6] or a referenced docket therein, such as HI-STORM 100 FSAR [1.3.3].

Table 4.2.1 ITS Classification of SSCs that Comprise the HI-STORE CIS Facility				
Name of SSC (Note 1)	**Function (See Section 1.3)**	**ITS Classification**	**Type**	**Source for ITS determination**
Cavity Enclosure Container (CEC)	Cavity Enclosure Container; defines the Canister's storage space	ITS-C	UG	[1.0.6]
CEC Closure Lid	A removable heavy structure placed atop the HI-STORM UMAX CEC that blocks sky shine from the stored Canister.	ITS-C	UG	
CEC Divider Shell	A removable insulated shell that surrounds the stored Canister	ITS-C	UG	
Support Foundation Pad (SFP)	Supports the HI-STORM UMAX VVM	ITS-C	UG	
ISFSI pad	Defines the top surface of the VVM	ITS-C	UG	
CLSM (see Glossary)	Occupies the subterranean space between the CECs	NITS	UG	
SNF Canisters	Provide a leak-tight confinement and criticality control to stored fuel	ITS-A	UG	[1.3.7]
HI-TRAC CS	Serves to facilitate ALARA transfer of the Canister between the transport cask and the HI-STORM UMAX VVM cavity	ITS-A	HS	[1.0.5], [4.2.1], [4.2.2], [1.2.2]
HI-TRAC CS Lift Yoke	Means for attaching HI-TRAC CS to CTB Crane for loaded or unloaded relocation within the CTB.	ITS-A	HS	
Cask Transfer Building (CTB)	Provides weather protection and climate control for canister transfer	NITS	HS	

Table 4.2.1

ITS Classification of SSCs that Comprise the HI-STORE CIS Facility

Name of SSC (Note 1)	Function (See Section 1.3)	ITS Classification	Type	Source for ITS determination
CTB Crane	Used to move, upend and down-end the transport cask (loaded an unloaded); remove the transport cask impact limiters; move and position HI-TRAC CS (loaded and unloaded); handling of other equipment	ITS-A [Note 2]	HS	[1.0.5], [4.2.1], [4.2.2], [1.2.2]
CTB Slab	Provide support for all canister receipt and loading operations within the CTB	ITS-C	HS	
Canister Transfer Facility (CTF)	Underground ventilated structure used to effectuate transfer of canister from the transport cask to the HI-TRAC CS (and reverse operation, if required)	ITS-C	HS	
HI-STAR 190 Transport Cask	Cask in which SNF canisters are received	ITS-A	UG	[1.3.6]
Transport Cask Horizontal Lift Beam	Serves to lift HI-STAR 190 transport cask (using CTB crane)	ITS-A	HS	[1.0.5], [4.2.1], [4.2.2], [1.2.2]
Transport Cask Tilt Frame	Serves to upend/downend HI-STAR 190 transport cask	ITS-C	HS	
Transport Cask Lift Yoke	Means to connect HI-STAR 190 Transport Cask to CTB crane for movement within the CTB	ITS-A	HS	
Vertical Cask Transporter (VCT)	Principal means to translocate the HI-TRAC CS and to effectuate Canister transfer to the HI-STORM UMAX VVM	ITS-A (Note 3)	UG	[1.3.7]

Table 4.2.1 ITS Classification of SSCs that Comprise the HI-STORE CIS Facility				
Name of SSC (Note 1)	**Function (See Section 1.3)**	**ITS Classification**	**Type**	**Source for ITS determination**
MPC Lift Attachment	Means of attaching rigging to MPC for download into VVM	ITS-A	HS	[1.0.5], [4.2.1], [4.2.2], [1.2.2]
MPC Lifting Device Extension	Means of attaching MPC Lift Attachment to VCT for download of MPC into VVM	ITS-A	HS	
Special Lifting Devices	Lifting components used to connect the cask or canister to the CTB crane or the VCT lift points	ITS-A	HS	

Note 1: The ancillaries used at the HI-STORE CIS facility are limited to those needed to transfer the arriving canisters into the HI-STORM VVMs. Thus, some ancillaries described in the HI-STORM UMAX FSAR [1.0.6], like the Forced Helium Drying System used to dry the canister internals), are not included in this table.

Note 2: The Cask crane's main girder and vertical columns are ITS-category A; the main hoist, auxiliary hoist and other electrical systems are treated as 'augmented quality" under Holtec's QA program.

Note 3: The VCT is ITS-A because of the Overhead beam. Other components are as listed below (See Figure 4.5.1):

VCT Component I.D.	**ITS Category**
Cask restraint system	NITS
Cask restraint strap	ITS-B
Control systems	NITS
Engine and drive systems	NITS
Hydraulic system	NITS
Jacks (lift cylinders)	NITS
Lifting towers (structure)	ITS-A
MPC downloader system	ITS-B
Overhead beam	ITS-A
Tracks	NITS
Vehicle frame	NITS
Load Drop Protection System	ITS-B

4.3 DESIGN CRITERIA FOR SSCS IMPORTANT TO SAFETY

4.3.1 Multi-Purpose Canisters (MPCs)

The MPCs that will be stored at the HI-STORE CIS are limited to those included in the HI-STORM UMAX FSAR [1.0.6].

4.3.1.1 Structural

The MPCs to be received and loaded at the HI-STORE CIS facility are comprised of a fuel basket within a welded enclosure vessel. As the only canisters certified for storage in the HI-STORE CIS facility are those qualified in the HI-STORM UMAX FSAR [1.0.6], the structural design criteria for the MPCs is incorporated by reference to Section 2.0.2 of [1.0.6].

4.3.1.2 Thermal

The thermal design criteria for the MPCs (including the design temperature limits of Table 2.3.7) are incorporated by reference from Section 2.0.3 (MPC Design Criteria), of the HI-STORM UMAX FSAR [1.0.6]. The portion of Section 2.0.3 of Reference [1.0.6] related to maximum permissible heat loads and helium backfill is not incorporated by reference, as it has been replaced with the information presented in Section 4.1.1 of this SAR.

4.3.1.3 Shielding

The site boundary dose requirement for the systems (including canisters) stored at HI-STORE is provided in Section 4.4. Compliance to the requirements (see Table 4.4.3) is demonstrated in Chapter 11.

4.3.1.4 Confinement

The MPC provides for confinement of all radioactive materials for all design basis, off-normal and postulated accident conditions. As the only canisters certified for storage in the HI-STORE CIS facility are those qualified in the HI-STORM UMAX FSAR [1.0.6], the confinement criteria for the MPCs is incorporated by reference from Section 2.0.6 of [1.0.6].

4.3.1.5 Criticality Control

Criticality control is maintained by the geometric spacing of the fuel assembles and the spatially distributed B-10 isotope in the Metamic-HT basket within the canister. As the only canisters certified for storage in the HI-STORE CIS facility are those qualified in the HI-STORM UMAX FSAR [1.0.6], the criticality control criteria for the MPCs is incorporated by reference to Section 2.0.5 of [1.0.6].

4.3.2 VVM Components and ISFSI Structures

The design criteria of the HI-STORM UMAX VVM components and ISFSI structures described in Chapter 2 of the HI-STORM UMAX FSAR [1.0.6] are largely applicable to the HI-STORE CIS. The criteria of [1.0.6] that bound the HI-STORE CIS design, and are therefore excluded

from further consideration in this SAR, are outlined in Table 4.3.1. Environmental conditions and constraints that differ from those bounded by [1.0.6], although minor in nature, are described in Table 4.3.2 and evaluated herein. With the following exceptions, all subsections of the HI-STORM UMAX FSAR are relevant to the HI-STORE CIS evaluation:

1 Criteria related to the HI-TRAC VW system. The HI-TRAC VW system is supplanted by the HI-TRAC CS system in this application, with the design criteria for the HI-TRAC CS system described herein.

2 Service conditions related to the used of Forced Helium Drying (FHD) described in Paragraph 2.3.3.5 of the HI-STORM UMAX FSAR. As the HI-STORE CIS facility accepts only pre-packaged canisters, operations related to internal canister drying are not applicable.

Information consistent with the regulatory requirements related to shielding, thermal performance, confinement, radiological, and operational considerations is also provided. The licensing drawing of the HI-STORM UMAX design variant used in the HI-STORE CIS application is included in Section 1.5 of this SAR. The licensing drawing provides information on the necessary critical characteristics that define the HI-STORE CIS UMAX system for this application.

4.3.2.1 Structural

The applicable loads, affected parts under each loading condition, and the applicable structural acceptance criteria related to the HI-STORM UMAX VVM and ISFSI structures that are compiled in Section 2.0 of [1.0.6] provide a complete framework for the required qualifying safety analyses in this SAR. The VVM storage system at the HI-STORE CIS ISFSI will be functionally identical to that certified in the HI-STORM UMAX docket. The conservative approach of basing the HI-STORE CIS design on the certified HI-STORM UMAX design is supported by the following:

1. The subgrade and under-grade soil properties at the HI-STORE CIS site are uniformly better than those assumed for the general certification of the HI-STORM UMAX system. These properties can be found in the geotechnical investigation completed December 2017 [2.1.24]
2. The top-of-pad earthquake spectra corresponding to a 10,000-year earthquake at the HI-STORE CIS site is enveloped by that assumed for the HI-STORM UMAX in its general certification. (Subsection 4.3.6 and Table 4.3.3 provide a summary of the applicable seismic loadings for the HI-STORE CIS facility).
3. The long-term settlement at the HI-STORE CIS ISFSI is computed to be less than that assumed in the certification of the HI-STORM UMAX. As stated in item 1, above, soil properties at the HI-STORE CIS site are more favorable than those assumed in the HI-STORM UMAX system certification [2.1.24].
4. The load combinations for the VVM and ISFSI structure at the HI-STORE CIS are consistent with those identified in the HI-STORM UMAX evaluation. Load combinations

that are bounded by the HI-STORM UMAX evaluation, and therefore excluded from further evaluation in this application, are listed in Table 4.3.1.

4.3.2.2 Thermal

The design temperatures for the VVM components and ISFSI structures are incorporated by reference from Table 2.3.7 of Reference [1.0.6].

4.3.2.3 Shielding

The site boundary dose requirement for the HI-STORM UMAX ISFSI at HI-STORE is provided in Section 4.4. Compliance to the requirements (see Table 4.4.3) is demonstrated in Chapter 11.

4.3.2.4 Confinement

The VVM and ISFSI structures do not perform any confinement function. Confinement during storage is provided by the SNF storage canisters which are protected from leak by an all- welded stainless steel confinement vessel and are certified in their native docket as subject to a non-credible risk of leakage, see Chapter 9.

4.3.2.5 Criticality Control

The VVM components and ISFSI structures do not perform any criticality control function. Criticality control is maintained during storage by the internal configuration of the SNF storage canisters, as described in Chapter 8.

4.3.3 HI-TRAC CS

The HI-TRAC provides physical protection and radiation shielding of the MPC contents during the extraction of a loaded canister from the transport cask and its subsequent transfer to the HI-STORM UMAX VVM. The design characteristics of the HI-TRAC CS are presented in Chapter 1. The HI-TRAC CS plays a central role in the Short Term Operations that are carried out to translocate the Canister from an arriving transport package to its designated HI-STORM UMAX storage cavity.

