PERMIT ATTACHMENT L

ENGINEERING REPORT
From the Permit Application, Volume III

Prepared for:

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ENGINEERING REPORT

TRIASSIC PARK WASTE DISPOSAL FACILITY
CHAVES COUNTY, NEW MEXICO

December 1997 (Revised October 2000)

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1.0 GENERAL

1.1 INTRODUCTION

Gandy Marley Inc. (GMI) is submitting a RCRA Part B Permit Application to construct and operate the proposed Triassic Park Waste Disposal Facility (EPA ID NO. NM0001002484) to be located in Chaves County, New Mexico. This engineering report prepared by TerraMatrix/Montgomery Watson (TerraMatrix) presents the detailed design of the Triassic Park Waste Disposal Facility submitted in support of the Triassic Park Waste Disposal Facility RCRA Part B Application.

1.1.1 Background

In 1994, Gandy Marley Inc. contracted the S.M. Stoller Corporation to perform site characterization work and to prepare RCRA Part A and Part B Permit Applications for location of a hazardous waste treatment, storage and disposal facility on a 480 acre parcel of privately owned land located in Chaves County, New Mexico. The proposed site is located in Section 17 and 18 of R31E, T11S which lies approximately 42 miles east of Roswell, New Mexico and 36 miles west of Tatum, New Mexico.

In August 1994, Gandy Marley Inc. contracted with TerraMatrix to prepare preliminary designs for the various site facilities and to assist S.M. Stoller in the preparation of the RCRA Part B Permit submittals. Since that time, S.M. Stoller and TerraMatrix have been working jointly to respond to comments and requests for additional information made by the New Mexico Environmental Department (NMED).

The facility design as presented herein is a product of several design iterations which incorporated additional information and design modifications as suggested by the NMED.

1.1.2 Objective and Scope

The primary objective of this report is to present the detailed design and engineering analyses required under 40 CFR Part 264 and 20 NMAC 4.1 in support of the Triassic Park Waste Disposal Facility RCRA Part B Permit Application. This engineering report presents detailed design drawings, construction specifications, construction quality assurance plan, surface water control plan, and supporting engineering analyses and laboratory studies applicable to the following site features and facilities:

- Site Arrangement
- Landfill
- Evaporation Pond
- Truck Roll-Off Area
- Stabilization Facility
- Drum Handling Facility
- Liquid Waste Storage Facility
- Truck Wash Facility

The report also presents the landfill and evaporation pond action leakage rate and response action plan along with its supporting engineering analyses.

1.1.3 Report Organization

This report is organized into ten sections including this Section 1.0, Introduction. Sections 2.0 through 9.0 describe the design elements and engineering analyses for the general facility arrangement, the landfill, the evaporation pond, the truck roll-off area, the stabilization facility, the drum handling facility, the liquid waste storage facility and the truck wash facility. Section 10.0 presents a list of references used in the report followed by the report appendices. Appendices A through H present, respectively, the detailed design drawings, construction quality assurance plan, construction specifications, laboratory test results, engineering calculations, surface water control plan, and action leakage rate and response action plan.

The drawings in Appendix A present final designs for the RCRA permitted facilities. Details on the non-RCRA components of the facilities may be supplemented during the bidding and construction phase. Gandy Marley will supply the additional details on the non-RCRA components of the design to NMRD for review and approval prior to the start of construction.

1.2 REGULATORY CRITERIA AND GUIDANCE

The following Federal and State regulations, as well as Federal guidance documents were used in the design:

- New Mexico Hazardous Waste Regulations, 20 NMAC 4.1;
- Title 40 -- Code of Federal Regulations (40 CFR), Part 264;
- U.S. Environmental Protection Agency (US EPA), 1984. Permit Applicants Guide Manual for Hazardous Waste Land Treatment Storage and Disposal Facilities
- U.S. Environmental Protection Agency, 1988. Lining of Waste Containment and Other Impoundment Facilities, Part 1 of 2 and Part 2 of 2.
- U.S. Environmental Protection Agency, 1988. Seminar Presentations - Requirements for Hazardous Waste Landfill Design, Construction and Closure.
- U.S. Environmental Protection Agency, 1996. Technical Guidance Document,. Construction Quality Assurance for Hazardous Waste Land Disposal Facilities.
- United States Environmental Protection Agency, July, 1990. Seminars - Design and Construction of RCRA/CERCLA Final Covers, Washington, DC.

Additional supporting reference documents are presented in Section 10.

1.3 REVIEW OF NMED COMMENT RESPONSES

In March 1997 comments on the GMI Triassic Park Waste Disposal Facility RCRA Part B Permit Application were prepared for NMED by A.T. Kearny. In June 1997, Montgomery Watson prepared a response to each comment and indicated how the comment would be addressed with revised information or submittal of additional information. In that submittal, we indicated that it was the intention of GMI to meet all relevant requirements stipulated under 40 CFR 264, 40 CFR 268, 40 CFR 270 and corresponding NMED requirements in 20 NMAC necessary to obtain a RCRA Part B Permit for the Triassic Park Waste Disposal Facility. In addition, GMI would provide the requested supporting technical information for each waste management unit proposed for the facility. Finally, GMI would also provide detailed design drawings, engineering reports, and specifications signed and stamped by a professional engineer registered in the State of New Mexico (Patrick G. Corser, P.E., Registration Number 12236) prior to NMED issuing a Draft RCRA Permit for the Triassic Park Waste Disposal Facility.

1.4 SUMMARY OF GEOLOGIC AND HYDROLOGIC CONDITIONS

Regional and site geologic and hydrologic conditions are discussed in the Triassic Park Waste Disposal Facility Part B Permit Application (45). This site characterization work was performed by the S.M. Stoller Corporation and is based on a series of exploration drilling and test pit programs conducted at the site and review of New Mexico Oil Conservation Division well logs. One of the results of primary importance to this engineering report stemming from the site characterization report is the identification of the "most favorable area" for the location of the landfill. A brief summary of the site geologic and hydrologic conditions based on the Part B Permit application is presented below.

1.4.1 Regional Conditions

The geologic formations present within the region where the Triassic Park Treatment, Storage, and Disposal Facility (TSDF) is situated range from Quaternary through Triassic in age. These include Quaternary alluvium, Tertiary Ogallala Formation, and the Triassic Dockum Group. Permian sediments do not outcrop in this region.

1.4.2 Site Geology

Site stratigraphy generally consists of, from top down, 2 to 20 ft thicknesses of Quaternary alluvial materials; 30 to 100 ft thicknesses of Upper Dockum mudstones, siltstones, and sandy siltstones; and up to 600 ft thicknesses of Lower Dockum mudstones. Permeability testing of mudstones core samples were found to average 2.2×10^{-7} cm/sec and siltstones averaged 1×10^{-4} cm/sec (45).

Based on the Regional Geologic Features, the potential for subsurface subsidence and the occurrence of sinkholes is considered negligible. In addition, there are no identified faults within the project area. The proposed site is located in a geologically stable area with low seismic activity potential. Design ground accelerations of 0.04 g were used in engineering evaluations presented in this report (1).

1.4.3 Site Hydrogeology

Permit Application Section 3.0, Ground Water Protection, provides a detailed discussion of the site geology and supporting investigation activities, as well as, site ground water characteristics and supporting ground water flow modeling. Based on these assessments, the "most favorable" area for the landfill construction was identified (see Figure 3-12 of Section 3.0). The footprint for the proposed landfill generally conforms to the "most favorable" area. Cross sections shown on Drawing No. 7 show the landfill base and geologic foundation intercepts.

1.5 ADDITIONAL FIELD AND LABORATORY STUDIES

In addition to the site characterization drilling and test pitting programs described above, a test pit program to characterize near surface soil conditions and laboratory studies to identify geotechnical properties of the soils and proposed liner components was conducted. Appendix D presents the results of the test pit program, soil index tests, and interface shear tests performed on the soil and geosynthetic liner materials.

1.6 SUMMARY OF CLIMATALOGICAL DATA

Site climatological data was obtained from the National Oceanic and Atmospheric Administration (NOAA) Class A recording station in Roswell, NM. Climate conditions of the area are typical of semi-arid regions characterized by dry, warm winters with minimal snow cover and hot, somewhat moister summers (45).

Moderate temperatures at the Triassic Park Site are typical throughout the year with annual average temperatures near 60°F. Temperatures in December through February show a large diurnal variation, averaging 36°F at Roswell. On approximately 75 percent of the winter mornings, temperatures are below freezing, and afternoon maximum temperatures in the high fifties. Afternoon winter temperatures of 70°F or more are common. Night time lows average near 23°F, occasionally dipping as low as 14°F. There are perhaps two or three winter days when the temperature fails to rise above freezing.

Precipitation is light and unevenly distributed throughout the year, averaging 10 to 13 inches. Winter is the season of least precipitation, averaging less than 0.6-inches of rainfall per month. Snow averages about 5 inches per year at the site and seldom remains on the ground for more than a day at a time because of the typically above freezing temperatures in the afternoon. Approximately half of the annual precipitation comes from frequent thunderstorms in June though September. Rains are usually brief but occasionally intense when moisture from the Gulf of Mexico spreads over the region.

Precipitation for the project area varies greatly from year to year. For example, Roswell's record low annual precipitation is 4.35 inches. The maximum 24 hour rainfall was 5.65 inches in October 1901. The record annual high is 32.92 inches. Most years are either "wet" or "dry"; few are "average". An average precipitation rate for Roswell, for a 107 year period from 1878 to 1982, is 10.61 inches per year.

The prevailing wind direction is from the south with a normal mean wind speed of 9.6 mph at Roswell.

2.0 GENERAL FACILITY DESIGN ELEMENTS

2.1 GENERAL FACILITY DESIGN ELEMENTS

2.1.1 General

General facility design elements include the overall facility layout, traffic plan, and site wide storm water control design. This permit application refers only to Phase 1A. However, potential expansions of the landfill to future phases have been included in the general layout drawings for completeness. This section describes the site layout and provides rationale for the individual facility locations and roadway network. In addition, the site wide storm water control feature system is described.

2.1.2 Facility Layout

Drawing No. 4, Facility Layout, illustrates the proposed locations of all site facilities including the site waste receiving, treatment, disposal, and storage facilities; the site maintenance area; soil stockpiles; surface water control features; water storage basins; and interconnecting access roadways. The location of these facilities is governed by the landfill layout and construction sequencing, existing roads leading to the facility, existing topography and surface water drainage, and operational interactions between the waste storage, treatment, and disposal facilities. Additional rationale for individual facility locations are discussed in the paragraphs below.

Facility entrance and receiving areas including the security gate, administration trailer, truck untarping and sampling stations, chemical laboratory, and truck staging area are located near the facility entrance in the northeast corner of the site. This arrangement facilitates site access security; incoming waste load inspection, sampling, testing, and weighing; and provides vehicle parking, truck staging, and emergency vehicle access.

Waste processing and storage areas including the drum handling facility, stabilization facility, liquid waste storage area, and truck roll-off area are located north of the landfill access. This arrangement will minimize traffic interference between waste processing facility operations, landfill operations, landfill construction activities. The drum handling facility and liquid waste storage area are located closest to the facility entrance because delivery vehicles to these units will not be required to access the landfill or other site facilities. The stabilization facility is located in close proximity to the liquid waste storage area, drum handling facility, truck roll-off area, and landfill entrance to facilitate waste transfer operations between these units.

The evaporation pond and truck wash facility are located to the northwest of the landfill. This arrangement allows trucks leaving the landfill, which need to be cleaned, to pass through the truck wash and exit the facility via the northernmost roadway. The evaporation pond location provides space for future evaporation pond development and is located near the truck wash and the landfill leachate tank locations to reduce leachate haul distances.

The facility maintenance shop area is located next to the truck wash facility because landfill operations equipment is typically cleaned prior to being serviced by the maintenance personnel. As the last facility along the western perimeter haul road, earthmoving and construction equipment will be able to access the maintenance shop from the south thus reducing interference with site operations traffic and minimizing ware to the perimeter road surface. The storm water detention basin is located in the northwest corner of the site because this is a natural low point to which clean run-off from the facility will be directed.

Stockpile and clay processing areas are located along the east side of the facility. These areas provide adequate soil storage space and allow construction equipment to operate separately from other site operations.

The landfill location is governed by subsurface geologic and hydrogeologic characterization discussed in Section 1.4.3.

