Enclosure 6 to E-55363

SAR Changed Pages

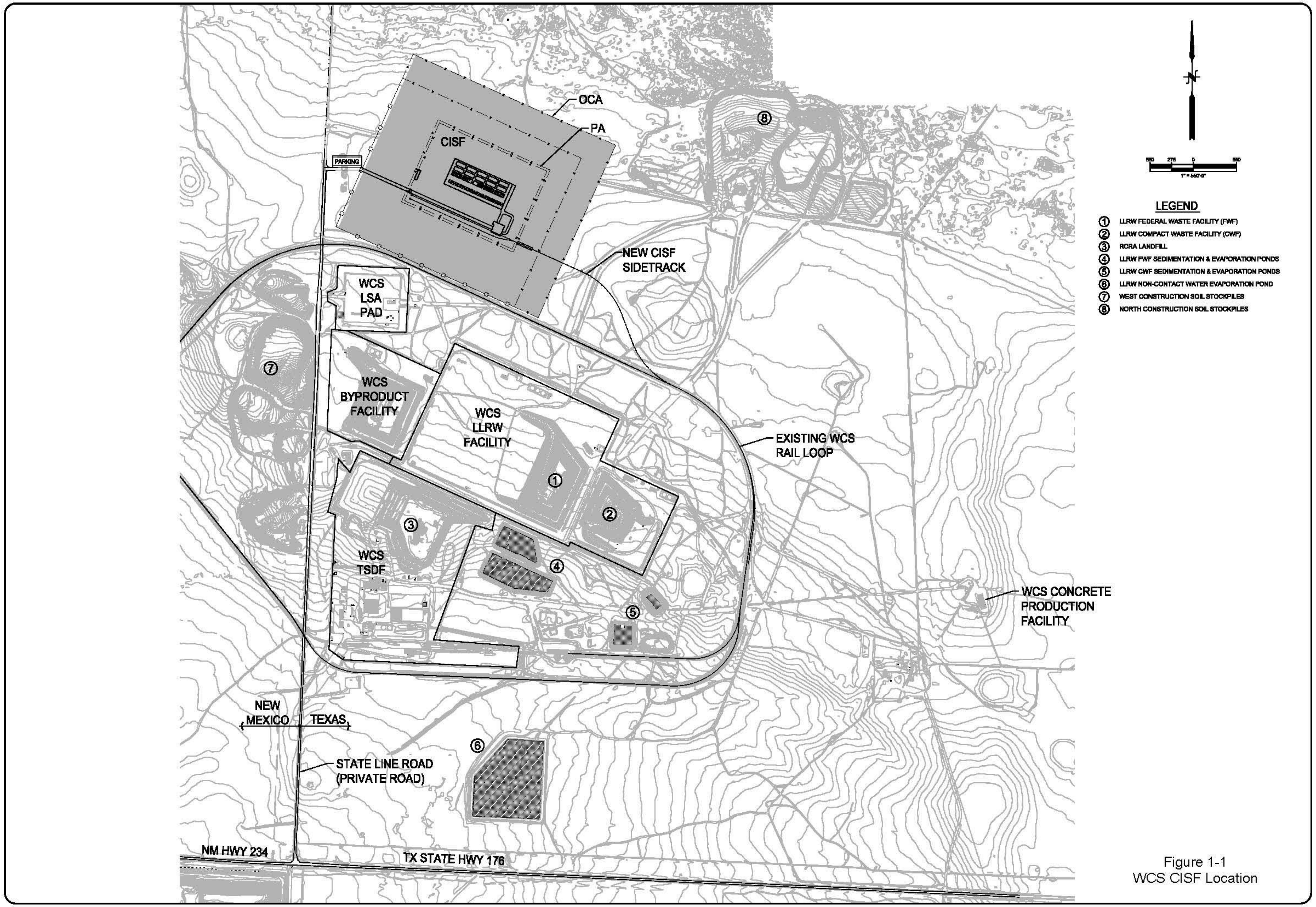


Figure 1-1
WCS CISF Location

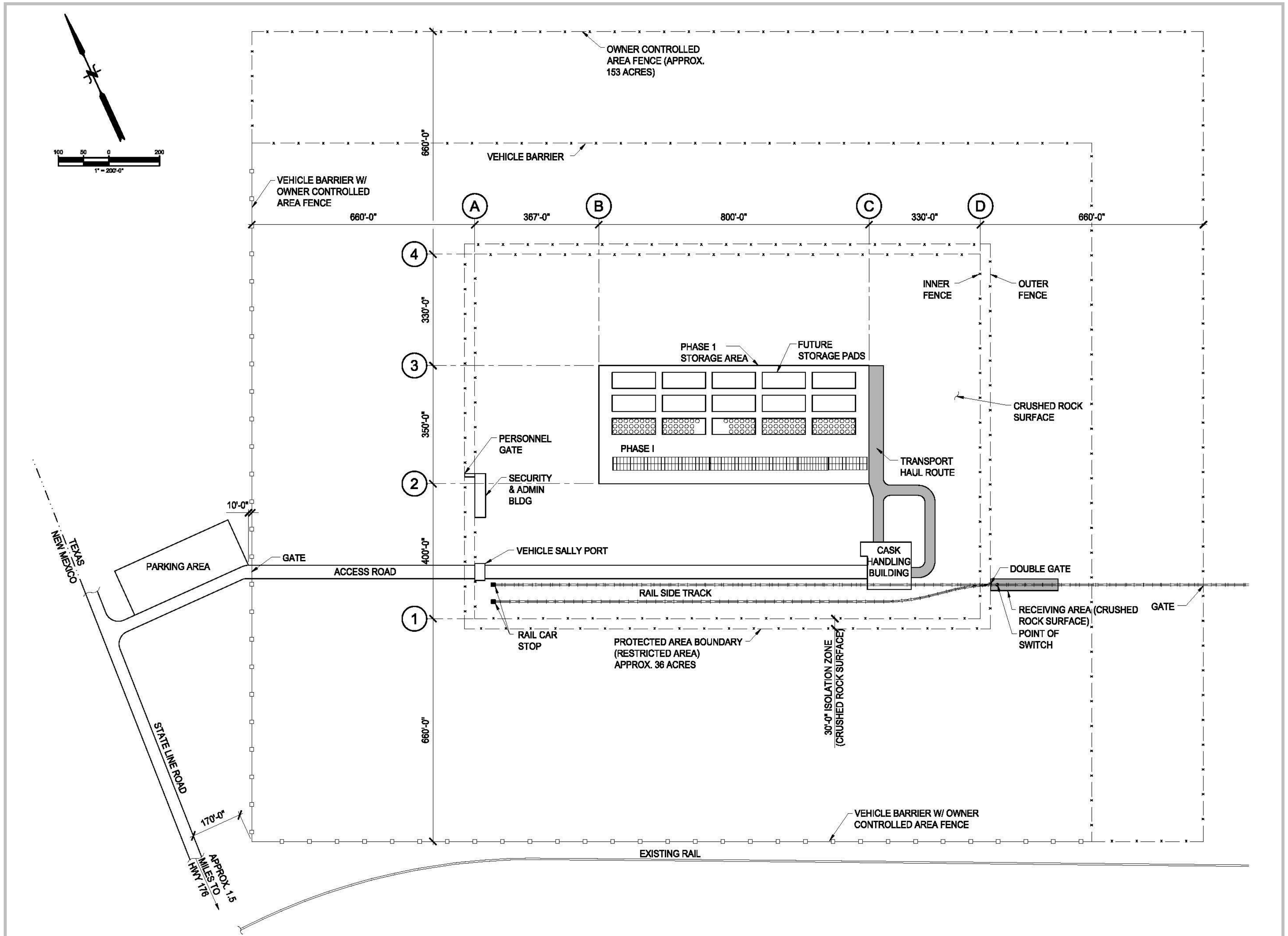


Figure 1-2
WCS CISF Site Boundary Layout

All Indicated Changes are in response to RAI PA-1

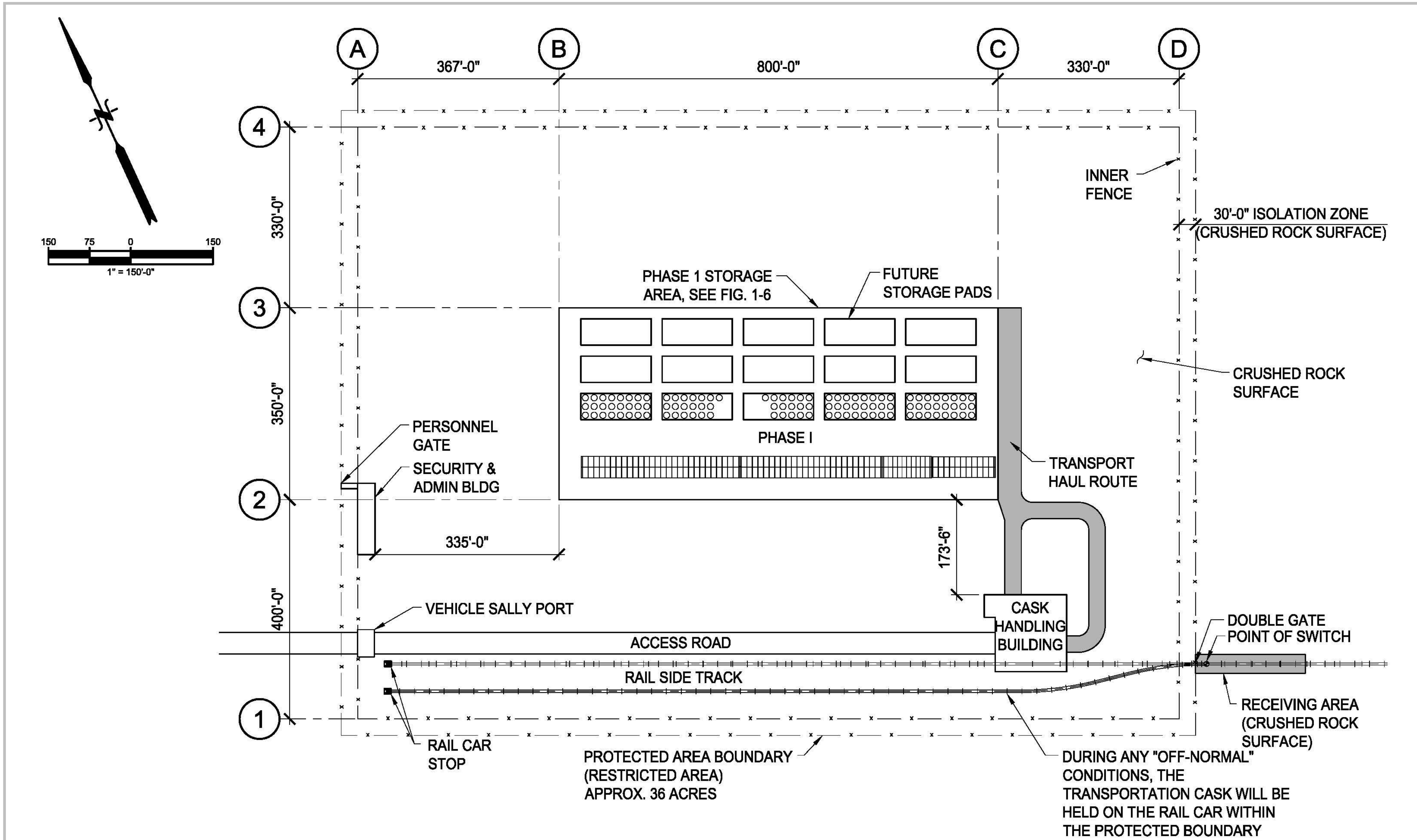


Figure 1-3
WCS CISF Site Overview

All Indicated Changes are in response to RAI PA-1

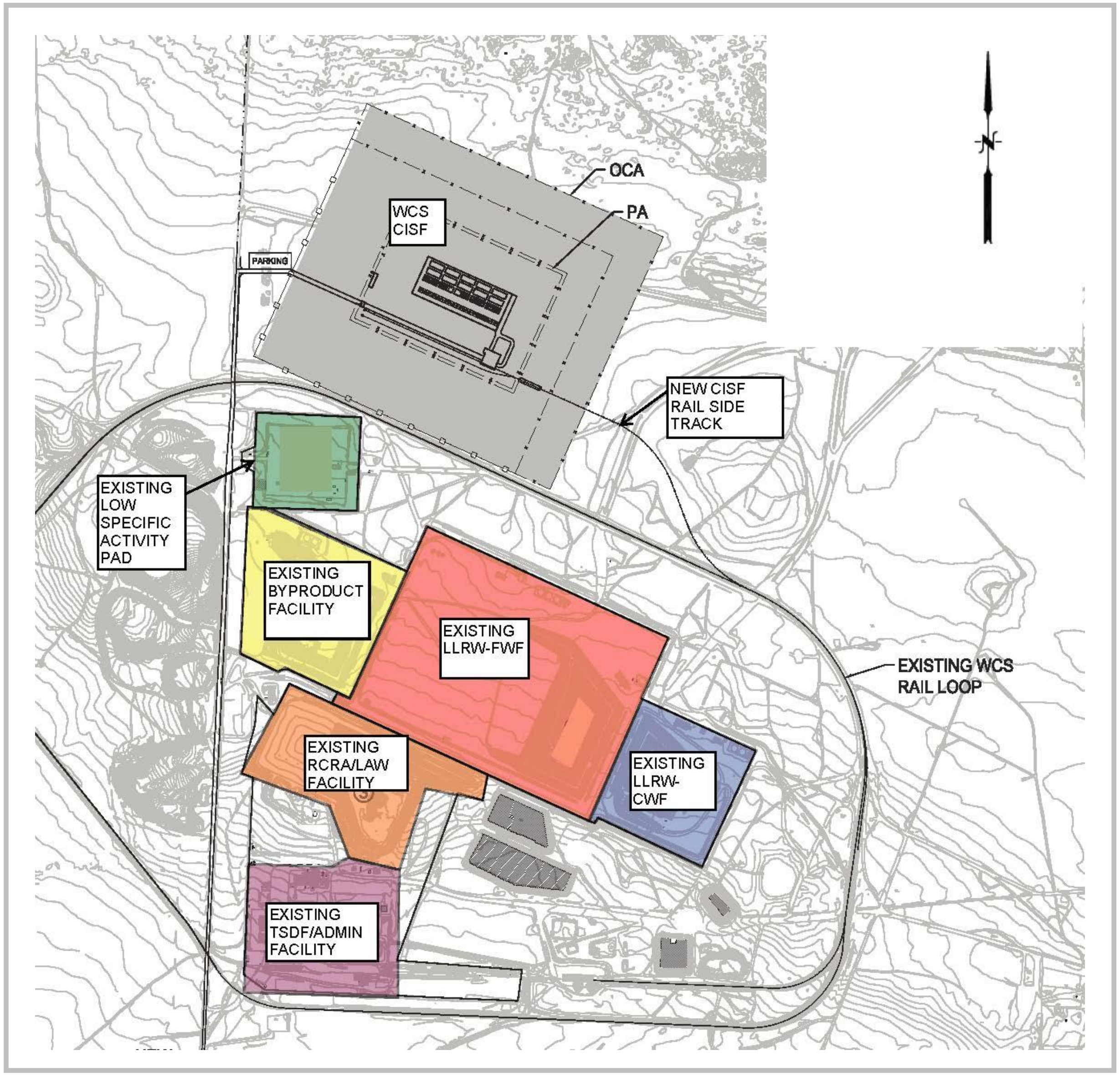


Figure 2-1
Waste Control Specialists Facility Site Plan

All Indicated Changes are in response to RAI PA-1

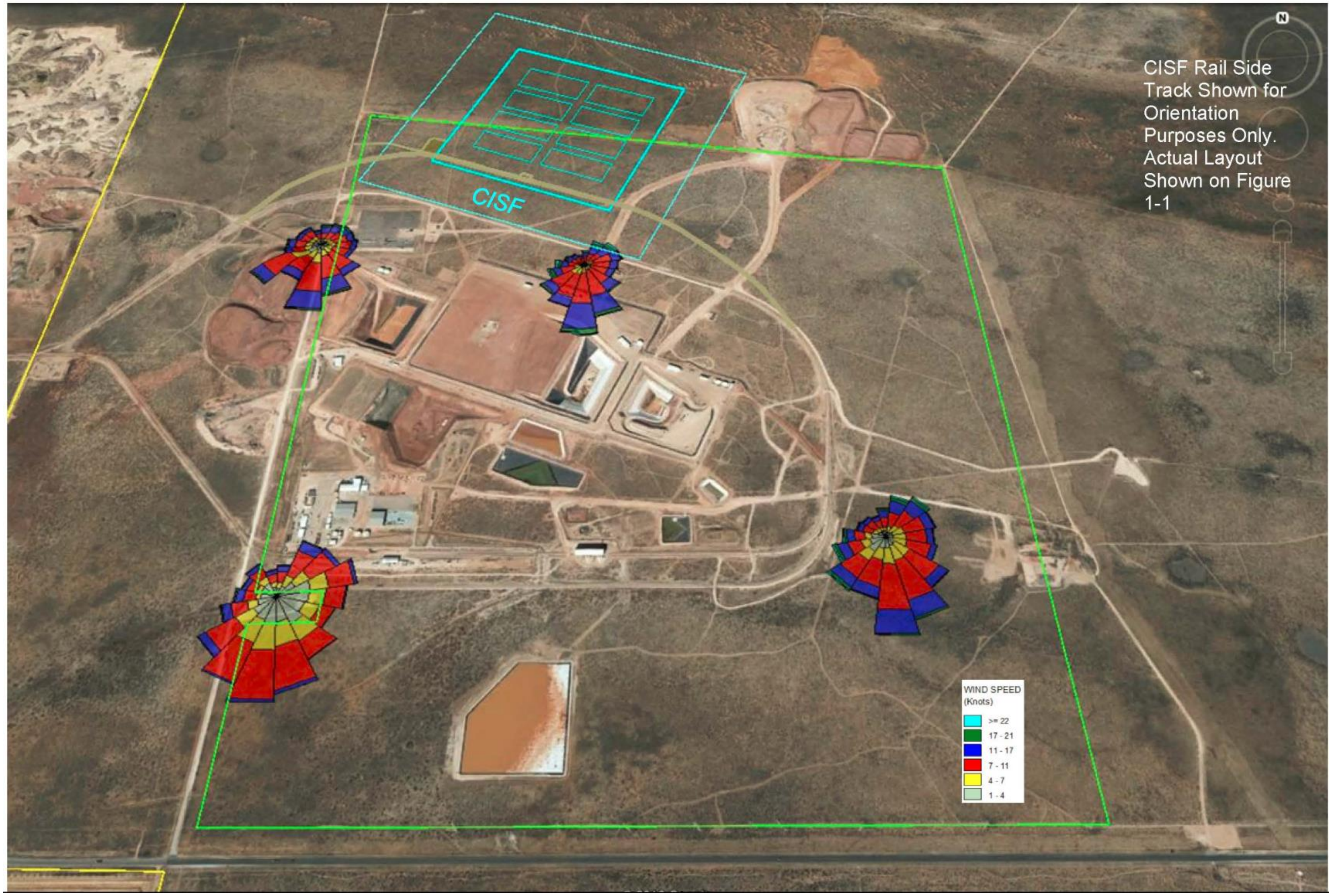
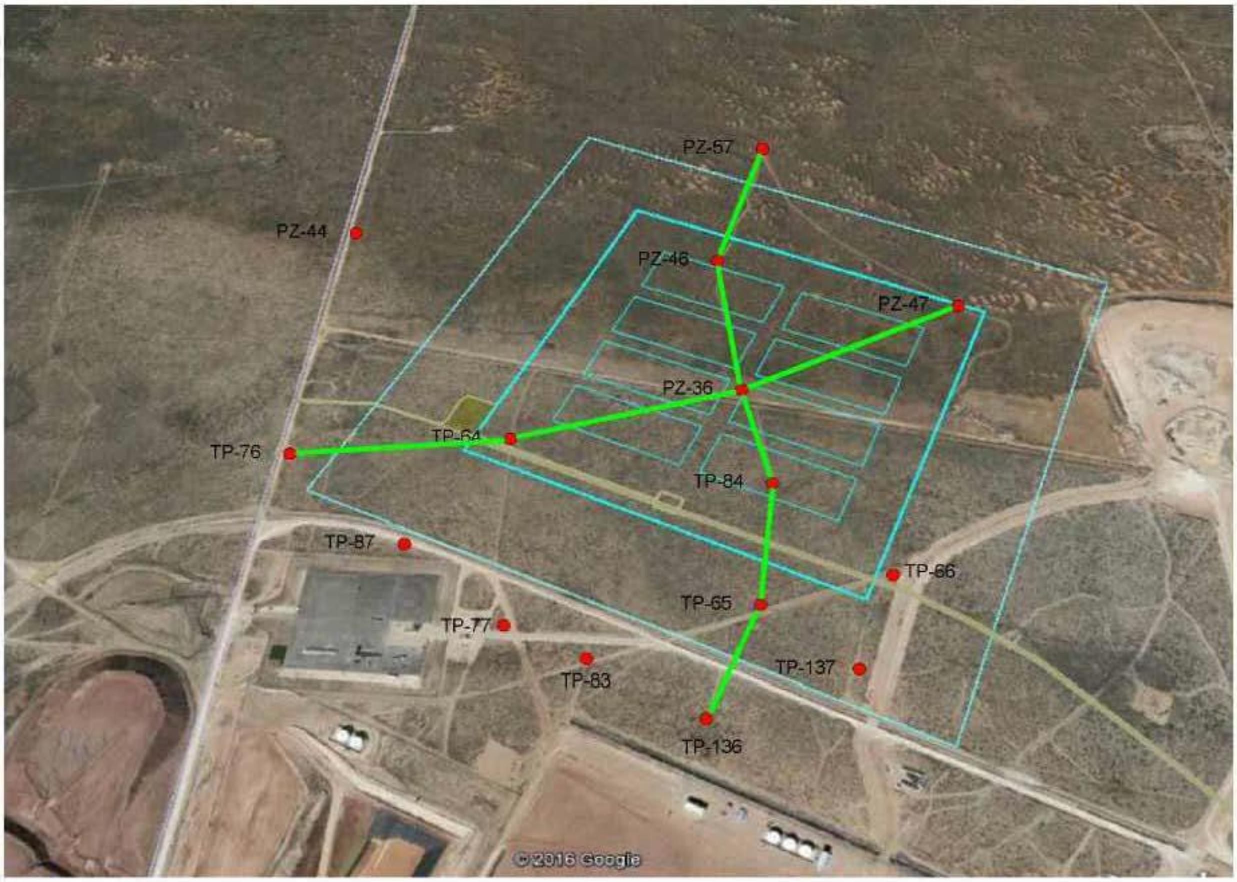


Figure 2-4
Wind Rose Location Map

All Indicated Changes are in response to RAI PA-1



Monitoring Well/ Piezometer Name	Date Drilled/ Completed	Total Depth Well (ft btoc)	Bottom of Well Elevation (ft msl)	Ground Elevation (ft msl)	Top of Casing Elevation (ft msl)	Depth to Top of Red Beds (ft bgs)	Top of Red Bed Elevation (ft msl)
PZ-36	7/20/05	78.98	3419.51	3494.79	3498.49	75.0	3419.79
PZ-44	1/22/08	82.98	3416.90	3496.59	3499.88	77.1	3419.49
PZ-46	1/23/08	93.83	3412.04	3502.38	3505.87	87.4	3414.98
PZ-47	1/24/08	92.22	3411.56	3500.60	3503.78	87.0	3413.60
PZ-57	1/23/08	99.56	3415.44	3511.79	3515.00	93.5	3418.29
TP-64	1/11/08	70.81	3433.99	3502.08	3504.80	65.3	3436.78
TP-65	1/11/08	57.68	3436.07	3490.40	3493.75	52.5	3437.90
TP-66	1/10/08	57.78	3430.88	3485.45	3488.66	51.0	3434.45
TP-76	2/7/08	53.42	3436.78	3487.06	3490.20	47.1	3439.96
TP-77	2/7/08	51.30	3436.09	3484.19	3487.39	45.4	3438.79
TP-83	2/11/08	55.55	3435.60	3487.77	3491.15	49.8	3437.97
TP-84	2/12/08	65.24	3429.59	3491.56	3494.83	58.7	3432.86
TP-87	3/15/08	49.02	3438.47	3484.17	3487.49	43.3	3440.87
TP-136	3/20/09	55.21	3438.01	3490.17	3493.22	50.5	3439.67
TP-137	3/20/09	56.46	3434.68	3488.00	3491.14	51.5	3436.50