4.3.3.1 Structural

The HI-TRAC CS transfer cask includes both structural and non-structural radiation shielding components that are classified as important-to-safety. The structural steel components of the HI-TRAC CS are designed to meet the stress limits of Section III, Subsection NF, of the ASME Code [4.5.1] for all operating modes. The embedded trunnions for lifting and handling of the transfer cask are designed in accordance with the requirements of NUREG-0612 [1.2.7] for interfacing lift points.

Table 4.3.4 lists the loading scenarios for HI-TRAC CS for which its structural qualification must be performed.

4.3.3.2 Thermal

The HI-TRAC CS cask must reject the canister's decay heat to the environment during the normal short term operations and accident scenarios, which are established by considering the operations described in Chapter 10. The thermally-significant loadings are listed in Table 4.3.5. The permissible temperature limits for all steel and concrete used in short-term operation SSCs used at HI-STORE, including HI-TRAC CS, are provided in Table 4.4.1.

4.3.3.3 Shielding

The HI-TRAC transfer cask provides shielding to maintain occupational exposures ALARA in accordance with 10CFR20 [7.4.1]. The HI-TRAC calculated dose rates for a set of reference conditions are reported in Chapter 7. These dose rates are used to estimate the occupational exposure to the work crew for the Short-Term Operations.

Section 4.4 provides dose limits applicable to the HI-STORE CIS facility.

4.3.3.4 Confinement

The HI-TRAC CS transfer cask does not perform any confinement function.

4.3.3.5 Criticality Control

The HI-TRAC CS transfer cask does not provide any criticality control function.

4.3.4 HI-STAR 190

As discussed in Chapter 3, the HI-STAR 190 transport cask, used to deliver the loaded Canister to the CTB, participates in the Short Term Operations, albeit to a limited extent. The safety analysis of HI-STAR 190 as a transport package under 10CFR71 regulations is documented in [1.3.6]. In order to insure that the transport condition loads that underlie the transport certification of HI-STAR 190 are not exceeded, the Short Term Operations in the CTB are configured such that:

i. The handling of the cask is always carried out using single failure proof devices and systems;

ii. As an additional defense-in-depth, the cask remains equipped with its impact limiters during its handling from the rail car and the free fall height of the cask is maintained below its certified limit in its Part 71 docket;

iii. The cask is kept free of any wrappings that may inhibit its heat rejection function during short term operations;

iv. In this subsection, HI-STAR 190's safety function as a canister containment device to the requirements of Part 72 is set down as a set of design criteria.

4.3.4.1 Structural

The structural qualification of HI-STAR 190 to the loadings of 10CFR71.71 (normal condition) and 10CFR71.73 (accident condition) in [1.3.6] are clearly much more severe than those

encountered during its handling in the CTB. Nevertheless, certain structural requirements are unique to the operations in the CTB that are unique to the Short Term Operations. Table 4.3.6 contains the structurally significant loadings on the HI-STAR 190 cask in the Cask Transfer Building. Acceptance criteria are provided in Section 4.4.

4.3.4.2 Thermal

The thermally-significant loadings on HI-STAR 190 that warrant safety demonstration are summarized in Table 4.3.6. The permissible temperature limits for all steel weldments in casks and structures used at HI-STORE, provided in Table 4.4.4, are applicable to the HI-STAR 190.

4.3.4.3 Shielding

HI-STAR 190 is designed to meet the dose attenuation requirements of 10CFR71 [1.3.2] which far exceed those expected of on-site transfer casks. However, HI-STAR 190's contribution to meeting the dose limits of Part 72, set down in Subsection 4.4 herein, is considered in demonstrating compliance.

4.3.4.4 Confinement

The confinement function of the canister is unaffected by the function of HI-STAR 190.

4.3.4.5 Criticality Control

HI-STAR 190 does not participate in the criticality control function.

4.3.5 Canister Transfer Facility (CTF)

The HI-STORE CTF is an underground structure used to effectuate transfer of the SNF canister from the transport cask (HI-STAR 190) to the transfer cask (HI-TRAC CS).

4.3.5.1 Structural

The CTF includes both structural and non-structural radiation shielding components that are classified as important-to-safety. The structural steel components of the CTF are designed to meet the stress limits of Section III, Subsection NF, of the ASME Code [4.5.1] for normal, off-normal and accident conditions, as applicable. The CTF reinforced concrete structures shall meet the applicable strength requirements of ACI 318-05 [5.3.1].

The CTF must withstand the static loads associated with the weights of each of its components, including the weight of the HI-TRAC CS transfer cask with the loaded MPC stacked on top during the canister transfer, and the weight of the transport cask with the loaded MPC staged on the CTF foundation slab. The CTF shall be capable of withstanding lateral loading in a seismic event as determined by the provisions of Chapter 8 of ASCE 4 [4.3.4].

4.3.5.2 Thermal

The allowable temperatures for the CTF structural steel components are based on the maximum temperature for material properties and allowable stress values provided in Section II of the

ASME Code. The allowable temperatures for the structural steel and shielding components of the CTF are provided in Table 4.4.1.

4.3.5.3 Shielding

The CTF provides shielding to maintain occupational exposures ALARA in accordance with 10CFR20 [7.4.1]. Dose rates for a set of reference conditions are reported in Chapter 7. These dose rates are used to perform a generic occupational exposure estimate for MPC transfer operations, as described in Chapter 11.

4.3.5.4 Confinement

The CTF does not perform any confinement function.

4.3.5.5 Criticality Control

The CTF does not perform any criticality control function.

4.3.6 Applicable Earthquake Loadings for the HI-STORE CIS Facility

Guided by the adjudication in the ASLB proceedings on the PFS, LLC docket [4.3.1], the Safe Shutdown Earthquake (SSE) or Design Basis Earthquake (DBE) for the HI-STORE CIS facility has been set to bound the 10,000 year return earthquake, which is discussed in Subsection 2.6.2. Similarly, the Operating Basis Earthquake (OBE) has been set to bound the 1,000 year return earthquake for the site. For additional conservatism and to overcome any potential uncertainty or future adjustments to the site seismological data, a Design Extended Condition Earthquake (DECE) has also been defined for the site, which has a ZPA value that is two-thirds greater than the DBE.

The response spectra of the bounding earthquakes are defined by the Regulatory Guide 1.60 spectra pegged to the respective ZPA values identified in Table 4.3.3. The generation of acceleration time histories, if required, shall meet the criteria specified in SRP 3.7.1 [5.4.1], which has been used to support safety analyses for HI-STORM deployments at numerous nuclear plant sites.

The DBE applies to the HI-STORM UMAX system which will serve to store the Canisters for a relatively long duration (depending on the need and licensing duration granted by the USNRC). In Chapter 5, however, the DECE is conservatively used to inform the structural evaluation of the HI-STORM UMAX system at the HI-STORE site.

The OBE applies to the Short-Term Operations required to load the arriving Canisters at HI-STORE. All equipment configurations, such as the stack-up at the Canister Transfer Facility and that at the HI-STORM UMAX VVM or the Vertical Cask Crawler (VCT) holding the HI-TRAC CS transfer cask by its straps (Figure 4.5.2), are subject to seismic qualification under the Operating Basis Earthquake. However, the seismic calculations in Chapter 5 for Short-Term Operations conservatively use the DBE as input.

Following the universally practiced "lift and set" rule at nuclear power plants, transient activities such as upending of a cask, attaching of slings or installation of fasteners, are treated as transient activities that are not subject to a seismic qualification. For clarity of application, any activity that spans less than a work shift is deemed to be seismic-exempt.

Table 4.3.1

Loadings Excluded from Further Consideration in the Qualification of Storage System and Ancillaries at the HI-STORE SAR

Internal Design Pressure	All canisters brought to the HI-STORE site in the HI-STAR 190 transport cask from operating at-plant ISFSIs must meet the transport cask heat load limit, which is much lower than the acceptable limit defined in Chapter 2 of the HI-STORM UMAX FSAR [1.0.6]. The associated internal design pressure shall therefore always be less than its design basis pressure. The canister internal pressure is incorporated by reference from the HI-STORM UMAX FSAR [1.0.6], Paragraph 2.3.2.1. The HI-TRAC transfer cask and HI-STORM UMAX VVM are not capable of retaining internal pressure due to their open design, and therefore no analysis is required.
Lightning	Lightning is considered to be innocuous to the HI-STORM UMAX ISFSI because of its underground configuration. It is therefore excluded from consideration in both the HI-STORM UMAX and HI-STORE CIS design loadings. The evaluation of the HI-STORM UMAX VVMs related to lightning is incorporated by reference from the HI-STORM UMAX FSAR [1.0.6], Section 2.3.1.
Snow and Ice	The latitude of the ELEA site makes heavy snow accumulation and the comparative low magnitude of snow loading removes snow as a Design Basis Load (DBL) *a priori* from further consideration
High Winds	Regulatory Guide 1.76 [2.7.1], ANSI 57.9 [2.7.2], and ASCE 7-05 [4.6.1] provide the wind data used to define the Design Basis Wind in the HI-STORM UMAX FSAR. The diminutive profile and heavy weight of the closure lid (over 17 tons) makes the HI-STORM UMAX facility immune from any kinematic movement under very high or tornadic wind conditions. The wind conditions at the ELEA site are considered to be bounded by the HI-STORM UMAX FSAR Design Basis Wind. The HI-STORM UMAX systems performance under high wind conditions is incorporated by reference from the HI-STORM UMAX FSAR [1.0.6], Section 2.3.2.7
Tornado Borne Missiles	The Design Basis Missiles (DBMs) analysis in the HI-STORM UMAX FSAR show large margins of safety and are considered to bound the HI-STORE CIS facility conditions. Therefore, a repetitive analysis in this SAR is unnecessary. The HI-STORM UMAX tornado borne missile analysis is incorporated by reference from the HI-STORM UMAX FSAR [1.0.6], Section 2.4.2.

Table 4.3.1

Loadings Excluded from Further Consideration in the Qualification of Storage System and Ancillaries at the HI-STORE SAR

Flood	As shown in Table 4.3.2, the Design Basis Flood used to qualify the VVM in the HI-STORM UMAX FSAR exceeds the most severe projection of flood at the ELEA site. Therefore, flood is eliminated from consideration as a meaningful loading event for HI-STORE CIS. The HI-STORM UMAX system design basis flood evaluation is incorporated by reference from the HI-STORM UMAX FSAR [1.0.6], Section 2.4.7.
Non-Mechanistic Tip-over	Because the HI-STORM UMAX VVM is situated underground, a tip-over event is not a credible accident for this design. It has been excluded in the HI-STORM UMAX safety analysis for the same reason.
Explosion	An explosion event has not been postulated as a Design Basis Load (DBL) for the HI-STORE ISFSI. However, the HI-STORM UMAX VVM is evaluated for a design basis explosion pressure per Table 2.3.1 of [1.0.6]. In addition, the canisters are evaluated for a Design Basis external pressure, under accident conditions, per Table 2.2.1 of [1.3.7].