2.1.3 Facility Traffic Plan

Drawing No. 26, Traffic Plan, illustrates the site roadway locations and grades, traffic flow directions, traffic control features, and emergency vehicle access lanes at the facility entrance. Roadway locations are governed by facility locations and operations requirements. Expected vehicle types and volumes, proposed road types and their intended uses, traffic control features, and individual facility traffic patterns are discussed below. Road design analyses are discussed in Section 2.2.1.

Table 1, Expected Vehicle Types, lists the types of vehicles, their gross vehicle weight, and estimated traffic volume per day which will travel on the site roadways. The traffic volumes shown in Table 1 are estimated based on an assumed waste receipt volume. Actual traffic volumes may vary.

TABLE 1
EXPECTED VEHICLE TYPES

Vehicle Type	Off Highway/On Highway	Gross Vehicle Weight (lb)	Estimated Traffic Volume (units/day)
Waste Haulers			
Roll-off Trucks	On Highway	< 100,000 lb	30-70
End Dump Trucks (Bulk Waste)	On Highway	< 100,000 lb	30-70
Tanker Trucks (Liquid Waste)	On Highway	< 100,000 lb	0-5
Semi Trailer Trucks (Drums)	On Highway	< 100,000 lb	0-5
Other Miscellaneous	On Highway	< 100,000 lb	0-5
Trucks	On Highway	< 100,000 lb	0-5
Site Operations Vehicles			
Vacuum Trucks	On Highway	< 100,000 lb	0-5
Tanker Trucks	On Highway	< 100,000 lb	0-5
Roll-Off Trucks	On Highway	< 100,000 lb	10-30
Flat Bed Trucks	On Highway	< 100,000 lb	0-5
Maintenance Vehicles	On Highway	< 100,000 lb	0-5
LF Waste Compactors	Off Highway	< 100,000 lb	0-2
Excavators	Off Highway	> 100,000 lb	0-2
Backhoes	Off Highway	< 100,000 lb	0-2
LF Scrapers	Off Highway	> 100,000 lb	0-2
Water Trucks	On Highway	< 100,000 lb	0-20
Front End Loader	Off Highway	< 100,000 lb	0-2
Fork Lifts	Off Highway	< 100,000 lb	0-2
Construction Vehicles *Restricted to construction roads*			
End Dump Trucks	Off Highway	< 100,000 lb	NA
Water Trucks	On Highway	< 100,000 lb	NA
Compactors	Off Highway	< 100,000 lb	NA
Graders	Off Highway	< 100,000 lb	NA
Dozers	Off Highway	< 100,000 lb	NA
Excavators	Off Highway	< 100,000 lb	NA
Employee Vehicles	On Highway	< 100,000 lb	30-50

Main Facility Roads

Drawing No. 26, Traffic Plan, identifies the extent of the main facility roadways. These roads include the facility entrance, north access road, south access road, and east and west landfill perimeter roads. Drawing No. 27, Perimeter Road Detail, illustrates the road dimensions, drainage slope, and road surface and subbase material types and thicknesses to be used in construction. The main facility road network will serve the majority of site traffic into and out of the landfill and the waste processing facilities. Construction equipment will typically be restricted to construction haul roads and the cut slope access ramp into the landfill.

Unimproved Access Roads and Temporary Construction Haul Roads

Unimproved access roads and temporary construction haul roads (not shown on the drawings) will be constructed as required by site operations and construction contractors. Access roads to the storm water detention basin, soil stock pile areas, and along the site perimeter fence or along power lines are typical locations for these roads. In general, these roads will be constructed by removing loose materials and vegetation and compacting the underlying soils. No road surface gravels will be placed, however, provisions for surface water drainage, such as culverts and ditches, as well as, erosion control features will be included.

The truck staging area located at the south end of the facility entrance will provide space for waste haul trucks awaiting disposal approval. This area will be surfaced with gravel and will drain to the surface water detention basin. Any localized spills will be cleaned up as required by the contingency plan presented in Volume I.

Parking areas for site personnel vehicles will be designated near the administration trailer, chemical laboratory, drum handling facility, stabilization facility, and maintenance shop area. These areas are also likely be gravel surfaced.

Traffic Control Features

Traffic control features incorporated in the site traffic plan include the main facility entrance gate, stop signs, posted speed limits, and warning and informational signs. Temporary road dividers such as K-rails (also known as California rails) are also often used to separate two-way traffic in high volume areas. Stop sign locations, as shown on Drawing No. 26, Traffic Plan, will serve to control traffic at main roadway intersections and at the various waste processing unit entrances. Speed limits will be posted on all roadways. The main facility road and unimproved access roads will be posted at 15 mph. Temporary construction haul roads will be posted at 35 mph. Additional signage will be posted to identify restricted areas, facility personal protection equipment (PPE) requirements, truck entrance areas, and facility names and access driveways.

Also shown on Drawing No. 26, Traffic Plan, are the emergency vehicle access lanes at the facility entrance. These lanes will remain clear at all times.

Individual Facility Traffic Patterns

The Drum Handling Facility entrance faces the north access road. Incoming trucks will enter the gravel lined apron and will back up to the loading dock areas. Once the truck unloading (or loading) operation is complete, the trucks will exit the facility via the same north access road. Parking areas for site personnel vehicles will be designated near the Drum Handling Facility Office. The gravel apron in front of the facility will not be used to stage waste haul trucks.

The Stabilization Facility has entrances for incoming trucks on both the north and south access roads. These accesses will be used for incoming waste trucks loaded with unstabilized waste for processing. Incoming trucks will enter the gravel lined apron on the north or south side of the facility and back into the stabilization building. Once the load has been dumped into the bin and the truck bed washed out, the truck will exit the facility via the its entrance route. The east and west building entrances will be used by stabilized waste loadout trucks which will cycle between the truck roll-off area or the landfill. The gravel lined areas surrounding the stabilization facility will not be used to stage waste haul trucks. Parking areas for site personnel vehicles will be designated near the stabilization facility office.

Access to the liquid waste storage area is provided on the east, west, and north sides of concrete tank pads. Tanker trucks can use either the north access road or the road to the east of the liquid waste storage area.

The truck roll-off area can be accessed via the north or south access roads.

The landfill design incorporates three access ramps. The two northern ramps will be used by waste haul trucks and landfill operations equipment. These 30 ft wide ramps will accommodate 2-way traffic when necessary, however, in general, the east ramp will be used for incoming traffic and the west ramp for exiting traffic. The third ramp located on the southern cut slope will provide access for earthmoving equipment involved with landfill expansion construction activities. Incoming waste haul trucks will be released from the truck staging area and use the south access road and northeast ramp to enter the landfill. Empty haul trucks will exit the landfill via the northwest ramp, pass through the truck wash facility, if necessary, and exit the site via the north access road.

Evaporation Pond 1A and 1B truck discharge stations are accessible via the north and south access roads, respectively. Pond 1B will be used predominantly for day to day operations for incoming waste. However, the liquid levels in both ponds will be maintained at approximately the same level to maximize evaporation. Tanker trucks will enter Pond 1B discharge station turnout from the west, discharge their load, and can exit the site via the north or south access roads.

2.1.4 Facility Storm Water Control

Facility storm water control is provided in the design by a network of surface water run-on and run-off diversion channels and collection and detention basins. These facilities have been designed to collect and contain the required 25-year, 24-hour storm event. Diversion ditch calculations are presented in Appendix F (Volume VI).

<u>Site Vicinity Drainage Pattern</u>

The proposed site is located on the far eastern flank of the Pecos River Basin. The land surface gently slopes to the west at approximately 40 to 50 feet per mile toward the river. The sloping plain is characterized by low relief hummocky wind-blown deposits, sand ridges, and dunes. The Caprock escarpment (or Mescalero Rim) is one of the most prominent topographic features in southeastern New Mexico. East of the proposed site, the escarpment has approximately 200 feet of relief. Up gradient sources of surface water flow are bounded by the Caprock escarpment. The United States Geologic Survey (USGS) Topographic Maps (7.5 minute series) for Mescalero and Mescaleo N.E. in Appendix F illustrate the topographic features and contributing surface water drainage areas pertinent to the site. The watershed associated with the east diversion channel encompasses an area of approximately 378 acres beginning at the Caprock escarpment and continuing down to the site's east property line.

Surface Water Run-On Diversion Channels

The east diversion channel located on the eastern edge of the landfill property line provides run-on control from the east watershed area. The remaining topography surrounding the site grades away from the site. The discharge location for this channel coincides with existing natural drainages to the north of the site as indicated on Drawing No. 25. The east diversion channel will remain in place after the cover system is constructed.

Surface Water Run-Off Channels

To control the run-off from the facilities area, several collection channels and culverts were designed to divert the peak discharge from the 25-year, 24-hour storm event to a storm water detention basin. The location of the collection channels (Ditch 1 through 6), culverts, and detention pond are shown on Drawing 25 . Channels 1 and 2 are located along the inside of the perimeter road at the toe of the final cover slope. The channels divert run-off from the final cover to channel 5 located at the northwest corner of the landfill. Channels 3 and 4 run along the outside edge of the perimeter road. Channel 3 collects the majority of runoff from the disturbed facilities areas immediately to the east and north of the landfill footprint. Channel 4 collects run-off from the west and south perimeter road. Both channels also discharge to channel 5 at the northwest corner of the landfill. Channel 5 collects the run-off from ditches 1, 2, 3, and 4 and conveys it to the detention pond. Channel 6 collects run-off from the facilities located near the entrance to the site and routes it to the detention pond.

Two ditches, Ditches 7 and 8, are located in the Phase I landfill. These channels are designed to divert runoff from unlined areas of the landfill to the clean water collection basin located in the south end of the landfill.

Two additional ditches (9 and 10) will be located around the evaporation ponds.

Surface Water Detention Basins

There will be three lined detention basins located on the site. The surface water detention basin located in the northwest corner of the site is shown on Drawing No. 25. The clean water collection basin located in the toe of the Phase 1A cut slope and the third basin, which will be located in the lined portion of Phase 1A and will extend from the waste fill slope to the clean water collection basin berm, are shown on Drawings No. 10 and 13.

A berm has been included at the base of the access road to the storm water retention basin of Phase 1A to prevent access road run-off into the contaminated water basin.

Final Cover

The Final Cover Grading Plan is shown on Drawing No. 22. An access road to the top of the landfill is located along the western side of the landfill. The surface water control ditch adjacent to the road will reduce erosion and control surface run-off of the cover. The ditch dimensions and details are shown on Drawings No. 25 and 27.

2.2 GENERAL FACILITY DESIGN ANALYSES

2.2.1 Road Designs

Drawing No. 27, Main Facility Road Detail, illustrates the road dimensions, drainage slope, and road surface and subbase material types and thicknesses to be used in construction. Construction Specification Section 02225, Road Base, provides details regarding road construction materials and placement execution.

Calculations presented in Appendix E, evaluates the main facility road design and specification relative to the expected traffic conditions identified in Table 1. As described in the calculation, the main facility bearing capacity of 2,000 psf is suitable for the expected traffic loading.

2.2.2 Facility Surface Water Control Design Analyses

All surface water calculations were conducted utilizing the SEDCAD+ computer model developed by Civil Software Design (63). Channels were sized based on the Mannings equation for open channel flow. The methodology and assumptions used in the design of the surface water control system are presented in Appendix F. Drawing No. 25 presents a layout of the surface water control plan and a schedule of channel and culvert dimensions and installation criteria.

Detention Basin Design Analyses

The surface water detention basin is designed to contain the storm water discharge from the entire active site area given flows from a 25-year, 24-hour storm event. In order to assess the required size of the surface water retention basin, a worst-case storm water volume discharge area was identified. The worst case scenario assumed that the final cover was in place and the run-off from the entire landfill footprint along with the run-off from the surrounding facilities area are all diverted to the basin. The total drainage area is approximately 265.5 acres. Of the 265.5 acres 44 percent is assumed to be reclaimed and revegetated and the remaining 56 percent is considered to be disturbed. The total run-off was computed to be approximately 51.4 ac-ft. Total volume of the detention pond at the invert of the spillway is 66.1 ac-ft.