Figure 2-15
Boring Locations in the Vicinity of the WCS CISF

All Indicated Changes are in response to RAI PA-1

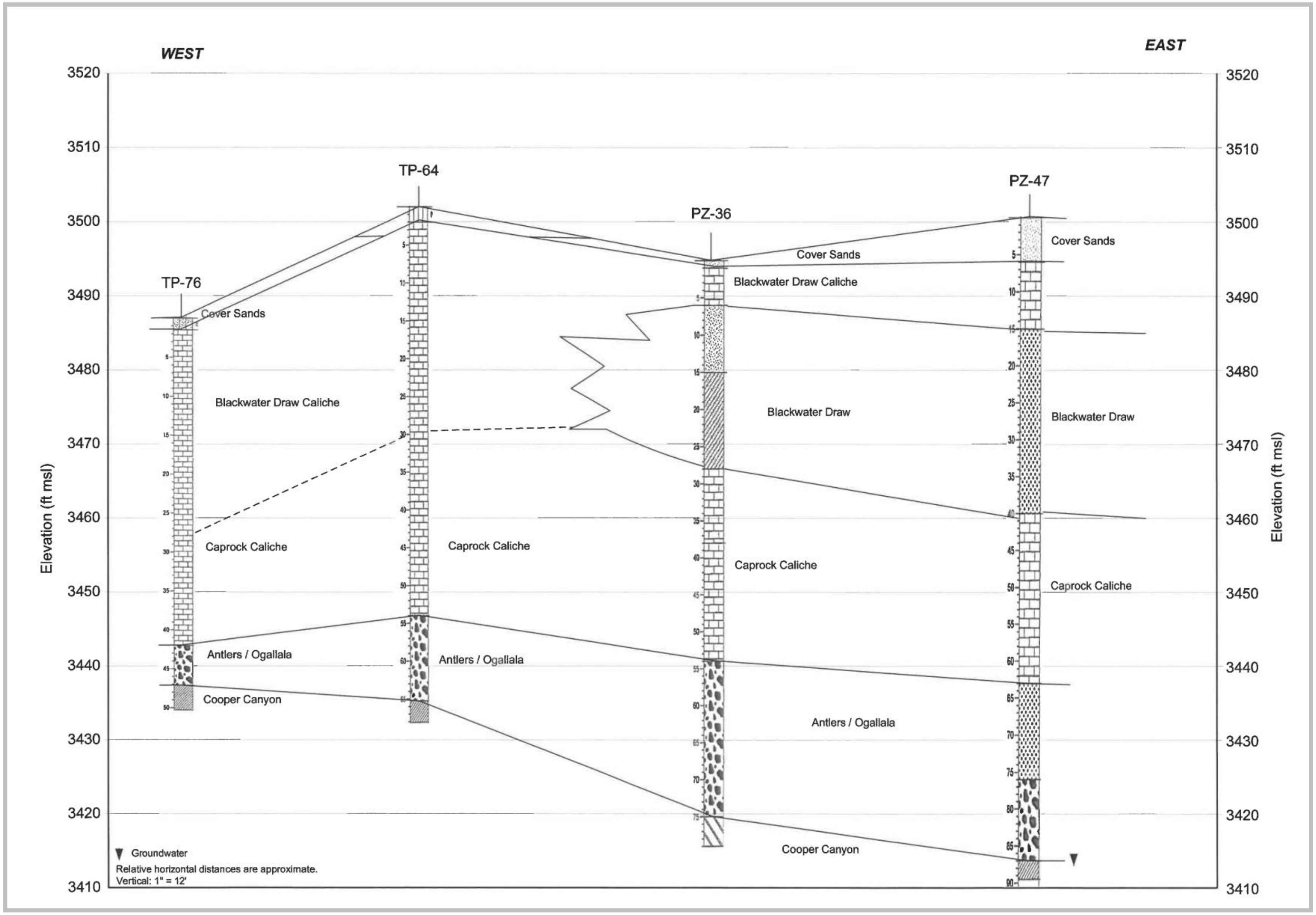


Figure 2-16
WCS CISF Cross Section West-East

All Indicated Changes are in response to RAI WR-8

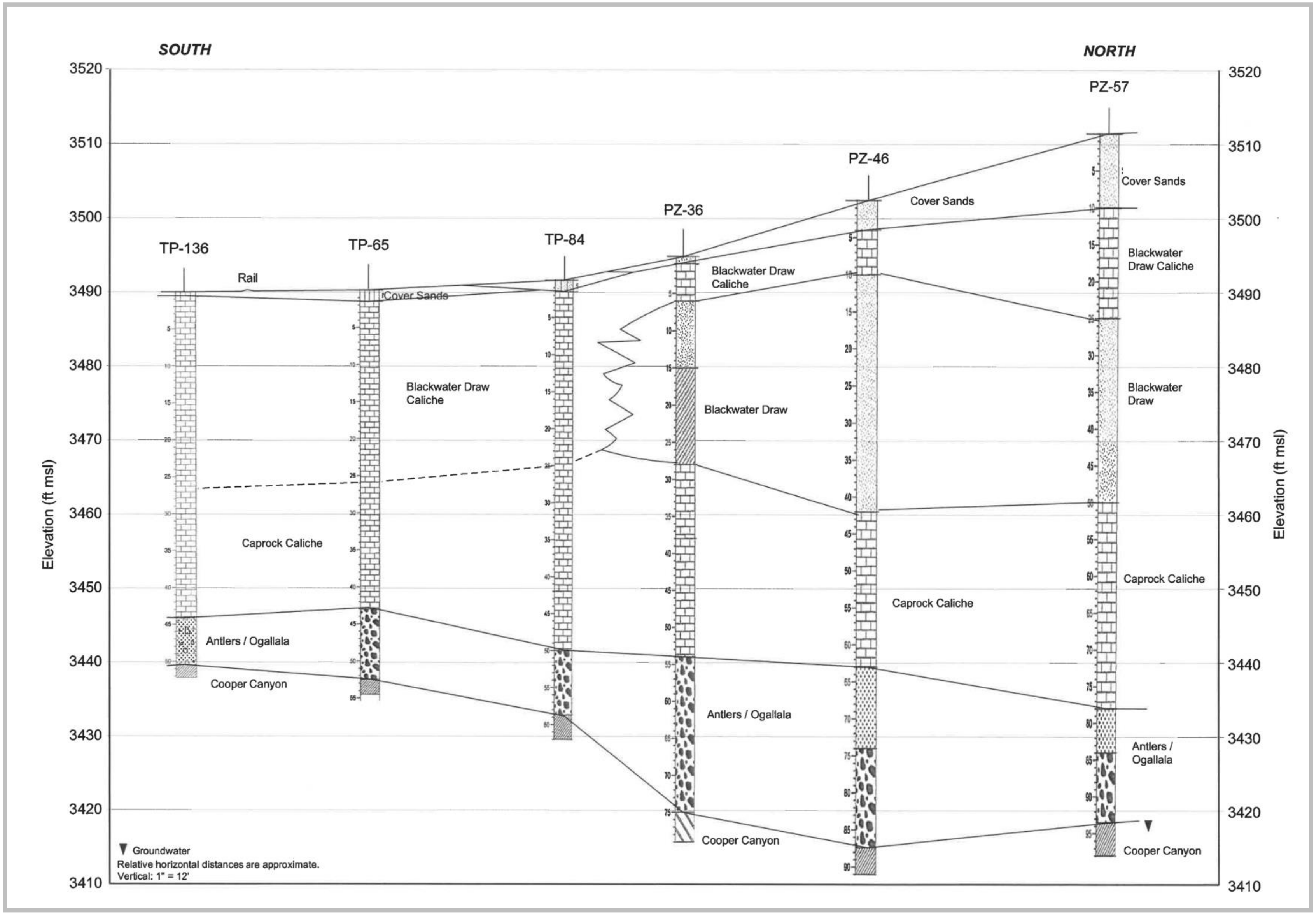


Figure 2-17
WCS CISF Cross Section South-North

Attachment B

Flood Plain Report

(*1053* pages)

Attachment B revised in response to RAI WR-4

COOK-JOYCE INC.
ENGINEERING AND CONSULTING
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CENTRALIZED INTERIM STORAGE FACILITY DRAINAGE EVALUATION AND FLOODPLAIN ANALYSIS

MARCH 2016
REVISED NOVEMBER 2016
REVISED DECEMBER 2016
REVISED FEBRUARY 2019
REVISED OCTOBER 2019

Prepared for:

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Andrews, Texas 78714

Prepared by:

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812 West 11th Street, Suite 205
Austin, Texas 78701

This report is issued for permitting or licensing purposes. It is not intended for bidding or construction purposes.

STATE OF TEXAS
DIANA G. DWORACZYK
63724
REGISTERED
PROFESSIONAL ENGINEER

Diana Dworaczyk P.E. No. 63724
10 October 2019

EXECUTIVE SUMMARY:

In the process of updating this report to incorporate the revisions to the proposed CISF railroad a new version of the U.S. Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) has become available. HEC-HMS, version 4.3 is used in this repot and Drainage Areas and parameters that were not revised due to the railroad revision were rerun and produced slightly higher peak flow rates in some scenarios.

These results amount to rounding errors to the peak flows and did not change the resulting elevations of the floodplain in the playa.

No changes to runoff volumes or peak water surface elevations from unchanged drainage areas were simulated using the HEC-HMS, version 4.3.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ADDENDA

1.0 INTRODUCTION

This report presents the results of a hydrologic and hydraulic analysis of the proposed conditions in and around the area of the Centralized Interim Storage Facility (CISF) proposed to be licensed by the Nuclear Regulatory Commission at the Waste Control Specialists, LLC (WCS) site located in Andrews County, Texas. This report is prepared in support of the Safety Analysis Report (SAR) as described at 10 CFR 72.24 and addresses items contained in the "Standard Review Plan for Spent Fuel Dry Storage Facilities", NUREG-1567, dated March 2000, Section 2.4.4 Surface Hydrology.

1.1 HYDROLOGIC DESCRIPTION

The CISF site is located in western Andrews County, Texas nearly at the Texas – New Mexico border, just north of Texas Highway 176 approximately 31 miles west of Andrews, Texas and 5 miles east of Eunice, New Mexico. There are no maps of special flood hazard areas for this location published by the Federal Emergency Management Agency (FEMA). The Site Location and Surrounding Topography Map, Figure 1.1-1, shows the CISF site location with respect to the surrounding topography and drainage features and the WCS property boundary.

1.1.1 Hydrosphere

From a surface water perspective, the general area is characterized by ephemeral drainages, sheet flow, minor gullies and rills, internally-drained playas, and a salt lake basin (identified on Figure 1.1-1 as the Depression Pond). The salt lake basin is the only naturally-occurring, perennial (year-round) water body located near the CISF site; the internally-drained salt lake basin is located approximately 5 miles from the eastern boundary of the CISF site and rarely has more than a few inches of water at scattered locations within the bottom footprint. Surface drainage from the CISF site does not flow into this basin. Other perennial surface water features are man-made, including various stock tanks (often replenished by shallow windmill wells) located across the area and the feature denoted as the Fish Pond on Figure 1.1-1, which is located at the existing Permian Basin Materials quarry west of the CISF site and is also replenished by well water. In addition, Sundance Services, LLC operates the Parabo Disposal Facility for oil and gas waste on portions of the Permian Basin Materials quarry property. Water collects periodically in excavated and/or diked areas at this disposal facility and in the active quarry areas at this property adjacent to and west of the WCS property in New Mexico.

Baker Spring, another man-made feature, is located at a historic quarry on WCS property about 2,150 ft west of the CISF site in Lea County, New Mexico. This feature was formed by excavation of the caliche caprock to the top of the underlying red bed clays. After periods of rainfall, the depression holds water for some period until it evaporates. During wet cycles, the depression may hold water for an extended period; during dry cycles, the depression may be dry for extended periods.

The National Oceanic and Atmospheric Administration's National Weather Service Office for Hobbs, New Mexico indicates that the minimum average annual precipitation recorded is 2.01 inches in 2011 and the maximum average annual precipitation recorded is 32.19 inches in 1941. The annual precipitation on average is approximately 14 inches.

The CISF site is located on the southwest-facing slope that transitions from the Southern High Plains to the Pecos Valley physiographic section. The Southern High Plains is an elevated area of undulating plains with low relief encompassing a large area of west Texas and eastern New Mexico. In Andrews County, the southwestern boundary of the Southern High Plains is poorly defined, but in this report is considered to be where the caprock caliche is at or relatively close to surface, such as on and near the CISF site.

The main surface water drainage in the area is Monument Draw, an ephemeral stream about 3 miles west of the WCS site in New Mexico. Ephemeral streams or drainage ways flow briefly only in direct response to precipitation in the immediate locality. Monument Draw is a reasonably well-defined, southward-draining feature (although not through-going) that is identified on the USGS topographic maps that serve as the base map source for Figure 1.1-1.

An ephemeral drainage feature, referred to as the Ranch House Draw crosses the WCS property from east to west, generally to the south of the CISF site, as shown on Figure 1.1-1. This feature is discernible from the topographic relief depicted on Figure 1.1-1, although it is much less pronounced than Monument Draw. This drainage feature is a relict drainage way that is choked with windblown sand and is not through-going to Monument Draw. Most of the drainage from the area of the CISF site is down slope toward the Ranch House Draw, with a small portion of the drainage from this area toward the southwest. Surface water eventually infiltrates into the windblown sands and dune fields to the south and southwest of the CISF site.

There are no ephemeral drainages that cross the CISF site. Most of the immediate area of the CISF site is drained from northwest to southeast by sheet flow. Sheet flow is a term describing overland flow or down slope movement of water taking the form of a thin, continuous film.

Playas, or small, internally-drained basins, occur on the WCS property. The playas are dry most of the time. Some of the playas occasionally hold water after relatively large precipitation events; however, the ponded water rapidly dissipates through infiltration, evaporation, and plant uptake. An established playa basin is present on the eastern edge of the CISF site. Surface topography maps indicate approximately 10 ft of relief in the playa.

The combination of low annual precipitation, relatively high potential evapotranspiration, permeable surficial soils down gradient of the CISF site, and topographic relief results in well-drained conditions. The engineering design and construction of the CISF site will eliminate areas that might promote ponding. Diversion berms and a collection ditch will direct stormwater from upstream drainage areas around the CISF.

There are no public or private surface water drinking-water supplies in the site vicinity. Potable water supply for the WCS facility is provided by the City of Eunice, which gets its water from wells in the Hobbs area. There are scattered windmills in the general area that take water from isolated pockets of groundwater perched on top of the red bed clay. This water is utilized primarily for livestock watering.

1.1.2 Site and Structures

The CISF site is defined as the area within the owner controlled fence and is approximately 320 acres as depicted on the Developed Drainage Plan, Figure 1.1.2-1. The CISF site is undeveloped and the existing land surface is fairly flat with an average slope of 0.8 percent (%). The existing maximum and minimum elevations of the site are about 3520 ft and 3482 ft msl, respectively. The cover type is desert shrub. The existing WCS railroad is generally aligned parallel with and south of the proposed southern CISF site boundary.

The CISF storage area, which is within the CISF site, is defined as the area within the protected area fence whose boundary is defined by a rectangle 2360 feet by 2430 feet, as indicated on the Developed Drainage Plan, Figure 1.1.2-1. Included in the storage area are the security/administration building, the cask handling building, the storage pads and a portion of the

CISF rail side track. The CISF storage area is approximately 132 acres and is graded for surface drainage with slopes of approximately 0.8 % from the northwest to the southeast. Developed elevations across the CISF storage area range from 3506 ft msl at the northwest corner to 3486 ft msl near the southeast corner.

All of the surface water runoff from the storage area will drain into the large playa southeast of the site. Flow arrows on Figure 1.1.2-2, Developed Drainage Area Map provide the detailed drainage patterns for the CISF site.

2.0 FLOODS

There is no evidence that the CISF site area has experienced flooding in the past. The ranch house drainage within the WCS property was evaluated as part of a Flood Plain Study conducted in February 2004 (Revised December 2004 and March 2006) for the Application for License to Authorize New-Surface Land Disposal of Low-Level Radioactive Waste (LLRW) that was approved by the Texas Commission on Environmental Quality (TCEQ) in 2009 as Radioactive Material License No. R04100. The 2004 Flood Plain Study as revised through March 2006 is provided as Appendix A and includes maps depicting the drainage areas within the WCS property and the location of the 100-year, 500-year and Probable Maximum Precipitation (PMP) flood plain. The 100-year flood plain extends across the southern portion of the WCS property area along the ranch house drainage. The northernmost limit of the 100-year floodplain is approximately 4,000 ft southeast of the CISF site while the northernmost limits of the 500-year and PMP floodplains are 3965 feet and 3895 feet southeast of the CISF site respectively.

The prior floodplain analysis indicated that the PMP elevation of the large playa located mostly east of the CISF site is 3488 ft msl. A portion of the CISF site is located over the large playa. Elevations of the storage pads, security/administration building, and the cask handling building are above 3490 ft msl.

An analysis of the drainage features around the CISF site is performed for the PMP to ensure that the structures important to safety are safe from flooding.

2.1 FLOOD HISTORY

The climate of the area is classified as semiarid, characterized by dry summers and mild, dry winters. Annual precipitation on average is approximately 14 inches and annual evaporation exceeds annual precipitation by nearly five times. The area is subject to occasionally winter storms, which produce brief snowfall events of short duration.

Rainfall records from July 2009 through December 2015, provided by WCS from a weather station near the CISF site, indicate an average annual rainfall of 12.6 inches and a maximum twenty-four hour rainfall total of 3.62 inches. According to WCS personnel, surface water runoff has not overflowed roads or existing drainage features at the WCS facility during this time frame.

2.2 FLOODPLAIN ANALYSIS DEVELOPED CONDITIONS

This analysis identifies the limits of the watershed in which the CISF site is proposed to be located and determines the local peak flow rates and water elevations at the watershed analysis points resulting from the 100-year and 500-year frequency storm events and the Probable Maximum Precipitation event (PMP) after the CISF site is fully developed. This analysis also identifies the location of the local PMP floodplain associated with a large playa/depression located within the subject watershed.

2.2.1 Description of Watershed

The contributing watershed that crosses the CISF site contains about 869 acres (1.4 square miles). For the most part, the CISF site is located on top of a hill and will be graded to allow drainage away from the site. Fully developed conditions result in four distinct drainage areas that predominantly slope away from the CISF site. The Developed Drainage Area Map, Figure 1.1.2-2, identifies the developed drainage area boundaries in relation to the CISF site and the associated analysis points described below.

Drainage Area P DA 1 contains 101.5 acres and drains the northwest portion of the site outside of the storage area. Analysis Point P AP 1 is located where surface water runoff from P DA 1 flows across State Line Road. Drainage Area P DA 2A contains 25.8 acres and drains the southwest portion of the CISF site contained between the existing WCS railroad and State Line Road outside of the storage area. Analysis Point P AP 2A is located at the intersection of State Line Road and the existing WCS railroad. Drainage Area P DA 2B contains 9.6 acres and drains the southwest portion of the CISF site towards State Line Road. Analysis Point P AP 2B is located where surface water from PD A 2B flows across State Line Road. Drainage Area P DA 3 contains 42.8 acres and drains the southeast portion of the CISF site bounded by the existing WCS railroad and the CISF rail side track. Surface water runoff from P DA 3 discharges into the large playa located east of the facility. Drainage Area P DA 4 contains 679.3 acres encompassing the large playa and the majority of the CISF site; surface water from this portion of the CISF site also discharges into the large playa. Analysis Point P AP 3 refers to the location where surface water runoff in the large playa will overtop the existing ground to the south.

The watershed is located in Andrews County, Texas. The *Custom Soil Resource Report for Andrews County, Texas, and Lea County, New Mexico*, prepared by the United States

Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), located in Appendix B, shows the watershed contains soils from the Blakeney and Conger, Jalmar-Penwell, Ratliff, and Triomas and Wickett series. These soils are classified with the hydrologic groups A, B and D. Group A soils have high infiltration and transmission rates. Group B soils have moderate infiltration and transmission rates. Group D soils have very low infiltration and transmission rates. The Soils Boundary Map with the CISF site location, topographic information and drainage area boundaries is included as Figure 2.2.1-1.

2.2.2 Description of Hydrologic Analysis Methodology

Surface water runoff from the watershed in which the CISF site is located is modeled using the U.S. Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), version 4.3. The rainfall amount for the 100-year frequency storm event is taken from the *USDA Soil Conservation Service (SCS) Texas Engineering Technical Note No. 210-18-TX5, October 1990 (TETN 210).* A 24-hour storm duration is used. The 100-year 24-hour rainfall amount from *TETN 210* for the CISF site is six (6) inches and is the same rainfall amount used in the floodplain study in Appendix A. The 500-year, 24-hour and PMP, 72-hour rainfall amounts are taken from the floodplain study in Appendix A and are 8.71 inches and 40.5 inches, respectively. The precipitation amounts used as input for the HEC-HMS model are as follows:

Return Period	Rainfall (In.)
100-Year, 24 Hour	6.0
500-Year, 24 Hour	8.71
PMP, 72 Hour	40.5

Peak discharges from small watersheds are usually caused by intense, brief rainfalls. Utilizing synthetic rainfall distribution as taken from *TETN 210* in this case is common practice instead of using actual storm events. The synthetic Type II, 24-hour rainfall distribution for Andrews County, Texas, as shown on Figure 1 of *TETN 210,* and the SCS dimensionless unit hydrograph method are used for the model. The method requires curve numbers to indicate the runoff potential of a hydrologic soil-cover complex and watershed lag to model watershed response. The development of these values is described in the following paragraphs.

The curve number (CN) is computed based on land use, cover type, hydrologic condition and soil group. A December 16, 2015 site visit supported determination of land use, cover types and hydrologic condition. Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff. The hydrologic condition of the cover at the site is considered poor. The soil group information is taken from the Soil Report in Appendix B. The variability of the CN from rainfall intensity and duration, total rainfall, soil moisture conditions, cover density, stage of growth, and temperature are collectively accounted for in the Antecedent Runoff Condition (ARC). The three classes of ARC are as follows: I for dry conditions, II for average conditions, and III for wetter conditions. Figure 5 of *TETN 210* indicates that the ARC across the state of Texas varies greatly and Andrews County is ARC I. In order to be conservative and check the sensitivity of the model to the various ARC conditions, all three classes are used in the CN determinations and the model.

The *USDA NRCS, Part 630 Hydrology, National Engineering Handbook (NEH*) explains that lag is the delay between the time runoff from a rainfall event over a watershed begins until runoff reaches its maximum peak. Lag is empirically estimated as six-tenths (0.6) of the time of concentration, (USDA NRCS, Part 630, NEH, Equation 15-3). The time of concentration is the time it takes for runoff to travel from the hydraulically most remote part of a watershed to a point of consideration. In hydrograph analysis it represents the time from the end of “excess rainfall” to the point of inflection of an SCS unit hydrograph.

Time of concentration is computed by determining the travel times for different segments of the flow path. The segments consist of sheet flow, shallow concentrated flow and concentrated flow. The sheet flow and shallow concentrated flow components are calculated for all of the drainage areas using the equations from USDA SCS *Technical Release 55*, *Urban Hydrology for Small Watersheds*. Drainage Area P DA 1, as shown on Figure 1.1.2-2, also exhibits channelized flow. Broad channelized flow occurs in P DA 1 as the surface water flows southwest out of the CISF site and crosses State Line Road. Concentrated flow is calculated based on the flow velocity for the channel being analyzed. Channel velocities are calculated using Manning’s Equation or they are estimated based on the results of the HEC-HMS model. All time of concentration parameters for the various drainage areas are included in Appendix C, Calculations.

Elevation, storage and cross-section data are developed for P DA 2A, P DA 3 and the playa/depression located within the subject watershed to determine their effect on the runoff from these areas and are included in Appendix C. All watershed parameters that are topography dependent are based on the WCS provided aerial survey dated May 29, 2014 flown by Dallas Aerial Surveys, Inc and the WCS provided proposed CISF elevations.

2.2.3 Site Drainage and Model Strategy

The CISF site drainage features consist of a collection ditch and three culverts through the CISF rail side track that are located as shown on the Developed Drainage Plan, Figure 1.1.2-1. The design criterion for the site drainage features are the 100-Year, 24 Hour, ARC I, peak flow rates as determined by HEC-HMS. Whenever possible, surface water runoff will be maintained as sheet flow. Conservative input parameters and strategies are used in the HEC-HMS modeling of the peak flow rates.

2.2.3.1 Site Drainage

Surface water runoff from the up gradient area north of the storage area will be diverted by a collection ditch located just north of the protected area fence as shown on Figure 1.1.2-1. Onsite surface water runoff will be mainly sheet flow off of the sloped storage pads and the sloped areas in between the pads. The land surface adjacent to the eastern and western perimeters of the storage pads will be sloped to drain as sheet flow toward the protected area fence and beyond through the owner controlled area fence. Surface water runoff between the collection ditch and the northern storage pads within the storage area will sheet flow to the southeast. Surface water runoff south of Phase 1 storage pad will drain southeast into Culvert 1 under the CISF rail side track just west of the cask handling building. Surface water runoff south of the Phase 5 storage pad and the CISF rail side track will sheet flow to the east.

The cask handling building roof drains half to the north and half to the south. The western portion of the area between the CISF rail side track and the existing railroad outside of the storage area will drain to the west with some of the surface water runoff flowing through the existing culvert under the WCS railroad crossing at State Line Road into existing surroundings. The eastern portion of the area between the CISF rail side track and existing railroad will drain to the east and empty into the large playa through Culverts 2 and 3.

2.2.3.2 Model Strategy

Conservative parameters are input into the HEC-HMS model to determine peak runoff rates and overflow elevations. Conservative assumptions include the following: (1) all areas inside the storage area are assumed to be impervious for the CN calculation; (2) all three ARC conditions are used for the CN calculation even though Andrews County exhibits ARC I conditions; (3) no consideration is given to initial losses or infiltration rates of the precipitation; (4) all culverts are presumed clogged and do not allow any flow through them; and (5) the collection ditch and berms are not in place in order to model the greatest possible area contributing runoff into the playa. Surface water runoff at the clogged culverts in P DA 2A and P DA 3 and at the outflow of the large playa are modeled as reservoir elements in HEC-HMS. To stimulate flow out of these areas the non-level dam top routine is used with a discharge coefficient of 2.6. The probable maximum flood (PMF) flow is modeled over the existing railroad and the proposed CISF rail side track.

3.0 SUMMARY OF RESULTS

The Developed Drainage Area Map, Figure 1.1.2-2 delineates the subject watershed including drainage areas and analysis points. The 100-year, 500-year, and PMP peak discharges for each drainage area and ARC condition as determined by the HEC-HMS model are shown in Table 1, Post-Development Drainage Areas – Peak Flow. The 100-year, 500-year, and PMP runoff volumes for each drainage area and ARC condition as determined by the HEC-HMS model are shown in Table 2, Post-Development Drainage Areas – Runoff Volumes.