Table 4.3.2
Environmental Data for the Licensing Basis in the HI-STORM UMAX Docket and the HI-STORE Site for Different Service Conditions

Service Condition	Item	HI-STORM UMAX General License Data	Site Specific Data for HI-STORE CIS
Normal Condition of Storage	Temperature (defined as annual average)	80 deg. F.	62 deg. F (Table 2.7.1)
	Ambient pressure corresponding to elevation above sea level	760 mm Hg	670 mm Hg (See Note 1)
Off-Normal Condition of Storage	Off-normal temperature (defined as the minimum of the 72-hour average of the ambient temperature at an ISFSI site.)	100 deg. F.	91 deg. F (Table 2.7.1)
Accident Condition of Storage	Accident Condition (maximum average ambient temperature over a 24-hour period)	125 deg. F	108 deg. F See Chapter 2
Short Term Operations	Maximum & minimum 3-day average ambient temperature	90 deg. F 0 deg. F	91 deg. F 0 deg. F
Maximum Flood Height (faulted States)	Peak height of the flood water above the ISFSI pad	125 feet	4.8 inches (See Chapter 2, site considered "flood dry")

Note 1: Ambient air pressure at 3500 ft elevation above sea level

Table 4.3.3

Applicable Earthquake and Long Term Settlement data for the Certified HI-STORM UMAX System and the HI-STORE CIS Facility

#	Data	HI-STORM UMAX Generic License Value (see Note 1)	HI-STORE CIS Site Value	Comment
1	ISFSI Pad and SFP concrete density concrete compressive strength rebar yield strength concrete cover on rebar	• 150 lb/ft^3 reference dry density • 4,500 psi minimum concrete compressive strength @ ≤ 28 days • 60,000 psi minimum rebar yield strength • minimum concrete cover on rebar per subsection 7.7.1 of ACI-318(05)	Same as the value certified in the HI-STORM UMAX docket.	See Licensing Drawings in Chapter 1 for details on concrete pad thickness. Grade 60 Rebar. Rebar is #11@9" (each face, each direction) Compressive strength, allowable bearing stress and reference dry density values for ISFSI structures are also applicable to the plain concrete used in the HI-STORM UMAX Closure Lid
2	Depth averaged density of subgrade in Space A (see Figure 4.3.1)	120 lb/ft^3 minimum	120 lb/ft^3 minimum	Required for shielding and structural analysis
3	Depth averaged density of subgrade in Space B (see Figure 4.3.1)	110 lb/ft^3 minimum	110 lb/ft^3 minimum	Required for shielding analysis.
4	Depth averaged density of subgrade in Space C (see Figure 4.3.1)	120 lb/ft^3 nominal	120 lb/ft^3 nominal	Not required for shielding.
5	Depth averaged density of subgrade in Space D (see Figure 4.3.1)	120 lb/ft^3 nominal	120 lb/ft^3 nominal	This space will contain native soil. Not required for shielding.
6	Strain compatible effective shear wave velocity in Space A	1300 ft/sec minimum	1300 ft/sec minimum	This space will typically contain CLSM or lean concrete.

Table 4.3.3

Applicable Earthquake and Long Term Settlement data for the Certified HI-STORM UMAX System and the HI-STORE CIS Facility

#	Data	HI-STORM UMAX Generic License Value (see Note 1)	HI-STORE CIS Site Value	Comment
7	Strain compatible effective shear wave velocity in Space B	450 ft/sec minimum	780 ft/sec minimum	Space will contain native soil.
8	Strain compatible effective shear wave velocity in Space C	485 ft/sec minimum	980 ft/sec minimum	Space may be remediated with vertical reinforcement such as pilings to achieve equivalent Boussinesq stiffness.
9	Strain compatible effective shear wave velocity in Space D, V	485 ft/sec minimum	980 ft/sec minimum	Space will contain native soil.
10	Density of plain concrete in the Closure Lid (nominal)	150 lb/cubic feet	150 lb/cubic feet	Used in shielding calculations
11	Reference compressive strength of plain concrete in the Closure Lid	4,000 psi	4,000 psi	Used in analysis of mechanical loadings on the Closure Lid
12	Minimum compressive strength of SES in Space A (see Figure 4.3.1)	1,000 psi	1,000 psi	Used in tornado missile impact analysis and SSI analysis
13	Two orthogonal horizontal and one vertical ZPAs for 10,000 -year return earthquake (DBE)	-	0.15,0.15, 0.15	5% Damped Reg. Guide 1.60 spectra [4.3.2]
14	Two orthogonal horizontal and one vertical ZPAs for 1000- year return earthquake (OBE)	-	0.10, 0.10, 0.10	2% Damped Reg. Guide 1.60 spectra [4.3.2]
15	Two orthogonal horizontal and one vertical ZPAs for Design Extended Condition Earthquake (DECE)	-	0.25,0.25, 0.25	5% Damped Reg. Guide 1.60 spectra [4.3.2]

Table 4.3.3

Applicable Earthquake and Long Term Settlement data for the Certified HI-STORM UMAX System and the HI-STORE CIS Facility

#	Data	HI-STORM UMAX Generic License Value (see Note 1)	HI-STORE CIS Site Value	Comment
16	Newmark Summation of the ZPAs at the Grade at the HI-STORE site (DECE)(Note 2)	1.3	0.45	The HI-STORM UMAX CoC uses the Newmark summation limit to indicate the severity of an earthquake event. The Newmark 100-40-40 response summation for a 3-D earthquake site is defined as: A= $a_1+0.4a_2+0.4a_3$, where a_1, a_2 and a_3 are the site's ZPAs in three orthogonal directions and $a_1 \geq a_2 \geq a_3$ This approach is consistent with Reg. Guide 1.92 [4.3.3].

Note 1: The HI-STORM UMAX ISFSI design data is reproduced from Table 2.3.2 of the HI-STORM UMAX FSAR [1.0.6].

Note 2: The Newmark summation, A, is the weighted scalar that defines the severity of an earthquake consisting of three orthogonal (vectorial) accelerations. The magnitude of A is used to compare the relative severity of earthquakes.

Table 4.3.4 Structurally Significant Loadings (SSL) for HI-TRAC CS			
Structural Loading Case	**Description of Loading**	**Affected part or Interfacing structure**	**Acceptance criterion**
SSL-1	Dead weight of the loaded HI-TRAC CS	Lifting trunnions	NUREG-0612 [1.2.7]
SSL- 2	Site's OBE while the loaded cask is mounted on a HI-STORM UMAX VVM	Threaded anchors fastening the cask to the CEC structure embedded in the ISFSI pad and substrate & shell structure of the cask body loaded as a cantilever beam	ASME Section III Subsection NF [4.5.1] stress limits for Level B service condition.
SSL-3	Site's OBE while the loaded cask is mounted on the CTF surface and anchored to its Threaded Anchor Locations (TAL)	Threaded anchors fastening the cask to the CTB slab & shell structure of the cask body loaded as a cantilever beam	ASME Section III Subsection NF [4.5.1] stress limits for Level B service condition.
SSL-4	Missile from an extreme environmental phenomenon striking the cask while it is mounted on the ISFSI pad	Threaded anchors fastening the cask to the CEC structure embedded in the ISFSI pad and substrate & shell structure of the cask body loaded as a cantilever beam	ASME Section III Subsection NF stress limits for Level D service condition & the canister must be retrievable (not jammed inside the cask due to excessive diametral deformation)

Table 4.3.5
Thermally Significant Loadings (TSL) for HI-TRAC CS

Thermally significant loading Condition	Description of condition	Ref Figure	Acceptance Criterion
TSL-1	Loaded Canister in HI-TRAC CS with its Shield Gate closed (constricted ventilation)	Figure 6.4.2	See Table 4.4.1
TSL-2	Collapse of the Cask Transfer Building (CTB) causing significant blockage of the top ventilation by the corrugated sheet metal from the roof	Further described in Subsection 6.5.2	
TLS-3	Enveloping fire	Further described in Subsection 6.5.2	

Table 4.3.6

Governing Structural and Thermal Loadings for HI-STAR 190 during Short Term Operations

Loading ID	Loading type	Description	Acceptance Criterion
SSL-1	Structurally significant	The OBE strikes while the cask loaded with the canister is in the CTF cavity (see Figure 3.1.1g/h)	The cask's movement under the OBE must be limited such that it does not impact the internal shell of the CTF
TSL-1	Thermally Significant	The cask is seated in the CTF cavity which limits its heat rejection capacity (see Figure 6.4.1)	The maximum fuel cladding temperature must remain below the Short-Term Operation limit (Section 4.4)
TSL-2	Thermally significant	The CTB roof collapses while the cask is inside the CTF cavity (see Figure 6.4.1)	The maximum fuel cladding temperature must remain below the Accident condition limit (Section 4.4)

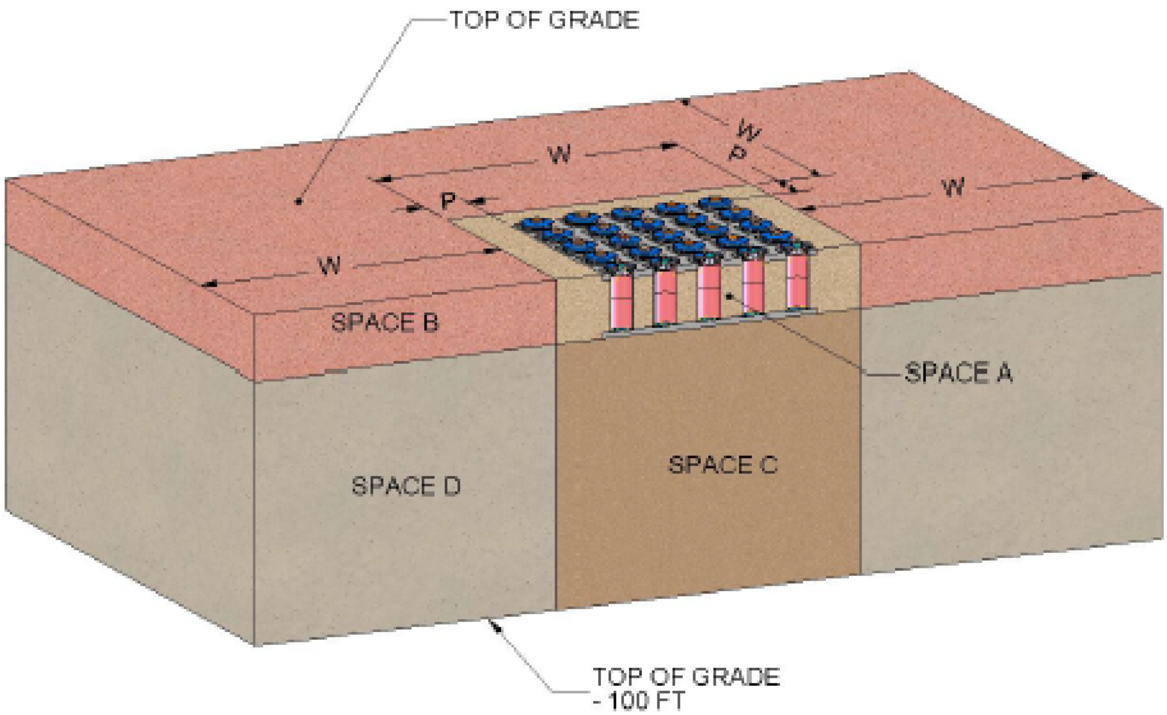


FIGURE 4.3.1: SUB-GRADE AND UNDER-GRADE SPACE NOMENCLATURE

Note 1: Space A is the lateral subgrade space in and around the VVMs which is refilled with CLSM or lean concrete after the construction of the SFP. Space B is the lateral subgrade that extends around the ISFSI. Space C is the under-grade below the SFP. Space D is the under-grade surrounding Space C. P is the distance between the outside VVMs and the edge of the ISFSI pad.