Erosion Control

Channels with flow velocities less than 5 fps from a 25-year event will not require erosion protection. Channels with peak flow velocities greater than 5 fps from a 25-year event but less than 5 fps from and average storm (2-year event) will also not utilize erosion protection. During average storm events these channels should be stable, however, during major storm events the channels may show signs of erosion in some areas. These areas will be repaired as required following all major storm events. Channels with peak flow velocities greater than 5 fps from an average storm will be lined with gravel or riprap, as required. All channels are designed with 1 foot of freeboard.

To minimize sediment transport to receiving streams the east channel will be lined with gravel. The channel was designed with 1 foot of freeboard. A riprap apron will be constructed at the end of the East channel to dissipate the flow before entering the natural channel to help reduces erosion. The location of the apron is shown on Drawing No. 25. Details of the apron is shown on Drawing No. 25. Design calculation are shown in Appendix F. Channels 7 and 8, which direct clean water runoff on the side slope of the landfill into the clean water detention basin, will be lined with a high density polyethylene (HDPE) liner.

2.2.3 Operations and Maintenance

All of the regulated facilities will be constructed in accordance with the Design Drawing, Specification and Construction Quality Assurance Plan presented in Volume II, Appendix O. In general, all maintenance and repairs to the facilities will be completed to meet the requirements of the original Design Drawings and Specifications and will be monitored in compliance with the Construction Quality Assurance manual.

3.0 LANDFILL

3.1 LANDFILL DESIGN

3.1.1 General

Landfill design elements include ultimate and interim landfill layout and phasing; subgrade design; liner system design; and leachate collection system, leak detection system, and vadose monitoring sump design. This section describes each of these design elements. This permit application refers only to Phase 1A. However, potential expansions of the landfill to future phases have been included in the general layout drawings for completeness.

3.1.2 Landfill Layout and Phasing

The proposed landfill footprint illustrated on Drawing No. 4, generally conforms to the most favorable area as previously described. The landfill footprint is divided into three phases (Phase 1, Phase 2, and Phase 3) with each phase having a separate leachate collection, leak detection, and vadose detection system. These phases will be further subdivided based on development sequencing and landfill waste receipt rates. The limits of Phase 1A , the first area of the landfill to be developed, is shown on Drawing Numbers 8, 9, and 10. Details of the ultimate landfill configuration and the Phase 1A configuration are discussed below.

Ultimate Landfill Configuration

Drawing Nos. 6, 7, and 22, illustrate the ultimate configuration of the landfill for Phases I, II and III. The landfill footprint defined by the crest line encompasses approximately 101 acres. The final cover area, which will extends 20 ft beyond the crest line, is approximately 107 acres. The final cover area for Phase 1A is approximately as shown in Drawing No. 22, no waste will be placed outside of the crest line of the landfill and leachate percolating vertically through the waste mass will be contained by the slope and floor liner systems.

The subsurface, or basal, portion of the landfill will be excavated to a depth of approximately 100 ft. At this depth, the floor and sumps of the landfill will be located in the Lower Dockum Unit (Drawing No. 7). All side slope angles are 3 horizontal: 1 vertical (3H:1V) and the base in each landfill phase grades approximately 3 percent with a minimum of 2 percent towards its respective sump area. The basal liner system anchor trench is located approximately 4 ft beyond the crest of the landfill (Drawing No. 12). Sumps are located at convenient locations in each phase to allow for subphase landfill development, to provide space for access ramps, and to maintain leachate collection system flow lengths capable of detecting a leak in a timely manner.

As shown on Drawing Nos. 7 and 22, the final cover system will reach a maximum elevation of approximately 4,205 ft. The cover system will crest at the mid-point of the landfill and will slope at 6 percent outwards. Slopes around the perimeter of the landfill will be 4H:1V.

Phase 1A Landfill Configuration

Phase 1A landfill development is illustrated on Drawing Nos. 8, 9, 10, and 11. The basal liner system will cover the entire north 3H:1V slope, the slopes below the access ramps, and most of the Phase 1A floor. Waste placement will occur only on lined areas as shown on Drawing No. 10.

Landfill access ramps located on the east and west sides of Phase 1A grade at 10 percent from the crest to the floor surface. The 30 ft wide ramps can facilitate two way traffic. Drawing No. 14, illustrates the access ramp cross sections when waste placement takes place below the ramps and when waste placement takes place above the ramps.

Drawing No. 13, shows slope run-off diversion ditches located along the access ramps that discharge into a collection basin positioned at the toe of the cut slope. This temporary storm water control feature will collect run-off from unlined slope areas above the access ramp and from the cut slope area during Phase 1A waste filling. Clean water collected in the basin may be used for dust control within the landfill or may be pumped out of the basin and discharged into the site surface water control system.

3.1.3 Subgrade Excavation, Liner System, LCRS, LDRS, and Vadose Sump Design

Subgrade Excavation

Drawing No. 6 shows the landfill excavation and structural fill contours. The crest of the landfill generally follows the site's surface topography which grades from the southeast to the northwest. Fill areas along the south and west sides of the landfill combined with cut areas along the landfill's north side provide sufficient grade differences for perimeter drainage ditches to move storm water run-off to the detention basin located in the northwest corner of the site. Drawing No. 5 indicates the initial cut and fill areas that would be required for the initial site development. This would require grading around the perimeter of the landfill and in the waste processing areas.

Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing No. 12 shows the landfill basal liner components intended for the floor, slopes, and anchor trench areas. The landfill liner system is a double lined system consisting of (from bottom up) a prepared subgrade, a composite (geosynthetic clay liner and geomembrane) secondary liner, a geocomposite leak detection drainage layer, a primary geomembrane liner, a geocomposite leachate collection drainage layer, and a protective soil layer. Details of each liner component are discussed below:

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *16-foot compacted clay liner (CCL) around landfill perimeter*

  During excavation, Quaternary Sands will be exposed around the perimeter of the landfill to depths ranging from 2 to 10 feet. As shown on Drawing No. 23, 16 feet of horizontal thickness of this sand material will be removed and replaced with a compacted CCL component. The purpose of the CCL is to provide the liner with enhanced water barrier qualities in the Quaternary Sand areas. The CCL will be extended into the Upper Dockum Unit to a depth of at least 2 feet. The CCL ($k \leq 1 \times 10^{-7}$ cm/sec) in combination with the overlying GCL described below will serve as a low permeability barrier layer to restrict infiltration of leachate into the subgrade. The CCL will consist of clay material (CL or CH) obtained during excavation of the landfill and surface impoundment. Specification Section 02221, Clay Liner, describes clay material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Soil liner leachate compatibility tests (ASTM D5084) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the CQA plan. The results of the permeability testing performed in compacted samples are shown in the appendices.

- *Geosynthetic Clay Liner (GCL)*

  The GCL will serve as a low permeability ($k \leq 5 \times 10^{-9}$ cm/sec) barrier layer to restrict infiltration of leachate into the subgrade. The GCL type used will consist of bentonite granules sandwiched between two layers of geotextile. The upper geotextile will be a non-woven 6 oz. material and the lower geotextile will be a woven 4 oz. material. Specification Section 02780, Geosynthetic Clay Liners, describes minimum GCL properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.

  Site specific compatibility tests (ASTM D5084) will be conducted prior to operations.
  Manufacturer published information on the compatibility of the GCL with typical leachate materials is provided in Appendix H-5.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (textured on both sides)*

  The 60-mil HDPE liner placed on top of the GCL is the second component of the composite secondary liner. Together, the GCL and HDPE liner form a highly efficient barrier layer to restrict percolation of leachate into the subgrade (see Section 3.2.7, HELP Modeling). HDPE texturing increases the friction angle between the geomembrane and the underlying and overlying geotextile liner elements. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance. Section 3.2.1, discusses slope stability analyses for the landfill liner system.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility. Manufactures' Published Information on the compatibility of the HDPE with typical leachate materials is provided in Appendix H-4.

- *Geocomposite leak detection drainage layer (transmissivity $\geq 2.2 \times 10^{-4}$ m^2/sec as tested under actual field conditions) consisting of*:

  * A 7 oz. geotextile (non-woven)
  * A geonet
  * A 7 oz. geotextile (non-woven)

  The high transmissivity geocomposite leak detection drainage layer provides a means to transmit and remove leachate percolating through any leaks in the primary geomembrane layer above. The upper and lower geotextiles serve to filter sediments from the leachate and cushion the geomembranes, respectively. Flow calculations discussed in Section 3.2.8 and presented in Appendix G indicate that the geocomposite, in combination with the centrally located 8 inch diameter drain pipe, are capable of removing leachate in a timely manner such that head on the underlying geomembrane will remain less than 1 foot. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance (CQA).

The arrangement for the 8 inch diameter drain pipes and surrounding drainage gravel and filtration geotextile, which are located in the floor of the leak detection layer and the leachate collection layer, are illustrated on Drawing No. 12. Specification Section 02714, Filter or Cushion Geotextile, describes minimum geotextile properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

Calculations demonstrating the leak detection system performance capabilities are presented in Section 3.2.7, HELP Modeling and Section 3.2.8, Leachate Collection and Removal Leak Detection and Removal, and Vadose Monitoring System Hydraulic Analyses.

- *60-mil thick HDPE geomembrane liner (textured on both sides)*

  This HDPE geomembrane serves as the primary barrier layer of the double liner system. Specification Section 02775, Geomembrane Liners, discussed above also applies to this geomembrane layer.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility. Manufactures' published information on the compatibility of the HDPE with typical leachate materials is provided in Appendix H-4.

- *Geocomposite leachate collection and removal drainage layer (transmissivity ≥ 2.2 x 10^{-4} m^2/sec as tested under actual field conditions) consisting of :*

  * A 7 oz. geotextile (non-woven)
  * A geonet
  * A 7 oz. geotextile (non-woven)

  This geocomposite layer serves as the primary leachate collection and removal system. Leachate percolating through the overlying waste fill will drain through the geocomposite to the central drain pipe and then flow to the leachate collection sump where it will be removed via the slope riser pipes. This material is the same used in secondary leak detection layer. The floor drain pipe arrangement is also the same.

  Primary geocomposite flow calculations are presented in Appendices E and G, and the performance demonstrations are provided in the HELP Modeling discussed in Section 3.2.7.

- *2-foot thick protective soil layer*

  A 2-foot thick protective soil layer will be placed above the primary leachate collection geocomposite. The protective soil layer will extend over all lined floor and side slope areas. The purpose of the soil layer is to protect the underlying geosynthetics from damage due to vehicle traffic or from waste debris settlement. Specification Section 02716, Protective Soil Layer, describes material requirements including particle size, placement requirements, and survey and field quality control requirements. This soil layer will be placed during construction of the liner system.

Leachate Collection and Removal, Leak Detection and Removal, and Vadose Monitoring Sump Systems

The leachate collection and removal (LCRS), leak detection and removal (LDRS), and vadose monitoring systems each have a separate sump from which fluids can be collected and removed. The liner systems on the landfill floor continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated into the drainage systems. Also, because liquids may be present, clay soil liner components have been added below the primary geomembrane liner and below the secondary GCL liner. These clay soil liner elements are not required by the regulations but are added to enhance the barrier qualities of the liner elements in the sump. Drawings describing the sump arrangements in Phase 1A include Drawing Nos. 15, 16, 17, and, 18. As shown on the drawings, the sumps are square pyramidal shapes which lie concentrically above one another. The slope riser pipes enter their respective sumps at the sump base and are horizontally offset to provide adequate space for slope riser trenches. The slope riser trench arrangement enables the vadose and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of the landfill rather than in the sump area. The leachate collection riser pipe lies on top of the primary geomembrane and therefore no liner penetration is required. Table 2, Landfill Sump Arrangement Summary, below lists the dimensions, volumes, flow capacity, slope riser pipe dimensions, pump type and capacity, and fluid level instrumentation included in each of the sumps. Performing curves for the proposed pumps are shown in Appendix H-1.

TABLE 2
LANDFILL SUMP ARRANGEMENT SUMMARY

	LCRS	LDRS	VADOSE
Fluid Capacity[1] (gallons)	102,900	16,840	1,965
Pipe Dimensions (length/diameter)	30 ft/18 in	15 ft/18 in	10 ft/12 in
Flow Capacity[2] (gallons per day)	618,480	135,400	For Detection
Pump Type/Capacity[3] (gallons per minute (gpm))	Grundfos/50 gpm	Grundfos/50gpm	Grundfos/25 gpm
Fluid Level Instrumentation	Yes	Yes	Yes

Notes:
(1) 0.3 x net volume accounts for gravel space
(2) Determined from Dupuit-Forcheimer equation for flow from the sump gravel to collection pipe
(3) Expected pump type and flow capacity for side slope riser.