The 100-year, 500-year, and PMP water surface elevations at analysis points for every ARC condition are shown in Table 3, Post-Development Analysis Points - Peak Elevation.

At Analysis Point 1, the peak discharge resulting from all modeled storm events flows over State Line Road. The peak discharge (during the 500-yearand ARC III conditions) is 445 cubic feet per second (CFS). The maximum depth of flow over the road (during the 500-year and ARC III conditions) is approximately 0.8 ft. which is equivalent to elevation 3487.3 ft. msl.

The peak discharge resulting from all modeled storm events flows over State Line Road at Analysis Point 2A. The peak discharge (during the 500-year and ARC III conditions) is 188 CFS. The maximum depth of water over the road (during the 500-year and ARC III) is approximately 2.0 ft. which is equivalent to elevation 3486.0 ft. msl.

The playa/depression contains all the runoff from drainage areas P DA 3 and P DA 4. The limit of the PMP, ARC III condition, water surface elevation of the playa/depression based on the topographic information provided by WCS is 3488.9 ft. msl and is shown on Figure 1.1.2-2, Developed Drainage Area Map. The results indicate that the playa/depression does not discharge during the 100-year frequency event but does discharge at Analysis Point 3 during the other modeled events. The peak discharge (during the PMP and ARC III conditions) flowing out of the playa is 3005 CFS. The depth of the PMP, ARC III, peak discharge flow over the railroad tracks at Analysis Point 3 is approximately 1.5 ft. which is equivalent to elevation 3488.9 ft. msl.

4.0 CONCLUSIONS

The local PMP floodplain analysis yields the PMF elevation near the CISF site of 3488.9 ft msl. Elevations of the storage pads vary from 3490 ft msl to 3504 ft msl. Elevations of the foundations of the security/administration building and the cask handling building are 3496 ft msl and 3493 ft msl, respectively.

5.0 OTHER CONSIDERATIONS

The naturally occurring playa/depression will reach its maximum elevation for a brief time as the surface water flows out over the rail and the natural ground and infiltrates into the existing ground. At the peak elevation the area of the water surface in the playa/ depression is approximately 280 acres which is too small to produce any wind wave activity.

No PMP analysis of perennial streams or rivers is considered since they do not exist in the vicinity of the CISF site.

There are no dams on any upgradient areas from the site; therefore, no analysis is required.

Since no large bodies of water exist near the site, no surge, seiche, or ice flooding is possible.

The site is located 480 miles from the Gulf of Mexico, which is the nearest coastal area; therefore, no tsunami sea waves are possible.

There are no liquid releases that result from the normal operation of the CISF.

The local short-term overland flow depth of surface water runoff and velocity on the CISF Phase 1 pad for the 500-year rainfall event are calculated using Manning's Equation. The maximum rainfall intensity for all analyzed storms is used which is the 500-year rainfall event and is taken from the HEC-HMS output. Calculations are found in Appendix C and the results are as follows:

Maximum depth: 1.1 inches

Maximum velocity: 1.7 feet/second

Berms and ditches upgradient of the storage area will be constructed of on-site available compacted red bed clay and armored with on-site available caliche in order to minimize erosion and seepage. Inspection of the berms for erosion and ditches for sediment buildup will be part of the routine inspection operations for the site. Areas of the site impacted by erosion and sediment buildup will be repaired to original grades. Inspection and maintenance will occur after normal and extreme precipitation events and through all phases of the facility.

6.0 REFERENCES

Waste Control Specialists LLC, Application for License to Authorize Near-Surface Land Disposal of Low-Level Radioactive Waste, Appendix 2.4.1: Flood Plain Study, March 2006.

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United States Department of Agriculture, Soil Conservation Service. *Texas Engineering Technical Note No. 210-18-TX5*, October 1990 (TETN 210).

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United States Department of Agriculture, Natural Resources Conservation Service Technical Release 55. June 1986. Urban Hydrology for Small Watersheds.

United States Army Corps of Engineers, Hydrologic Engineering Center, Hydrologic Modeling System, version 4.3

TABLES

TABLE 1
WCS - CISF FLOOD ANALYSIS
POST-DEVELOPMENT DRAINAGE AREAS - PEAK FLOW

ARC I

Drainage Area	100 YR Peak Flow (CFS)	500 YR Peak Flow (CFS)	PMP Peak Flow (CFS)
P DA 1	119.4	247.7	413.3
P DA 2A	84.0	145.1	106.4
P DA 2B	37.1	65.5	39.8
P DA 3	127.9	218.8	178.4
P DA 4	806.1	1527.6	2787.0

ARC II

Drainage Area	100 YR Peak Flow (CFS)	500 YR Peak Flow (CFS)	PMP Peak Flow (CFS)
P DA 1	225.5	376.6	424.2
P DA 2A	115.4	177.1	107.3
P DA 2B	53.0	82.5	40.2
P DA 3	174.3	266.1	179.8
P DA 4	1327.9	2120.0	2839.4

ARC III

Drainage Area	100 YR Peak Flow (CFS)	500 YR Peak Flow (CFS)	PMP Peak Flow (CFS)
P DA 1	294.7	444.8	426.9
P DA 2A	127.5	187.5	107.5
P DA 2B	59.9	88.5	40.3
P DA 3	191.6	280.7	180.1
P DA 4	1579.3	2353.7	2849.7

TABLE 2
WCS - CISF FLOOD ANALYSIS
POST-DEVELOPMENT DRAINAGE AREAS - RUNOFF VOLUMES

ARC I

Drainage Area	100 YR Runoff Volume (IN)	500 YR Runoff Volume (IN)	PMP Runoff Volume (IN)
P DA 1	2.09	4.11	33.97
P DA 2A	3.28	5.69	36.76
P DA 2B	2.99	5.32	36.18
P DA 3	3.38	5.81	36.94
P DA 4	2.62	4.84	35.35

ARC II

Drainage Area	100 YR Runoff Volume (IN)	500 YR Runoff Volume (IN)	PMP Runoff Volume (IN)
P DA 1	3.68	6.17	37.48
P DA 2A	4.63	7.26	38.91
P DA 2B	4.41	7.02	38.61
P DA 3	4.74	7.38	39.05
P DA 4	4.20	6.78	38.30

ARC III

Drainage Area	100 YR Runoff Volume (IN)	500 YR Runoff Volume (IN)	PMP Runoff Volume (IN)
P DA 1	4.96	7.63	39.34
P DA 2A	5.41	8.11	39.88
P DA 2B	5.30	7.99	39.74
P DA 3	5.53	8.23	40.00
P DA 4	5.18	7.87	39.61

TABLE 3
WCS - CISF FLOOD ANALYSIS
POST-DEVELOPMENT ANALYSIS POINTS - PEAK ELEVATION

ARC I

Analysis Point	100 YR MAX WSE (FT)	500 YR MAX WSE (FT)	PMP MAX WSE (FT)
P AP 1	3486.9	3487.1	3487.2
P AP 2A	3485.5	3485.8	3485.6
P AP 2B	3486.5	3486.5	3486.5
P AP 3	3484.4	3485.8	3488.8

ARC II

Analysis Point	100 YR MAX WSE (FT)	500 YR MAX WSE (FT)	PMP MAX WSE (FT)
P AP 1	3487.0	3487.2	3487.2
P AP 2A	3485.7	3485.9	3485.6
P AP 2B	3486.5	3486.5	3486.5
P AP 3	3485.4	3486.5	3488.9

ARC III

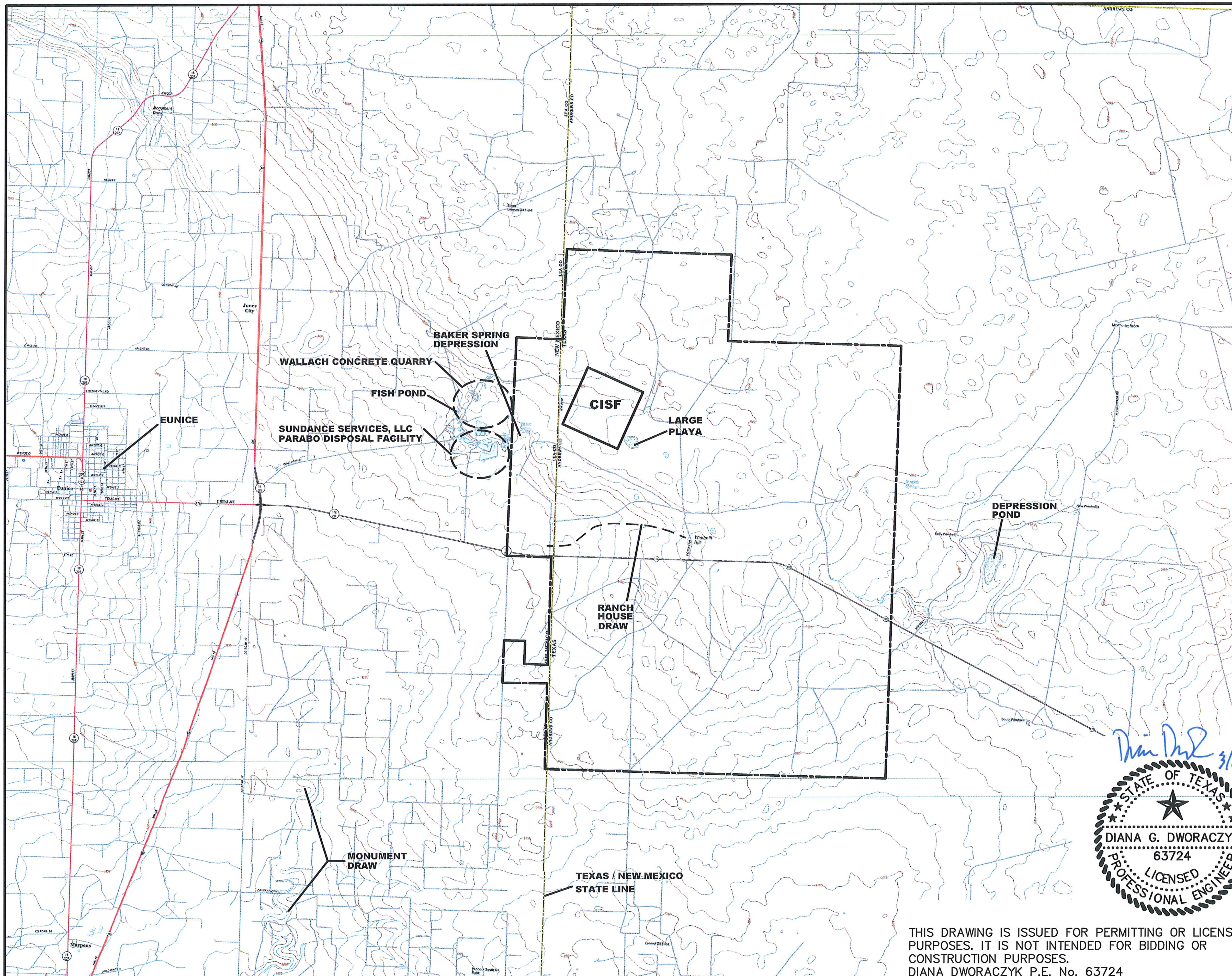
Analysis Point	100 YR MAX WSE (FT)	500 YR MAX WSE (FT)	PMP MAX WSE (FT)
P AP 1	3487.1	3487.3	3487.3
P AP 2A	3485.7	3486.0	3485.6
P AP 2B	3486.5	3486.6	3486.5
P AP 3	3486.0	3486.8	3488.9

NOTES:

1. Water surface elevation (WSE) represent elevation above mean sea level (AMSL).

2. Elevations are taken from topographic aerial survey provided by Dallas Aerial Surveys, Inc., flown 5-29-2014. 10220 Forest Lane, Dallas, Texas 214-349-2190, 800-862-2190, Fax 214-349-2193.

FIGURES



N

6000 3000 0 6000

(SCALE IN FEET)

LEGEND

———	CISF OWNER CONTROLLED FENCE (site)
—·—·—	WCS PROPERTY BOUNDARY

NOTE: CISF LOACTION PROVIDED BY WCS.

BASE MAP SOURCE: WWW.USGS.GOV

USGS 7.5 MIN. TOPOGRAPHIC QUADRANGLE:
EUNICE NE, 2012
FRANKEL CITY SW, 2012
JUMBO HILL, 2012
BRINSON RANCH, 2012
HOBBS SE, 2012
HOBBS SW, 2012
EUNICE, 2012
RATTLESNAKE CANYON, 2012
EUNICE SE, 2012

REV.	DATE	DESCRIPTION	DR BY	APP BY

WCS
THE TEXAS SOLUTION

COOK-JOYCE INC.
ENGINEERING AND CONSULTING
812 WEST ELEVENTH 512-474-9097
AUSTIN, TEXAS 78701
HUB & WBE CERTIFIED
TEXAS REGISTERED ENGINEERING FIRM F-883

PROJECT:
CENTRALIZED INTERIM STORAGE FACILITY
ANDREWS COUNTY, TEXAS

SHEET TITLE:
SITE LOCATION AND SURROUNDING TOPOGRAPHY MAP

DES BY	DD	SCALE: SEE BAR SCALE
DR BY	SDB	PROJECT NO. 15052.01
CHK BY	DD	CJI NO. 15052003
APP BY	DD	SHEET 1 OF 1 SHEETS
DATE ISSUED: 03-08-2016		FIGURE NO. 1.1-1
PURPOSE:		

STATE OF TEXAS
DIANA G. DWORACZYK
63724
LICENSED
PROFESSIONAL ENGINEER

3/08/16

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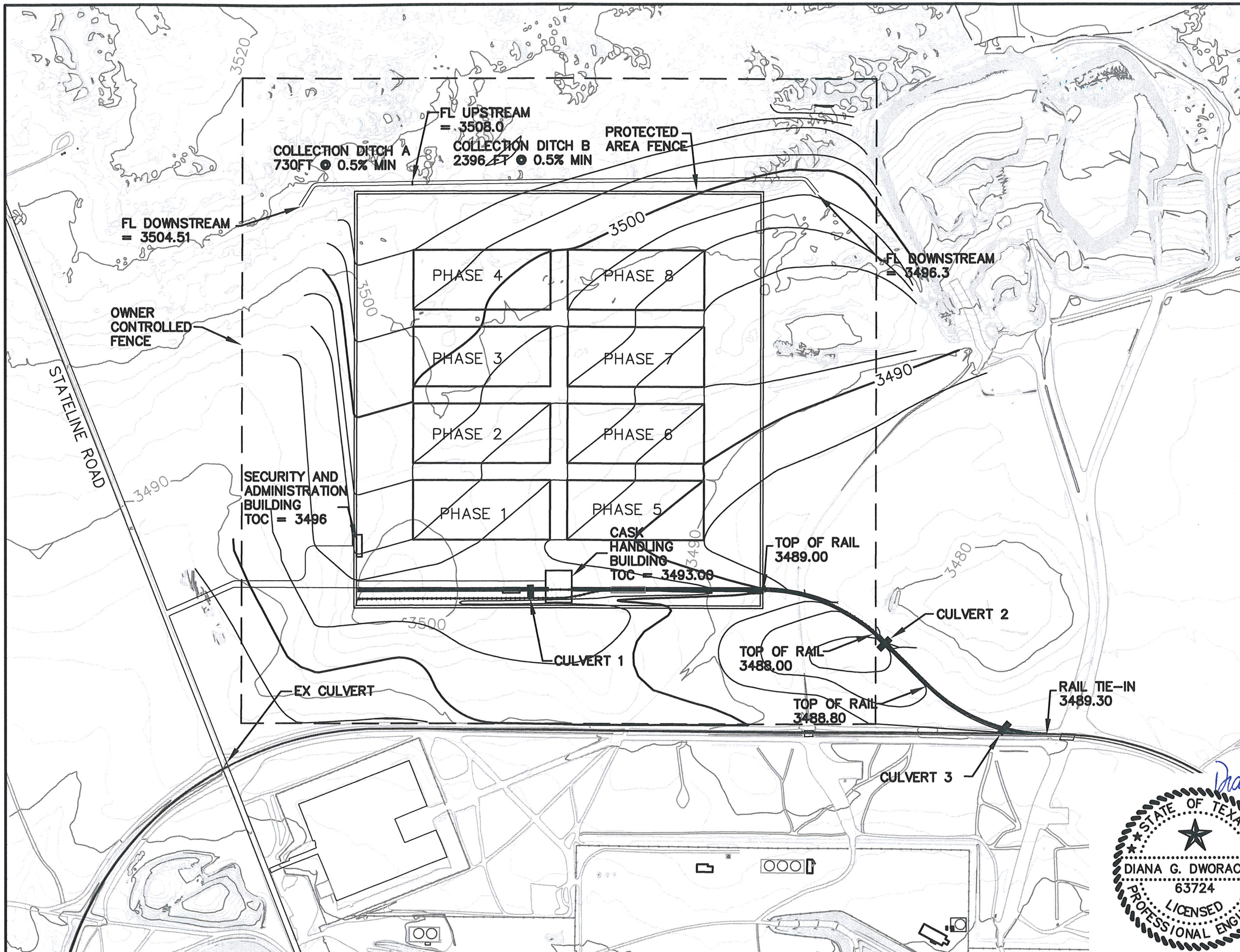
DIANA DWORACZYK P.E. No. 63724

S:\CAD\WCS\15052 CISF Floodplain\15052003 - 1.1-1.dwg, 3/8/2016 3:13:55 PM, 1:1



600 300 0 600

(SCALE IN FEET)

LEGEND

— — —	CISF OWNER CONTROLLED AREA FENCE
	EXISTING MINOR CONTOUR
—3490—	EXISTING MAJOR CONTOUR
———	PROPOSED MINOR CONTOUR
—3490—	PROPOSED MAJOR CONTOUR

NOTES:

1. EXISTING TOPOGRAPHIC INFORMATION WITHIN LIMITS SHOWN PROVIDED BY DALLAS AERIAL SURVEYS, INC., FLOWN 5-29-2014. 10220 FOREST LANE, DALLAS, TEXAS 214-349-2190, 800-862-2190, FAX 214-349-2193.
2. EXISTING TOPOGRAPHIC INFORMATION OUTSIDE OF THE LIMITS SHOWN IS BASED ON A DIGITAL ELEVATION MODEL (DEM) PROVIDED BY THE TEXAS NATURAL RESOURCE INFORMATION SYSTEM (TNRIS).

REV.	DATE	DESCRIPTION	DR BY	APP BY
3	10/19	REVISE RAIL ROAD		
2	01/19	BUILDING NAME		
1	12/16	REVISE PROPOSED CONTOURS		

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HUB & WBE CERTIFIED
TEXAS REGISTERED ENGINEERING FIRM F-883

STATE OF TEXAS
DIANA G. DWORACZYK
63724
LICENSED
PROFESSIONAL ENGINEER
10/10/19

PROJECT:
CENTRALIZED INTERIM STORAGE FACILITY
ANDREWS COUNTY, TEXAS

SHEET TITLE:
DEVELOPED DRAINAGE PLAN

DES BY	AVV	SCALE:	SEE BAR SCALE
DR BY	AVV	PROJECT NO.	15052.01
CHK BY	DD	CJI NO.	15052007R3
APP BY	DD	SHEET	1 OF 1 SHEETS
DATE ISSUED:	02-15-2016	FIGURE NO.	1.1.2-1

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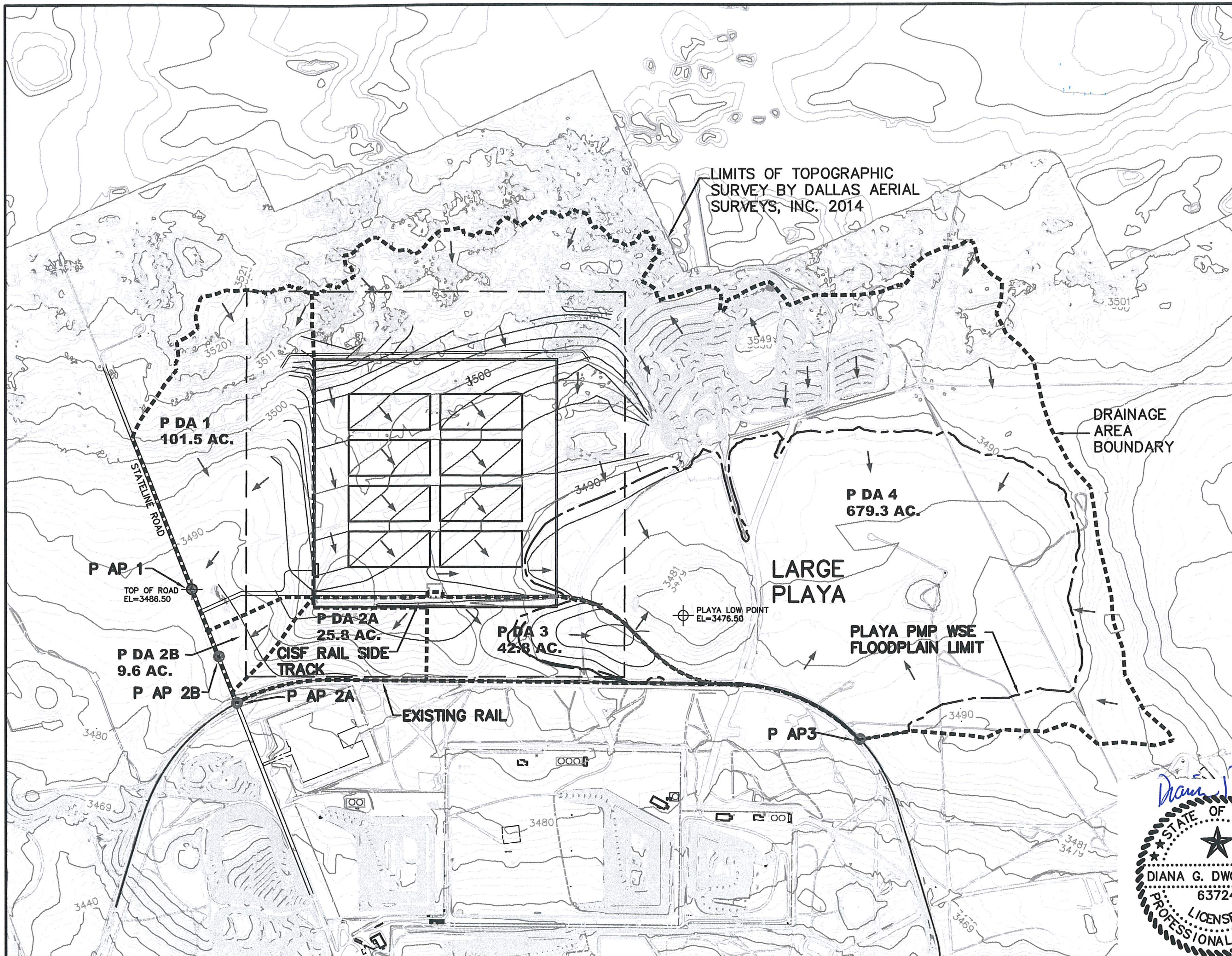

1000 500 0 1000

(SCALE IN FEET)

LEGEND

- DRAINAGE AREA BOUNDARY
- LIMITS OF TOPOGRAPHIC SURVEY BY DALLAS AERIAL SURVEY 5-29-2014
- ANALYSIS POINT
- DIRECTION OF FLOW
- APPROXIMATE PLAYA PMP WSE FLOODPLAIN LIMIT
- CISF OWNER CONTROLLED AREA FENCE
- EXISTING MINOR CONTOUR
- 3490 EXISTING MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 3490 PROPOSED MAJOR CONTOUR

NOTES:

1. EXISTING TOPOGRAPHIC INFORMATION WITHIN LIMITS SHOWN PROVIDED BY DALLAS AERIAL SURVEYS, INC., FLOWN 5-29-2014. 10220 FOREST LANE, DALLAS, TEXAS 214-349-2190, 800-862-2190, FAX 214-349-2193.
2. EXISTING TOPOGRAPHIC INFORMATION OUTSIDE OF THE LIMITS SHOWN IS BASED ON A DIGITAL ELEVATION MODEL (DEM) PROVIDED BY THE TEXAS NATURAL RESOURCE INFORMATION SYSTEM (TNRIS).
3. DEVELOPED DRAINAGE AREAS REPRESENT THE ABSENCE OF PROPOSED BERMS OR DITCHES.