Note 2: As indicated by the title, this figure is provided to show the nomenclature for the various spaces around a HI-STORM UMAX ISFSI. This figure is not intended to provide specific dimensions or layout of the site- specific design in this SAR.

4.4. ACCEPTANCE CRITERIA FOR CASK COMPONENTS

4.4.1 Stress and Deformation Limits

In the ASME Code, plant and system operating conditions are commonly referred to as normal, upset, emergency, and faulted. Consistent with the terminology in NRC documents, this SAR utilizes the terms normal, off-normal, and accident conditions.

The ASME Code defines four service conditions in addition to the Design Limits for nuclear components. They are referred to as Level A, Level B, Level C, and Level D service limits, respectively. Their definitions are provided in Paragraph NCA-2142.4 of the ASME Code. The four levels are used in this SAR as follows:

i. Level A Service Limits are used to establish allowables for normal condition load combinations.

ii. Level B Service Limits are used to establish allowables for off-normal conditions.

iii. Level C Service Limits are not used.

iv. Level D Service Limits are used to establish allowables for certain accident conditions.

The ASME Code service limits are used in the structural analyses for definition of allowable stresses and allowable stress intensities, as applicable. Allowable stresses and stress intensities of materials required for structural analyses are tabulated in Section 4.5. These service limits are matched with normal, off-normal, and accident condition loads combinations in the following subsections.

The following definitions of terms apply to the tables on stress intensity limits; these definitions are the same as those used throughout the ASME Code:

S_m: Value of Design Stress Intensity listed in ASME Code Section II, Part D, Tables 2A, 2B and 4

S_y: Minimum yield strength at temperature

S_u: Minimum ultimate strength at temperature

The following stress limits are applicable to the SSCs at the HI-STORE CIS facility:

i. Canisters: The MPC confinement boundary is required to meet Section III, Class 1, Subsection NB stress intensity limits. Because the MPCs (canisters) are certified to loads in their native docket [1.0.6] that bound those at the HI-STORE site, it is not necessary to re-perform their stress qualifications. Accordingly, the stress intensity limits for the MPC are not presented in this SAR.

ii. HI-STORM UMAX CEC and Closure Lid: The applicable Code for stress analysis is ASME Section III, Subsection NF. Because the HI-STORM UMAX structure has been qualified to loads that uniformly bound those at the HI-STORE site, it is not necessary to re-qualify the HI-STORM UMAX structure to the site specific loads in this SAR.

iii. Load bearing ancillaries: All structurally significant ancillaries are qualified to ASME Section III Subsection NF. The stress limits for the different service conditions are listed in Table 4.4.2. Appendix 4.A provides a summary of specific stress categories extracted from the Code for NF structures

iv. Lifting and handling equipment: The applicable codes and requirements are provided in Section 4.5.

v. Special handling devices: ANSI N14.6 [1.2.4] applied. Detailed requirements are provided in Section 4.5.

4.4.2 Thermal Limits

The thermal acceptance criteria for all components are identical to the design criteria described in Section 4.3.

4.4.3 Dose Limits

The off-site dose for normal operating conditions to any real individual beyond the controlled area boundary is limited by 10CFR72.104(a) for normal conditions and 10CFR72.106 for accident conditions (including contributions from all Short-Term operations) at the HI-STORE CIS facility. Table 4.4.3 provides the numerical dose limits.

Table 4.4.1: Permissible Temperature Limits for HI-TRAC CS and CTF Materials (Note 4)

ITEM	Short Term Operations, Deg. F. (Note 1)	Accident Condition, Deg. F.	Notes
Shielding Concrete	300 (section average)	650 (local maximum)	Note 3
All steel weldments in casks and structures used at HI-STORE	600	700	Note 2; Note 3

Note 1: Short term operations include all activities in the CTB and at the ISFSI to effectuate canister transfer and onsite translocation.

Note 2: For accident conditions that involve heating of the steel structures and no mechanical loading (such as the blocked air duct accident), the permissible metal temperature of the steel parts is defined by Table 1A of ASME Section II (Part D) for Section III, Class 3 materials as 700°F

Note 3: For the ISFSI fire event, the local temperature limit of concrete is 1100°F (HI-STORM 100 FSAR Appendix 1.D [1.3.3]), and the steel structure is required to remain physically stable (i.e., so there will be no risk of structural instability such as gross buckling, the maximum temperature shall be less than 50% of the component's melting temperature and the specific temperature limits in this table do not apply). Concrete that exceeds 1100°F shall be considered unavailable for shielding of the overpack.

Note 4: The temperature limits of MPC components and its contents including fuel cladding under short-term operations are provided in Table 2.3.7 of the HI-STORM UMAX FSAR [1.0.6].

Table 4.4.2: Stress and Acceptance Limits for Different Loading Conditions for the Primary Load Bearing Structures in the Steel Weldments of Casks

(Adapted from Table 2.2.12 of HI-STORM FW FSAR [1.3.7])

STRESS CATEGORY	DESIGN + NORMAL	OFF-NORMAL	ACCIDENT
Primary Membrane, P_m	S	1.33·S	See Note 1
Primary Membrane, P_m, plus Primary Bending, P_b	1.5·S	1.995·S	
Shear Stress (Average)	0.6·S	0.6·S	

Note 1: Under accident conditions, the cask must maintain its physical integrity, the loss of solid shielding (lead, concrete, steel, as applicable) shall be minimal and the Canister must remain recoverable.

Definitions:

S = Allowable Stress Value for Table 1A, ASME Section II, Part D.
S_m = Allowable Stress Intensity Value from Table 2A, ASME Section II, Part D
S_u = Ultimate Stress

Table 4.4.3: Radiological Site Boundary Requirements from 10CFR72

(Reproduced from Table 2.3.1 of HI-STORM FW FSAR [1.3.7])

MINIMUM DISTANCE TO BOUNDARY OF CONTROLLED AREA (m)	100
NORMAL AND OFF-NORMAL CONDITIONS: -Whole Body (mrem/yr) -Thyroid (mrem/yr) -Any Other Critical Organ (mrem/yr)	 25 75 25
DESIGN BASIS ACCIDENT: -TEDE (rem) -DDE + CDE to any individual organ or tissue (other than lens of the eye) (rem) -Lens dose equivalent (rem) -Shallow dose equivalent to skin or any extremity (rem)	 5 50 15 50

Table 4.4.4
HI-STAR 190 Materials Temperature Limits

Component	Short-Term Temperature Limits[(a)] °C (°F)	Accident Temperature Limits[(a)] °C (°F)
Fuel Basket	500 (932)[(b)]	500 (932)[(b)]
DFC	570 (1058)[(b)]	570 (1058)[(b)]
Basket Shims and Solid Shim Plates	500 (932)[(b)]	500 (932)[(b)]
MPC Shell	427 (800)[(b)]	427 (800)[(b)]
MPC Lid	427 (800)[(b)]	427 (800)[(b)]
MPC Baseplate	427 (800)[(b)]	427 (800)[(b)]
Containment Shell	232 (450)[(c)]	371 (700)[(d)]
Containment Bottom and Top Forgings	232 (450)[(c)]	371 (700) (Structural Accidents)[(d)] 788 (1450) (Fire Accident[(e)]
Closure Lid	232 (450)[(c)]	371 (700) (Structural Accidents)[(d)] 788 (1450) (Fire Accident[(e)]
Remaining Cask Steel	232 (450)[(c)]	371 (700) (Structural accidents)[(d)] 788 (1450) (Fire Accident)[(e)]
Lid Seal	120 (248)	210 (410)
Neutron Shield	204 (400)	Note (g)
Gamma Shield	316 (600)	316 (600)[Note (h)]

4.5 LIFTING EQUIPMENT (CTB CRANE & VCT), SPECIAL LIFTING DEVICES AND MISCELLANEOUS ANCILLARIES

Ancillaries for the HI-STORE CIS are equipment, systems or devices that are needed to carry out Short Term Operations to place the canister into interim storage or to remove the loaded canister from storage. Ancillaries are differentiated from "certified" SSCs by the fact that they are not a part of the storage system and their detailed design is not subject to regulatory certification. However, as required by NUREG-1567 [1.0.3], their design criteria must be articulated in this SAR. In what follows, the design criteria for the different types of ancillaries envisaged for the HI-STORE facility are set down in sufficient detail to ensure that the resulting detailed design will fulfill their safety imperatives in full measure.

The description of principal ancillaries needed at the HI-STORE facility provided in Chapter 1 indicates that the list is quite small due to the fact that the canisters arrive in ready-to-store condition at the site and the needed operations pertain entirely to handling of the loaded canister. As a result, the ancillaries belong entirely to the class of special and standard lifting devices and certain miscellaneous equipment.

Heavy load handling device criteria summarized in the following are adopted from the HI-STORM FW FSAR [1.3.7]

4.5.1 Design Requirements Applicable to Lifting Devices and Special Lifting Devices

The lifting and handling ancillaries needed for operation of the HI-STORE CIS are classified as either "*lifting devices*" or "*special lifting devices*."

The term *special lifting device* refers to components to which ANSI N14.6 [1.2.4] applies. As stated in ANSI N14.6 (both 1978 and 1993 versions), "This standard shall apply to *special lifting devices* that transmit the load from lifting attachments, which are structural parts of a container to the hook(s) of an overhead hoisting system." Examples of *special lifting devices* are canister lift cleats, cask lift brackets, and cask lift yokes.

The term *lifting device* as used in this SAR refers to components of a lifting and handling system that are not classified as *special lifting devices*. ANSI N14.6 is not applicable to these *lifting devices.* These include non-active structural components (components that bear the primary load but are not a constituent of a moving part, e.g., gear train, hydraulic cylinder) of the system.

4.5.1.1 Stress Compliance Criteria Applicable to Lifting Devices (LDs):

Examples of *lifting devices* used with Holtec's systems include the VCT or the main girder of the gantry crane used in the transport cask receiving area of the Cask Transfer Building (CTB).

The stress compliance criteria for *lifting devices* are taken from the code applicable to the specific component. For example, slings are required to meet the guidelines of ANSI B30.9 [4.5.6], and overhead beams in a crane are required to meet the guidelines of an applicable consensus national standard selected by the designer, such as AISC, CMAA, or ASME Code (Subsection NF [4.5.1]).