LCRS Vertical Riser

In addition to its side slope riser, the LCRS sump also has a vertical riser which will extend from the LCRS through the waste fill and final cover system to the surface. The vertical riser is redundant design feature which provides an additional access to the LCRS sump whereby a second pump can be added to rapidly increase leachate removal rates. As shown on Drawing Nos. 17 and 20, the vertical riser arrangement consists of three pipes and three vertical riser pipe pads. The innermost pipe is a 18 inch diameter stainless steel pipe which rests on an HDPE flatstock and extends from the bottom of the LCRS sump through an opening in the concrete vertical riser pad above. Because this pipe is not attached to the concrete pad, any settlement that the concrete pad incurs will not be transferred to the pipe. The concrete vertical riser pad rests on the LCRS gravel and provides support for the second pipe which will extend through the waste fill to the surface. This pipe is wrapped with a double layer of HDPE. This arrangement isolates the pipes from the surrounding soils which reduces down drag forces resulting from waste settlement. Calculations which evaluate the down drag forces and structural design of the concrete vertical riser pad are included in Appendix E.

Crest Riser Pad Arrangement

Drawing No. 19, illustrates the slope riser piping and valving , the double lined 9,000 gallon polyethylene tank (poly tank) system for leachate storage, and the concrete containment pad. Also indicated are high and low level tank cutoff switches, flexible piping connections between the inner and outer poly tanks, the fluid level sight gauge, 50 gpm leachate discharge pump and control panel locations.

The double lined poly tank consists of two tanks, one inside of the other. The inner tank will have a capacity of 9,000 gallons and the outer tank will have a minimum capacity of 15,500 gallons. Liquids containing solvents such as MEK, toluene, zylene, diesel, or gasoline in concentrations greater than 15 percent will not be placed in the tanks. Tank tie down details have been provided by the manufacturer and are included in Appendix H-2. A chemical resistance chart for the tanks is provided in Appendix H-3.

The concrete containment pad will slope towards the landfill crest. A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped providing drainage toward the sump areas. Calculations on the bearing capacity of the concrete pad are detailed in Appendix E-35. Should a catastrophic failure of the tank or piping system occur, leachate will flow back into the landfill leachate collection system rather than be released to unlined areas. The landfill liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the landfill leachate collection system. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

3.1.4 Waste Filling Sequence

As mentioned previously in Section 3.1.2, landfill development will begin in Phase 1A, proceed southward into Phase 2, and then finish in Phase 3. The extent of landfill subphases will be based on waste receipt rates.

Liner installation in Phase 1A will take place in two stages: the slope and floor area below the access ramps and the slope area above the access ramps. The initial stage of the Phase 1A liner installation will consist of liner placement below the access ramps and is the only portion relevant to this permit application. The approximate area that will be lined during the Phase 1A construction is 14.9 acres which is delineated on Drawing No. 10.

Detailed planning for Phase 1B, Phase 2 and Phase 3 liner installation, access ramp location, and waste fill sequencing will be determined and permitted in the future, however, the ultimate landfill configuration will be developed as follows. Once the waste fill approaches the Phase 1A limits defined in Drawing No. 10, the cut slope will be advanced southward into Phase 2 and the remaining floor and slope areas of Phase 1 will be lined. At this time, the stormwater collection basin in the landfill will be removed from Phase 1 and re-established in Phase 2. Waste filling in Phase 1 will continue during this liner expansion. As the waste fill extends beyond and above the access ramps, a ramp will be established in the south waste fill slope to provide access to the newly lined floor areas of Phase 1.
Waste filling will take place in 5 to 10 foot thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will be at least 0.5 ft.

3.1.5 Final Cover

Drawing Nos. 21, 22, and 23 illustrate the landfill's ultimate waste fill configuration and final cover design. The final cover system is a composite cover consisting of (from top down) a vegetative cover, a geocomposite drainage layer, a geomembrane layer, a geosynthetic clay layer, a prepared subgrade layer, and a cover soil layer. Details of each component of this 4.5 foot thick cover system are discussed below.

- *2.5-foot thick vegetative cover*

  The vegetative cover will provide a substrate for plant growth on the cover surface and protect the underlying geosynthetics from frost and sun exposure damage. Establishment of plant growth will enhance evapotranspiration of precipitation that soaks into the vegetative cover and will reduce soil erosion due to rainwater runoff. Specification Section 02227, Vegetative Cover, discusses vegetative cover material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Specification Section 02900, Vegetation and Seeding, identifies seed mixtures, site preparation, and planting requirements for cover vegetation.

- *Geocomposite drainage layer (transmissivity* $\geq 2 \times 10^{-4}$ *m²/sec consisting of :*

  * A 7 oz. geotextile (non-woven)
  * A geonet
  * A 7 oz. geotextile (non-woven)

  The high transmissivity geocomposite drainage layer provides a means to transmit and remove precipitation percolating through the vegetative cover above. The upper and lower geotextiles serve to filter sediments from the rain water and cushion the geomembrane below. Flow calculations discussed in Section 3.27 and presented in Appendix E indicate that the geocomposite, in combination with the vegetative cover above, is capable of removing 99 percent of the precipitation falling on the cover. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

- *60-mil thick HDPE geomembrane (textured on both sides)*

  The 60-mil HDPE liner placed below the geocomposite drainage layer and on top of the GCL is the primary barrier layer of the cover system. Together with the underlying GCL, the HDPE geomembrane forms a highly efficient barrier layer to restrict percolation of rain water into the waste fill (see Section 3.2.7, HELP Modeling). HDPE texturing serves to increase the geocomposite/geomembrane/GCL friction angles to enhance slope stability. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility. Manufacturers published information on the compatibility of the HDPE is presented in Appendix H.

- *Geosynthetic clay liner (GCL)*

  In conjunction with the overlying HDPE geomembrane, the GCL will serve as a low permeability ($k \leq 5 \times 10^{-9}$ cm/sec) barrier layer to restrict infiltration of precipitation runoff into the waste fill. The GCL type used will consist of bentonite granules sandwiched between two layers of geotextile. The upper geotextile will be a non-woven 6 oz. material and the lower geotextile will be a woven 4 oz. material. Specification Section 02780, Geosynthetic Clay Liners, describes the minimum GLC properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, material construction quality assurance.

Manufacture published information on the compatibility of the GCL with typical leachate materials is provided in Appendix H-5.

- *6-inch thick prepared subgrade layer*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *2-foot thick cover soil layer*

  The cover soil layer placed on the surface of the waste fill serves to isolate the waste and any near surface debris from the overlying cover elements and also provides a base for the prepared subgrade layer. Specification Section 02226, Cover Soil, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

As shown on Drawing No. 23 the final cover system will extend 24 ft outside the crest of the landfill. In addition, the waste fill terminates inboard of the crest line. Rain water that percolates through the vegetative cover will flow in the cover system's geocomposite layer to the drainage pipe located in the cover anchor trench. The water will then be discharged to the landfill perimeter drainage ditch system. Rain water that percolates through the cover system and comes in contact with the waste will flow vertically downward and be captured in the LCRS.

Prior to closure of the landfill, an assessment will be made of the landfill waste gas generating potential. If it is concluded that gas generation may result in gas build-ups beneath the barrier layer of the cover or releases following closure exceeding regulator air quality standards, then provisions will be made to collect and monitor gas generation and release during the post-closure period. If this occurs, the latest technology available will be implemented into the construction of the cover system.

Drawing No. 22 indicates the location of the cover access road and surface water diversion ditches. Traffic on the cover access road will be limited to light vehicles such as pick up trucks. Surface water drainage ditches on the cover are included to reduce runoff flow lengths and thereby reduce surface soil erosion. Sections 3.2.10 and 3.2.11 discuss ditch sizing and cover soil erosion, respectively.

Waste settlement impacts on the 6 percent and 4H:1V cover slopes are discussed in Section 3.2.2.

3.1.6 Landfill Storm Water Control Features

Drawing Nos. 13, 14, 22 and 25 illustrate the landfill's storm water control features designed to contain and control rain water run-off and run-on for the required 25 year, 24 hour storm event. These features include the landfill's collection basin and slope run off drainage ditches, cover system drainage ditches, perimeter drainage ditch, and the culverts and drainage ditches leading to the storm water detention pond.

During the Phase 1A waste filling, runoff from the slope areas above the access ramps and from the cut slope area will be diverted to the HDPE lined collection basin located near the toe of the cut slope on the floor of the landfill. HDPE lined diversion ditches located on the side of the access ramps will carry slope run-off to the stormwater collection basin. The landfill perimeter ditches located on either side of the perimeter road will intercept run-off from areas outside of the landfill and divert this water to the stormwater detention basin. . Runoff from active waste filling area will drain to the contaminated water basin at the south end of the landfill. The contaminated water basin is not its own separate entity, but is a part of the Phase 1A landfill that will not initially receive waste. The layout of the contaminated water basin is shown on Drawing Nos.: 10, 11, 13, and 24. Since the contaminated water basin is only a portion of the landfill set aside to store stormwater, it will not be removed as the landfill is expanded to the south. Rather waste will be placed over the top of the contaminated water basin.

During the operational period, when the final cover system is partially installed in some areas and waste filling continues to take place in other areas, run-off from the final cover will be diverted to the surface water detention basin. Following the post closure period, after the effectiveness of the landfill cover has been demonstrated, the surface water detention basin will be removed from service and the area will be regraded to its approximate predisturbance state. Run-off from the landfill cover will be allowed to flow into the natural drainages which existed prior to construction.

Section 4.2.8 summarizes surface water calculations performed to size the landfill's stormwater control features. The calculations are presented in Appendix F.

3.2 LANDFILL DESIGN ANALYSES

3.2.1 Slope Stability

Cut Slope Stability

Prior to filling, unsupported cut slopes will exist on all sides of the landfill. These slopes were analyzed for static and dynamic stability using the Janbu Simplified Method. A computerized slope stability program (XSTABL) was used to analyze the cut slopes (44). Strength parameters used for soil and rock materials were estimated using design overburden pressures and plasticity index data gathered from laboratory testing of site soil materials correlated to published data (46). The material properties used in the analyses are summarized in Calculation No. E-1, presented in Appendix E.

The site grading plans (Drawing Nos. 5 and 6) indicate that the maximum cut slopes will be 3H:1V and maximum height will be approximately 100 feet. Results for the critical 3H:1V slope indicate a static factor of safety of 1.4 for the critical short term (undrained) condition. Stability during seismic loading was estimated by applying a pseudo-static earthquake force in the Janbu analysis. Results based on the 0.04 g design acceleration indicate a dynamic factor of safety of 1.2 for the short term (undrained) condition.

The stability of the outward slopes was also evaluated. Results indicate a static factor of safety of 1.3 and a dynamic factor of safety of 1.1. These slopes were analyzed using Bishop's Method (Appendix E-34).

The temporary cut slope along the south side of Phase 1A was analyzed using Bishop's Method giving a static factor of safety of 1.1 (Appendix E-37).

Waste Fill Stability

Waste fill stability was considered for both the Phase 1A and ultimate landfill configurations. In both cases a face failure through the waste and along the lining system, and a basal failure along the lining system was considered. The analysis assumed a 4H:1V waste fill slope and floor at design base grades. The Sarma analysis method was used to calculate factor of safety and acceleration coefficient (Kc). Kc is the net acceleration that would have to be applied to a slide mass to initiate movement.

Phase 1A Waste Fill Stability

Critical inputs for the Phase 1A stability analysis were as follows:

- *GCL, saturated undrained condition: friction angle = 2° and C=440 psf*

  Based on testing performed by Geosyntec Inc. using actual site soils and a needle punched GCL, the critical failure interface under saturated conditions occurs in bentonite layer between the geotextile components of the GCL. It should be noted that this value is highly conservative since the GCL is most likely to remain in an unsaturated state during the life of the landfill. Additionally, the type of GCL tested was the needle punched variety. Other types of GCLs with stitching between the geotextile components offer substantially greater interface shear strengths.