REV.	DATE	DESCRIPTION	DR BY	APP BY
3	10/19	REVISE DRAINAGE AREAS & RAIL ROAD	DD	DD
2	12/16	REMOVE FLOW PATH INFO, REVISE DRAINAGE AREAS, PROPOSED CONTOURS, PLAYA LIMIT	DD	DD
1	11/16	FIX FLOW ARROWS & ADD FLOW PATH INFO	DD	DD

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TEXAS REGISTERED ENGINEERING FIRM F-883

STATE OF TEXAS
DIANA G. DWORACZYK
63724
LICENSED
PROFESSIONAL ENGINEER
10/10/19

PROJECT:
CENTRAL INTERIM STORAGE FACILITY
ANDREWS COUNTY, TEXAS

SHEET TITLE:
DEVELOPED DRAINAGE AREA MAP

DES BY	AVV	SCALE: SEE BAR SCALE	
DR BY	AVV	PROJECT NO. 15052.01	
CHK BY	DD	CJI NO. 15052005R2	
APP BY	DD	SHEET 1 OF 1 SHEETS	
DATE ISSUED: 03-08-2016		FIGURE NO. 1.1.2-2	

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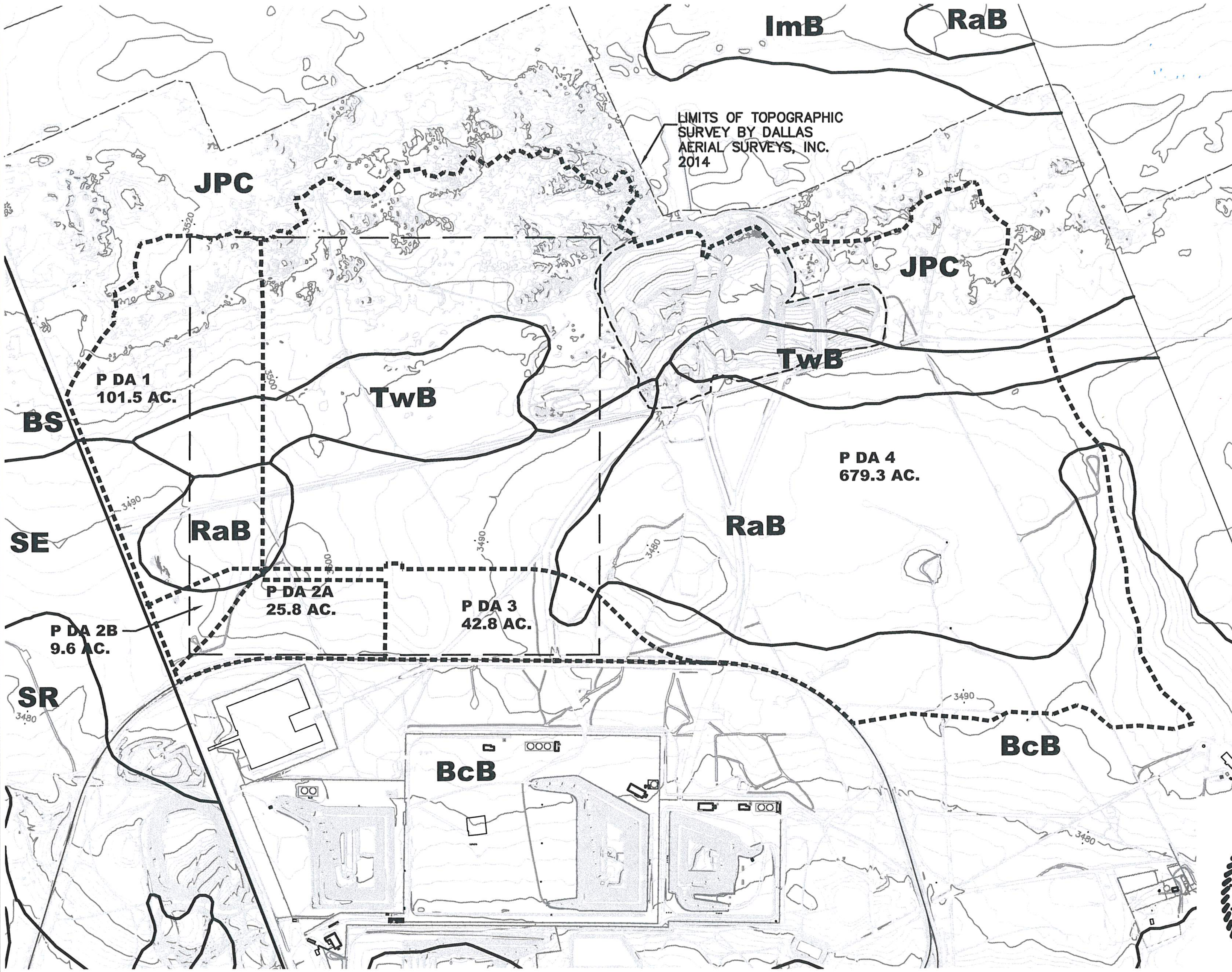

LEGEND

(solid line)	SOILS BOUNDARY
(dash-dot line)	LIMITS OF TOPOGRAPHIC SURVEY BY DALLAS AERIAL SURVEY 5-29-2014
(long dashed line)	CISF OWNER CONTROLLED AREA FENCE
(heavy dotted line)	DRAINAGE BOUNDARY
(short dashed line)	REDBED / CALICHE STOCKPILE AREA

Soils Information

Symbol	Group	Name	County
BcB	D	Blakeney & Conger	Andrews Co, TX
ImB	A	Ima	Andrews Co, TX
JPC	A/B	Jalmar-Penwell	Andrews Co, TX
RaB	B	Ratliff	Andrews Co, TX
TwB	B	Triomas & Wickett	Andrews Co, TX
BS	A/B	Brownfield-Springer	Lea Co, N.M.
SE	D	Simona	Lea Co, N.M.
SR	D	Simona-Upton	Lea Co, N.M.

NOTES:

1. EXISTING TOPOGRAPHIC INFORMATION WITHIN LIMITS SHOWN PROVIDED BY DALLAS AERIAL SURVEYS, INC., FLOWN 5-29-2014. 10220 FOREST LANE, DALLAS, TEXAS 214-349-2190, 800-862-2190, FAX 214-349-2193.
2. EXISTING TOPOGRAPHIC INFORMATION OUTSIDE OF THE LIMITS SHOWN IS BASED ON A DIGITAL ELEVATION MODEL (DEM) PROVIDED BY THE TEXAS NATURAL RESOURCE INFORMATION SYSTEM (TNRIS).
3. SOIL INFORMATION TAKEN FROM US DEPARTMENT OF AGRICULTURE, NATURAL RESOURCES CONSERVATION SERVICE CUSTOM SOIL RESOURCE REPORT FOR ANDREWS COUNTY, TEXAS, AND LEA COUNTY, NEW MEXICO, DATED DECEMBER 22 2015
4. DEVELOPED DRAINAGE AREAS REPRESENT THE ABSENCE OF PROPOSED BERMS OR DITCHES.

REV.	DATE	DESCRIPTION	DR BY	APP BY
2	10/19	REVISE DRAINAGE AREAS	DD	DD
1	12/16	REVISE DRAINAGE AREAS	DD	DD

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STATE OF TEXAS
DIANA G. DWORACZYK
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LICENSED
PROFESSIONAL ENGINEER
10/10/19

PROJECT:
CENTRALIZED INTERIM STORAGE FACILITY
ANDREWS COUNTY, TEXAS

SHEET TITLE:
SOILS BOUNDARY MAP

DES BY	AVV	SCALE:	SEE BAR SCALE
DR BY	AVV	PROJECT NO.	15052.01
CHK BY	DD	CJI NO.	15052006R1
APP BY	DD	SHEET	1 OF 1 SHEETS
DATE ISSUED:	03-08-2016	FIGURE NO.	2.2.1-1

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APPENDICES

APPENDIX A
FLOOD PLAIN STUDY, FEBRUARY 2004

APPENDIX 2.4.1
FLOOD PLAIN STUDY

ATTACHMENT II.F.

FLOOD PLAIN STUDY

FEBRUARY 2004
(REVISED DECEMBER 2004
AND MARCH 2006)

Prepared for:

Waste Control Specialists LLC
Andrews, Texas

Prepared by:

Frederick H. Haas, P.E.
812 West Eleventh Street
Austin, Texas 78701

STATE OF TEXAS
FREDERICK H. HAAS
55490
REGISTERED

3/31/06

This document is issued for interim review purposes only.

Frederick H. Haas, P.E., No. 55490

TABLE OF CONTENTS

LIST OF TABLES

TABLE

LIST OF TABLES - continued

TABLE

LIST OF FIGURES

FIGURE

LIST OF APPENDICES

LIST OF APPENDICES - continued

1.0 INTRODUCTION

The following report presents the results of a hydrologic and hydraulic analysis for Waste Control Specialist LLC (WCS) Andrews County, Texas Facility. This report is prepared in support of the licensing and permitting activities at the WCS facility. In accordance with applicable requirements, this analysis identifies the location of the 100-year floodplain to determine its location with respect to the facility. There are no maps of special flood hazard areas for this location published by the Federal Emergency Management Agency (FEMA).This analysis also identifies the location of the floodplain resulting from the 500-year frequency storm event and the Probable Maximum Precipitation (PMP).

This report includes the following items.

- Description of watershed
- Description of hydrologic analysis
- Description of hydraulic analysis
- Summary of Results

2.0 DESCRIPTION OF WATERSHED

There is a draw that crosses the southern portion of the facility. This draw crosses the facility north of the RCRA permit boundary and south of the process area. The draw flows from east to west across the facility. The draw crosses under the access road west of the facility through six (6) - 29 inches by 18 inches corrugated metal pipe-arch culverts. The draw continues south and west downstream and crosses under State Highway 176 through two (2) - 43 inches by 27 inches corrugated metal pipe-arch culverts. After crossing the state highway the draw continues to the west and south downstream and ultimately drains into Monument Draw.

The contributing watershed to the draw that crosses the facility contains about 1350 acres (2.1 square miles). This contributing watershed is divided into six (6) sub areas (Drainage Areas 1A, 1B, 3, 4, 5A, & 5B) to model the runoff into the draw within the facility. There is another drainage area (Drainage Area 6) downstream of the access road that contributes runoff to the reach of the draw between the access road and the state highway. There is also a drainage area (Drainage Area 7) adjacent to State Highway 176 that crosses the access road through an 18 inches diameter corrugated metal pipe. This area contributes runoff to the two (2) - 43 inches by 27 inches corrugated metal pipe-arch culverts under State Highway 176.

There is a playa/depression in the area near the northeast corner of the facility. The contributing watershed (Drainage Area 2) that drains into this depression contains about 680 acres (1.1 square miles). This watershed was modeled to determine if the runoff is contained within the depression or if there is an overflow that contributes runoff to the draw that crosses the facility. The results indicate that Drainage Area 2 does not discharge from the playa/depression during the 100 and 500-year frequency storm events.

The Drainage Area Map is included as Figure II.F.1.

The watershed is characterized by gently rolling terrain with slopes ranging from about one-half percent (0.5%) to about four and a half percent (4.5%). The average slope in the watershed is about one percent (1%). The land is mostly undeveloped except for the facility and the highway. The cover type is desert shrub. The hydrologic condition of the cover ranges from fair in the southern portion of the watershed to poor in the northern portion of the watershed.

The watershed is located in Andrews County. The *Soil Survey of Andrews County Texas*, prepared by the USDA, Soil Conservation Service (SCS) shows the watershed contains soils from the Blakeney, Faskin, Ima, Jalmar, Kimbrough, Ratliff, and Triomas series. These soils are classified with the hydrologic groups A, B and C. Group A soils have high infiltration and transmission rates. Group B soils have moderate infiltration and transmission rates. Group C soils have low infiltration and transmission rates. The soils map is included as Figure II.F.2. Please note that the SCS has changed its name since the publication of this document to the National Resources Conservation Service (NRCS).

3.0 DESCRIPTION OF HYDROLOGIC ANALYSIS

The watershed runoff is modeled using the U.S. Army Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), version 2.2.1. The existing 100-year and 500-year storm events and the PMP are the only conditions modeled.

The rainfall amount for the 100-year frequency storm event is taken from the U.S. Weather Bureau, Technical Paper 40, (TP-40). A 24-hour storm duration is used. The 100-year 24-hour rainfall amount from TP-40 for this facility is six (6) inches. An SCS type II rainfall distribution is used.

The rainfall amount for the 500-year frequency storm event is calculated based on the procedure in *Depth-Duration Frequency of Precipitation for Texas, Water Resources Investigations Report 98-4044,* W.H. Asquith, U.S. Geological Survey, 1998. The General Logistic (GLO) Distribution Equation is used to determine the precipitation depth for the 500-year storm event. The parameter, K, in the GLO distribution is a shape parameter. It is estimated to be between –0.20 and –0.22 for the 24-hour storm event. The shape parameter, K, estimate of –0.20 results in the 500-year 24-hour rainfall amount for this facility of 8.71 inches. The shape parameter, K, estimate of –0.22 results in the 500-year 24-hour rainfall amount for this facility of 9.24 inches. Each of these precipitation amounts is input into the HEC-HMS model. The results of the HEC-HMS model are input into HEC-RAS to determine the sensitivity of the 500-year water surface elevation to the shape parameter, K. The water surface elevations change less than one inch (from 0.48 inches to 0.96 inches). Therefore, the value of the shape parameter, K, does not have a significant impact on the resulting 500-year water surface elevation. Based on the information in the reference, the shape parameter, K, is estimated to be closer to –0.20 than –0.22. A 24-hour storm duration is used. The 500-year 24-hour rainfall amount for this facility is 8.71 inches. An SCS type II rainfall distribution is used. Both the HEC-HMS model results from the sensitivity analysis for the shape parameter, K, are included in Appendix D. Both the HEC-RAS model results from the sensitivity analysis for the shape parameter, K, are included in Appendix F.

The rainfall amount for the Probable Maximum Precipitation (PMP) is calculated based on the procedure in *Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates,* *United States East of the 105th Meridian,* Schreiner and Riedel, National Weather Service. A 72-hour storm duration is used. The rainfall is distributed based on the procedure outlined in *Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates – United States East of the 105th Meridian,* Hansen, Schreiner and Miller, National Weather Service (HMR 52). Two temporal sequences are modeled to determine which distribution produces the greatest runoff. One temporal sequence conforms to Figure 3 from HMR 52 and the other conforms to the example provided in the stepwise procedure Section 7.1.E, HMR 52. The temporal sequence from Figure 3, HMR 52 provides the greatest runoff and the results from that model are included in this report.

The SCS dimensionless unit hydrograph method is used for this model. The method requires curve numbers to indicate the runoff potential of a hydrologic soil-cover complex and watershed lag to model watershed response.

The curve number is computed based on land use, cover type, hydrologic condition and soil group. A dry antecedent moisture condition (AMC I) is used to compute the curve number. The amount of precipitation occurring in the five days preceding the storm in question is an indication of the antecedent moisture condition of the soil. *Texas Engineering Technical Note, Hydrology, No. 210-18-TX5, Estimating Runoff for Conservation Practices*, Figure 1 shows the average condition runoff curve number in West Texas is AMC I. This publication also states that when an adjusted AMC results in a curve number less than 60 then a curve number of 60 will be selected as the minimally applicable number.

The curve number computed for Drainage Area 1A is 62. The curve number computed for Drainage Areas 1B, 2, 3, 4, 5A, 5B, 6 and 7 is 60.

The watershed lag is the time from the center of mass of excess rainfall to the time to peak for an SCS unit hydrograph. Lag is empirically estimated as six-tenths (0.6) of the time of concentration. The time of concentration is the time it takes for runoff to travel from the hydraulically most remote part of a watershed to a point of consideration. In hydrograph analysis it represents the time from the end of excess rainfall to the point of inflection of an SCS unit hydrograph. Time of concentration is computed by determining the travel times for different segments of the flow path. The segments consist of sheet flow, shallow concentrated flow and concentrated flow. The sheet flow and shallow concentrated flow components are calculated using the equations from USDA SCS *Technical Release 55*, *Urban Hydrology for Small Watersheds*. Concentrated flow is calculated based on the flow velocity for the channel. Channel velocities are calculated using Manning's Equation or they are estimated based on the results of the hydraulic model.

The lag time for drainage area 1A is eighty-six (86) minutes. The lag time for drainage area 1B is forty-four (44) minutes. The lag time for drainage area 2 is sixty-five (65) minutes, but does not contribute to the runoff in the draw. The lag time for drainage area 3 is forty-four (44) minutes. The lag time for drainage area 4 is thirty-nine (39) minutes. The lag time for drainage area 5A is thirty-eight (38) minutes. The lag time for drainage area 5B is fifty-three (53) minutes. The lag time for drainage area 6 is thirty (30) minutes. The lag time for drainage area 7 is sixty-four (64) minutes.

Hydrographs are routed through the stream reaches using the Lag model. The Lag model simply translates the hydrograph ordinates by a specified duration. The travel times are estimated using the velocities from the results of the hydraulic model or by calculating the velocity using Manning's Equation. The lag for Reach 1 is thirty-five (35) minutes. The lag for Reach 1A is seventeen (17) minutes. The lag for Reach 1B is three (3) minutes. The lag for Reach 2 is fifteen (15) minutes. The lag for Reach 3 is seventeen (17) minutes. The lag for Reach 4 is twenty-one (21) minutes. The lag for Reach 5 is fourteen (14) minutes. The lag for Reach 6 is zero (0) minutes.

Storage, elevation, and outflow curves are developed for the playa/depression to determine the effect of the storage on the runoff from the area.

Calculations for the parameters used in the HEC-HMS model are included in the Drainage Calculations, Appendix A.

4.0 DESCRIPTION OF HYDRAULIC ANALYSIS

The water surface elevations are determined using the U.S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS), version 3.0.1.

Cross sections for the model are taken from an Aerial Survey Map prepared by Cooper Aerial Surveys Co. This information is supplemented with ground elevations taken from a field survey by West Texas Consultants, Inc. This topographic information is then used to estimate the location of the 100-year, 500-year, and PMP water surfaces through the facility.

The starting station for the model is at the inlet to the culverts under State Highway 176 downstream of the facility. This is about 1700 feet downstream of the access road. Additional sections are located in this downstream reach to determine the sensitivity of the model to the downstream water surface elevation. Different starting water surface elevations are input to determine any impact on the 100-year water surface within the facility. The top of the Highway is greater than elevation 3405 based on information provided for the flow line elevation and the size of the existing culverts. The starting water surface elevations range from 3404.5 to 3407 msl. The water surface elevations within the facility are the same regardless of the starting water surface elevation. The elevation of the 100-year water surface at the RCRA permit line where the floodplain exits the facility (Section 2989) is 3414.32. The elevation of the 500-year water surface at the RCRA permit line is 3414.57. The elevation of the PMP water surface at the RCRA permit line is 3415.54.

The Manning's n value for the draw and overbanks is 0.033 based on an earth channel with minor irregularity and low vegetation. There is no difference in the material or vegetation for the draw or its overbanks. Photographs of six (6) - 29 inches by 18 inches corrugated metal pipe-arch culverts under the access road and a representative section of the draw are included as Figure II.F.3.

Calculations for the parameters used in the HEC-RAS model are included in the Drainage Calculations, Appendix A.

5.0 SUMMARY OF RESULTS

The 100-year peak discharges for each drainage area as determined by the HEC-HMS model are shown in Table II.F.1. The HEC-HMS model for the calculation of the 100-year peak discharges for each drainage area is included in Appendix B.

The 100-year peak discharge at the access road is about 790 cubic feet per second. The playa/depression contains all the runoff from drainage area 2.

The 100-year water surface elevations through the facility as determined by HEC-RAS are shown in Table II.F.2. The HEC-RAS model for the calculation of the water surface profile is included in Appendix C. The limits of the 100-year floodplain based on the topographic information provided and the location of the cross-sections are shown on Figure II.F.4, Floodplain Map.

The 100-year peak discharge flows over the access road at the six (6) - 29 inches by 18 inches corrugated metal pipe-arch culverts. The maximum depth of flow over the road during the 100-year storm event is about one (1) foot.

The 100-year floodplain of the draw is generally characterized as shallow and wide. The maximum depths of flow in the sections through the facility range from less than one half (0.5) of a foot to less than two (2) feet. The average maximum depth in the sections through the facility is about one (1) foot. The width of the floodplain ranges from about one hundred (100) feet to about seven hundred and fifty (750) feet. The average width of the floodplain through the facility is about three hundred and fifty (350) feet. The velocity of flow for the 100-year storm event within the draw through the facility is less than about four (4) feet per second.

The 500-year peak discharges for each drainage area as determined by the HEC-HMS model are shown in Table II.F.3. The HEC-HMS model for the calculation of the 500-year peak discharges for each drainage area is included in Appendix D.

The 500-year water surface elevations through the facility as determined by HEC-RAS are shown in Table II.F.4. The HEC-RAS model for the calculation of the water surface profile is included in Appendix F. The limits of the 500-year floodplain based on the topographic information provided and the location of the cross-sections are shown on Figure II.F.4, Floodplain Map.

The PMP peak discharges for each drainage area as determined by the HEC-HMS model are shown in Table II.F.3. The HEC-HMS model for the calculation of the PMP peak discharges for each drainage area is included in Appendix E.

The PMP water surface elevations through the facility as determined by HEC-RAS are shown in Table II.F.5. The HEC-RAS model for the calculation of the water surface profile is included in Appendix F. The limits of the PMP floodplain based on the topographic information provided and the location of the cross-sections are shown on Figure II.F.4, Floodplain Map.

6.0 IMPACT OF DEVELOPMENT OF THE LOW LEVEL AND BYPRODUCT FACILITY ON THE FLOODPLAIN

There is a temporary diversion ditch (Primary Ditch) north of the Low Level and Byproduct Facility. This ditch intercepts rainfall runoff from the north and directs it around the facility. As a result, a total of about 96 acres of the runoff from drainage areas 4 and 3 are diverted into drainage area 1. The impact of this diversion is modeled as described previously.

Runoff is modeled for the 100-year and 500-year storm events and the PMP using HEC-HMS. These models are changed to reflect the presence of the diversion ditch. It is assumed that all the possible runoff from each storm event is captured and diverted by the ditch. This is a conservative assumption since the maximum amount of runoff diverted will produce the greatest difference in the floodplain (i.e. if the diversion ditch does not convey the runoff then the floodplain remains as calculated previously). Drainage areas, lag times, curve numbers, and routing through stream reaches are adjusted as necessary. The Developed Low Level & Byproduct Facility Drainage Area Map is included as Figure II.F.5. Table II.F.6 summarizes the 100-year peak discharge. Results of the 100-year HEC-HMS model for the Developed Low Level & Byproduct Facility are included in Appendix G. Results of the 500-year HEC-HMS model for the Developed Low Level & Byproduct Facility are included in Appendix I. Results of the PMP HEC-HMS model for the Developed Low Level & Byproduct Facility are included in Appendix J. Table II.F.8 summarizes the 500-year and PMP peak discharges.

Water surface profiles are modeled for the 100-year and 500-year storm events and the PMP using HEC-RAS. The flowrate for these models is changed to reflect the runoff calculated by the HEC-HMS models. Table II.F.7 summarizes the 100-year water surface elevations. The results of the HEC-RAS model for 100-year storm with the Developed Low Level & Byproduct Facility in operation are included in Appendix H. The results of the HEC-RAS model for 500-year storm and PMP with the Developed Low Level & Byproduct Facility in operation are included in Appendix K. Table II.F.9 summarizes the 500-year water surface elevations. Table II.F.10 summarizes the PMP water surface elevations.

The water surface elevation increases by a maximum of less than one inch between sections 9690 and 8130 (about 1600 feet) for the 100-year storm event. The remaining water surface elevations are about the same for the 9700-foot long floodplain reach through the site. The water surface elevation increases by a maximum of less than one and one half inches between sections 9690 and 8130 (about 1600 feet) for the 500-year storm event. The remaining water surface elevations are about the same for the 9700-foot long floodplain reach through the site. The water surface elevation increase ranges from five and four tenths and eight and one half inches between sections 9690 and 7717 (about 2000 feet) for the PMP. The remaining water surface elevations are about the same for the 9700-foot long floodplain reach through the site.

There are no structures in the vicinity of the floodplain that are affected by this minor increase in the water surface elevation that occurs over a small reach of the floodplain. Furthermore, the diversion ditch is temporary. It will direct water around the Low Level and Byproduct Facility during the operation of the facility. The diversion ditch will be filled in and the natural drainage patterns will be restored after the final grades are restored to the facility.

In conclusion, the impact of the diversion of runoff from the north around the Low Level and Byproduct Facility is insignificant in the magnitude of the increase in water surface elevation, limited in length of affected reach, and it is temporary.

7.0 IMPACT OF CHANGES IN ANTECEDENT MOISTURE CONDITION ON THE FLOODPLAIN

The floodplain determined as discussed in Sections 1.0 through 5.0 of this report and depicted on Figure II.F.4, Floodplain Map, is the current floodplain for the draw that crosses the southern portion of the facility. It is also the floodplain for the draw for the foreseeable future assuming there are no improvements to the floodplain. If there are some unforeseen climatic changes that occur in the distant future that also changes the climate of west Texas from semi-arid to tropical or wet, then the antecedent moisture condition of the soil will also change. The antecedent moisture condition of the soil is indicated by the amount of precipitation occurring in the five days preceding the storm in question. As discussed in Section 3, Description of Hydrologic Analysis, AMC I is the average condition runoff curve number in west Texas. Curve numbers based on AMC II and AMC III are modeled to determine the sensitivity of the floodplain to the Antecedent Moisture Condition of the soil. AMC I represents dry conditions, AMC II represents average moisture conditions, and AMC III represents a watershed that is practically saturated from antecedent rains.

The curve numbers for each drainage basin increase as the Antecedent Moisture Condition of the soil becomes wetter. As a result the runoff also increases. This increase in runoff becomes less significant as the magnitude of the storm increases. As the magnitude of the storm increases, the percentage of the direct runoff from rainfall increases so the affect of the curve number decreases.

The increase in water surface elevation for the 100-year storm event from AMC I to AMC II is an average of 0.28 feet (about three inches). This increase ranges from 0.2 feet to 0.36 feet. The increase in water surface elevation for the 100-year storm event from AMC I to AMC III is an average of 0.45 feet (about five inches). This increase ranges from 0.35 feet to 0.55 feet. The increase in water surface elevation for the 500-year storm event from AMC I to AMC II is an average of 0.25 feet (about three inches). This increase ranges from 0.2 feet to 0.31 feet. The increase in water surface elevation for the 500-year storm event from AMC I to AMC III is an average of 0.39 feet (about five inches). This increase ranges from 0.30 feet to 0.47 feet. The increase in water surface elevation for the PMP from AMC I to AMC II is an average of 0.05 feet (less than one inch). This increase ranges from 0.0 feet to 0.08 feet. The increase in water surface elevation for the PMP from AMC I to AMC III is an average of 0.08 feet (less than one inch). This increase ranges from 0.0 feet to 0.15 feet.