The transporter used to handle the loaded transfer cask or overpack during transport operations must be engineered to provide a high integrity handling of the load, defined as a lifting/handling operation wherein the risk of an uncontrolled lowering of the heavy load is non-credible. In handling equipment, such as a transporter, high integrity handling is achieved through (a) a body and any vertical columns designed to comply with stress limits of ASME Section III, Subsection NF, Class 3, (b) an overhead beam that is single-failure-proof, and (c) redundant drop protection features. Single failure proof handling capability is achieved by ensuring that the applicable factor of safety is 200% of that required by the reference design code or national consensus standard. It is acceptable to have certain load carrying members (such as the lifting towers in a vertical cask transporter) designed with redundant devices and others (such as the transverse beam) designed to the doubled factor of safety in order to meet the criteria set above.

4.5.1.2 Stress Compliance Criteria Applicable to Special Lifting Devices (SLDs):

The stress compliance criteria for *special lifting devices* are taken directly from ANSI N14.6 [1.2.4], which requires safety factors of three against the yield strength and five times against ultimate strength. Although not required by ANSI N14.6, Holtec International requires the yield and ultimate strengths of the primary load bearing member used in the stress analysis to be at its average metal temperature (in lieu of the ambient temperature).

4.5.1.3 Single Failure Proof Criteria

In order for a *lifting device* or *special lifting device* to be considered single failure proof, the design must also follow the guidance in NUREG-0612 [1.2.7], which requires that a single failure proof device have twice the normal safety margin. This designation can be achieved by either providing redundant devices or providing twice the design safety factor as required by the applicable code. Therefore, for a *lifting device* to be considered single failure proof, the applicable code requirements should be doubled, or a redundant *lifting device* should be provided. Similarly, for a *special lifting device* to be considered single failure proof, the design safety factors in ANSI N14.6 [1.2.4] should be doubled, or a redundant *special lifting device* should be provided.

4.5.1.4 Stress Criteria and Critical Load Drop Accident

Both NUREG-0612 [1.2.7] and ANSI N14.6 [1.2.4] allow for a load drop analysis to be performed. If the consequences of that analysis are below the permissible dose rate and sub-criticality limits, the increased safety factors are not required. If the handling devices are designed to the correct stress limits, then the drop accident is non-credible.

4.5.2 Cask Transfer Building (CTB) Crane

The CTB crane is a rail-supported (gantry) load handling device located in the Cask Transfer Building (CTB). It is the principal load handling device used to lift, upend, down-end and translocate the casks & other heavy loads used inside the CTB. It is the in-CTB counterpart to the Vertical Cask Transporter (VCT) which principally handles the transfer cask and other heavy loads outside the CTB. The Cask Crane renders the following repetitive operations:

1. Removal of the transport cask from the railcar

2. Removal of the transport cask impact limiters
3. Movement of the transport cask in and out of the CTF
4. Movement of the transport cask (empty and loaded) inside the CTB
5. The ITS designation of the crane is provided in Table 4.2.1

4.5.2.1 Structural

The CTB Crane shall be a single failure proof load handling device designed and built in accordance with the provisions of ASME NOG-1 [3.0.1].

The applicable Design Basis dead weight and seismic loadings on the CTB Crane are set down in Table 4.5.1.

- The crane shall be designed for a load capacity specified in Table 4.5.2.
- For loading conditions that exceed the duration defined as seismic-exempt, a seismic analysis of the loaded crane shall be performed in accordance with the provisions of ASME NOG-1 [3.01].

4.5.2.2 Thermal

The CTB crane does not operate in an elevated temperature environment. The design temperature of the gantry crane is conservatively specified in Table 4.5.1 to be well above the maximum ambient temperature in the CTB.

4.5.2.3 Shielding

The CTB crane does not provide a shielding function.

4.5.2.4 Confinement

The CTB crane does not provide a confinement function.

4.5.2.5 Criticality Control

The CTB crane does not perform any criticality control function.

4.5.2.6 Operational Requirements

- The crane design shall allow interfacing with all the lifting ancillaries such as MPC Lift Extension, HI-TRAC CS Lifting Device, and HI-STAR 190 Lift Yoke.
- The crane design shall provide for the ability to upend and lift the HI-STAR from the railcar.
- The crane design shall meet the requirements per Table 4.5.1 and 4.5.2.
- The crane shall meet the operational requirements per ASME NOG-1 [3.0.1].

4.5.2.7 Environmental Conditions

The ambient conditions for the crane are identical to those for the VCT summarized in Table 4.5.3. In addition, the design of the crane shall preclude materials that may degrade under the radiation from casks during the crane's service life.

4.5.2.7 Interfaces and Media Requirements

The electrical supply requirements are specified in Table 4.5.2. The crane shall have ability to receive signals from lifted equipment in order to fulfill operational requirements described in Chapter 10.

4.5.2.8 Electric Requirements

The following requirements shall be met.

The crane shall meet the electrical requirements per ASME NOG-1 [3.0.1]

- All safety relevant functions such as interlocking mechanisms, releases, selections, acceptances, and other connections shall be established via hard wire. All other functions can be realized via PLC. The operating and display elements which have no safety implications can be linked with a bus system to the PLC. The speed and torque controllers can be linked with the PLC directly via bus system. The electrical design shall be properly configured for easy maintenance.
- Phase and voltage protection shall be provided for main power feed.
- Sufficient space shall be provided for the cable routing and buses into the electrical cabinet.
- Properly sized electrical grounding conductors shall be implemented in the cable routing of the main components.

4.5.3 Vertical Cask Transporter

The Vertical Cask Transporter (VCT) is the principal load handling device used at the HI-STORE CIS ISFSI. This Subsection provides the essential design requirements that the VCT procured for the HI-STORE facility must fulfill to comply with this SAR.

The VCT is a U-shaped, tracked vehicle (also called a tracked crawler) used for handling and on-site transport of loaded and empty HI-TRAC transfer cask. The structural characteristics of the so-called "wheeled" VCT are identical and therefore are not spelled out separately. The tracked crawler configuration has been selected for the HI-STORE site because of greater in-use experience with it in the United States. Use of a wheeled crawler at a later date will require a safety evaluation pursuant to 10CFR72.48.

The VCT is used for transferring an MPC, loaded in a HI-TRAC transfer cask, at the CTF and the HI-STORM UMAX cavity. The constituent parts of the VCT are indicated in Figure 4.5.1. As shown in Figure 4.5.1, the VCT consists of the vehicle main frame, the lifting towers, an overhead crossbeam that connects between the lifting towers, a cask restraint system, the drive system and control system, and the cask lifting attachment. The transfer cask is supported by the lifting attachments that are connected to the overhead beam (Figure 4.5.2). The overhead beam is

supported at the ends by a pair of lifting towers. The lifting towers transfer the cask weight directly to the vehicle frame. The lifting towers have an independent means of affording protection against uncontrolled lowering of the load. Figure 4.5.3 illustrates the dual-path MPC handling system utilized for Canister raising or lowering operations. In summary, used in conjunction with the special lifting devices, it provides the critical lifting and handling functions associated with the canister transfer operations. The VCT is also used to transfer HI-TRAC CS from CTB to the HI-STORM UMAX ISFSI.

The ITS designation of the VCT and its constituent components is provided in Table 4.2.1.

4.5.3.1 General Design Requirements

Prevention of a cask or canister drop is afforded by design conformance with NUREG-0612 [1.2.7] and ANSI N14.6 [1.2.4] combined with the use of automatic redundant drop protection features along with hydraulic check valves and enhanced safety margins. The automatic drop protection features shall prevent an uncontrolled lowering of the load under any potential single system failure or loss of hydraulic or electric power at any time, including travel.

The VCT vehicle frame shall be designed in accordance with applicable industry standards such as ASME Section III, Subsection NF, for Class 3, linear-type supports or equivalent such as AISC [4.5.9]. The MPC downloader system shall be fully redundant and each side shall be capable of holding the entire weight of a loaded MPC (Figure 4.5.3). Overhead beam deflection shall meet the requirements of [4.5.11]

The overhead beam, lifting attachments, and MPC downloader pulley/pins and/or other attachments shall be designed in accordance with ANSI N14.6 [1.2.4] and the applicable guidance of NUREG-0612, Section 5.1.6 [1.2.7]. The safety factor shall be based on the lower of 1/6th the yield strength or 1/10th the ultimate strength.

Jack/Lifting Towers (including top lugs connecting to overhead beam pins and the pins connecting the Lifting Towers to the frame) shall be designed in accordance with ASME Section III, Subsection NF, for Class 3, Linear-Type Supports [4.5.1] and ASME B30.1 [4.5.8] with design safety factors consistent with the guidance of [1.2.7], Section 5.1.6 (1)(a) for the specific load lifted.

The Load Drop Protection System shall be designed to meet the applicable stress limits of ASME Section III, Subsection NF, for Class 3, Linear-Type Supports using 115% of the design basis load.

The hydraulic fluids used in jacks or other hydraulic equipment shall be appropriate for use throughout the range of service temperatures listed in Table 4.5.1. The hydraulic fluids used in the cask transporter should have a flashpoint greater than or equal to 500°F per ASTM D92 [4.5.10]. Hydraulic fluids with flashpoints lower than 500°F may be used provided they are included as combustible material in the applicable fire analyses.

The Lifting Cylinders shall meet the requirements of ASME B30.1-2009 [4.5.8].High-energy hydraulic lines shall be guarded or properly secured for personnel protection to ensure no personnel injuries from whipping of a ruptured line.

4.5.3.2 Fabrication

The VCT shall be designed, fabricated, inspected, and tested in accordance with the applicable guidance of NUREG-0612 [1.2.7]. All directly loaded tension and compression members shall be engineered to satisfy the enhanced safety criteria of paragraphs 5.1.6 (1) (a) and (b) of [1.2.7]. All welding shall comply with [4.5.3] or [4.5.4]. The VCT shall be manufactured in accordance with the provisions of [4.5.5]. Slings shall comply with the provisions of [4.5.6].

4.5.3.3 Structural

The following structural requirements apply to the components comprising the HI-STORE CIS facility VCT:

i. All materials used in the design of the overhead beam and lifting towers shall be ASTM approved or equal and shall be consistent with the ITS category of the part.

ii. Prevention of a cask or canister drop is afforded by design conformance with NUREG-0612 [1.2.7] and ANSI N14.6 [1.2.4] combined with enhanced safety margins and the use of redundant drop protection features, such as hydraulic check valves and a fail-safe electrical control system;

iii. The VCT vehicle frame shall be designed in accordance with applicable industry standards such as ASME Section III, Subsection NF, for Class 3, linear-type supports or equivalent, or AISC [4.5.9];

iv. The overhead beam, lifting attachments, and MPC downloader pulley/pins and/or other attachments shall be designed in accordance with ANSI N14.6 [1.2.4] and the applicable guidance of NUREG-0612 [1.2.7], Section 5.1.6. The safety factor shall be based on the lower of 1/6th the yield strength or 1/10th the ultimate strength;

v. Jacks shall be designed in accordance with ASME Section III, Subsection NF, for Class 3, Linear-Type Supports [4.5.1] and ASME B30.1 [4.5.8] with design safety factors consistent with the guidance of NUREG-0612 [1.2.7], Section 5.1.6 (1)(a) for the specific load lifted. Multi-stage jacks may have several rated capacities based on the extension stage. The jacks' rated capacity shall be coupled with the load based on the jack configuration for the lift of the load.

vi. The applicable Design Basis dead weight and seismic loadings on the VCT are listed in Table 4.5.3. The VCT shall be shown to not tip-over under any specified service condition. The vehicle's lateral and transverse center of gravity shall be lower than the HI-TRAC's lateral and transverse center of gravity while transporting a loaded HI-STORM. Tip-over shall assume a 7% transverse grade in all modes. A national consensus standard such as ASCE 43-05 [5.4.5] shall be used for stability evaluation. The seismic restraints and their attachment points on the VCT frame shall be designed to meet the Level D stress limits of ASME Subsection NF.