- *Design ground acceleration = 0.04 g*
- *Waste friction angle ϕ = 29° (29)*
- *Design fill configuration shown on Drawing No. 10*

Results of the Phase 1A analyses presented in Calculation No. E-3, Phase 1A Filling Plan Stability, indicated a static factor of safety of 1.5 and a dynamic factor of safety of 1.0. These factors of safety are considered acceptable for the interim fill configuration of Phase 1A.

Ultimate Landfill Configuration Waste Fill Stability

The ultimate landfill configuration analyses used same liner interface strength inputs as the Phase 1A evaluation and the final waste configuration shown on Drawing No. 22. Results of the ultimate configuration waste fill stability analyses presented in Calculation No. E-4, Ultimate Filling Plan Waste Stability, indicated a static factor of safety of 3.7 and a dynamic factor of safety of 1.5. These factors of safety are considered acceptable for the ultimate waste fill configuration.

Protective Soil Layer Stability

An infinite slope model approach was used to evaluate the stability of the protective soil layer on the 3H:1V landfill slopes which considered the loading scenario of the protective soil layer only, and a loading scenario with a D6 dozer (9.8 psi track loading [16]) on top of the protective soil. The analysis considered saturated and undrained soil conditions. The soil/geotextile interface shear strength was based on a friction angle of 31° and an adhesion of 15 psf obtained from interface shear tests. Results of the analyses indicated a static factor of safety of 2.0 for the soil only case and a static factor of safety of 1.8 for the case with the dozer loading. Both factors of safety are considered acceptable. Calculation No. E-2, Protective Soil Layer Stability, is presented in Appendix E.

Cover Stability

The cover system stability analysis focused on two potential failure mechanisms: a deep block failure through the waste and along the basal liner system, and an infinite slope failure within the cover system. Both stability analyses were conducted for static and dynamic conditions assuming undrained soil conditions. The block failure analysis assumed a zero head condition on the liner system while the infinite slope failure analyses considered a zero head condition and a head condition of 2.5 ft in the cover. As with other stability analyses, a design ground acceleration of 0.04g, waste friction angle of 29°, and liner interface strength of $\phi = 2°$ and c = 440 psf was assumed.

Results of the analyses indicated a static factor of safety of 2.8 and dynamic factor of safety of 1.5 for the deep block failure. The infinite slope analyses indicated a static factor of safety of 10.9 and dynamic factor of safety of 6.5 for the zero head condition and a static factor of safety of 5.2 and dynamic factor of safety of 3.1 for the 2.5 ft. head condition. All of these factors of safety are considered acceptable. Calculation No. E-5, Cover Stability, is presented in Appendix E.

3.2.2 Settlement

Subgrade Settlement

Total settlement of the landfill base due to settlement of the subgrade and prepared subgrade layers was calculated to ensure that the base liner grades did not fall below EPA's recommended minimum of 2 percent.

Subgrade settlement was modeled assuming the subgrade behaves as an elastic medium (30). This assumption implies that any settlement occurs during placement of a given load. Therefore, settlement in the subgrade should occur during the operating life of the landfill and post-closure settlement should be negligibly small. The most important parameter used in this analysis is the elastic modulus of the subgrade. The elastic modulus used was 72,000 ksf which was obtained from conservative estimates for unweathered mudstone (32). The maximum calculated settlements near the center of the landfill are expected to be on the order of 5 inches. Settlement should progressively decrease towards the toe of the sideslopes. These settlements are not expected to result in any excessive stress in the liner system. Details of the subgrade settlement analysis are presented in Calculation No. E-9, in Appendix E.

Final Cover Grades Due to Waste Settlement

As previously mentioned, waste placed at the Facility will consist of hazardous waste which contains no free liquids. All drummed solid material and lab packs will be stacked horizontally in rows within the landfill and the voids between drums filled with compacted bulk wastes. Bulk waste filling will take place in 5 to 10 foot thick horizontal lifts. Waste will be covered with daily cover soil as soon as practicable following waste placement (and minimally at the end of each operating shift). Daily cover soil thicknesses will range from 0.2 to 0.5 ft.

EPA guidelines (54 and 55) suggest a minimum of 3 percent for final cover grades on hazardous waste landfills. The proposed 6 percent initial design cover grade was analyzed to determine the maximum settlement factor to main the final 3 percent grade. The calculated maximum settlement factor was 7 percent. The analysis assumed that the waste settlement is uniform. Calculation No. E-11, Waste Settlement, presents waste settlement computations in Appendix E.

EPA estimates, based on finite element modeling, indicate that settlement factors of 11.5 percent are appropriate for hazardous waste landfills (38). This model considered that the most significant portion of the waste would be solidified material buried in steel drums, with the drums having a maximum allowable void space of ten percent. This model may not be applicable to the Triassic Park Facility because there should be less void space in the waste than that assumed for the model.

In order to mitigate this potential discrepancy between the suggested 11.5 percent and 7 percent, the post-closure waste settlement of Phase 1 should be monitored. The monitoring results will be compared to the estimated settlement factor of 7 percent. If settlement is greater than 7 percent, cover grades of subsequent phases will be steepened to accommodate the settlement and maintain the minimum 3 percent final grade.

3.2.3 Geosynthetics Strength and Performance Analyses

3.2.3.1 Geomembranes

Settlement Induced Stress

The maximum settlement will occur at the base of the cell slopes where the waste load is highest. The subgrade settlement is estimated to be approximately 0.5 feet. This settlement will vary from this calculated maximum at the slope toe to zero at the slope crest. Resulting stresses of 65 psi in the geomembrane are much lower than the 2200 psi geomembrane yield stress. Differential settlement is therefore not expected to damage the liner (34). Details of the liner stress analysis are presented in Calculation No. E-12, Settlement Induced Stress.

Thermal Induced Stress

Due to the 2-foot thick protective soil layer above the liner, the 60-mil HDPE geomembrane liner will not be subject to extended periods of contraction and expansion from daily temperature differentials. Temperature restrictions for installation of geomembrane are discussed in Specification Section 02775.

Tear and Puncture

All geomembranes in the landfill liner and cover system are overlain by at least one layer of geotextile. Review of the puncture resistance of the geotextiles indicates a worst case factor of safety of 3.5 (see Calculation No. E-17, Geomembrane Puncture Resistance in Landfill and Calculation No. E-21, Puncture Resistance of Geotextile/Geocomposite [33]). Therefore, the proposed 60-mil HDPE is adequate to resist puncture stresses.

3.2.3.2 Geocomposites

The geocomposite is intended to act as a lateral drainage layer in both the LCRS and the LDRS. The geonet in the core of the geocomposite is the drainage media and the overlying and underlying geotextile act as filters. The primary design criteria of the geocomposite is the transmissivity. As part of the design process the typical transmissivity values reported in the literature and by manufactures have been reduced to account for clogging of the geotextile, penetration of the geotextile in to the geonet and creep of the geonet.

In order to confirm the actual transmissivity of the material that arrives on the site, the specifications require that the material be tested as part of the conformance testing program. The specific test methods, including backing materials, normal loads, seating times, gradients, and test durations are detailed in the specifications and meet actual design conditions (55).

3.2.3.3 Geotextiles

Geotextile Filtration

Geotextiles are used in a number of locations in both the liner and cover sections for filtration. Specifically, the geotextiles act as filters between the clay liners and drainage layers or between the granular leachate collection material, protective soil cover or general fill and a drainage layer. All of the soil materials expected to be used for either the liners, covers, protective soil cover or general fill are conservatively expected to be fine grained with more than 50 percent of the material passing the Number 200 sieve.

The design criteria outlined by Task Force 25 (31) indicated that for soil material with more than 50 percent passing the #200 sieve, the apparent opening size (AOS) of the geotextile should be less than 0.297 mm. The current geotextile specifications require that the AOS is less than 0.212 mm. Therefore, the geotextile should adequately retain any of the onsite soils. Calculation E-20, Geotextile/Geocomposite filtration, compares specified material AOS values to site soil analyses results.

Geotextile Cushion

The puncture resistance during installation of the proposed geotextile materials was analyzed. The analysis, which used standard design equations (33), was based on the maximum ground pressure exerted by construction equipment, the largest average aggregate size that will be in contact with the geotextile, and the minimum puncture strength properties specified in the General Specifications. Based on these parameters the calculated safety factor for puncture is 3.6, which is acceptable (see Calculation No. E-21, Puncture Resistance of Geotextile/Geocomposite).

3.2.3.4 Geosynthetic Clay Liner

No specific design analyses were conducted on the GCL other than determining the interface friction angle of the material in the liner and cover section. The GCL has a specified permeability of $5x10^{-9}$ cm/sec which exceeds EPA's criteria of $1x10^{-7}$ cm/sec. Detailed specifications for the GCL are presented in the specifications. The critical parameters for the GCL will be confirmed through a conformance testing program on the material that is delivered to the site.

3.2.3.5 Geosynthetics Leachate Compatibility

Specific leachate compatibility tests have not been conducted on the soil or geosynthetic liner components for the Triassic Park facility. These tests have not been conducted at this time, because the specific manufacture of the liner components has not been selected and there is not a representative leachate available for testing. EPA (55) recommends that compatibility testing be done on the specific (manufacture and resin type) liner materials selected for use in a facility and a representative leachate for the facility. Therefore, it is proposed that testing be completed prior to construction once the geosynthetic materials have been selected. Since the facility will not be in operation, a representative leachate will not be available. However, as recommended by EPA (55), market studies can be used to characterize expected waste streams and a synthetic leachate can be developed for use in compatibility testing.

Although compatibility has not been completed, it is expected that the geosynthetic materials selected for the liner and leachate collection system for the Triassic Park Facility have a long track record of successful use at a variety of waste disposal facilities (both municipal waste and hazardous waste) across the US. Therefore, it is not expected that there will be any compatibility issues that would impact the current design. However, as mentioned above, site specific testing will be completed and the results submitted to NMED for approval prior to construction. Supporting information on the compatibility of the HDPE and GCL components of the lining system with various leachates is presented in Appendix H.

3.2.4 Sump Compacted Clay Liner

In the sump base a compacted clay liner will be placed in addition to a GCL layer. The compacted clay liner (CCL) will provide an added thickness to the liner in the area of the sump where leachate is expected to have the longest resident time and the largest head. The specifications for processing, placement, and compaction are detailed in the specifications. The placement criteria in terms of moisture content and dry density is defined by a window with limits defined by the zero air voids curve, a percent saturation line, a minimum dry density and a minimum moisture content. A graph indicating these specific limits is presented in the specifications which were based on actual laboratory testing conducted as part of this study (Appendix D). This method of specifying a compaction window for a CCL is recommended by EPA and is detailed in a series of articles by Prof. Craig Benson (12).

As part of the CQA program samples of the material to be used as the compacted clay liner will be obtained and tested to confirm the permeability criteria ($1x10^{-7}$ cm/sec) can be met. In addition, samples will be taken from the in-place liner to confirm the permeability.

3.2.5 Anchor Trench Design

The pullout capacity of the primary and secondary geosynthetics from the landfill anchor trench was determined. It was assumed the geosynthetics will pull out of the trench with single-sided shear. Single-sided shear is believed to occur rather than double-sided shear because there is less shearing resistance for single-sided shear. Assumed interface friction angles were based on previous laboratory testing for similar materials at low normal stresses. Based on the trench geometry, critical HDPE geomembrane properties, and assumed interface friction angles, both the secondary and primary liners will pull out prior to tearing. Stability calculations for both the secondary and primary liner systems indicate that there are no net downslope forces on the anchor trench because the liner systems are held in place by friction (see Calculation No. E-15, Anchor Trench Pullout Capacity).

3.2.6 Access Ramp Design

Calculation No. E-24, Wheel Loading on Access Ramp, presented in Appendix E, evaluated the puncture resistance of the geomembrane on the landfill access ramps. The ramps grade at 10 percent from the crest of the landfill to the floor. Drawing No. 14, shows the access ramp configuration during initial Phase 1A filling below the ramps and the final configuration after the slope areas above the ramp are lined.

The ramp section consists of the following components(from top down):

- 1 ft thickness of roadbase material
- 12 oz cushion geotextile (enveloping the top and sides of the underlying subbase)
- 2 ft thickness of subbase material
- Basal liner geosynthetics (geocomposite/60 mil THDPE/geocomposite/60 mil THDPE/ GCL/prepared subgrade)

The calculation considered a Caterpillar 631 scraper which weighs approximately 168,000 lbs when fully loaded (16). A factor of safety of 4.6 against puncture of the HDPE is considered acceptable for this loading condition.