The increase in the water surface elevation resulting from an increase in the Antecedent Moisture Condition of the soil will not impact the facility. The maximum increases are for the 100-year water surface profile and that is only about one-half of a foot. The increase in the water surface elevation resulting for an increase in the Antecedent Moisture Condition of the soil for the most extreme storm, the PMP, is less than two inches at its maximum. The existing ground around the Low Level and Byproduct Facility is at a minimum about twenty feet above the elevation of the PMP water surface in the area. Based on the location of the facility with respect to the floodplain these minor increases in water surface elevation resulting from increased Antecedent Moisture Condition of the soil are insignificant and will not impact the facility.

The 100-year peak discharge for Antecedent Moisture Condition II is shown in Table II.F.11. The 100-year water surface elevations for Antecedent Moisture Condition II are shown in Table II.F.12. The 500-year peak and PMP discharge for Antecedent Moisture Condition II is shown in Table II.F.13. The 500-year water surface elevations for Antecedent Moisture Condition II are shown in Table II.F.14. The PMP water surface elevations for Antecedent Moisture Condition II are shown in Table II.F.15. The 100-year peak discharge for Antecedent Moisture Condition III is shown in Table II.F.16. The 100-year water surface elevations for Antecedent Moisture Condition III are shown in Table II.F.17. The 500-year peak and PMP discharge for Antecedent Moisture Condition III is shown in Table II.F.18. The 500-year water surface elevations for Antecedent Moisture Condition III are shown in Table II.F.19. The PMP water surface elevations for Antecedent Moisture Condition III are shown in Table II.F.20.

The HEC-HMS model for the calculation of the 100-year peak discharges for Antecedent Moisture Condition II is included in Appendix L. The HEC-RAS model for the calculation of the 100-year water surface profile for Antecedent Moisture Condition II is included in Appendix M. The HEC-HMS model for the calculation of the 500-year peak discharges for Antecedent Moisture Condition II is included in Appendix N. The HEC-HMS model for the calculation of the PMP peak discharges for Antecedent Moisture Condition II is included in Appendix O. The

HEC-RAS model for the calculation of the 500-year and PMP water surface profiles for Antecedent Moisture Condition II are included in Appendix P. The HEC-HMS model for the calculation of the 100-year peak discharges for Antecedent Moisture Condition III is included in Appendix Q. The HEC-RAS model for the calculation of the 100-year water surface profile for Antecedent Moisture Condition III is included in Appendix R. The HEC-HMS model for the calculation of the 500-year peak discharges for Antecedent Moisture Condition III is included in Appendix S. The HEC-HMS model for the calculation of the PMP peak discharges for Antecedent Moisture Condition III is included in Appendix T. The HEC-RAS model for the calculation of the 500-year and PMP water surface profiles for Antecedent Moisture Condition III are included in Appendix U.

TABLES

Table II.F.1

100-Year Peak Discharge

Drainage Area/Junction	100 Year Flowrate (cfs)
Drainage Area 2	440
Playa/Depression	0
Drainage Area 1A	257
Junction 1A	325
Junction 1	364
Junction 2	687
Junction 3	790

Table II.F.2

100-Year Water Surface Elevations

Section	100 Year Flowrate (cfs)	100 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	257	3478.09	1.09	1.71	266.62
11337	257	3470.06	1.06	3.96	117.70
10937	257	3465.38	1.38	3.45	101.30
10288	257	3456.67	0.67	3.57	187.76
9690	325	3451.19	1.19	2.13	250.83
9009	325	3446.12	1.12	3.57	169.88
8130	325	3441.25	1.25	1.84	273.95
7717	325	3438.44	0.64	3.64	223.91
7253	364	3436.09	1.09	1.28	491.10
6343	687	3430.46	0.46	3.65	469.62
5363	687	3426.02	1.02	1.41	739.57
4221	790	3420.71	0.71	4.01	402.25
3489	790	3416.92	1.91	1.66	743.33
2989	790	3414.32	0.52	3.36	600.34

Table II.F.3

500-Year And PMP Peak Discharge

Drainage Area/Junction	500 Year Flowrate (cfs)	PMP Flowrate (cfs)
Drainage Area 2	949	2726
Playa/Depression	0	2194
Drainage Area 1A	533	1768
Junction 1A	677	2568
Junction 1	770	4793
Junction 2	1496	6409
Junction 3	1717	6969

Table II.F.4

500-Year Water Surface Elevations

Section	500 Year Flowrate (cfs)	500 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	533	3478.39	1.39	2.31	306.92
11337	533	3470.41	1.41	5.03	132.24
10937	533	3465.80	1.80	4.31	130.37
10288	533	3456.93	0.93	4.13	250.47
9690	677	3451.55	1.55	2.64	325.16
9009	677	3446.51	1.51	3.89	252.56
8130	677	3441.63	1.63	2.28	355.10
7717	677	3438.71	0.91	4.26	284.67
7253	770	3436.41	1.41	1.75	523.18
6343	1496	3430.75	0.75	4.53	524.36
5363	1496	3426.40	1.40	1.94	851.92
4221	1717	3421.06	1.06	4.81	517.17
3489	1717	3417.25	2.25	2.14	1002.71
2989	1717	3414.57	0.77	4.34	629.71

Table II.F.5

PMP-Year Water Surface Elevations

Section	PMP Flowrate (cfs)	PMP WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	1768	3479.22	2.22	3.61	417.81
11337	1768	3471.40	2.40	7.37	173.86
10937	1768	3466.73	2.73	6.57	197.71
10288	1768	3457.50	1.50	5.03	466.54
9690	2568	3452.40	2.40	4.32	473.42
9009	2568	3447.55	2.55	4.66	472.01
8130	2568	3442.51	2.51	3.85	498.79
7717	2568	3439.61	1.81	5.19	449.87
7253	4793	3437.73	2.73	4.15	656.51
6343	6409	3431.79	1.79	6.69	787.68
5363	6409	3427.60	2.60	3.49	1207.27
4221	6969	3422.09	2.09	6.36	1009.59
3489	6969	3418.33	3.33	3.59	1076.90
2989	6969	3415.54	1.74	6.56	879.23

Table II.F.6

Developed Low-Level and Byproduct Facility
100-Year Peak Discharge

Drainage Area/Junction	100 Year Flowrate (cfs)
Drainage Area 2	440
Playa/Depression	0
Drainage Area 1A	257
Junction 1A	385
Junction 1	406
Junction 2	679
Junction 3	770

Table II.F.7
Developed Low-Level and Byproduct Facility
100-Year Water Surface Elevations

Section	100 Year Flowrate (cfs)	100 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	257	3478.09	1.09	1.71	266.62
11337	257	3470.06	1.06	3.96	117.70
10937	257	3465.38	1.38	3.45	101.30
10288	257	3456.67	0.67	3.57	187.76
9690	385	3451.27	1.27	2.23	266.72
9009	385	3446.20	1.20	3.65	186.98
8130	385	3441.33	1.33	1.93	291.13
7717	385	3438.49	0.69	3.79	235.89
7253	406	3436.11	1.10	1.39	492.58
6343	679	3430.47	0.46	3.60	469.90
5363	679	3426.01	1.01	1.41	737.55
4221	770	3420.70	0.70	3.99	399.36
3489	770	3416.90	1.90	1.64	739.55
2989	770	3414.31	0.51	3.33	599.61

Table II.F.8
Developed Low-Level and Byproduct Facility
500-Year And PMP Peak Discharge

Drainage Area/Junction	500 Year Flowrate (cfs)	PMP Flowrate (cfs)
Drainage Area 2	949	2726
Playa/Depression	0	2194
Drainage Area 1A	533	1768
Junction 1A	828	4796
Junction 1	872	4942
Junction 2	1470	6399
Junction 3	1668	6955

Table II.F.9

Developed Low-Level and Byproduct Facility
500-Year Water Surface Elevations

Section	500 Year Flowrate (cfs)	500 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	533	3478.39	1.39	2.31	306.92
11337	533	3470.41	1.41	5.03	132.24
10937	533	3465.80	1.80	4.31	130.37
10288	533	3456.93	0.93	4.13	250.47
9690	828	3451.67	1.67	2.79	349.80
9009	828	3446.63	1.63	4.04	277.44
8130	828	3441.76	1.76	2.41	382.07
7717	828	3438.80	1.00	4.48	304.12
7253	872	3436.44	1.44	1.91	526.19
6343	1470	3430.74	0.74	4.51	522.87
5363	1470	3426.38	1.38	1.93	847.50
4221	1668	3421.05	1.05	4.76	511.16
3489	1668	3417.23	2.23	2.12	1001.82
2989	1668	3414.56	0.76	4.28	628.05

Table II.F.10

Developed Low-Level and Byproduct Facility
PMP - Water Surface Elevations

Section	PMP Flowrate (cfs)	PMP WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	1768	3479.22	2.22	3.61	417.81
11337	1768	3471.40	2.40	7.37	173.86
10937	1768	3466.73	2.73	6.57	197.71
10288	1768	3457.50	1.50	5.03	466.54
9690	4796	3453.03	3.03	5.43	560.63
9009	4796	3448.10	3.10	5.69	579.12
8130	4796	3443.22	3.22	4.75	590.61
7717	4796	3440.06	2.26	6.74	521.44
7253	4942	3437.75	2.75	4.24	658.36
6343	6399	3431.80	1.80	6.68	788.09
5363	6399	3427.59	2.59	3.49	1206.47
4221	6955	3422.09	2.09	6.35	1009.43
3489	6955	3418.33	3.33	3.58	1076.73
2989	6955	3415.53	1.73	6.56	878.78

Table II.F.11

100-Year Peak Discharge
Antecedent Moisture Condition II

Drainage Area/Junction	100 Year Flowrate (cfs)
Drainage Area 2	744
Playa/Depression	0
Drainage Area 1A	257
Junction 1A	611
Junction 1	697
Junction 2	1328
Junction 3	1500

Table II.F.12

100-Year Water Surface Elevations
Antecedent Moisture Condition II

Section	100 Year Flowrate (cfs)	100 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	488	3478.35	1.35	2.23	301.04
11337	488	3470.36	1.36	4.87	130.23
10937	488	3465.74	1.74	4.21	126.27
10288	488	3456.90	0.90	4.04	242.43
9690	611	3451.49	1.49	2.56	313.59
9009	611	3446.45	1.45	3.84	239.94
8130	611	3441.57	1.57	2.21	342.53
7717	611	3438.66	0.86	4.18	274.48
7253	697	3436.35	1.35	1.69	517.58
6343	1328	3430.70	0.70	4.37	514.6
5363	1328	3426.33	1.33	1.85	830.57
4221	1501	3420.99	0.99	4.67	483.60
3489	1501	3417.18	2.18	2.05	998.9
2989	1501	3414.52	0.72	4.14	623.28

Table II.F.13

500-Year And PMP Peak Discharge
Antecedent Moisture Condition II

Drainage Area/Junction	500 Year Flowrate (cfs)	PMP Flowrate (cfs)
Drainage Area 2	1343	2805
Playa/Depression	0	2380
Drainage Area 1A	818	1833
Junction 1A	1032	2662
Junction 1	1201	5170
Junction 2	2315	6871
Junction 3	2625	7467

Table II.F.14

500-Year Water Surface Elevations
Antecedent Moisture Condition II

Section	500 Year Flowrate (cfs)	500 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	818	3478.64	1.64	2.70	340.14
11337	818	3470.67	1.67	5.89	143.25
10937	818	3466.11	2.11	4.88	152.46
10288	818	3457.15	1.15	4.08	402.08
9690	1032	3451.81	1.81	2.97	378.22
9009	1032	3446.77	1.77	4.19	307.32
8130	1032	3441.91	1.91	2.56	413.44
7717	1032	3438.91	1.11	4.70	328.51
7253	1201	3436.66	1.66	2.11	548.75
6343	2315	3430.98	0.98	5.08	568.22
5363	2315	3426.68	1.68	2.32	934.95
4221	2625	3421.33	1.33	5.21	648.13
3489	2625	3417.51	2.51	2.45	1016.94
2989	2625	3414.77	0.97	5.02	651.07

Table II.F.15

PMP-Year Water Surface Elevations
Antecedent Moisture Condition II

Section	PMP Flowrate (cfs)	PMP WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	1833	3479.26	2.26	3.66	421.93
11337	1833	3471.45	2.45	7.43	175.84
10937	1833	3466.73	2.73	6.81	197.77
10288	1833	3457.54	1.54	4.94	474.18
9690	2662	3452.41	2.41	4.45	474.74
9009	2662	3447.61	2.61	4.59	485.14
8130	2662	3442.51	2.51	3.98	499.24
7717	2662	3439.69	1.89	5.00	463.57
7253	5170	3437.80	2.80	4.32	663.98
6343	6871	3431.88	1.88	6.95	836.71
5363	6871	3427.67	2.67	3.60	1229.57
4221	7467	3422.16	2.16	6.45	1031.21
3489	7467	3418.39	3.39	3.72	1083.03
2989	7467	3415.64	1.84	6.54	894.76

Table II.F.16

100-Year Peak Discharge
Antecedent Moisture Condition III

Drainage Area/Junction	100 Year Flowrate (cfs)
Drainage Area 2	1108
Playa/Depression	0
Drainage Area 1A	645
Junction 1A	817
Junction 1	966
Junction 2	1873
Junction 3	2128

Table II.F.17

100-Year Water Surface Elevations
Antecedent Moisture Condition III

Section	100 Year Flowrate (cfs)	100 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	645	3478.49	1.49	2.49	320.33
11337	645	3470.53	1.53	5.36	137.13
10937	645	3465.93	1.93	4.57	139.30
10288	645	3457.07	1.07	3.87	349.93
9690	817	3451.66	1.66	2.78	348.04
9009	817	3446.62	1.62	4.03	275.79
8130	817	3441.75	1.75	2.40	380.21
7717	817	3438.79	0.99	4.47	302.82
7253	966	3436.53	1.53	1.92	535.68
6343	1873	3430.86	0.86	4.82	545.10
5363	1873	3426.53	1.53	2.13	892.02
4221	2128	3421.19	1.19	5.0	581.33
3489	2128	3417.37	2.37	2.30	1009.36
2989	2128	3414.67	0.87	4.64	640.02

Table II.F.18

500-Year And PMP Peak Discharge
Antecedent Moisture Condition III

Drainage Area/Junction	500 Year Flowrate (cfs)	PMP Flowrate (cfs)
Drainage Area 2	1741	2847
Playa/Depression	0	2519
Drainage Area 1A	976	1850
Junction 1A	1242	2689
Junction 1	1483	5399
Junction 2	2888	7144
Junction 3	3286	7766

Table II.F.19

500-Year Water Surface Elevations
Antecedent Moisture Condition III

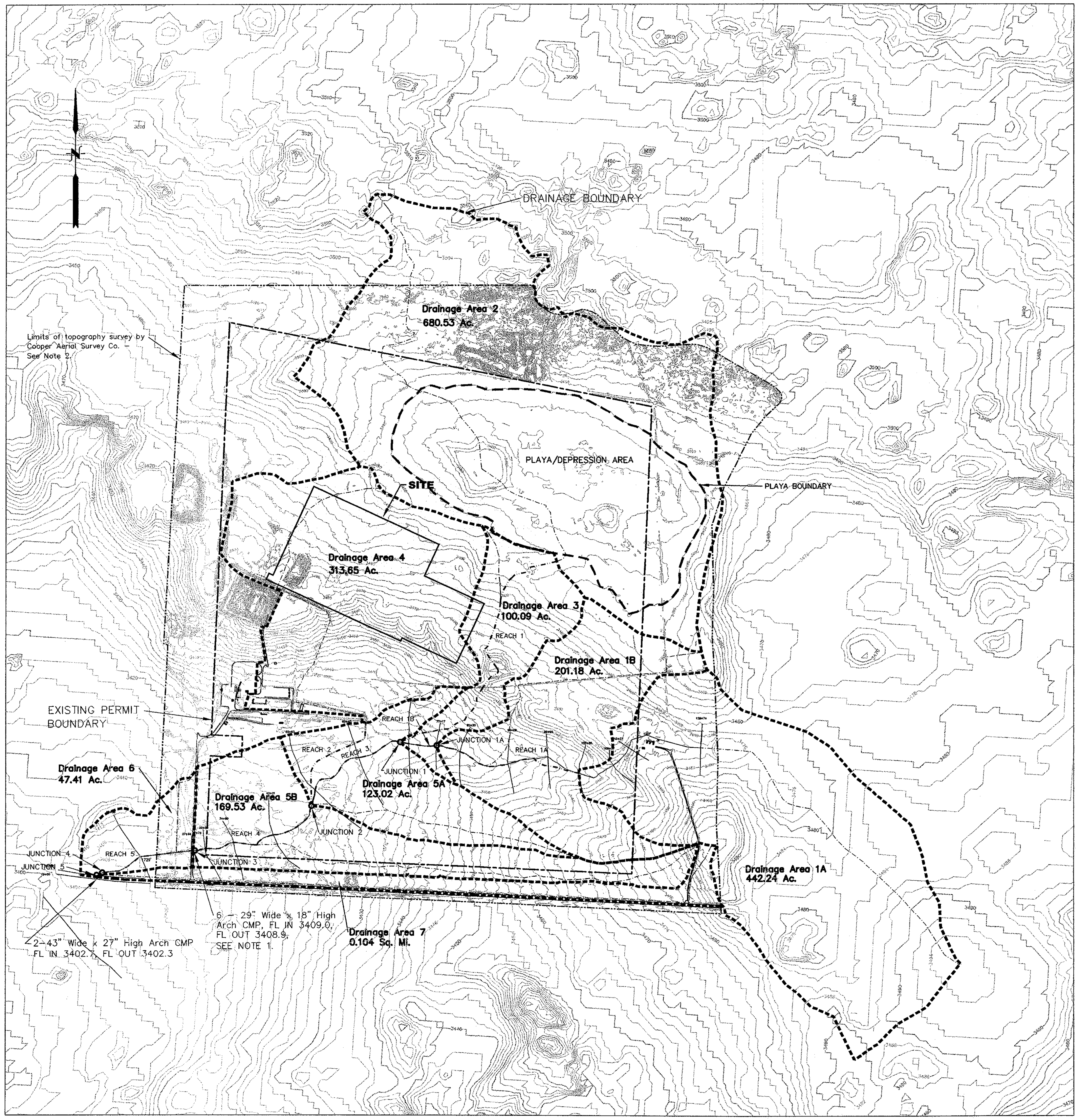
Section	500 Year Flowrate (cfs)	500 Year WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	976	3478.76	1.75	2.90	355.40
11337	976	3470.81	1.81	6.21	149.13
10937	976	3466.24	2.24	5.21	162.01
10288	976	3457.22	1.22	4.31	413.97
9690	1242	3451.93	1.93	3.13	404.17
9009	1242	3446.90	1.90	4.31	334.67
8130	1242	3442.03	2.03	2.73	437.11
7717	1242	3439.01	1.21	4.88	350.81
7253	1483	3436.81	1.81	2.29	563.87
6343	2888	3431.11	1.11	5.44	583.36
5363	2888	3426.84	1.84	2.54	934.24
4221	3286	3421.49	1.49	5.39	728.53
3489	3286	3417.66	2.66	2.66	1025.44
2989	3286	3414.95	1.15	5.40	788.45

Table II.F.20

PMP-Year Water Surface Elevations
Antecedent Moisture Condition III

Section	PMP Flowrate (cfs)	PMP WSEL (msl)	Maximum Depth (ft)	Channel Velocity (fps)	Top Width (ft)
12674	1850	3479.26	2.26	3.69	422.29
11337	1850	3471.47	2.47	7.39	176.84
10937	1850	3466.72	2.72	6.91	197.22
10288	1850	3457.57	1.57	4.82	479.25
9690	2689	3452.40	2.40	4.52	473.62
9009	2689	3447.65	2.65	4.51	492.15
8130	2689	3442.50	2.50	4.06	497.59
7717	2689	3439.74	1.94	4.84	471.42
7253	5399	3437.84	2.84	4.42	667.97
6343	7144	3431.94	1.94	6.76	867.12
5363	7144	3427.72	2.72	3.65	1242.81
4221	7766	3422.20	2.20	6.51	1043.46
3489	7766	3418.44	3.44	3.78	1087.51
2989	7766	3415.68	1.88	6.62	900.85

FIGURES



LEGEND

- PLAYA AREA BOUNDARY
- DRAINAGE AREA BOUNDARY
- LIMITS OF TOPOGRAPHIC SURVEY BY COOPER AERIAL SURVEY CO.
- EXISTING PERMIT BOUNDARY
- REACH LENGTH
- TRAVEL TIME FLOW PATH
- JUNCTION

STATE OF TEXAS
DIANA G. DWORACZYK
63724
REGISTERED PROFESSIONAL ENGINEER

10/14/04
Sealed for evidence of addition of site boundary.

NOTES:

1. Existing pipe sizes taken from field observation. Pipe flowlines taken from Survey by West Texas Consultants, Inc., 305 NW Ave. C, Andrews, TX 79714, (915) 523-2181, Fax: (915) 524-2346, dated 10/07/96.
2. Existing topographic information within the limits shown is provided by Cooper Aerial Survey Co., 11402 N. Cave Creek Road, Phoenix, AZ 85020, (602) 678-5111 Fax: (602) 678-5228, 1-800-229-2279.
3. Existing topographic information outside the limits shown is based on a digital elevation model (DEM) provided by The Texas Natural Resources Information System (TNRIS).
4. Permit boundary and facility information provided by Waste Control Specialists LLC.

Drainage Area Map
SCALE: 1" = 1000'

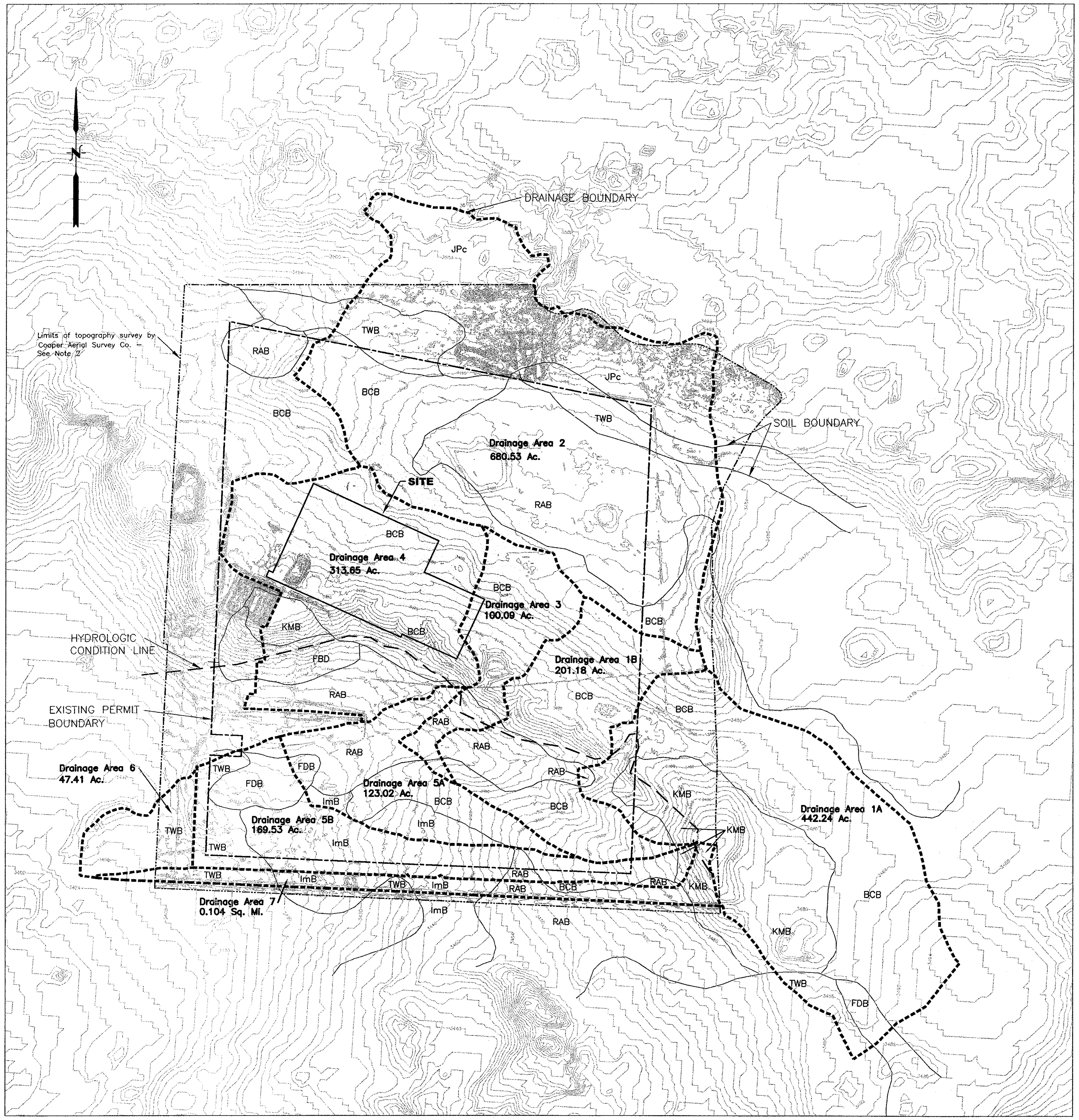
STATE OF TEXAS
FREDERICK H. HAAS
55490
REGISTERED PROFESSIONAL ENGINEER
2/9/04

FREDERICK H. HAAS, P.E.
CONSULTING ENGINEER
3618 A SUMMIT BEND
AUSTIN, TEXAS 78759
512-478-5530
FAX 512-474-8463

WASTE CONTROL SPECIALISTS LLC
Andrews County, Texas

DRAWN BY:	DGD
DESIGNED BY:	DGD
CHECKED BY:	FHH
DATE:	2/09/04
REVISED:	
JOB NAME:	WCS
DRAWING NAME:	DrainageMap

II.F.1



LEGEND

- SOIL BOUNDARY
- HYDROLOGIC CONDITION
- DRAINAGE AREA BOUNDARY
- LIMITS OF TOPOGRAPHIC SURVEY BY COOPER AERIAL SURVEY CO.
- EXISTING PERMIT BOUNDARY

SYMBOL	GROUP	NAME
JPC	A	Jalmar
TWB	B	Triomas
BCB	B	Blakeney
RAB	B	Ratliff
FDB	B	Faskin
Imb	B	Ima
KMB	C	Kimbrough

STATE OF TEXAS
DIANA G. DWORACZYK
63724
REGISTERED PROFESSIONAL ENGINEER
10/14/04
Sealed for evidence of addition of site boundary.