4.5.3.4 Functional Requirements

The VCT shall be operated and controlled by means of a control panel. The control panel shall be suitably positioned to allow for easy access and operator visibility during cask engagement,

lifting, movement, and lowering. The control panels shall be enclosed or suitably protected from weather conditions. From the operator's chair, the operator shall be able to see all gauges and indicators necessary to accurately monitor the condition of both the power source and the hydraulic system at all times. The VCT shall be equipped with a dead man's throttle.

The VCT shall be equipped with an emergency stop switch tethered to the rear of the vehicle by means of a retractable cord reel. The emergency stop switch shall be easily and sagely carried and operated by ground personnel walking behind or to either side of the VCT.

The VCT shall be equipped with flashing movement warning lights and audible alarm with a minimum 30' range.

The VCT shall be capable of being towed and secured against movement in the event that it becomes inoperable during transit.

The design shall ensure that any electrical malfunction in the control system, motors, or power supplies will not lead to an uncontrolled lowering of the load.

Portable fire extinguisher(s) meeting the requirements of NFPA 10 [4.5.7, 4.5.12].

A catch pan or a double wall fuel tank with a hose connection to route spills away from the VCT shall be mounted beneath the fuel tank.

The VCT shall be equipped with auxiliary power receptacles. Voltage, frequency, amperage ratings, and receptacle shall be specified by Holtec to meet site specific requirements.

4.5.3.5 Thermal

The VCT does not operate in an elevated temperature environment. The design temperature of the VCT is conservatively specified in Table 4.5.3 to be well above the maximum ambient temperature in the CTB, on the VCT haul path, and the ISFSI pad.

4.5.3.6 Shielding

The VCT does not provide a shielding function.

4.5.3.7 Confinement

The VCT does not provide a confinement function.

4.5.3.8 Criticality Control

The VCT does not perform any criticality control function.

4.5.3.9 Material Failure Modes

All materials used in the design of the overhead beam and lifting towers shall be ASTM approved or equal and shall be consistent with the ITS category of the part.

The material properties and allowable stress values for all structural steel members shall be taken from the applicable national consensus standard. Acceptance criteria for the Charpy testing requirements for the overhead beam, lifting towers, cask transporter lift points and MPC downloader system load bearing components shall be per ASME Section III, Subsection NF

[4.5.1] or ANSI N14.6 [1.2.4]. The lowest service temperature used for developing the test parameters for Charpy testing shall be equal to 0°F for all the components mentioned above. Lateral expansion will be per Table NF-2331(a)-3 and required Cv energies shall be extrapolated from Fig. NF-2331(a)-2 for Class 3 Materials.

Fatigue failure modes of primary structural members whose failure may result in the uncontrolled lowering of the load shall be evaluated. A minimum safety factor of 2 on the number of permissible loading cycles (1000 loading cycles) for critical members shall apply.

4.5.3.10 Environmental Conditions

The ambient conditions for the VCT are summarized in Table 4.5.3. The design of the VCT shall preclude materials that may degrade under the radiation from casks during the service life.

4.5.4 Miscellaneous Ancillaries

Miscellaneous ancillaries are those weldments that are not used in a load lifting function and do not contain or in contact with fissile material. Such ancillaries do not render a confinement or criticality function. Certain ancillaries, however, are used to reduce crew dose such as tungsten screens and lead blankets. Such non-structural ancillaries are also called “accessories” because their design is guided by ALARA, not by any regulatory regimen.

The miscellaneous ancillaries are subject to mechanical loadings under any operating modes shall meet the following design criteria:

i. The Design loads and associated applicable to the ancillary under normal and accident conditions (if any) shall be defined based on its function and application.

ii. ASME Section III Subsection NF Class 3 is designated as the governing code for purposes of stress analysis of the ancillary. Specifically, Subsection NF shall be used to demonstrate:

   a. Compliance with the Code stress limits

   b. Absence of the risk of brittle fracture at low service conditions (See Table 2.7.1)

   c. Absence of elastic instability effects such as buckling

   d. Absence of the risk of fatigue failure

iii. The load rating and maximum/minimum operating temperature for the ancillary shall be marked on the ancillary.

The stress and strength tables for common materials used in the manufacturing of ancillaries have been extracted from [1.3.3] and are provided in this sub-section.

Table 4.5.1 Design Basis Loadings on the Cask Crane inside the CTB		
Item	**Value**	**Comment**
Design Basis Dead Load	200 tons	Bounds the weight of all heavy loads lifted by the crane
Operating Basis Earthquake (OBE)	See Table 4.3.3	The seismic motion is applied at the elevation of the CTB Slab
Reference temperature	150 Deg. F.	Conservative upper bound on the maximum ambient temperature

Table 4.5.2 **Design Parameters for the CTB Crane**	
Specification	**Specification Description**
Component Type per ASME NOG-1-2015 [3.0.1]	Main Hoist: Type I Auxiliary Hoist: Type II Gantry: Type I Trolley: Type I
Service Factor	Main Hoist, Gantry, and Trolley: To meet or exceed minimum requirements as provided in ASME NOG-01 [3.0.1]; Auxiliary Hoist: CMAA 70 [4.5.2]: CMAA Class D
Material of Construction	Carbon steel frame, commercial winch and trolley components.
Main Hoist Capacity	200 ton minimum
Auxiliary Hoist	20 tons
Hook Type	Duplex (sister) hook with pin eye
Crane Speed (reference)	45 feet /min (infinitely variable speed control with minimum 30:1 speed range)
Trolley Speed (reference)	35 feet/min (infinitely variable speed control with minimum 30:1 speed range)
Main Hoist Speed (reference)	5 feet/min (infinitely variable speed control with minimum 100:1 speed range)
Auxiliary Hoist Speed (reference)	20 feet/min (infinitely variable speed control with minimum 100:1 speed range)
Operator Controls	Radio Control – To operate on Frequencies as allowed by local codes. Pendent backup with quick disconnect and full length festoon.
Main Hoist Reeving	Single Failure Proof reeving – True Vertical Lift
Auxiliary Hoist Reeving	Single or Double reeving. If double reeving is used, ropes must be equalized using an equalizer sheave or bar.
Motor Controls	Variable Frequency Drives with infinite speed control.

Table 4.5.2
Design Parameters for the CTB Crane

Specification	Specification Description
General Additional Safety Devices	1. Overload protection for critical loads and maximum capacity of each hoist. Critical load overload protection shall be field adjustable. Approximate values are provided in this document. 2. Slack Rope protection (underload) for critical loads with override for lowering of the load. Settings should be field adjustable. Approximate values are provided in this document. 3. Over Speed protection for critical loads. 4. Gantry end of travel limit switches with slowdown and stop. 5. Trolley end of travel limit switches with slow down and stop. 6. Audible alarms 7. Visual alarms (lights) 8. Fail-Safe Emergency Stop (pendant, radio control, and operating floor)
Gantry Service Platform	Walkway/Service Platform mounted to one side of the crane along the entire length of the span. An entry way to be coordinated with the crane access point is to be provided for safe personnel access to the platform. All electrical control enclosures shall be serviceable from the platform.
Trolley Service Platform	Walkway/Service Platform to allow inspection and service to hoist and trolley components. Access to the platform is to be provided from the gantry platform for safe personnel access.
Gantry Bumpers	Energy absorbing bumpers sized to decelerate and stop the while traveling without power at 40% of the rated load speed at a rate of deceleration not to exceed an average of 0.91 m/s^2 (3 ft/sec^2).
Trolley Bumpers	Energy absorbing bumpers sized to decelerate and stop the while traveling without power at 50% of the rated load speed at a rate of deceleration not to exceed an average of 1.4 m/s^2 (4.7 ft/sec^2).
Lighting	LED Gantry Crane Lighting for operators and others working under the crane.
Runway Rail and End stops	As needed by Manufacturer to meet hook coverage requirements, including all fastening hardware, splices, and end-stops.

Table 4.5.2
Design Parameters for the CTB Crane

Specification	Specification Description
Power	3 phase, 380V, 50 Hz.
Power Disconnect	Floor Mount Power Disconnect lockable in the open position
Runway Electrification	Sliding Double Shoe Collectors and Buss Bar
Coatings	ASME NOG-01 [3.0.1]; Service Level II

Table 4.5.3

Design Basis Conditions and Loadings on the Vertical Cask Transporter

Item	Value	Comment
Design Basis Dead Load	200 tons	Bounds the weight of the loaded HI-TRAC CS along with the associated lifting hardware
Maximum Loaded MPC	110,000 lbs	Bounding weight per HI-STORM UMAX FSAR [1.0.6] Table 3.2.1
Operating Basis Earthquake (OBE)	See Table 4.3.3	The seismic motion is applied at the elevation of the Haul Path slab
Design Temperature	150 Deg. F.	Upper bound on the maximum ambient temperature
Design Life	20 years	Normal life expectancy of the VCT
Maximum permitted service temperature	125 Deg. F	Limiting environmental temperature
Minimum permitted service temperature	0 Deg. F.	Limiting environmental temperature
Relative humidity range	0 to 100%	Design Basis Relative humidity range at the site
Maximum design basis incline or grade in the haul path	10%	Used to size the engine and transmission system of the VCT
Maximum design basis lateral grade	7%	

Table 4.5.4: Design and Level A Stress

Code: ASME NF
Material: SA516, Grade 70, SA350-LF3, SA203-E
Service Conditions: Design and Level A
Item: Stress

Temp. (Deg. F)	Classification and Value (ksi)		
	S	Membrane Stress	Membrane plus Bending Stress
-20 to 650	17.5	17.5	26.3
700	16.6	16.6	24.9

Notes:

1. S = Maximum allowable stress values from Table 1A of ASME Code, Section II, Part D.
2. Stress classification per Paragraph NF-3260.
3. Limits on values are presented in Table 4.4.2.
4. Table reproduced from [1.3.3], Table 3.1.10

Table 4.5.5: Level B Allowable Stress

Code: ASME NF
Material: SA516, Grade 70, SA350-LF3, and SA203-E
Service Conditions: Level B
Item: Stress

Temp. (Deg. F)	Classification and Value (ksi)	
	Membrane Stress	Membrane plus Bending Stress
-20 to 650	23.3	34.9
700	22.1	33.1

Notes:

1. Limits on values are presented in Table 4.4.2 with allowables from Table 4.5.4.
2. Table reproduced from [1.3.3], Table 3.1.11

Table 4.5.6: Level D Stress Intensity

Code: ASME NF
Material: SA516, Grade 70
Service Conditions: Level D
Item: Stress Intensity