An assessment of the stability of the Ramp Liner System under breaking forces from a loaded scraper was also analyzed (34). This analysis utilized the strength parameters from the interface shear testing program. The results presented in Appendix E-6 indicate a factor of safety of 4.3 against sliding on the ramp.

3.2.7 HELP Modeling

Hydrologic Evaluation of Landfill Performance (HELP) (41) modeling was performed to demonstrate equivalency of the proposed Triassic Park landfill liner and cover system with EPA's Minimum Technology Requirement (MTR) systems. This demonstration was submitted to NMED for review and was subsequently approved by NMED on March 11, 1996 and EPA on March 14, 1996. The report entitled, *Triassic Park Hazardous Waste Landfill Alternative Liner System Analyses (Revision 1),* dated March 1996 presents the HELP modeling performed and is reproduced in Appendix E.

The HELP modeling approach used to evaluate the hydrologic performance of the proposed landfill liner and cover alternative follows the NMED's Draft Guidance Document for Performance Demonstration for an Alternative Liner Design Using the HELP Modeling Program Under the New Mexico Solid Waste Management Regulations (20 NMAC 9.1). This approach was selected because it allows a direct comparison between MTR liner system and an alternative liner system,. The results can be used to demonstrate performance equivalency required under 40 CFR 264.301(d).

The conclusions of the HELP modeling as stated in the report are as follows:

- There is little difference between the proposed alternative and MTR in terms of percolation rates through the bottom liner over the life of the facility. The differences that exist in Years 0 through 10 are insignificantly small. The proposed alternate liner performance can therefore be considered equivalent to the MTR liner performance.

- Hydraulic pressure on the primary and secondary liners of both the MTR and proposed alternate liner system is well below the regulatory maximum of 12 inches.

- The cover system leakage is less than or equal to the leakage of the liner system. It effectively reduces precipitation infiltration which will allow the waste to drain once the cover is in place.

3.2.8 Leachate Collection and Removal, Leak Detection and Removal, and Vadose Monitoring System Hydraulic Analyses

Analyses performed to evaluated the effectiveness of the LCRS, LDRS, and Vadose Monitoring Systems are discussed below. Also discussed are slope and vertical riser pipe strength evaluations and the concrete crest riser pad structural analyses.

<u>Leachate Collection and Removal System Analyses</u>

Based on HELP modeling data presented in *Triassic Park Hazardous Waste Landfill Alternative Liner System Analyses (Revision 1),* dated March 1996, maximum LCRS flow rates of 116.8 gallons per acre per day (gpad) for slope areas and 50.9 gpad for floor areas occur during year 11 of the simulated facility life. For Phase 1A, which has a slope surface area of 7.9 acres and floor surface area of approximately

3.4 acres, this totals to approximately 1,100 gpd. Calculation No. E-31, LCRS Pumping Capacity, estimates the flow capacity of the LCRS sump design to be approximately 618,000 gpd (based on Dupuit-Forchniemer Equation [11]).

The flow capacity of the LCRS sump far exceeds the flow rates delivered from the LCRS as determined from the HELP modeling. A Grundfos 50 gpm pump which has the capacity to remove 72,000 gpd is recommended for the LCRS sump. In addition, should flow rates into the LCRS increase beyond those predicted by the HELP modeling or the capacity of the 50- gpm pump, a second leachate removal pump can quickly be added via the vertical riser system, thus increasing the leachate removal rates.

Leak Detection and Removal System Analyses

Adequacy of the leak detection and removal system for Phase 1A is addressed in the Landfill Action Leakage Rate calculation presented in Action Leakage Rate and Response Action Plan (see Appendix G). In this calculation, leakage rates into the LDRS, as determined by EPA's recommended method (60), were compared to flow capacities of the LDRS geocomposite drainage layer and the LRDS sump. Based on these calculations, the flow capacity of the LDRS sump exceeds the flow capacity of the LDRS geocomposite drainage layer and the flow capacity of the LDRS geocomposite drainage layer exceeds the leakage rate into the LDRS. A Grundfos 50 gpm pump which has the capacity to remove 72,000 gpd is recommended for the LDRS system sump.

Vadose Monitoring System Analyses

The vadose monitoring sump serves as a detection system for leakage of the secondary LDRS system. A Grundfos 25 gpm pump is recommended for vadose monitoring sump. In the unlikely event that a leak develops in the LDRS sump, leachate will flow to the vadose monitoring sump where it can be collected and removed.

Evaluation of Slope Riser Pipe and Vertical Riser Pipe Strengths

Calculation No. E-26, Pipe Crushing, presented in Appendix E, considers the stresses and deflections to the slope riser pipes. Based on this calculation, the 18 inch diameter HDPE SDR 11 slope riser pipe ring deflection at maximum burial depths of 160 ft is 0.4 percent. This is less than the manufacturer's recommended ring deflection limit of 2.7 percent (39).

The downdrag loads on the vertical riser pipe were evaluated in Calculation No. G-30 to determine if the vertical riser pipe could damage the liner. The vertical downdrag loads are developed as a result of waste settlement around the vertical pipe. In order to limit the downdrag loads acting on the liner, the lower portion of the vertical riser was de-coupled from the upper portion. The upper portion was founded on a large concrete pad that is located on top of the sump gravel. In addition, a friction break consisting of a double wrap of HDPE was included around the steel vertical riser pipe.

3.2.9 Action Leakage Rate and Response Action Plan

Because of the similar liner components used in the landfill and the evaporation pond a single Action Leakage Rate and Response Action Plan (RAP) was developed which includes both facilities. This plan and its supporting calculations are presented in its entirety in Appendix G . The results are summarized below.

An Action Leakage Rate (ALR) and RAP for the proposed Triassic Park Waste Disposal Facility landfill is required under 40 CFR Parts 302. The ALR, as defined in the final rule published in January 29, 1992, is the maximum design flow rate that the LDRS may remove without the fluid head on the bottom liner exceeding one foot (60). The RAP describes the steps to be taken in the event the ALR is exceeded in landfill . The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA recommended method for determining the landfill ALR presented in Federal Register Vol. 57, No. 19 and in reference No. 59 were used to calculate the ALR for the landfill facility. Using the flow equation for geonets and applying field representative geocomposite transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the landfill was determined to be 900 gpad.

The ALR value of 900 gpad is above the EPA recommended value of 100 gpad. The primary reason for this difference is that the EPA value is based on a sand drainage layer with a permeability of 1 x 10^{-2} cm/sec compared to the geocomposite drainage layer transmissivity of 2.2x10^{-4} m^2/sec proposed for the Triassic Park Landfill.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in the Appendix G.

Response Action Plan steps outlined in the Action Leakage Rate and Response Action Plan closely follow the recommended actions presented in Federal Register Volume 57, No. 19.

3.2.10 Surface Water Drainage Analyses

Design parameters for HDPE lined Channels 7 and 8 located above the landfill access ramps are presented on Drawing No. 25 (Sheet 2 of 2). The methodology, assumptions, and run-off calculations for these channels and the collection basins discussed below and are presented in Appendix F.

The clean stormwater collection basin located at the toe of the 2H:1V cut slope in the south end of landfill will contain the run-off from the 15 acres of unlined area of Phase 1A (above the access ramps). The total run-off from the 25-year, 24-hour event is approximately 4.5 ac-ft. Total volume of the detention pond assuming 1 foot of freeboard is 5.2 ac-ft.

The contaminated water basin at the toe of the Phase 1A waste fill slope is designed to contain the run-off from the entire 15.6 acre fill area of Phase 1A. The total run-off from the 25-year, 24-hour event is approximately 4.3 ac-ft. The contaminated water basin is approximately 560 feet by 200 feet and can store approximately 10.4 ac-ft assuming 1 foot of freeboard. The contaminated water basin will be constructed at the same time as the rest of the Phase 1A landfill so it can accommodate runoff from waste placed in Phase 1A.

3.2.11 Soil Erosion Analyses

Due to the temporary nature of the 2H:1V cut slope and the 3H:1V subgrade slopes above the access ramps, severe soil erosion of these slope areas is not anticipated. The 2H:1V cut slope will be excavated during future landfill construction and the 3H:1V subgrade areas above the access roads will be conditioned prior to liner placement as required in the specifications.

Erosional features such as rills and localized slumping in exposed areas of the protective soils layer on the 3H:1V slope areas will be repaired following rain events.

3.2.12 Frost Protection

The maximum frost depths in the Roswell area, indicates that frost may reach 23 inches during the winter months. In addition, site-specific frost penetration modeling for the site indicated a maximum design freezing depth of 2.3 feet for this cover. Recent studies by Kraus (36) evaluating the effects of frost on geosynthetic clay liners indicate that there is little change in the permeability of the GCLs due to frost. Since the landfill utilizes GCLs in combination with HDPE as barrier elements for both the liner system and the cover system, frost damage to these layers is not expected. However, the 2.5-foot thick vegetative layer on the cover system will also provide frost protection for underlying geosynthetics and soil components in the cover section, two feet protective soil is specified on the side slopes of the landfill. Due to the relatively short time period that the side slopes will be exposed without waste placement, the 2-foot cover thickness is considered adequate.

3.2.13 Earthwork Volumetrics

Table 3 lists the material quantities for subgrade excavation, structural fill, cover and liner soil components, and the net waste airspace available for Phase 1A development. Table 3 also lists material quantities for the final landfill configuration.

TABLE 3
LANDFILL PHASE 1A MATERIAL BALANCE
AND ULTIMATE LANDFILL MATERIAL BALANCE

Material Balance Phase 1A	LOOSE OR COMPACTED CUBIC YARDS	BANK CUBIC YARDS
Design Capacity		
Total Airspace		691,540 bcy
Liner Area		14.5 acres
Cover Area (Top of Waste)		11.9 acres
Volume of cover (NOT included in airspace)		0 bcy
Volume of Liner (NOT included in airspace)		0 bcy
Remaining Airspace		691,540 bcy
Volume of Daily Cover (20% of total)		138,308 bcy
Total Waste Capacity		**553,232 bcy**
Total Soil Requirements		
Volume of Daily Cover (20% of total)	170,119 lcy	138,308 bcy
Volume of Liner Material (0.5 foot)	92,194 ccy	83,813 bcy
Volume of Cover (4 feet)	718,385 ccy	653,077 bcy
Total Volume of Soil Required		875,198 bcy
Total Cut Volume		2,797,921 bcy
Cut/Fill Balance Difference		**1,922,723 bcy**
Material Balance Ultimate Landfill		
Design Capacity		
Total Airspace		13,997,654 bcy
Liner Area		103.9 acres
Cover Area (Top of Waste)		101.2 acres
Volume of cover (NOT included in airspace)		0 bcy
Volume of Liner (NOT included in airspace)		419,063 bcy
Remaining Airspace		13,578,591 bcy
Volume of Daily Cover (20% of total)		2,715,718 bcy
Total Waste Capacity		**10,862,873 bcy**
Total Soil Requirements		
Volume of Daily Cover (20% of total)	3,340,333 lcy	2,715,718 bcy
Volume of Liner Material (0.5 foot)	92,194 ccy	88,813 bcy
Volume of Cover (4 feet)	718,385 ccy	653,077 bcy
Total Volume of Soil Required		3,452,608 bcy
Total Cut Volume		10,281,466 bcy
Cut/Fill Balance Difference		**6,828,858 bcy**
Notes: 1) lcy = 1.23 bcy; 2) ccy = 1.1 bcy		

4.0 EVAPORATION POND

4.1 EVAPORATION POND DESIGN

4.1.1 General

The purpose of the evaporation pond is to treat liquid wastes which meet land ban restrictions. The majority of these liquid wastes will be leachates collected from the landfill LCRS or other containment sump systems on site. The pond may receive leachates from other off-site sources. This unit will not be used to manage wastes containing volatile organic concentrations greater than 500 parts per million by weight (ppmw).

The volume of liquids in the pond will be dependent on the waste market. Net evaporation (total evaporation minus rainfall) for the site is in the range of 80 inches per year.

Evaporation pond design elements include pond layouts and phasing; subgrade design; liner system design; and leak detection system , and vadose monitoring sump design. This section describes each of these design elements.