NOTES:

1. Soil information taken from the Soil Conservation Service Soil Survey of Andrews County, Texas issued August 1974.
2. Existing topographic information within the limits shown is provided by Cooper Aerial Survey Co., 11402 N. Cave Creek Road, Phoenix, AZ 85020, (602) 678–5111, Fax: (602) 678–5228, 1–800–229–2279.
3. Existing topographic information outside the limits shown is based on a digital elevation model (DEM) provided by The Texas Natural Resources Information System (TNRIS).
4. Hydrologic condition north of the line is considered poor. Hydrologic condition south of the line is considered fair.
5. Permit boundary information provided by Waste Control Specialists LLC.

Soil Map
SCALE: 1" - 1000'

STATE OF TEXAS
FREDERICK H. HAAS
55490
PROFESSIONAL ENGINEER
2/9/04

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WASTE CONTROL SPECIALISTS LLC
Andrews County, Texas

DRAWN BY:	DGD
DESIGNED BY:	DGD
CHECKED BY:	FHH
DATE:	2/09/04
REVISED:	
JOB NAME:	WCS
DRAWING NAME:	SoilsMap

II.F.2

6 – 29" x 18" CMP ARCH CULVERTS
UNDER THE ACCESS ROAD

SECTION OF THE DRAW

STATE OF TEXAS
FREDERICK H. HAAS
55490
REGISTERED PROFESSIONAL ENGINEER

2/9/04

FREDERICK H. HAAS, P.E.
CONSULTING ENGINEER
3813A SUMMIT BEND
AUSTIN, TEXAS 78759
512-478-6580

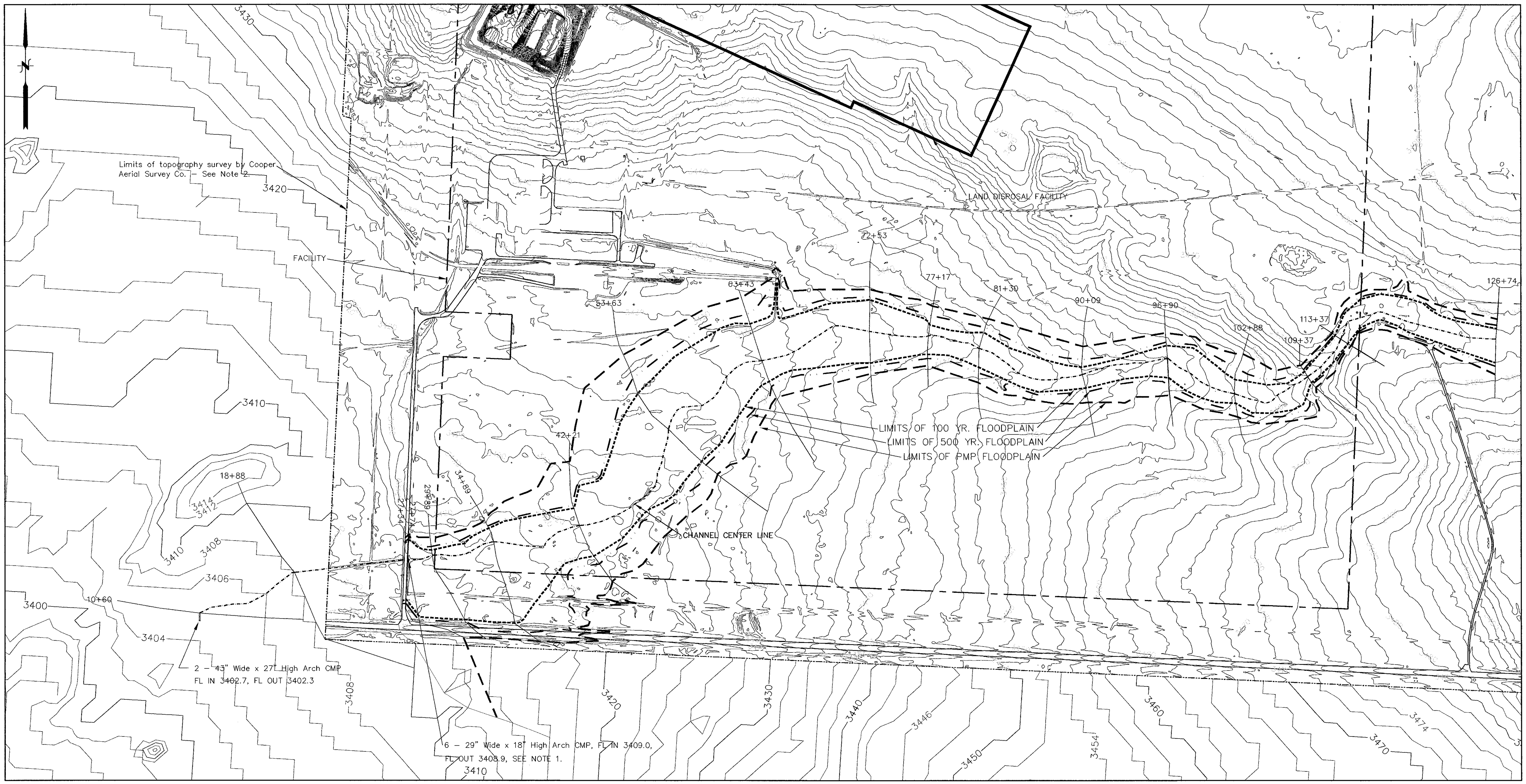
DATE ISSUED: 02/09/04				
PURPOSE: PERMIT RENEWAL				
PROJECT: WASTE CONTROL SPECIALISTS LLC ANDREWS COUNTY, TEXAS RCRA PERMIT RENEWAL				
SHEET TITLE: PHOTOGRAPHS				
DES BY DGD	DRW BY CGD	CHK BY FHH	DRAWING NAME: D:\WCS\DRAW\WCS FLOODPLAIN\DWG\	REV.
SCALE: N.T.S.		SHEET 1 OF 1	FIGURE NO. II.F.3	

NOTES:

1. Existing pipe sizes taken from field observation. Pipe flowlines taken from Survey by West Texas Consultants, Inc., 305 NW Ave. C, Andrews, TX 79714, (915) 523-2181, Fax: (915) 524-2346, dated 10/07/06.
2. Existing topographic information within the limits shown is provided by Cooper Aerial Survey Co., 11402 N. Cave Creek Road, Phoenix, AZ 85020, (602) 678-5111 Fax: (602) 678-5228, 1-800-229-2279.
3. Existing topographic information outside the limits shown is based on a digital elevation model (DEM) provided by The Texas Natural Resources Information System (TNRIS).
4. Facility boundary and Land Disposal Facility information provided by Waste Control Specialists LLC.

LEGEND

- PROBABLE MAXIMUM PRECIPITATION FLOODPLAIN LIMITS
- 500 YEAR FLOODPLAIN LIMITS
- 100 YEAR FLOODPLAIN LIMITS
- LIMITS OF TOPOGRAPHIC SURVEY BY COOPER AERIAL SURVEY CO.
- FACILITY
- CHANNEL CENTER LINE
- 34+89 CHANNEL CROSS-SECTION LOCATION



FREDERICK H. HAAS, P.E.
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3613 A SUMMIT BEND
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512-478-8580
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WASTE CONTROL SPECIALISTS LLC

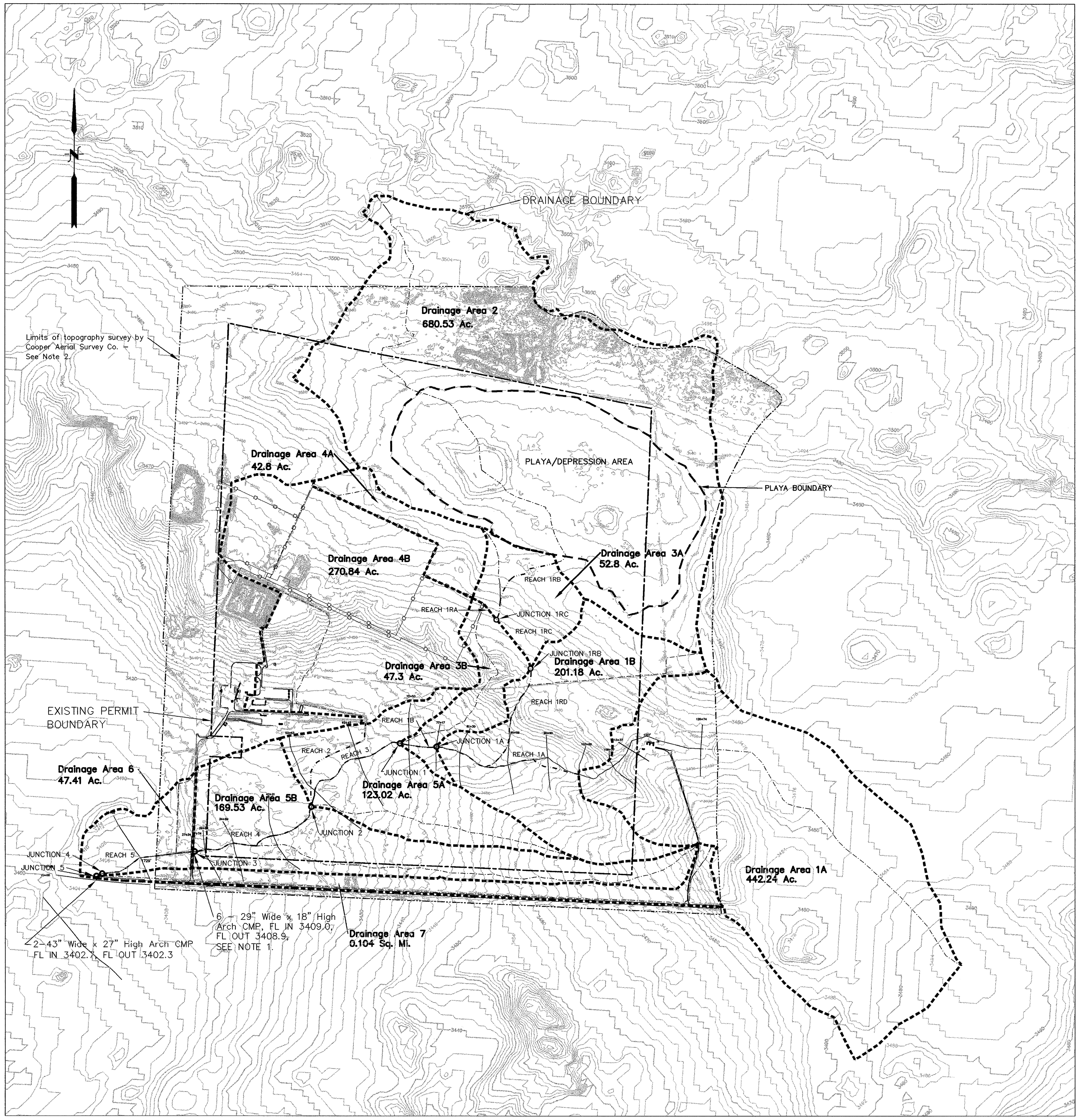
Andrews County, Texas

DRAWN BY: DGD
DESIGNED BY: DGD
CHECKED BY: FHH
DATE: 12/15/04
REVISED:
JOB NAME: WCS
DRAWING NAME: FLDPLAINMAPR2

FLOODPLAIN MAP

SCALE: 1" = 400'

II.F.4



LEGEND

- PLAYA AREA BOUNDARY
- DRAINAGE AREA BOUNDARY
- LIMITS OF TOPOGRAPHIC SURVEY BY COOPER AERIAL SURVEY CO.
- EXISTING PERMIT BOUNDARY
- REACH LENGTH
- TRAVEL TIME FLOW PATH
- JUNCTION

NOTES:

1. Existing pipe sizes taken from field observation. Pipe flowlines taken from Survey by West Texas Consultants, Inc., 305 NW Ave. C, Andrews, TX 79714, (915) 523–2181, Fax: (915) 524–2346, dated 10/07/96.
2. Existing topographic information within the limits shown is provided by Cooper Aerial Survey Co., 11402 N. Cave Creek Road, Phoenix, AZ 85020, (602) 678–5111 Fax: (602) 678–5228, 1–800–229–2279.
3. Existing topographic information outside the limits shown is based on a digital elevation model (DEM) provided by The Texas Natural Resources Information System (TNRIS).
4. Permit boundary and facility information provided by Waste Control Specialists LLC.

Developed Low Level & Byproduct Facility Drainage Area Map

SCALE: 1" = 1000'

STATE OF TEXAS
FREDERICK H. HAAS
55490
LICENSED PROFESSIONAL ENGINEER

FREDERICK H. HAAS, P.E.
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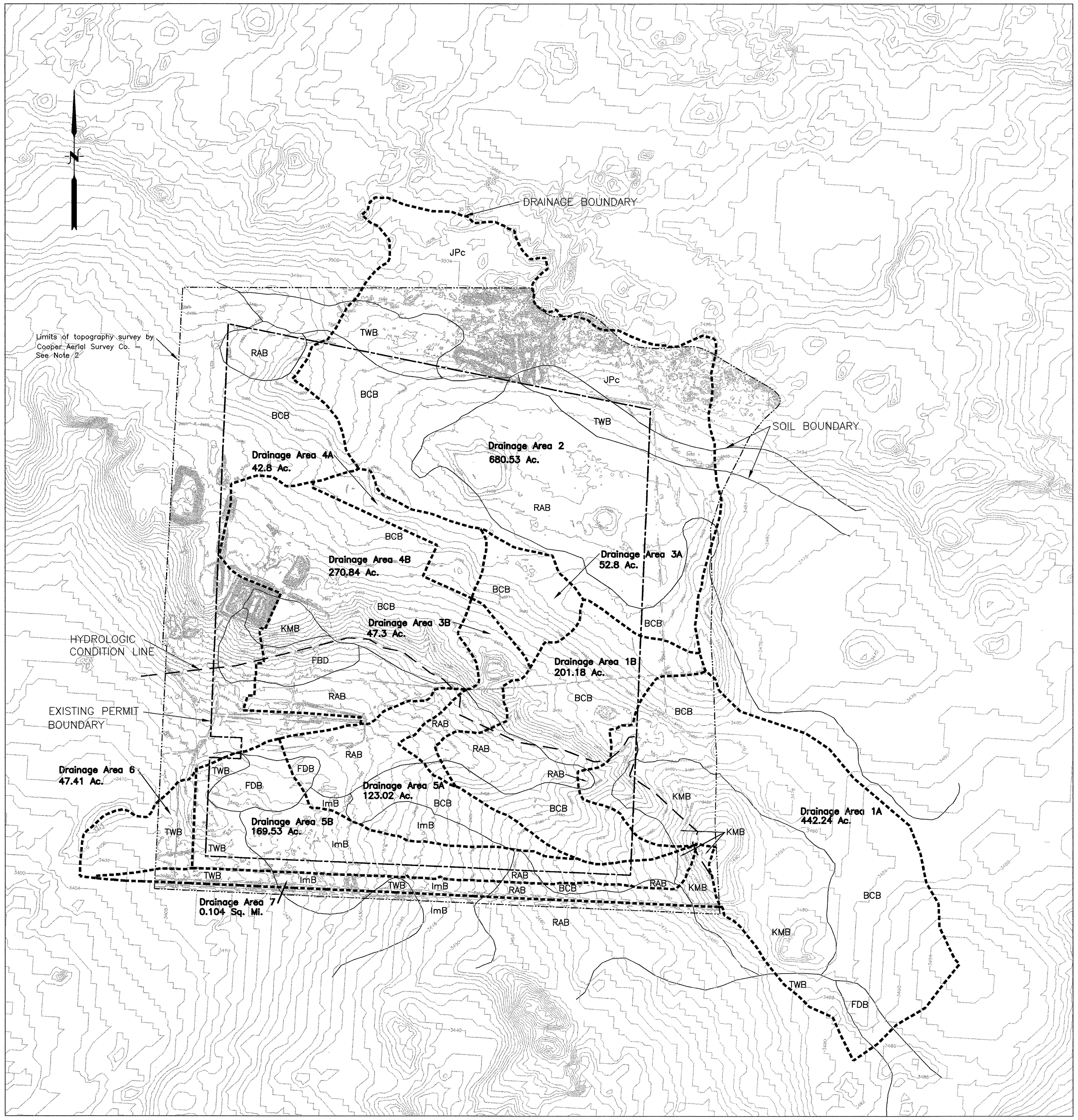
812 WEST 11TH ST., STE 205 512-478-8580
AUSTIN, TEXAS 78701 FAX 512-474-8463

WASTE CONTROL SPECIALISTS LLC

Andrews County, Texas

DRAWN BY:	DGD
DESIGNED BY:	DGD
CHECKED BY:	FHH
DATE:	03/31/06
REVISED:	
JOB NAME:	WCS
DRAWING NAME:	DRAINAGE MAP

II.F.5



LEGEND

- SOIL BOUNDARY
- HYDROLOGIC CONDITION
- DRAINAGE AREA BOUNDARY
- LIMITS OF TOPOGRAPHIC SURVEY BY COOPER AERIAL SURVEY CO.
- EXISTING PERMIT BOUNDARY

SYMBOL	GROUP	NAME
JPC	A	Jalmar
TWB	B	Triomas
BCB	B	Blakeney
RAB	B	Ratliff
FDB	B	Faskin
Imb	B	Ima
KMB	C	Kimbrough

NOTES:

1. Soil information taken from the Soil Conservation Service Soil Survey of Andrews County, Texas issued August 1974.
2. Existing topographic information within the limits shown is provided by Cooper Aerial Survey Co., 11402 N. Cave Creek Road, Phoenix, AZ 85020, (602) 678-5111, Fax: (602) 678-5228, 1-800-229-2279.
3. Existing topographic information outside the limits shown is based on a digital elevation model (DEM) provided by The Texas Natural Resources Information System (TNRIS).
4. Hydrologic condition north of the line is considered poor. Hydrologic condition south of the line is considered fair.
5. Permit boundary information provided by Waste Control Specialists LLC.

Developed Low Level & Byproduct Facility Soils Map

SCALE: 1" = 1000'

FREDERICK H. HAAS, P.E.
CONSULTING ENGINEER

WASTE CONTROL SPECIALISTS LLC

Andrews County, Texas

DRAWN BY: DGD
DESIGNED BY: DGD
CHECKED BY: FHH
DATE: 03/31/06
REVISED:
JOB NAME: WCS
DRAWING NAME: Soils Map

II.F.6

APPENDIX A

DRAINAGE CALCULATIONS

FREDERICK H. HAAS
55490
PROFESSIONAL ENGINEER
12/17/04

500 YEAR STORM CALCULATIONS

REF: DEPTH-DURATION FREQUENCY OF PRECIPITATION FOR TEXAS, W.H. ASQUITH, WATER RESOURCES INVESTIGATIONS REPORT 98-4044, U.S. GEOLOGICAL SURVEY, 1998 (98-4044)

GENERALIZED LOGISTIC DISTRIBUTION

Xd(F)= $\xi + \alpha / \kappa \{1 - [(1-F)/F]^\wedge \kappa\}$ EQ 10, 98-4044

WHERE: Xd(F)= PRECIPITATION DEPTH FOR A GIVEN FREQUENCY
$\xi, \alpha, and \kappa$ = LOCATION, SCALE AND SHAPE PARAMETERS FOR THE GLO DIST.
F= ANNUAL NONEXCEEDANCE PROBABILITY

FOR 500 YEAR STORM

ξ =	1.93	FIGURE 18, 98-4044
α =	0.55	FIGURE 32, 98-4044
κ =	-0.22	FIGURE 46, 98-4044
F=	0.998	

Xd(F)= 9.24 INCHES

11/15/05

Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

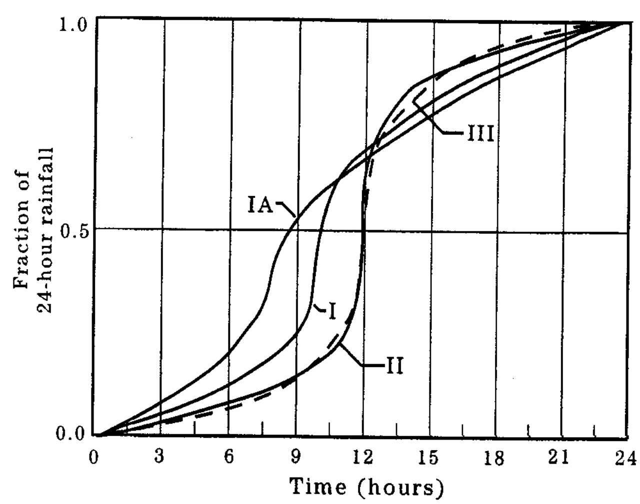
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c. For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c.

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having "nested" rainfall intensities was developed. The set "maximizes" the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

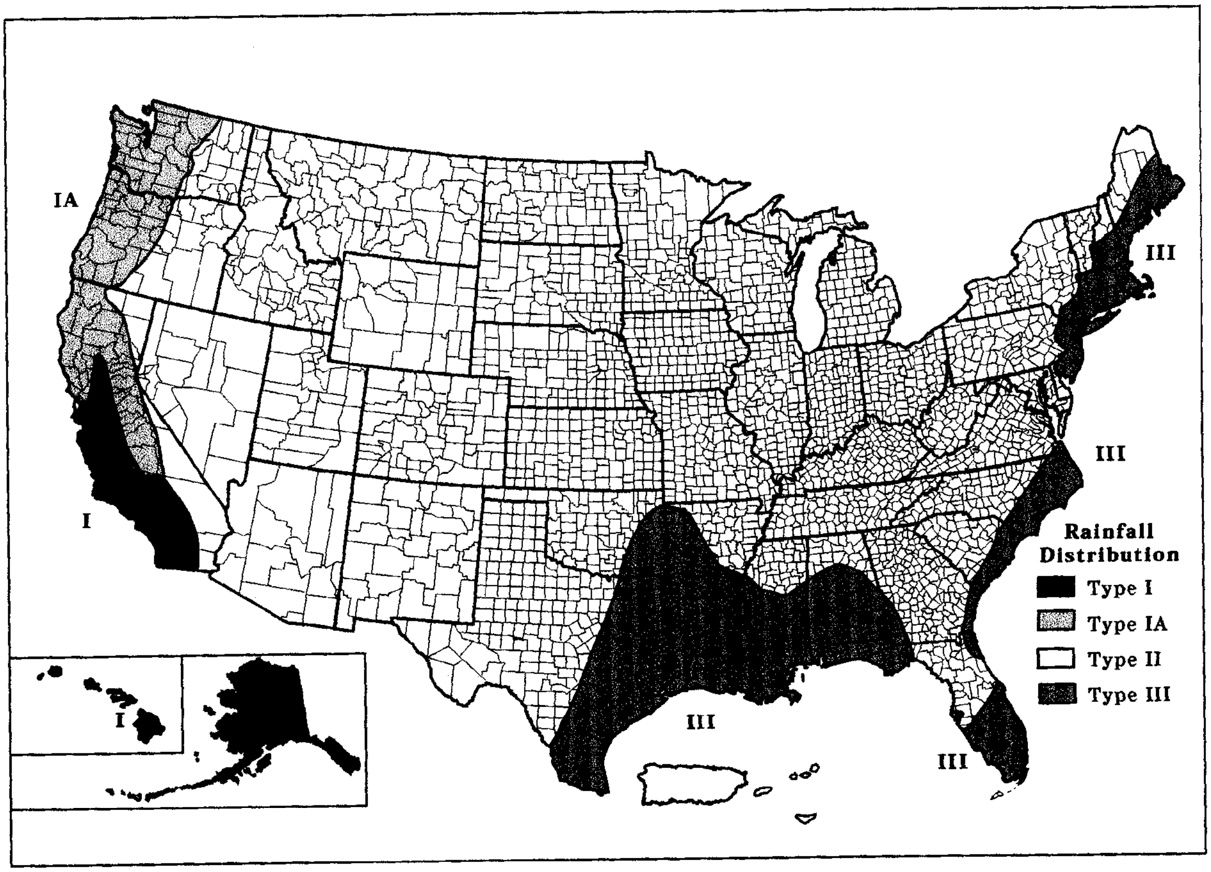
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061; Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Figure B-3 2-year, 24-hr rainfall