Temp. (Deg. F)	Classification and Value (ksi)		
	S_m	P_m	$P_m + P_b$
-20 to 100	23.3	45.6	68.4
200	23.1	41.5	62.3
300	22.5	40.4	60.6
400	21.7	39.1	58.7
500	20.5	36.8	55.3
600	18.7	33.7	50.6
650	18.4	33.1	49.7
700	18.3	32.9	49.3

Notes:

1. Level D allowable stress intensities per Appendix F, Paragraph F-1332.
2. S_m = Stress intensity values per Table 2A of ASME, Section II, Part D.
3. Table reproduced from [1.3.3], Table 3.1.12

Table 4.5.7: Design and Level A Stress

Code: ASME NF
Material: SA36
Service Conditions: Design and Level A
Item: Allowable Stress

Temp. (Deg. F)	**Classification and Value (ksi)**		
	S	**Membrane Stress**	**Membrane plus Bending Stress**
-20 to 650	14.5	14.5	21.8
700	13.9	13.9	20.9

Notes:

1. S = Maximum allowable stress values from Table 1A of ASME Code, Section II, Part D.
2. Stress classification per Paragraph NF-3260.
3. Table reproduced from [1.3.3], Table 3.1.19

Table 4.5.8: Level B Allowable Stress

Code:	**ASME NF**
Material:	**SA36**
Service Conditions:	**Level B**
Item:	**Allowable Stress**

Temp. (Deg. F)	**Classification and Value (ksi)**	
	Membrane Stress	**Membrane plus Bending Stress**
-20 to 650	19.3	28.9
700	18.5	27.7

Notes:

1. Table reproduced from [1.3.6, Table 3.1.20]

Table 4.5.9: Level D Stress Intensity

Code:	**ASME NF**
Material:	**SA36**
Service Conditions:	**Level D**
Item:	**Stress Intensity**

Temp. (Deg. F)	**Classification and Value (ksi)**		
	S_m	P_m	$P_m + P_b$
-20 to 100	19.3	43.2	64.8
200	19.3	37.0	55.5
300	19.3	36.0	54.0
400	19.3	34.7	52.1
500	19.3	32.8	49.2
600	17.7	30.0	45.0
650	17.4	29.5	44.3
700	17.3	29.2	43.8

Notes:

1. Level D allowable stress intensities per Appendix F, Paragraph F-1332.
2. S_m = Stress intensity values per Table 2A of ASME, Section II, Part D.
3. Table reproduced from [1.3.3], Table 3.1.21

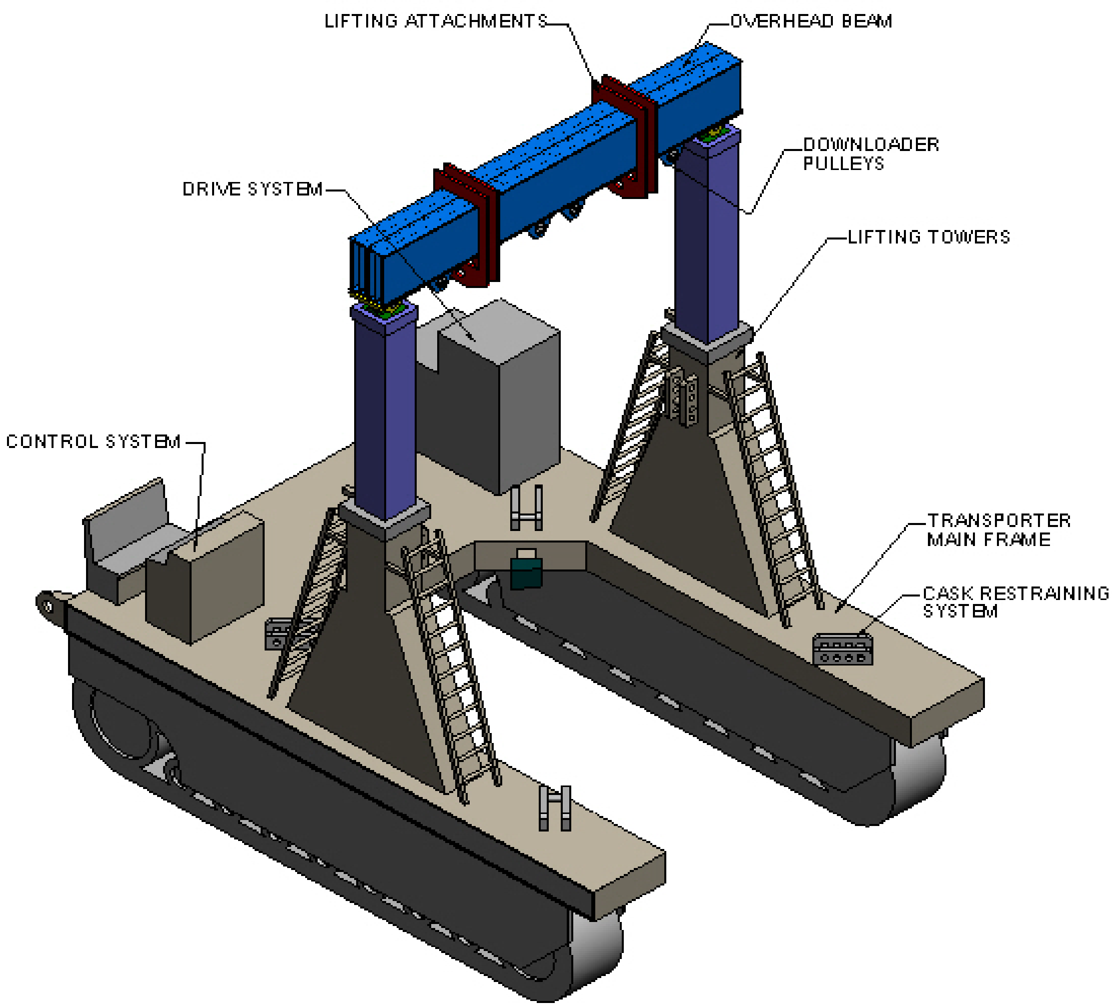


FIGURE 4.5.1: VCT MAJOR COMPONENTS

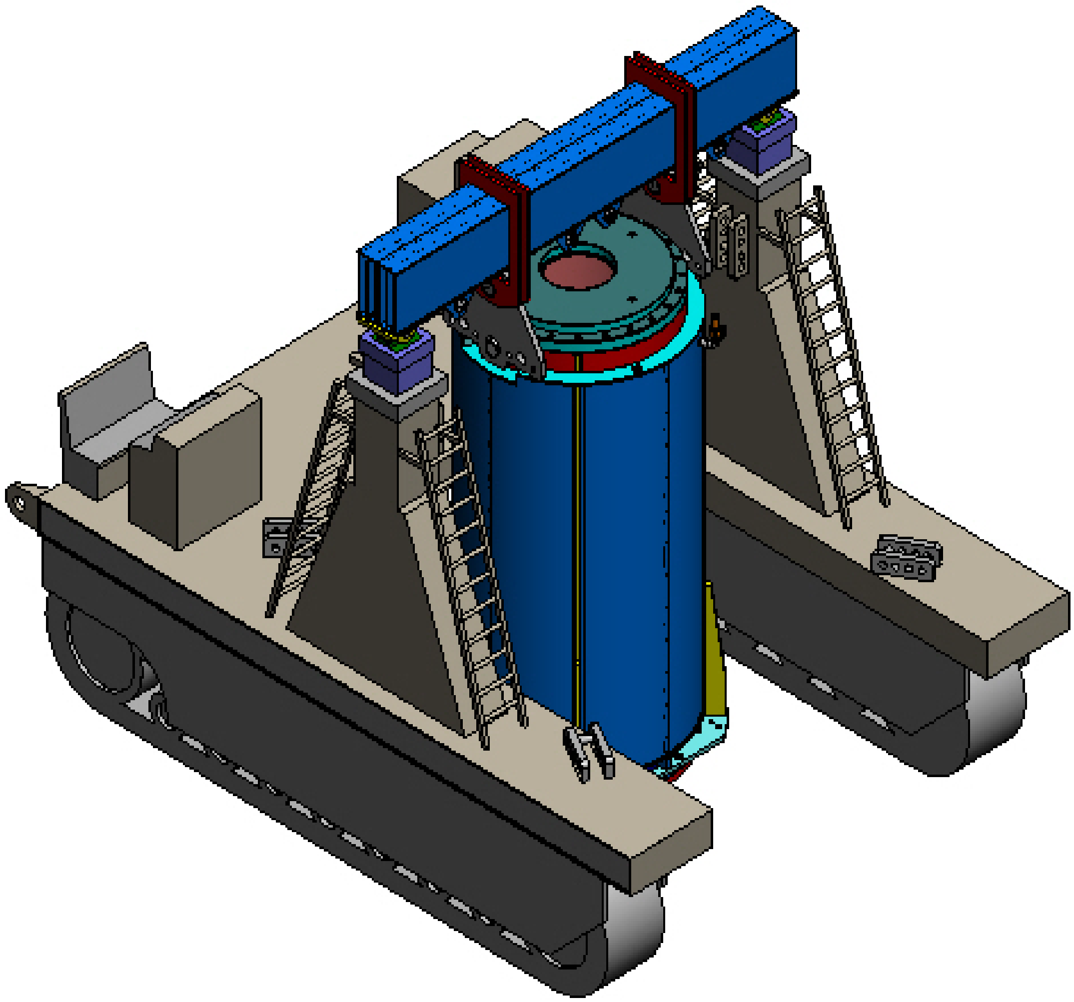


FIGURE 4.5.2: VCT CARRYING A HI-TRAC TRANSFER CASK

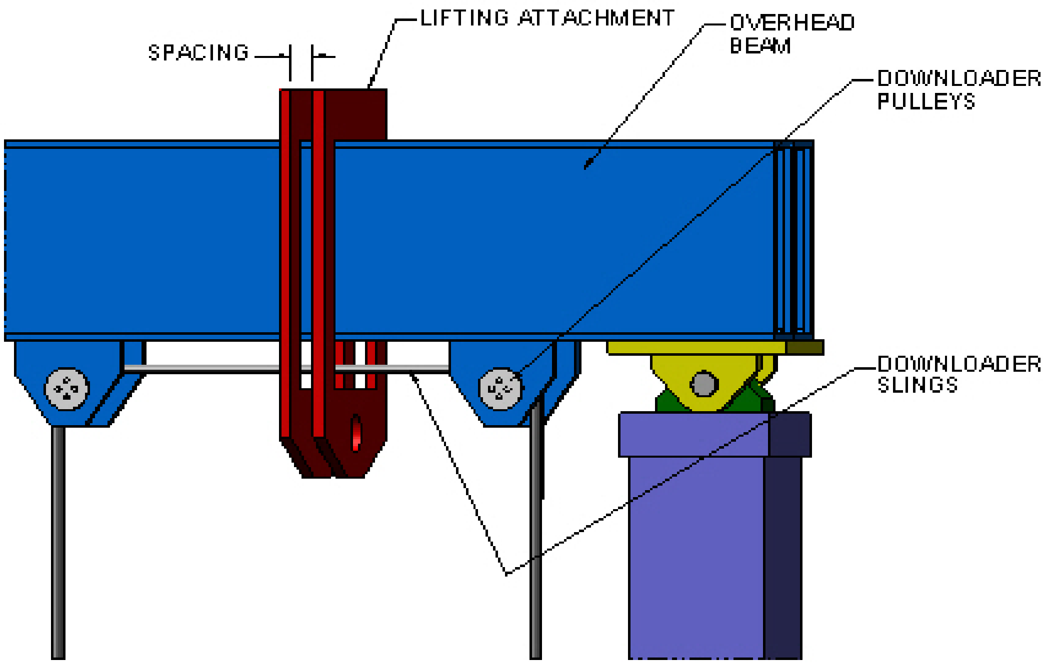


FIGURE 4.5.3: ILLUSTRATIVE VIEW OF THE VCT OVERHEAD BEAM AND CANISTER DOWNLOADER PULLEY SYSTEM

4.6 DESIGN CRITERIA FOR THE CASK TRANSFER BUILDING (CTB)

4.6.1 Design Features of the CTB

The Cask Transfer Building (CTB) is a NITS structure at the HI-STORE CIS facility. It serves as a weather enclosure for the cask handling equipment, facilities and structures, all of which are floor mounted. The CTB Crane, summarized in Section 4.5, is a gantry crane mounted on a set of rails founded on the CTB's slab. The layout of the equipment and ancillaries in the CTB is provided in Figure 3.1.2 of Chapter 3. Chapter 10 contains the summary of the operations that are envisaged to occur in the CTB.