4.1.2 Evaporation Pond Layout and Phasing

The proposed evaporation pond area layout and phasing is illustrated on Drawing No. 28. Pond 1 will be constructed initially and will service site operations during waste filling of landfill Phase 1A. A future Pond 2 would be located east of Pond 1 and would provide additional pond treatment capacity as the landfill expands into Phases 2 and 3. Space has been allocated in the site layout to the east of Future Pond 2 should demand for pond storage capacity increase beyond that currently provided in the design.

Ponds 1 and 2 are each divided into two separate ponds, A and B. This arrangement provides separate pond units which can be placed into service independently. For example, in the event of a major rain event or should the Pond 1A primary liner begin to leak, additional pond storage capacity available in Pond 1B could immediately be brought on line. Each pond unit is equipped with its own discharge station. An inter-pond transfer pump will be located on separation berm between the A and B pond units. Provisions to curtail placement of liquid wastes into an impoundment that has exceeded its ALR are discussed in Appendix G.

Pond units 1A and 1B are each 135-ft wide by 290-ft long by 12-ft deep and each will contain approximately 2.62 million gallons. Side slope angles are 3H:1V except for the inter pond berms which have 2H:1V sideslopes. Leak detection and vadose monitoring sumps are located centrally on the long side of the pond units. Pond floor grades are a minimum 2 percent towards the sumps.

Pond overtopping will be controlled manually through the use of liquid elevation indicators placed in the pond. These indicators will be graduated vertical rods fixed to a stable base. The rods will be placed such that graduated markings can be easily read from the discharge station. The rods will be surveyed when placed and checked by survey periodically to ensure accuracy. Correlation charts between elevation and pond volume will be maintained at the discharge station of each pond. Pond discharge pipes will also be equipped with flow meters so that liquid volumes placed in the pond can be continuously tracked and documented. Filling of the ponds above the 2-foot freeboard limit will not be permitted. Site personnel will be present during all fluid discharge and transfer operations to ensure that pond overtopping does not occur in the event of equipment malfunction or other human error.

Due to the small aerial extent of the evaporation ponds and limited fetch distance, wave action developed in the pond fluid surface will also be limited. The 2-ft freeboard distance will accommodate minimal wave action without overtopping. At closure, the pond will be backfilled to surrounding ground and revegetation.

4.1.3 Subgrade Excavation, Liner System, LDS Sump Design and Vadose Monitoring Sump Design

Subgrade Excavation

Drawing No. 28 shows the evaporation pond excavation contours. The crest of the evaporation pond is essentially flat. Fill areas around the perimeter of the ponds along with site grading outside of the pond area provide sufficient grade differences for storm water run-off to flow to the perimeter road ditches and ultimately to the storm water detention basin located in the northwest corner of the site.

Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing Nos. 30, 31 and 32 show the evaporation pond liner components covering the floor and slopes, and extending into the anchor trench areas. The liner system will be continuous over the berm between the A and B units. The evaporation pond liner system is a double lined system consisting of (from bottom up) a composite (compacted clay and geomembrane) secondary liner, a geonet leak detection drainage layer, and a primary geomembrane liner. Details of each liner component are discussed below:

- *3-foot thick compacted clay liner (CCL)*

  The CCL ($k \leq 1x10^{-7}$ cm/sec) in combination with the overlying HDPE geomembrane will serve as a low permeability barrier layer to restrict infiltration of leachate into the subgrade. The CCL will consist of clay material (CL, CH) obtained during excavation of the landfill and surface impoundment. Specification Section 02221, Clay Liner, describes clay material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements. Soil under leachate compatibility tests (two stage permeability testing using ASTM D 5084) will be conducted prior to construction. In addition, a test fill will be constructed, as per the procedures outlined in the CQA plan. The results of the permeability testing performed compacted samples are shown in the appendices.

  Soil liner compatibility is normally not a problem unless the leachate contains high concentrations of organics (Eklund, 1985; Peterson and Gee, 1985; Mitchell and Madsen, 1987; Finno and Schubert, 1986). Additional supporting information on the compatibility of the CGL with various leachate is presented in Appendix E-40.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (smooth)*

  The 60-mil HDPE liner placed on top of the CCL is the second component of the composite secondary liner. Together, the CCL and HDPE liner form a highly efficient barrier layer to restrict percolation of leachate into the subgrade (see Section 3.2.7, HELP Modeling). Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *Geonet leak detection drainage layer (transmissivity ≥ $5x10^{-3}$ m^2/sec as tested under actual field conditions)*

  The high transmissivity geonet leak detection drainage layer provides a means to transmit and remove leachate percolating through any leaks in the primary geomembrane layer above. Flow calculations discussed in Section 4.2.7 and presented in Appendix G indicate that the geonet is capable of removing leachate in a timely manner such that head on the underlying geomembrane will remain less than 1 foot. Specification Section 02712, Geonet, describes minimum geonet properties required, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (smooth)*

  This HDPE geomembrane serves as the liner systems primary barrier layer of the double liner system. Specification Section 02775, Geomembrane Liners, discussed above also applies to this geomembrane layer.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

Since portions of this liner component will be permanently exposed to sunlight and UV radiation, it may be necessary to replace it prior to the end of the facility life. The lifetime of exposed geomembrane liners varies, however, it is generally limited to the warranty period of the product which may be as long as 20 years (33). The staged approach to pond development will help alleviate this concern, as will maintaining fluid levels near capacity in the primary use pond unit. Periodically alternating pond units for primary use will also reduce exposure time.

Leak Detection and Removal and Vadose Monitoring Sump Systems

The leak detection and vadose monitoring systems each have a separate sump from which fluids can be collected and removed. The liner systems on the evaporation pond floor continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated into the drainage systems. Drawing No. 32 illustrates the sump layout and cross section. As shown on the drawings, the sumps are square pyramidal shapes which lie concentrically above one another. The slope riser pipe trenches enter their respective sumps at the sump base. The slope riser trench arrangement enables the vadose and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of the evaporation pond rather than in the sump area. The leak detection sump has a total fluid capacity of 1,790 gallons (after accounting for gravel). Similar to the landfill leak detection sump, the evaporation pond sump will be equipped with fluid level instrumentation and a 50 gpm fluid removal pump. The vadose monitoring sump has a total fluid capacity of 95 gallons (after accounting for gravel).

4.1.4 Evaporation Pond Discharge Pad Arrangement

Drawing No. 31 illustrates the slope riser piping and valving, the discharge pipe arrangement, and the layout for the concrete containment pad. Tanker trucks will pull up next to the concrete pad and hook up to the desired piping system. Hose connections at the pipes are located within the concrete pad area to contain any leakage. A concrete pad will be placed in the loading/unloading area for the tanker trucks. This pad will be sloped providing drainage toward the sump area. The concrete containment pad slopes towards the evaporation pond crest. Should a catastrophic failure of the piping system occur, leachate will flow back into the evaporation pond rather than be released to unlined areas. The evaporation pond liner system anchor trench will completely encompass the pad so that any leakage through the pad will also drain back into the evaporation pond. Construction details for the concrete containment pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

Storm Water Control Features

Drawing No. 5 depicts the surface grades around the perimeter of the pond area. Surface water run off from these areas will flow to the roadway ditch system and ultimately to the surface water detention pond.

4.2 EVAPORATION POND DESIGN ANALYSES

4.2.1 Slope Stability

Cut Slope Stability

Prior to filling, unsupported cut slopes will exist on all sides of the evaporation pond. These slopes were analyzed for static and dynamic stability using the Bishop method of slices. A computerized slope stability program (XSTABL) (44) was used to analyze the cut slopes. Strength parameters used for soil and rock materials were estimated using pocket penetrometer data gathered during test pitting of the site soil materials. The material properties used in the analyses are summarized in Appendix E.

The site grading plans (Drawing Nos. 28 and 29) indicate that the maximum cut slopes will be 3H:1V and 2H:1V and maximum height will be approximately 12 feet. Results for the critical 2H:1V slope as presented in Calculation E-7, indicate a static factor of safety of 19.8 for the critical short term (undrained) condition. Stability during seismic loading was estimated by applying a pseudo-static earthquake force in the Bishop analysis. Results based on the 0.04 g design acceleration indicate a dynamic factor of safety of 15.7 for the short term (undrained) condition.

Slope stability was not considered for the filled evaporation pond configurations. Filling the pond with fluid does not place any stresses on the liner system which could cause instability.

4.2.2 Settlement

The evaporation pond will experience relatively low overburden pressures due to its shallow depth and liquid fill density in comparison to pressures previously imparted to the clay during placement compaction. Clay liner consolidation will therefore be negligible.

4.2.3 Geosynthetics Strength and Performance Analyses

As discussed in Sections 4.2.1 and 4.2.2 above geosynthetics components of the evaporation pond will not experience significant stresses related to slope stability or settlement. Settlement induced stresses to evaporation pond geosynthetics were, therefore, not considered.

4.2.3.1 Geomembranes

The general use of geomembranes in the evaporation pond is similar to that described for the landfill. Thermal induced stress and tear and puncture evaluations are discussed below.

Thermal Induced Stress

The 60-mil HDPE geomembrane liner will be subject to contraction and expansion from daily temperature differentials. The contraction/expansion potential of the HDPE liner was determined, and the maximum induced stress was determined. Calculation No. E-27, Thermal Induced Stress in Evaporation Pond Liner, indicates the maximum induced thermal stress in the liner would be 560 psi. This value is far below the 2200 psi minimum yield strength of liner, which yields a design safety factor of 3.9.

Tear and Puncture

The evaluation of geomembrane tear and puncture in the landfill liner system was presented in Section 3.2.1.2 . The results of that analyses indicated that the 60-mil HDPE geomembranes were adequate for loading conditions which were much more severe than those expected for the evaporation pond. Since similar HDPE products will be used in the evaporation pond and the same subgrade surface preparation methods are required by the specifications, separate calculations for evaporation pond geomembrane tear and puncture are not necessary.

4.2.3.2 Geonets

The geonet is intended to act as a lateral drainage layer in the evaporation pond LDRS. The primary design criteria of the geonet is the transmissivity. Calculations presented in Appendix G-2 evaluate the typical transmissivity values reported in the literature and by manufactures. These values have been reduced to account for clogging of the geotextile, penetration of the geotextile in to the geonet and creep of the geonet.

In order to confirm the actual transmissivity of the material that arrives on the site, the specifications require that the geonet be tested as part of the conformance testing program. The specific test methods, including backing materials, normal loads, seating times, gradients, and test durations are detailed in the specifications.

4.2.3.3 Geotextiles

Geotextile Filtration

Geotextiles are used in a number of locations in both the liner and sump sections for filtration. Specifically, the geotextiles act as filters between the pipe bedding material or between the granular leachate collection material. Similar to the landfill evaluation, if these soil materials are conservatively estimated to be fine grained with more than 50 percent of the material passing the Number 200 sieve, then the specified geotextile with a AOS of less than 0.212 mm should adequately retain these soils.

Geotextile Cushion

The puncture resistance during installation of the proposed geotextile materials was analyzed for more severe conditions in the landfill design. Therefore, these calculations are not repeated for the evaporation pond application.

4.2.4 Compacted Clay Liner

As previously discussed for the sump CCL, the criteria for the CCL materials characteristics and the placement and compaction criteria are presented in the specifications.

4.2.5 Anchor Trench Design

The pullout capacity of the primary and secondary geosynthetics from the evaporation pond anchor trench was determined. It was assumed the geosynthetics will pull out of the trench with single-sided shear. Single-sided shear is believed to occur rather than double-sided shear because there is less shearing resistance for single-sided shear. Assumed interface friction angles were based on previous laboratory testing for similar materials at low normal stresses. Based on the trench geometry, critical HDPE geomembrane properties, and assumed interface friction angles, pullout resistance calculations for both the secondary and primary liner anchor trenches indicate that the HDPE geomembranes will pull out prior to tearing (see Calculation No. E-15).

4.2.6 Leak Detection and Vadose System Hydraulic Analyses

The leak detection system design and performance is very similar to the landfill system. Therefore, design analyses for the following criteria are not discussed. Rather the reader is referred to Appendix E for the detail of the calculations.

Adequacy of the leak detection and removal system for the evaporation pond is addressed in the Action Leakage Rate calculation presented in Action Leakage Rate and Response Action Plan (see Section 4.2.7 below and Appendix G). In this calculation, leakage rates into the LDRS, as determined by EPA's recommended method, were compared to flow capacities of the LDRS geonet drainage layer and the LRDS sump. Based on these calculations, the flow capacity of the LDRS sump exceeds the flow capacity of the LDRS geonet drainage layer and the estimated leakage rate into the LDRS. A Grundfos 50 gpm pump which has the capacity to remove 72,000 gpd is recommended for the LDRS system sump.