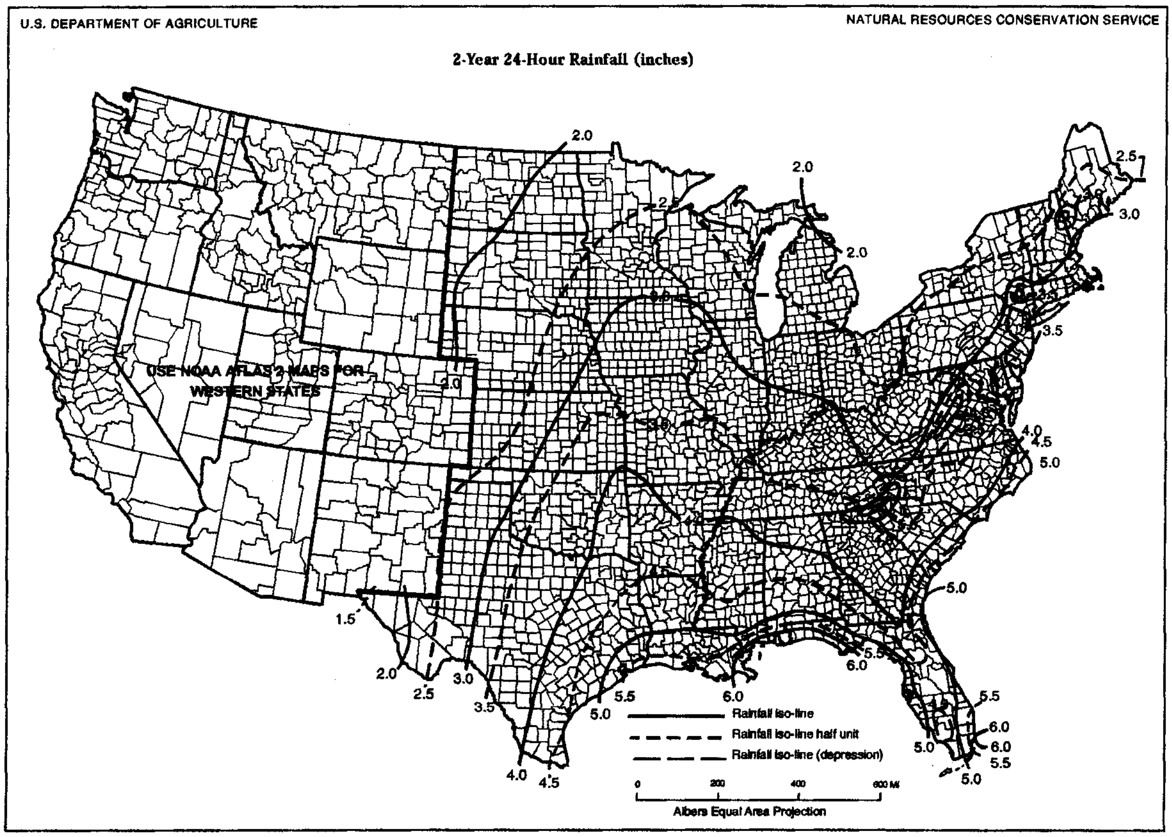


Figure B-4 5-year, 24-hour rainfall

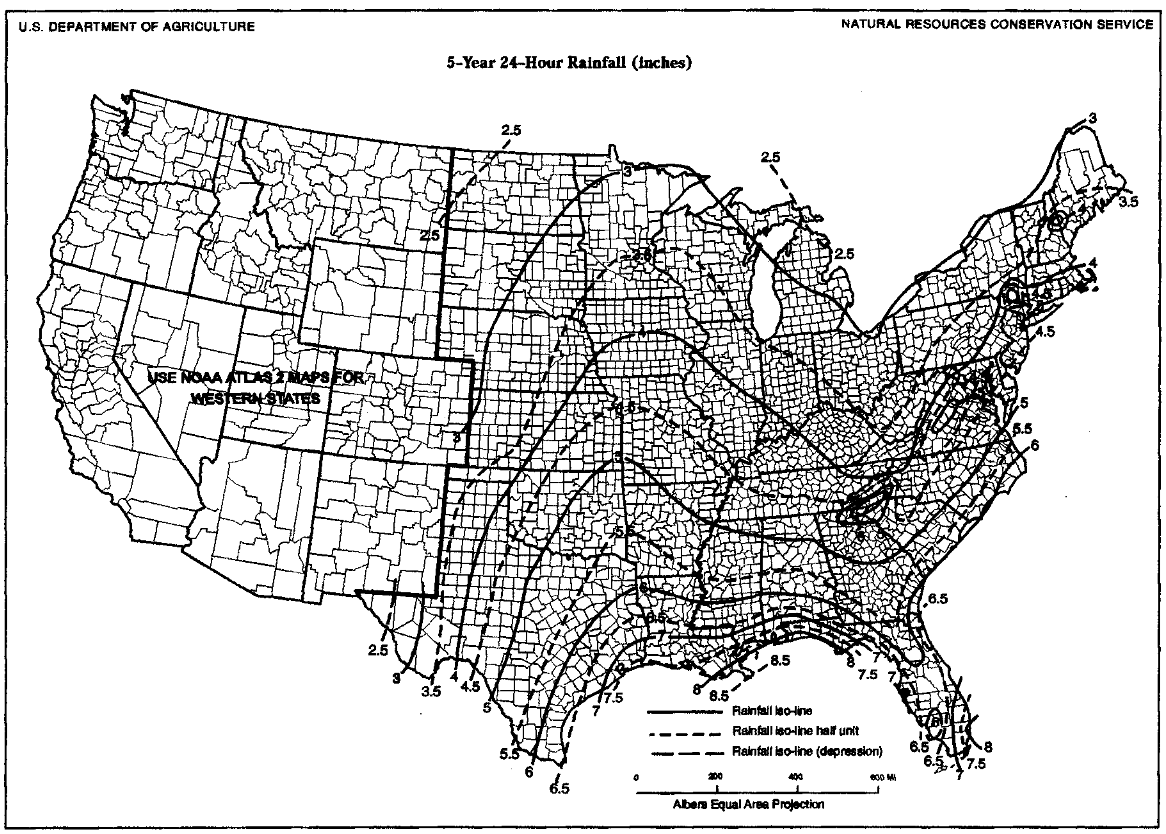


Figure B-5 10-year, 24-hour rainfall

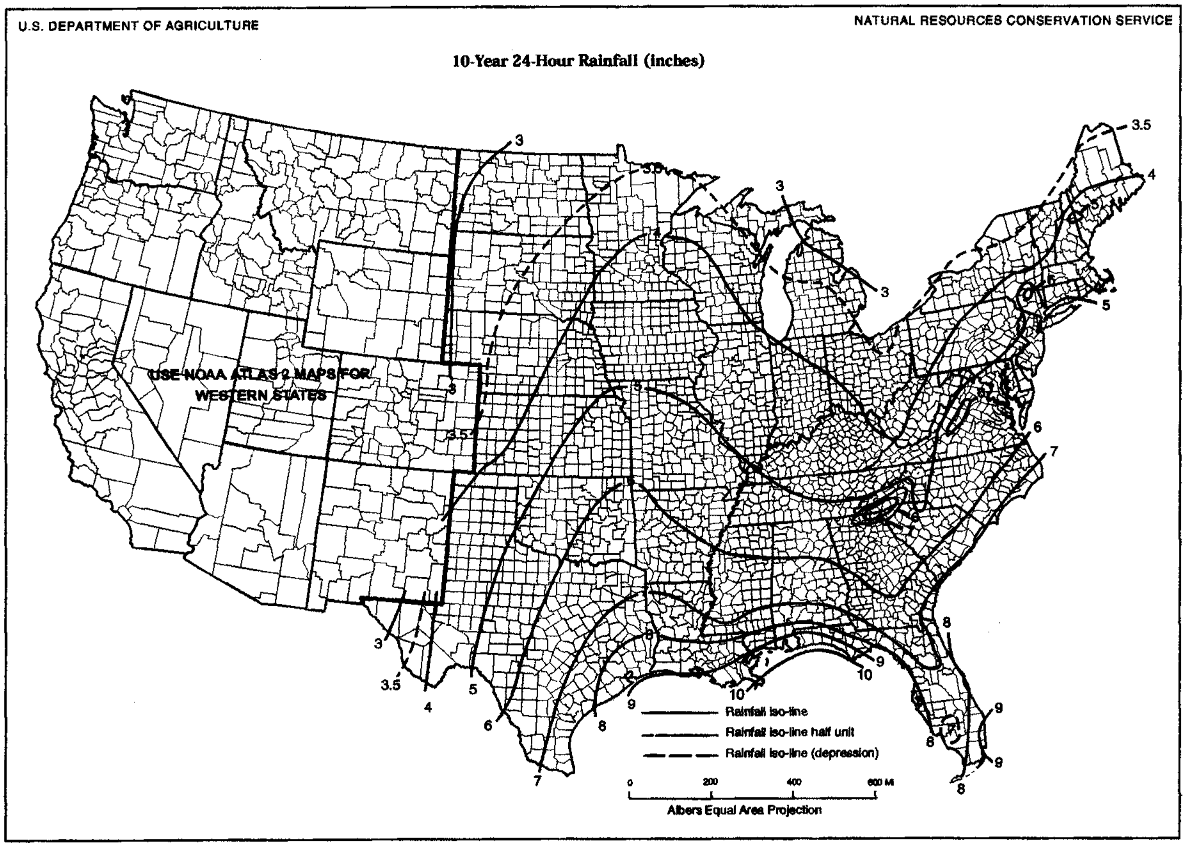


Figure B-6 25-year, 24-hour rainfall

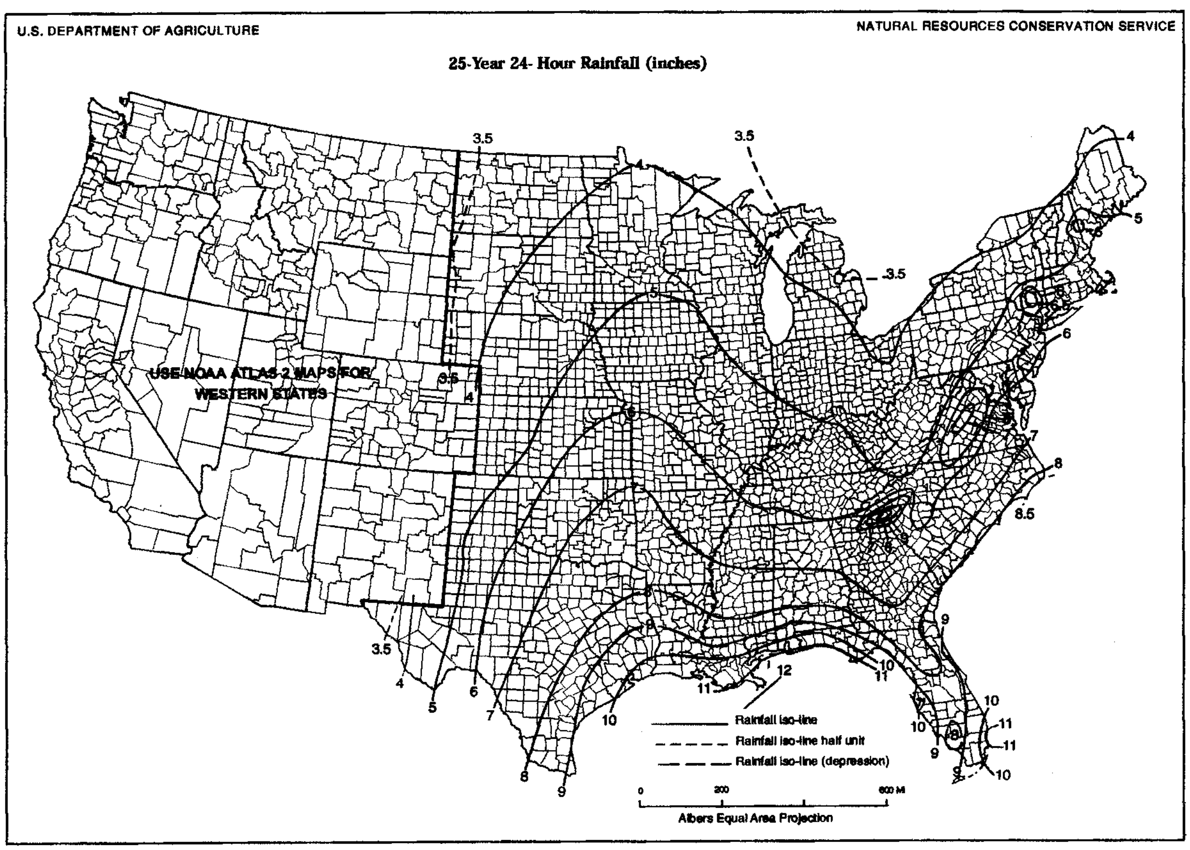


Figure B-7 50-year, 24-hour rainfall

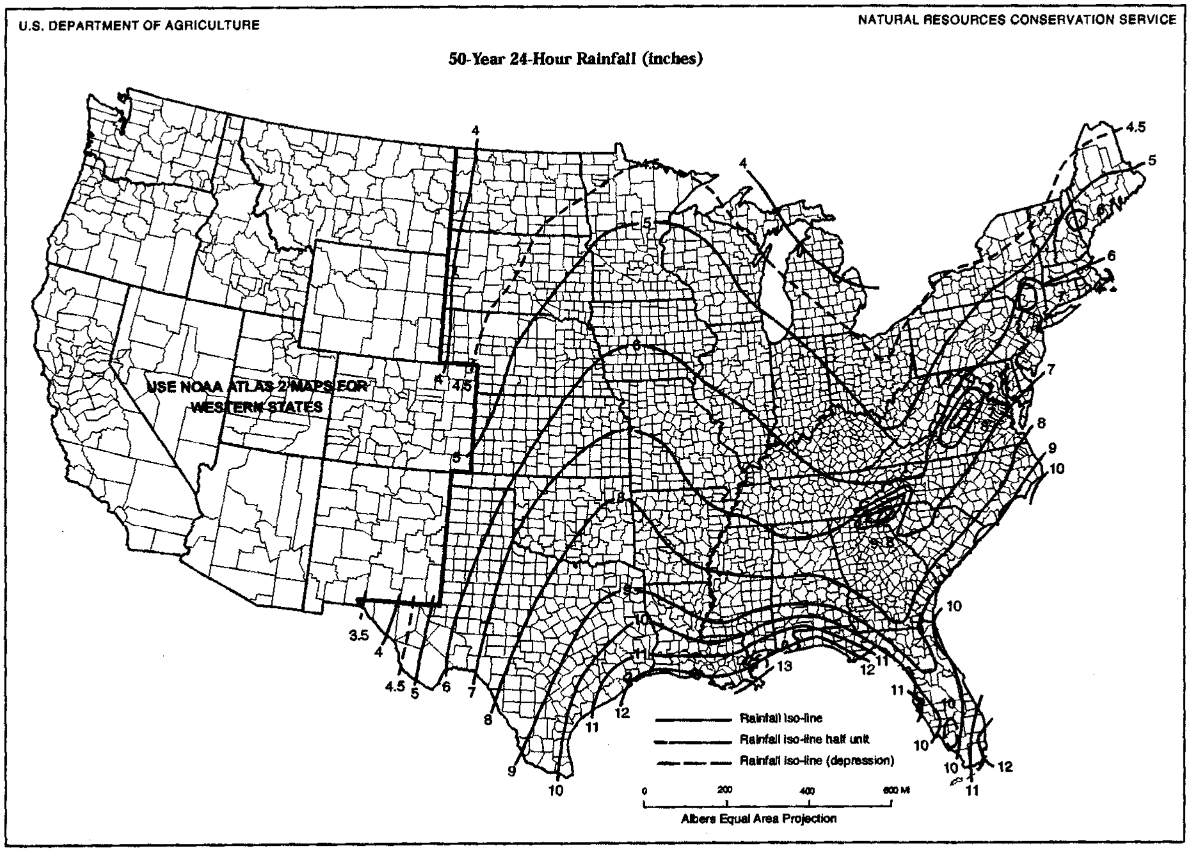
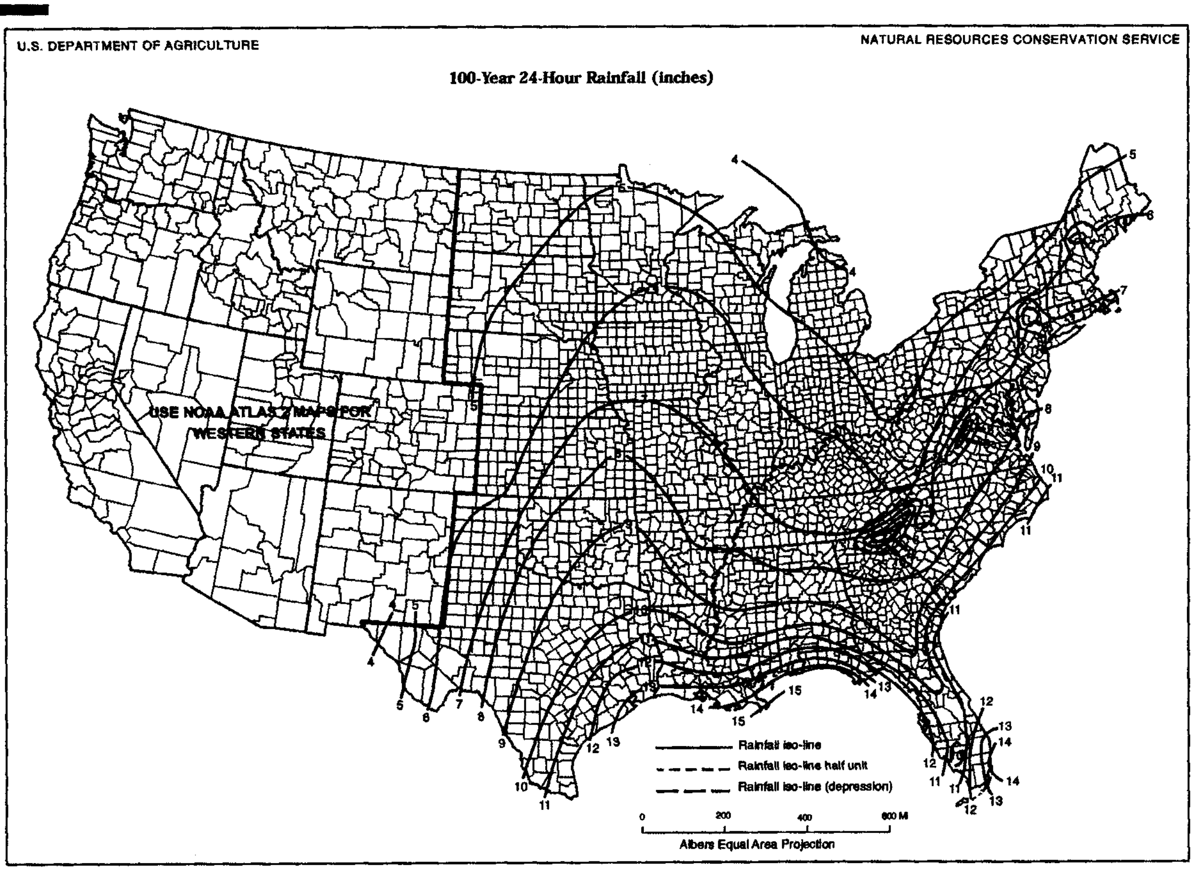


Figure B-8 100-year, 24-hour rainfall



100-YEAR 24-HOUR RAINFALL (INCHES)

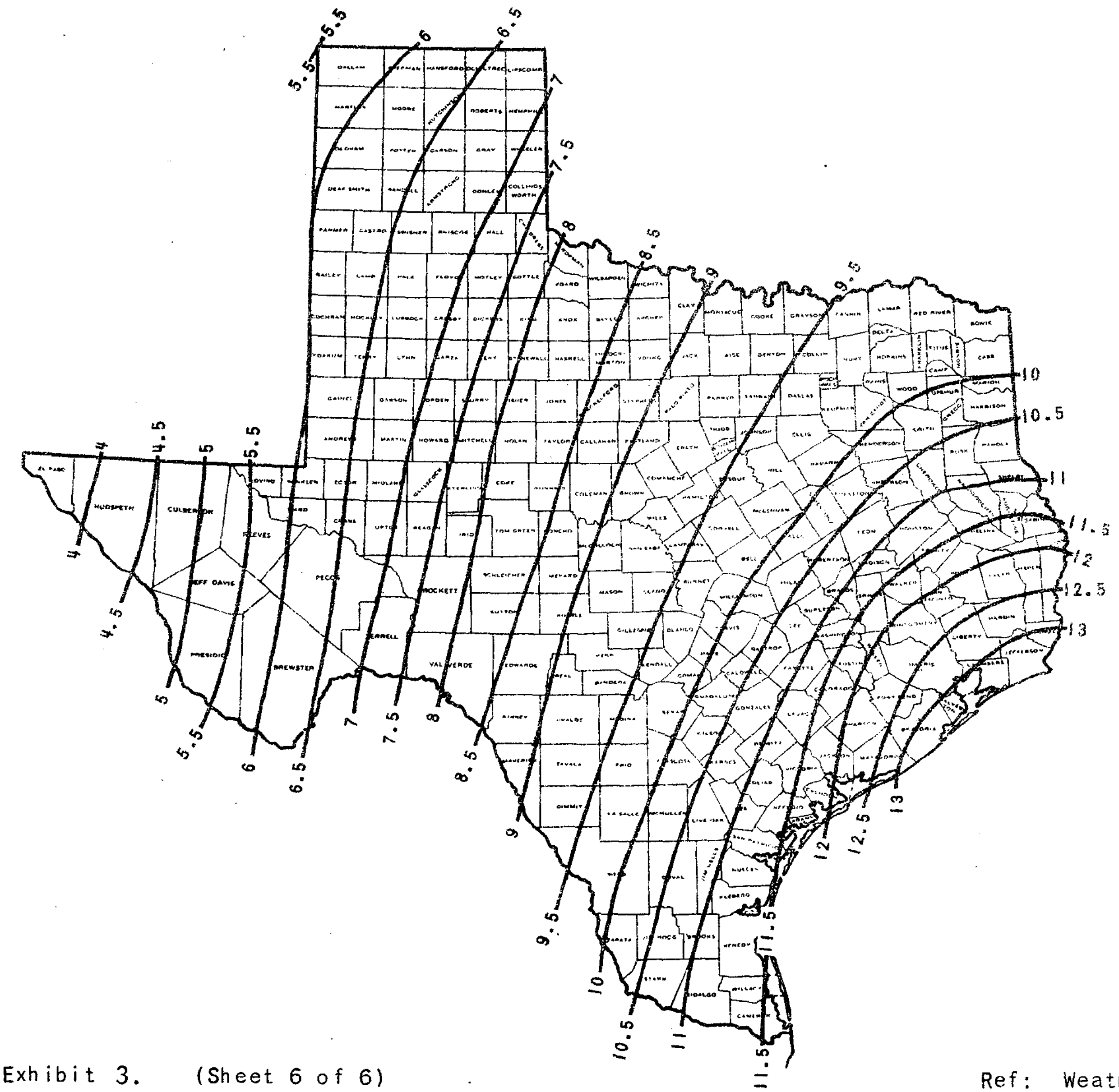


Exhibit 3. (Sheet 6 of 6)

Ref: Weather Bureau TP No. 40

DRAINAGE CALCULATIONS

500 YEAR STORM CALCULATIONS

REF: DEPTH-DURATION FREQUENCY OF PRECIPITATION FOR TEXAS, W.H. ASQUITH, WATER RESOURCES INVESTIGATIONS REPORT 98-4044, U.S. GEOLOGICAL SURVEY, 1998 (98-4044)

GENERALIZED LOGISTIC DISTRIBUTION

Xd(F)= $\xi + \alpha / \kappa \{1 - [(1-F)/F]^\wedge \kappa\}$ EQ. 10, 98-4044

WHERE:
Xd(F)= PRECIPITATION DEPTH FOR A GIVEN FREQUENCY
$\xi, \alpha, and \kappa$ = LOCATION, SCALE AND SHAPE PARAMETERS FOR THE GLO DIST.
F= ANNUAL NONEXCEEDANCE PROBABILITY

FOR 500 YEAR STORM

ξ =	1.93	FIGURE 18, 98-4044
α =	0.55	FIGURE 32, 98-4044
κ =	-0.20	FIGURE 46, 98-4044
F=	0.998	

Xd(F)= 8.71 INCHES

STATE OF TEXAS
FREDERICK H. HAAS
55490
REGISTERED PROFESSIONAL ENGINEER

12/17/04

Figure 18

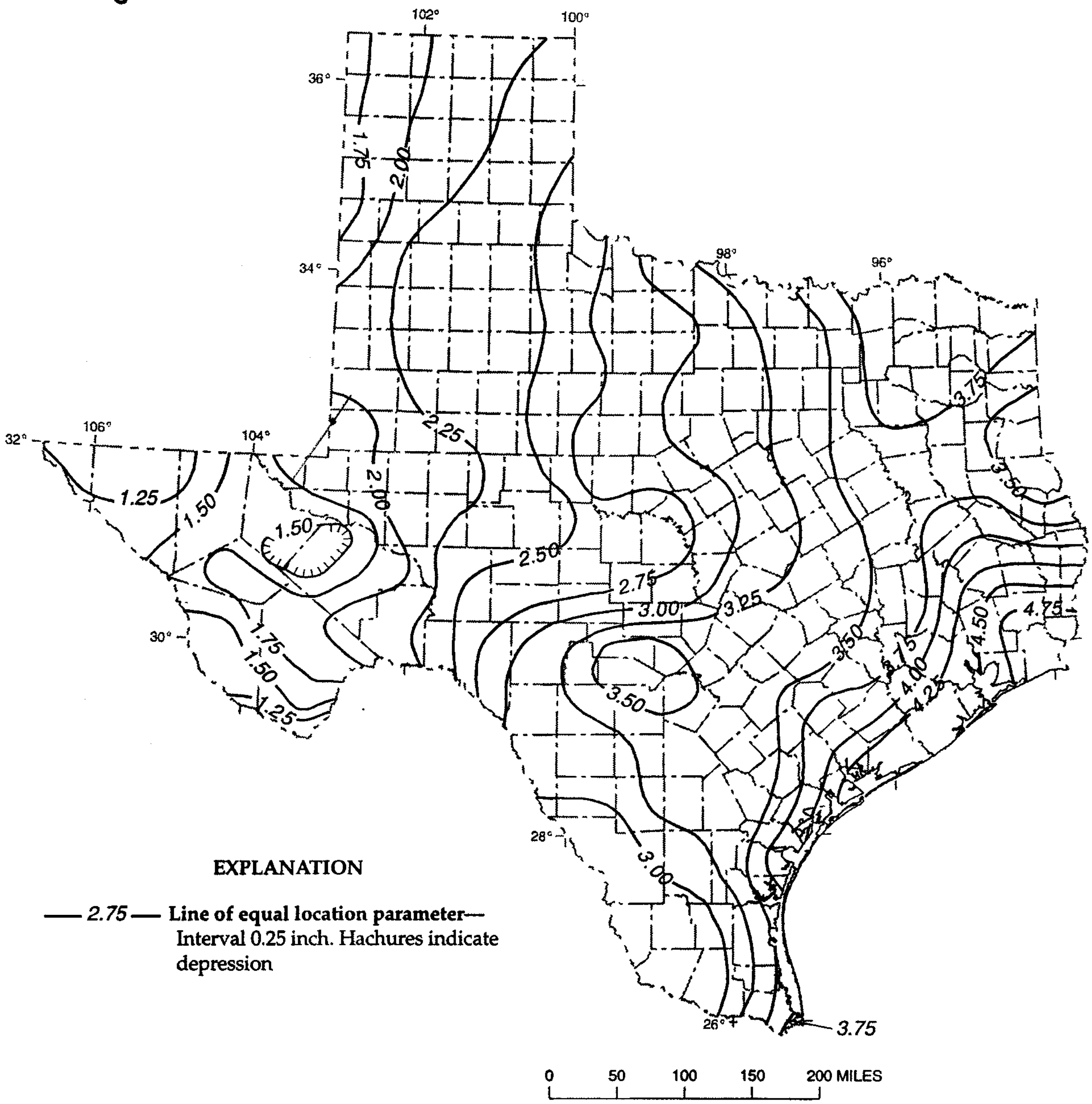


Figure 18. Location (ξ) parameter of generalized logistic (GLO) distribution for 24-hour precipitation duration in Texas.