The CTB is a conventional sheet metal building consisting of a thick load bearing concrete slab mentioned above and a set of knee-high concrete walls which support the steel frame that serves as the backbone for the building. Corrugated sheet metal panels are fastened to the steel frame to create the lateral enclosure system. An overhead truss provides the framework to support the roof, also made of corrugated sheet metal.

The CTB is designed to the provisions of [4.6.1] and New Mexico's state and local Building Codes. The building steel (wall and roof structures) design is informed by the load combinations and criteria in IBC-2015 [4.6.4] and ASCE 7-10 [4.6.2]. While the CTB renders no safety function, it houses safety-significant equipment. Therefore, under an extreme environmental phenomenon, such as high wind, it is necessary to postulate that its roof collapses and falls on the ITS SSCs below. Table 4.6.1 provides loading data for designing the CTB walls and roof structure; this data is used in the building collapse evaluation in Chapter 5.

4.6.2 CTB Slab

The CTB is founded on a thick reinforced concrete slab whose essential design data is summarized in Table 4.6.2.

The CTB slab is designed to the following governing dead and live loads:

(i) The live load from the railroad car wheels carrying the loaded transport cask
(ii) The live load from the CTB Crane carrying the transport or the HI-TRAC CS cask
(iii) The live load from the loaded VCT (Figure 4.5.2)

The CTB slab is designed to meet the strength requirements of ACI 318-05 [5.3.1] for the following governing load combinations:

Load Combination # 1: 1.4D

Load Combination # 2: 1.2D + 1.6L

Load Combination # 3: 1.2D + L + E

where D is the dead load of the CTB slab including long-term settlement effects, L is the live load acting on the CTB slab (including weight of VCT, CTB Crane, etc.), and E is the OBE for the site.

Table 4.6.2 provides the essential design data for the CTB slab which is used in Chapter 5 to demonstrate its compliance with ACI-318 using bounding values of loadings (live and seismic).

Table 4.6.1

Reference Design Basis Loading Data for the CTB

Item	Value	Comment
Ultimate Design Wind Speed, V_{ult}	115 mph	Used to size the wall and roof structures in Chapter 5; based on IBC 2015 Risk Category II building classification
Nominal Design Wind Speed, V_{asd}	90 mph	
Reference Weight of a CTB Roof Truss that may fall on the ITS equipment	32,400 lb	Used in the safety analysis of the ITS equipment from collapse of the CTB in Chapter 5
Design Basis Height of the CTB Roof Truss above CTB floor	66 feet (20 meters)	Used in the safety analysis of the ITS equipment from collapse of the CTB in Chapter 5

Table 4.6.2

Reference Design Data for the CTB Slab

Item	Reference value
Minimum Compressive strength of concrete	4,500 psi
Min Slab thickness	36 inches
Size of re-bars in the two orthogonal directions	#11
Re-bar nominal spacing	10 inch
Minimum concrete cover on the re-bar assembly (both faces)	3 inch
Minimum thickness of the engineered fill (or mud mat) undergirding the slab	12 inch

4.7 SUMMARY OF DESIGN CRITERIA

The Design Criteria set down in this chapter seek to ensure that during any condition of storage (normal, off-normal or accident) and during canister transfer operations, the following metrics of safety will be observed:

i. The confinement boundary is not breached.

ii. There is no risk of exceeding the neutron multiplication factor limit of 0.95 including all uncertainties and biases.

iii. The temperature of the used fuel remains below the limit set forth in ISG-11, Rev. 3 [4.0.1] which insures that the fuel will not undergo any significant degradation in storage.

iv. The stresses in the primary structural members remain within the applicable ASME code limits under every condition of storage.

v. The accreted site boundary radiation dose from the storage system meets the 72.104 & 10CFR 72.106 limits for the normal and accident conditions, respectively.

vi. The occurrence of an accidental load drop event is rendered non-credible by the *use of single failure proof* lifting and handling devices.

vii. There is no risk of brittle fracture of a primary load bearing member in the storage system under all storage scenarios.

viii. There is no risk of fatigue failure in a load bearing member under all applicable storage scenarios.

ix. There is no risk of structural instability (buckling), large deformation or similar non-linear behavior in any primary load bearing member during any (normal, off-normal and accident) condition of storage.

The above criteria are fulfilled either by reference to the HI-STORM UMAX FSAR [1.0.6] or by the safety analyses performed in support of this SAR. For the latter case, the justification for relying on the safety analysis in [1.0.6] is provided.

In particular, the information presented in this chapter shows that every loading germane to long term storage of Canisters in the HI-STORM UMAX VVM at a HI-STORM UMAX ISFSI, as described in the HI-STORM UMAX FSAR [1.0.6], either equals or bounds its site-specific counterpart for the HI-STORE CIS ISFSI. Likewise, the structural margins of safety in the short-term operations involving the HI-STAR transfer cask have been quantified in the HI-STORM UMAX FSAR for a much stronger seismic event than the Design Basis Earthquake (10,000 year return earthquake) applicable to the HI-STORE site. Finally, the Design Criteria set down in Chapter 4 of this SAR for the non- certified SSCs such as the vertical cask transporter, gantry crane and special lifting devices are identical to those specified for such components in other HI-STORM dockets [1.3.3, 1.3.7].

Therefore, the safety analyses for all aspects of safe deployment and storage of HI-STORM UMAX at the HI-STORE site, including structural, criticality, thermal and confinement are

substantially pre-empted by the qualifications in the HI-STORM UMAX FSAR making a re-evaluation for HI-STORE unnecessary. The only exceptions are:

i. The site boundary dose qualification which must be performed to demonstrate compliance with the 10CFR72.104 dose limits under the maximum fuel inventory scenario, i.e., when every storage location in the ISFSI is occupied.

ii. The temperature of the fuel within the stored canister at the HI-STORE ISFSI will meet the normal storage condition limit of ISG-11, Rev. 3. This analysis is required because the high altitude of the ISFSI (Table 2.7.1) reduces the air ventilation rate. The maximum heat load, however, is limited by the rating of the transport cask which is substantially less than the thermal capacity of HI-STORM UMAX licensed by the USNRC (Docket # 72-1040). Therefore, the ISG temperature limit is expected to be met with a large margin. Nevertheless, to support the safety case, this margin is quantified in Chapter 6.

In addition, a new transfer cask, named HI-TRAC CS has been introduced in this docket. While the design of this transfer cask is similar to the other HI-TRAC models certified in other HI-STORM dockets, viz. [1.0.6, 1.3.3, 1.3.7], there are sufficient physical differences to warrant a safety analysis of HI-TRAC CS to be performed. The applicable design criteria for such analyses are provided in this chapter.

Finally, all ancillaries must meet the design criteria presented in Section 4.5.

APPENDIX 4.A: [PROPRIETARY APPENDIX WITHHELD IN ITS ENTIRETY IN ACCORDANCE WITH 10CFR2.390]

CHAPTER 19: CONSOLIDATED REFERENCES

References cited throughout this SAR are compiled in this chapter. Each reference may be cited multiple times in multiple chapters. The context of the citation delineates the extent of reliance in this SAR on any particular reference. No reference, unless so stated, is invoked in its entirety. Each reference is identified by a decimal system (its native chapter. Section, and numeric sequence) and is enclosed in square brackets throughout this document. All Holtec origin documents are proprietary subject to 10CFR2.390 protection from dissemination except for Safety Analysis Reports which are available in redacted version in the Public Document Room. The unabridged version of any referenced Holtec document is shared with the USNRC upon request.

[1.0.1] Report to the Secretary of Energy, "Blue Ribbon Commission on America's Nuclear Future", January 2012. (https://energy.gov/sites/prod/files/2013/04/f0/brc_finalreport_jan2012.pdf)

[1.0.2] USNRC Regulatory Guide 3.50 "Standard Format and Content for a Specific License Application for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Facility", Revision 2, September 2014.

[1.0.3] USNRC NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities", March 2000.

[1.0.4] "Environmental Report on The HI-STORE CIS Facility", Holtec Report 2167521, dated March 2017

[1.0.5] 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-level Radioactive Waste, and Reactor-Related Greater than Class C Waste", Title 10 of the Code of Federal Regulations- Energy, Office of the Federal Register, Washington, D.C.

[1.0.6] USNRC Docket 72-1040, "Final Safety Analysis Report on The HI-STORM UMAX Canister Storage System", Holtec Report No. HI-2115090, Revision 3. Submitted with Holtec Letter 5021032 (ML16193A336), dated June 30, 3016

[1.2.1] "Aging Assessment and Management Program for HI-STORE CIS", Holtec Report 2167378, Revision 0, dated March 2017

[1.2.2] NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety", U.S. Nuclear Regulatory Commission, February 1996.

[1.2.3] ANSI/NSF Standard 61, "Drinking Water System Components – Health Effects", 2013.

[1.2.4] ANSI N14.6-1993, "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 Kg) or More", American National Standards Institute, Inc., Washington D.C., June 1993.

[1.2.5] Interim Staff Guidance (ISG) – 2, "Fuel Retrievability", Revision 1, February 22, 2010.

[1.2.6] Interim Staff Guidance (ISG) – 3, "Post Accident Recovery and Compliance with 10 CFR 72.122(l)"

[1.2.7] NUREG 0612, "Control of Heavy Loads at Nuclear Power Plants", U.S. Nuclear Regulatory Commission, Washington, D.C., July 1980.

[1.3.1] 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities", Title 10 of the Code of Federal Regulations, Office of the Federal Register, Washington, D.C.

[1.3.2] 10CFR Part 71, "Packaging and Transportation of Radioactive Material", Title 10 of the Code of Federal Regulations, Office of the Federal Register, Washington, D.C.

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