Figure 32

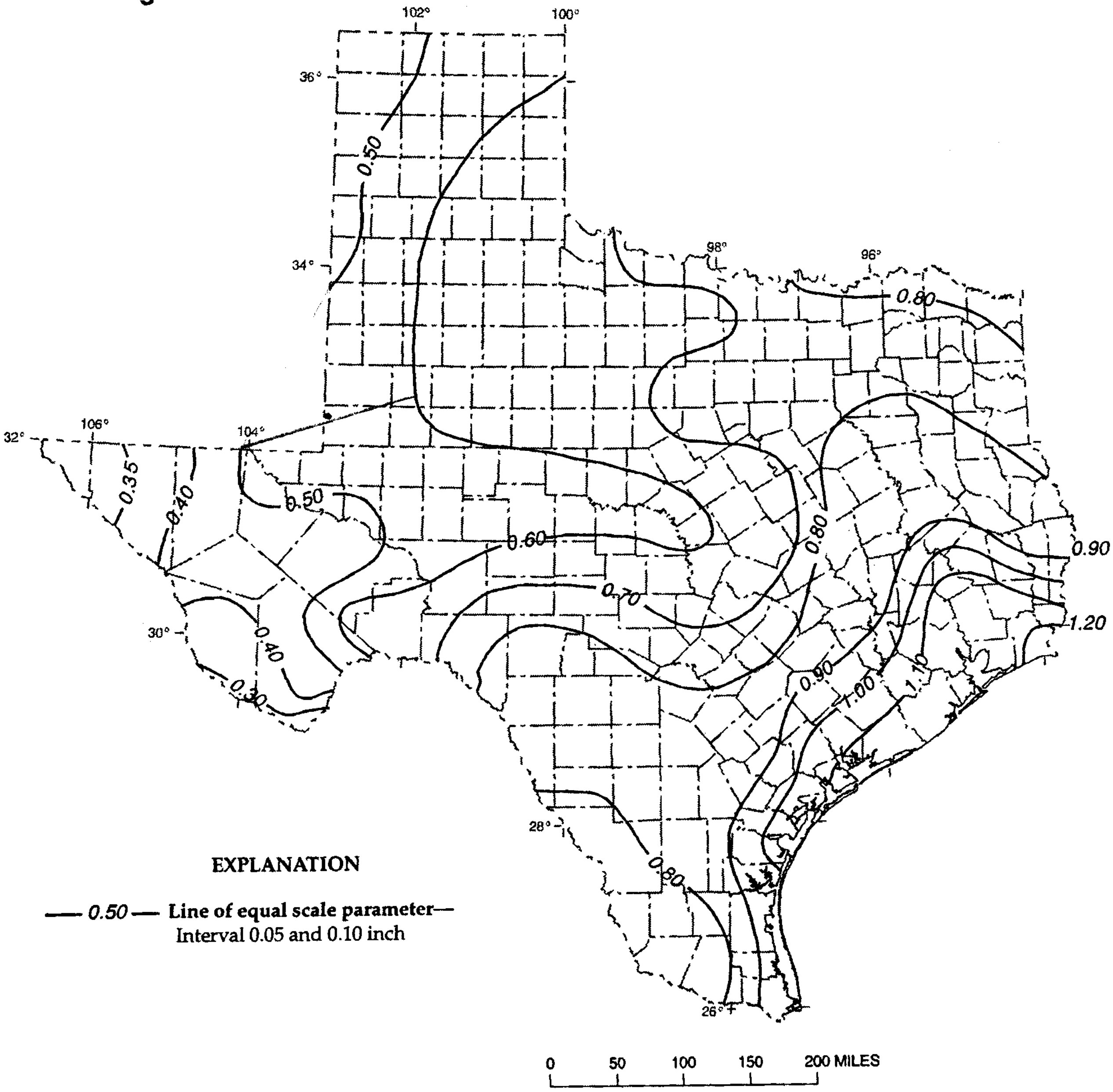


Figure 32. Scale (α) parameter of generalized logistic (GLO) distribution for 24-hour precipitation duration in Texas.

Figure 46

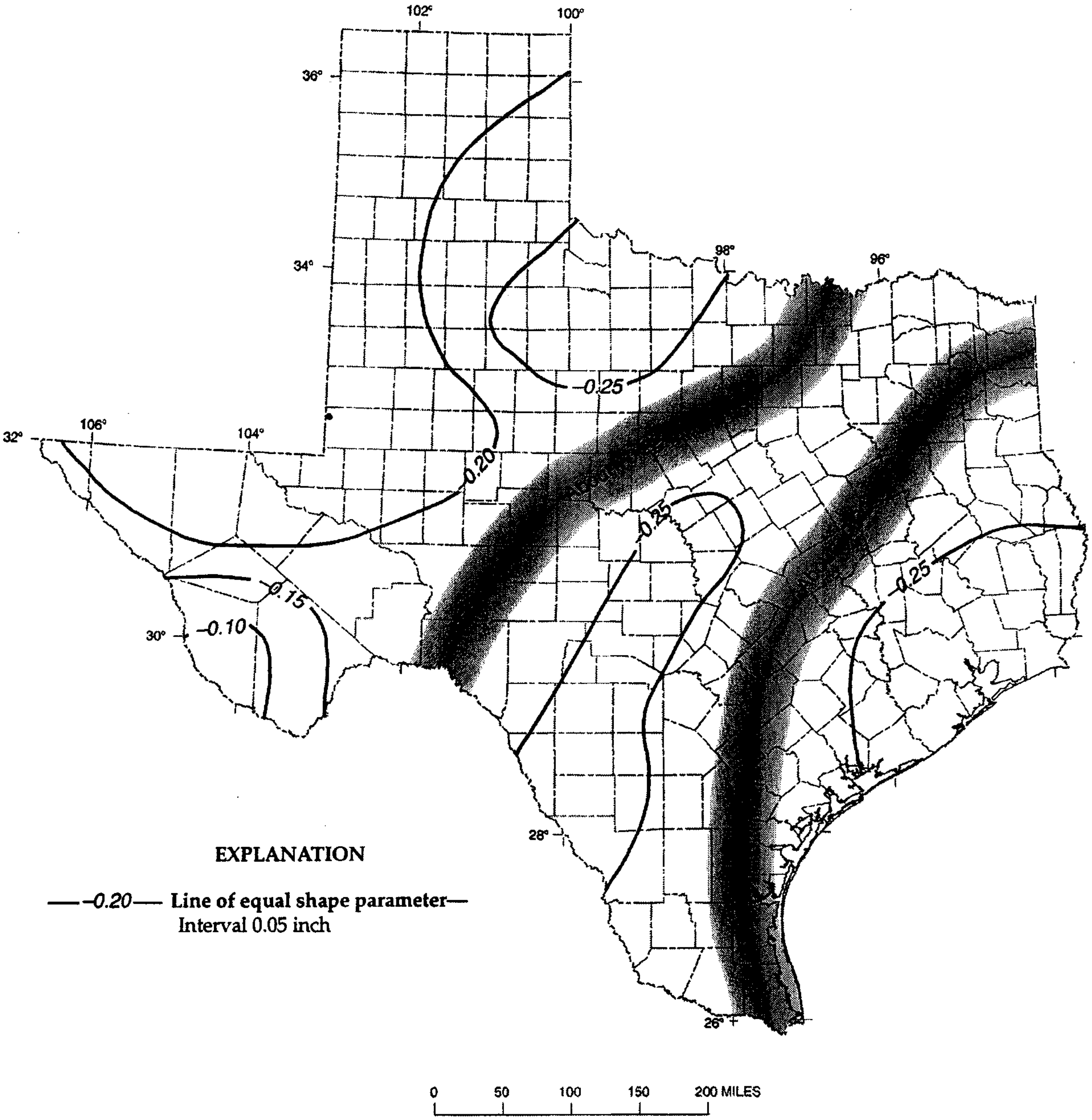


Figure 46. Shape (κ) parameter of generalized logistic (GLO) distribution for 24-hour precipitation duration in Texas.

DRAINAGE CALCULATIONS

PMP CALCULATIONS

REF: HYDROMETEOROLOGICAL REPORT NO. 51, PROBABLE MAXIMUM PRECIPITATION ESTIMATES, UNITED STATES EAST OF THE 105TH MERIDIAN, NATIONAL WEATHER SERVICE, 1978 (HMR 51)

NOAA HYDROMETEOROLOGICAL REPORT NO. 52, APPLICATION OF PROBABLE MAXIMUM PRECIPITATION ESTIMATES - UNITED STATES EAST OF THE 105TH MERIDIAN, NATIONAL WEATHER SERVICE, 1982 (HMR 52)

STATE OF TEXAS
FREDERICK H. HAAS
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REGISTERED PROFESSIONAL ENGINEER

12/17/04

AREA-DEPTH-DURATION FROM HMR 51

AREA SQ.MI.	DURATION (HR) 6	12	24	48	72
10	25.0	30.5	35.0	39.0	40.5
25	23.2	28.1	32.5	36.6	38.2
50	21.9	26.1	30.3	34.5	36.2
100	20.1	24.0	28.1	32.2	34.0
175	18.8	22.3	26.3	30.2	32.3
300	17.1	20.4	24.4	28.2	30.2
450	15.7	19.0	22.9	26.9	28.8
700	14.2	17.4	21.1	25.0	27.0
1000	13.0	16.1	19.6	23.5	25.0

FROM CURVE

AREA SQ.MI.	18 - HR DURATION
10	33.0
25	30.6
50	28.5
100	26.4
175	24.7
300	22.8
450	21.3
700	19.6
1000	18.1

DRAINAGE CALCULATIONS

FIRST THREE SIX HOURS

AREA SQ.MI.	1	2	3
10	25.0	5.5	2.5
25	23.2	4.9	2.5
50	21.9	4.2	2.4
100	20.1	3.9	2.4
175	18.8	3.5	2.4
300	17.1	3.3	2.4
450	15.7	3.3	2.3
700	14.2	3.2	2.2
1000	13.0	3.1	2.0

FROM GRAPH

AREA SQ.MI.	1	2	3
10	24.99	5.50	2.53
25	23.50	4.62	2.51
50	21.90	4.20	2.48
100	20.10	3.86	2.44
175	18.60	3.63	2.40
300	17.00	3.42	2.35
450	15.70	3.30	2.29
700	14.20	3.18	2.20
1000	13.00	3.08	2.02

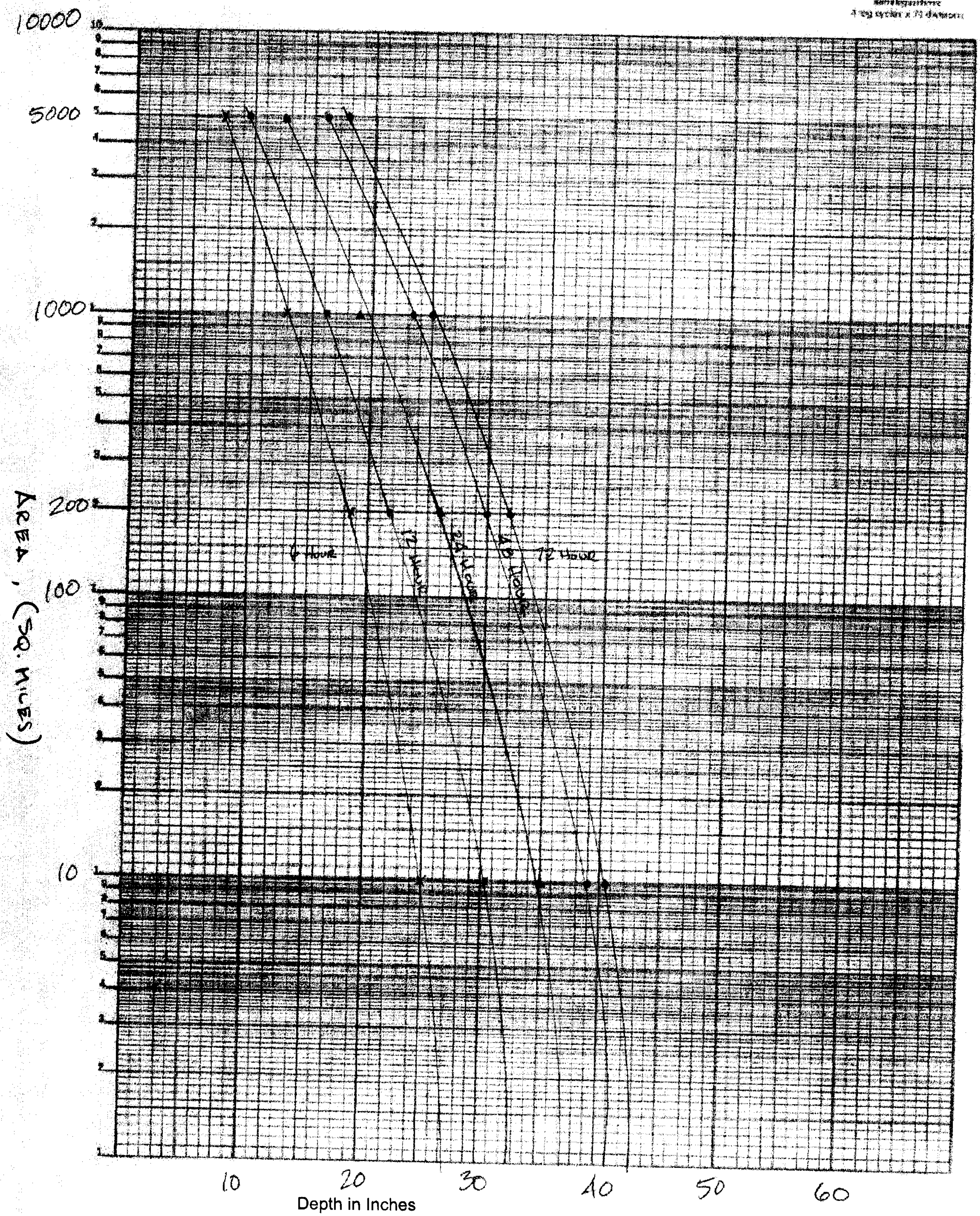
6-HR INC.	PRECIP. (IN.)	DELTA PRECIP (IN.)
1	24.99	24.99
2	30.49	5.50
3	33.02	2.53
4	35.00	1.98
5	36.00	1.00
6	37.00	1.00
7	38.00	1.00
8	39.00	1.00
9	39.50	0.50
10	40.00	0.50
11	40.30	0.30
12	40.50	0.20

DRAINAGE CALCULATIONS

TEMPORAL DISTRIBUTION

INTERVAL (HR)	SEQUENCE A	SEQUENCE B
0 to 6	0.20	0.30
6 to 12	0.30	0.50
12 to 18	0.50	1.00
18 to 24	0.50	1.00
24 to 30	1.00	24.99
30 to 36	1.00	5.50
36 to 42	1.00	2.53
42 to 48	2.53	1.98
48 to 54	24.99	1.00
54 to 60	5.50	1.00
60 to 66	1.98	0.50
66 to 72	1.00	0.20

7HH 12/04


semi-logarithmic
4 log cycles x 70 divisions
10000
5000
1000
200
100
10
Area, (Sq. Miles)
6 Hour
12 Hour
24 Hour
48 Hour
72 Hour
10
20
30
40
50
60
Depth in Inches

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HAESTAD METHODS
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WATERBURY, CT 06708 USA
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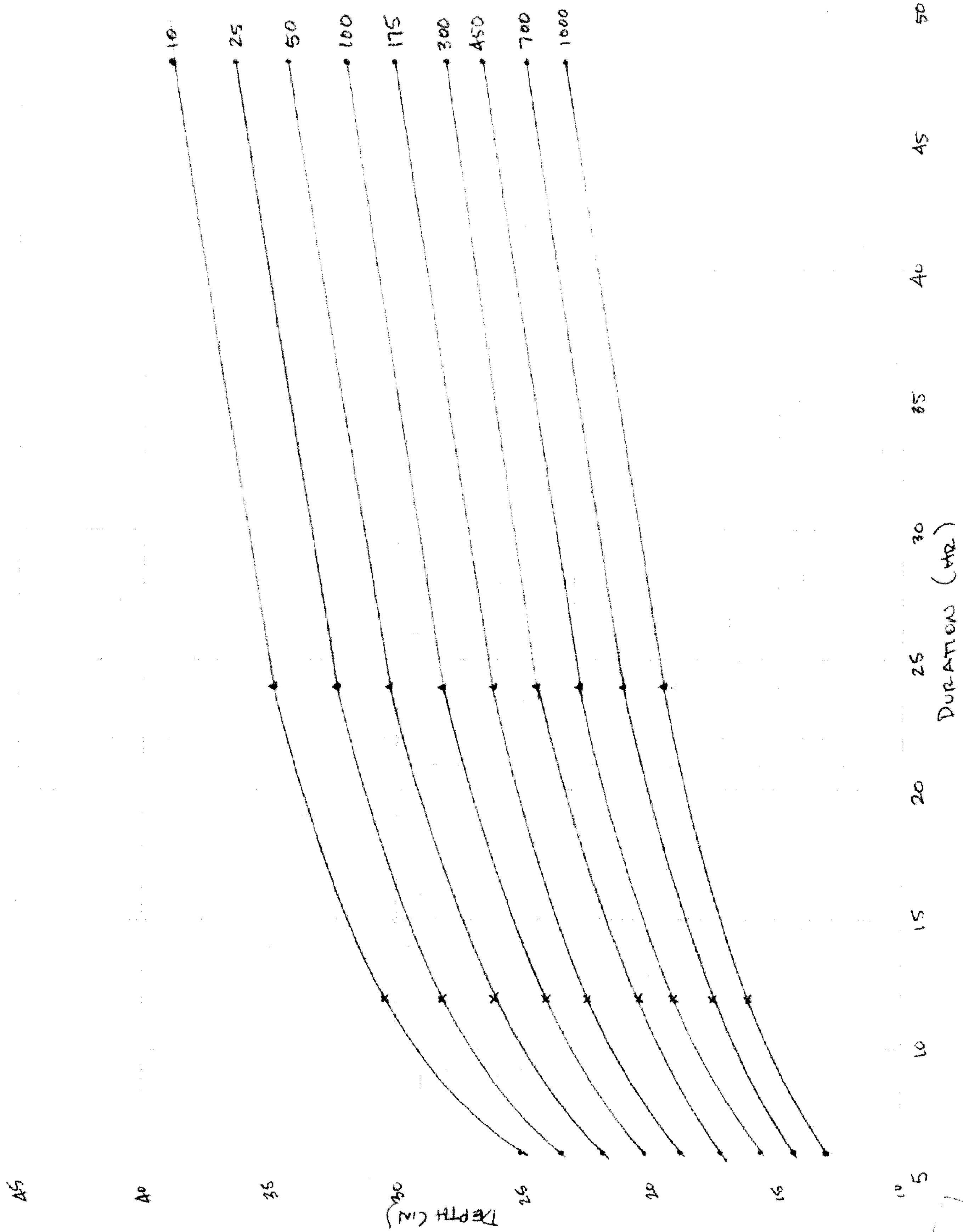
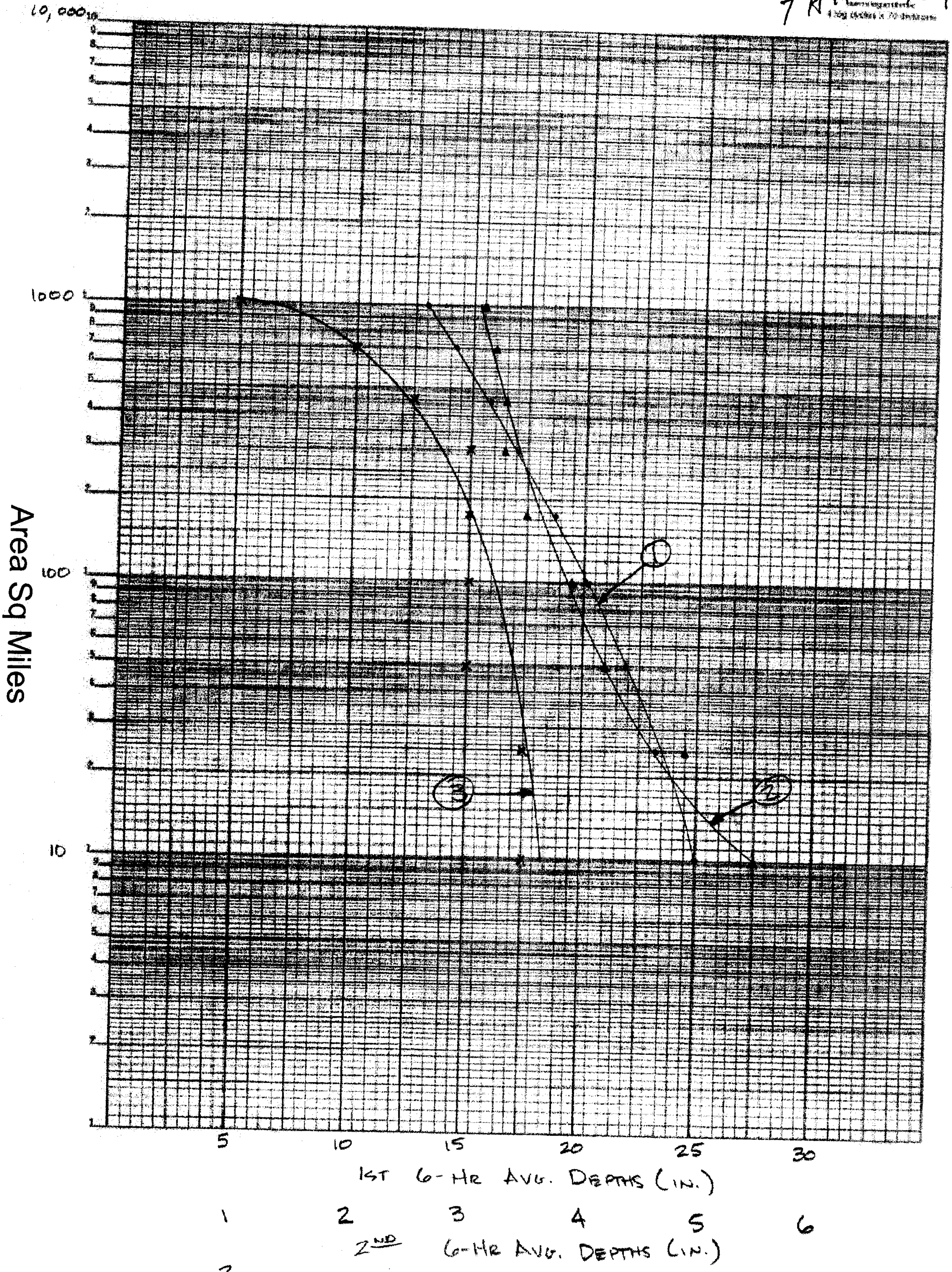
INTERNET: www.haestad.com & www.civilprojects.com

Project
Project #
Date 12/04
Engineer MHH



7HH 12/04


10,000
1000
100
10
Area Sq Miles
5
10
15
20
25
30
1ST 6-HR AVG. DEPTHS (IN.)
1
2
3
4
5
6
2ND 6-HR AVG. DEPTHS (IN.)
2
3
1
2
3