Vadose Monitoring System Analyses

The vadose monitoring sump serves as a detection system for leakage of the secondary LDRS system. A Grundfos 25 gpm pump is recommended for vadose monitoring sump. In the unlikely event that a leak develops in the LDRS sump, leachate will flow to the vadose monitoring sump where it can be detected and removed.

4.2.7 Action Leak Rate and Response Action Plan

Because of the similar liner components used in the landfill and the evaporation pond a single ALR and RAP was developed which includes both facilities. This plan and its supporting calculations are presented in its entirety in Appendix G. The results are summarized below.

An ALR and RAP for the proposed Triassic Park Waste Disposal Facility evaporation pond is required under 40 CFR Parts 302. The ALR, as defined in the final rule published in January 29, 1992, is the maximum design flow rate that the LDRS may remove without the fluid head on the bottom liner exceeding one foot. The RAP describes the steps to be taken in the event the ALR is exceeded in the evaporation pond. The RAP specifies the initial notifications, steps to be taken in response to the leakage rate being exceeded, and follow-up reports.

The EPA recommended method for determining the landfill ALR was used to calculate the ALR for the evaporation pond. Using the flow equation for geonets and applying field representative geonet transmissivities and appropriate factors of safety for geonet creep and sediment clogging, the recommended ALR for the evaporation pond was determined to be 1000 gpad.

Although computations indicated a much higher ALR value could be justified, the ALR value of 1000 gpad, which is equal to the maximum EPA recommended value of 1000 gpad, was selected because this value adequately represented a "large and rapid" leak considering the small size of the evaporation ponds.

Additional computations to check the LDRS sump capacity and LDRS drain pipe capacity are also presented in the Appendix G.

Response Action Plan steps outlined in the ALR and RAP closely follow the recommended actions presented in the Federal Regulations.

4.2.8 Frost Protection

Based on the landfill design, the design depth of frost at the site could be in the range of 2.3 feet (see Calculation No. E-25, Frost Penetration). Review of the evaporation pond design indicates that portions of the clay liner above the pond fluid level may be exposed to frost action. The following paragraph discusses resulting effects this may have on leakage to the environment.

Unlike the landfill, the evaporation pond is a temporary facility to be removed from service during the facility's post closure period. Increased permeability of the clay liner and any resulting leakage is therefore, not as critical as with a permanent landfill installation. Further, due to the insulating effects of the pond liquids, only portions of the clay liner above the fluid level in the pond will reach freezing temperatures. Finally, the evaporation pond design incorporates a vadose detection system and a leak detection system. Any leakage detected will be removed and if large enough, based on the action leakage rate, will cause remedial steps to be taken to locate and repair damage to the geomembrane, thus limiting exposure of fluids to the clay liner. Therefore, in our judgment, any increase in permeability of the clay liner due to potential damaging effects of frost will not result in significant increases of liquids released to the environment.

4.2.9 Earthwork and Pond Volumetrics

Approximately 62,500 cy of soil materials will be excavated to construct evaporation Pond 1. Clay liner construction will require placement of 22,150 cy of compacted clay liner material. The resulting pond volume available for liquid evaporation (not including 2 ft of freeboard) is approximately 5.2 million gallons.

5.0 TRUCK ROLL-OFF AREA

5.1 TRUCK ROLL-OFF AREA DESIGN

5.1.1 General

It should be noted that the incoming trucks containing unstabilized waste will be Department of Transportation (DOT) approved roll off vehicles (17). These trucks are required by DOT to be covered. Additionally, the roll-off bin must be free of leaks and the waste must be contained with a plastic bed liner. Together, the roll-off bin and the plastic bed liner are considered a double lined system. This containment system will remain in place the entire period the roll-off bin is staged in the truck roll-off area. The liner system incorporated in the waste roll-off area is included as a precautionary measure.

It should also be noted that some roll-off containers staged in the area will contain stabilized waste which has met the paint filter tests for free liquids. Additionally, these roll-off bins will be lined using a plastic bed liner and will be covered in a manner similar to DOT approved roll-off containers.

The purpose of the truck roll-off area is to provide a staging area for incoming roll-off bins containing unstabilized waste destined for the stabilization facility and a second staging area for roll-off bins containing post treatment stabilized waste awaiting landfill disposal approval.

The truck roll-off area is surrounded by a berm with a minimum height of 2.0 feet (see Drawing 41). This berm will divert run-on surface water around the perimeter of the truck roll-off area. Culverts are proposed under each of the access ramps to allow surface water flow to the west towards the run-off detention basin. The interior depth of the berms is also a minimum of 2.0 feet. The 25-year, 24-hour storm for the site is 4.3 inches. This is expected to result in ponding inside the roll-off area to a depth of approximately 2 feet in the sump area and in the range of 1-foot or less in the central area. Incoming waste roll-off containers are not expected to contain free liquids. The sumps will be pumped to remove any accumulated water after any rainfall event.

Truck roll-off area design elements include truck roll-off area layout, subgrade design; liner design; and drainage sump design. This section describes each of these design elements.

5.1.2 Truck Roll-Off Area Layout

Drawing Nos. 41 and 42 illustrate the layout of the Truck Roll-Off Facility. Each is approximately 310 ft long by 180 ft wide roll-off cell can stage approximately 66 roll-off bins. The floor of each cell grades at 2 percent towards its respective sump and the surrounding soil berms have side slopes of 1.5H:1V and range in elevation from 4 ft to 8 ft. Cell access is provided by four ramps which grade at 10 percent.

The west cell will be used for unstabilized waste, and the east cell will be used for stabilized waste

5.1.3 Subgrade Excavation, Liner System, Drainage Sump Design, and Leak Detection System Design

Subgrade Excavation

Drawing No. 41 shows the truck roll-off area excavation and fill contours. Cut areas in the central portion of the facility are made to achieve the required floor grades. The berms and fill areas around the perimeter of the truck roll-off area and surrounding site grading provide sufficient grade differences for storm water run-off to flow to the perimeter road ditches and ultimately to the storm water detention basin.

Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing No. 43 shows the liner components on the floor, berm, and anchor trench areas. The truck roll-off area for roll-off bins is a single lined system consisting of (from bottom up) a prepared subgrade, a geomembrane underliner, a geonet drainage layer, a geotextile filter layer, a soil subbase layer, and a surface gravel layer. This design should accommodate the limited truck traffic that will be required to load and unload the roll-off boxes. Details of each liner component are discussed below.

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *60-mil thick high density polyethylene (HDPE) geomembrane underliner (smooth)*

  The 60-mil HDPE liner placed on top of the prepared subgrade liner form a highly efficient barrier layer to restrict percolation of rain water into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *Geocomposite leak detection drainage layer (transmissivity $\geq 2.2 \times 10^{-4}$ m^2/sec) as tested under actual field conditions*

  The high transmissivity geocomposite drainage layer provides a means to transmit and remove rainwater falling within the unstabilized waste roll-off bin area. Flow calculations discussed in Appendix E indicate that the geocomposite is capable of removing rainwater so that ponding can be minimized and trafficability of the upper gravel surface can be maintained. Specification Section 02710, Geocomposite, describes minimum geocomposite properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

- *18-inch thickness of soil subbase layer*

  The soil subbase will consist of free draining soils classified as SM, SW, GM, of GW. Specification Section 02230, Subbase, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *6-inch thick road base gravel surface*

  The road base gravel surface will allow storm water to drain from the surface while providing sufficient bearing capacity for truck traffic. Any disturbance of the road base surface as a result of loading and unloading the roll-off trailers will be observed during the weekly inspections of the unit and repaired by placement of new material or re-grading of the raising material. In the case of severe rutting (greater than 6 inches) the area will be excavated and the geosynthetic materials will be inspected for damage. Repairs will be made if required. Specification Section 02225, Road Base, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

  Potential leakages from the containers would be very limited and are not expected to react with the road-base aggregate.

Drainage Sump System

The drainage sump will collect storm water run off from the floor of the truck roll-off area. The liner systems on the truck roll-off area continue into the sump, however, in order to provide adequate volume to efficiently operate the removal pump, a gravel thickness has been incorporated into the drainage systems. Drawing No. 43 illustrates the sump layout and cross section. As shown on the drawings, the sump is a triangular pyramidal shape. The slope riser pipe enters the sump at the sump base. The slope riser trench arrangement enables the leak detection slope riser pipe to penetrate the overlying geomembrane liner elements at the crest of the truck roll-off area berm rather than in the sump area. The sump has a total fluid capacity of 1,406 gallons (after accounting for gravel). The truck roll-off area drainage sump will be monitored visually to determine whether pumping is required. Fluid removal will be performed by a vacuum truck.

5.2 TRUCK ROLL-OFF AREA DESIGN ANALYSES

5.2.1 Geosynthetics Strength and Performance Analyses

5.2.1.1 Geomembranes

The evaluation of geomembrane puncture in the truck roll-off liner system is presented in Calculation No. 18, Geomembrane Puncture Resistance. The results of the calculation indicate that the 6-inch road base and 18 inch subbase materials will adequately dissipate truck wheel loads and, in conjunction with the subgrade preparation specifications, which call for a 1 inch maximum particle size, will adequately protect the geomembrane from puncture. A calculated factor of safety of 60 to 1 against puncture was computed.

5.2.1.2 Geocomposite

Low overburden pressures due to the overlying roadbase and subbase are not high enough to adversely affect transmissivity of the geocomposite. Review of the texnet transmissivity charts presented in Calculation No. G-1, Landfill Action Leakage Rate support this.

5.2.1.3 Geotextiles

Geotextile filtration and puncture resistance are evaluated in Calculation No. E-20, Geotextile/Geocomposite Filtration, and Calculation No. E-21, Puncture Resistance of Geotextile/Geocomposites, respectively. Based on these calculations, the geotextiles specified for the truck roll-off area will adequately filter the sites fine grained materials and resist puncture.

5.2.2 Anchor Trench Design

The purpose of the truck roll-off facility anchor trench is to hold the geosynthetic liner components in place during placement of the overlying subbase and roadbase materials. Pull out considerations due to settlement are not a relevant concern for this facility.

5.2.3 Storm Water Collection Sump and Leak Detection Sump Containment Hydraulic Analyses

Calculation No. E-32, Truck Roll-Off LDRS Pumping Capacity, evaluates the capacity of the storm water collection sump in the lined portion of the truck roll-off facility to remove water from the geonet drainage layer. Based on this calculation, the geonet flow capacity is estimated to be 161,000 gpd and the sump capacity is estimated to be 199,000 gpd. The sump will, therefore, provide adequate water removal capabilities.

6.0 STABILIZATION FACILITY

6.1 STABILIZATION FACILITY DESIGN

6.1.1 General

The purpose of the stabilization facility is to treat waste streams using a chemical stabilization process which will chemically alter hazardous waste constituents such that their leachability is reduced to levels allowing landfill disposal. The stabilization treatment process involves combining chemical reagents with waste materials according to a specific treatment recipe and mixing until the waste/reagent reactions are complete. The batch stabilization mixing method to be used in the Triassic Park Stabilization Facility requires a backhoe excavator to mix waste with reagents in a large double lined steel bin. The materials treated will be in the bins for a limited amount of time, therefore only concentrated acids will not be allowed in the bins.

Stabilization facility design elements presented here include stabilization facility layout; stabilization bin, bin vault, and floor design; and stabilization process design. This section describes each of these design elements. It should be noted that certain components of the stabilization building, process control and delivery systems, ventilation systems and steel bins will be completed under future design/build contracts.

6.1.2 Facility Layout

Drawing No. 3 illustrates the layout of the stabilization building and the surrounding area. As previously discussed, the Stabilization Facility has entrances for incoming trucks on both the north and south access roads. These accesses will be used for incoming waste trucks loaded with unstabilized waste for processing in the bins. Incoming trucks will enter the gravel lined apron on the north or south side of the facility and back into the stabilization building. Once the load has been dumped into the bin and the truck bed washed out, the truck will exit the facility via the entrance route. The east and west building entrances will be used by stabilized waste loadout trucks which will cycle between the truck roll-off area or the landfill. The gravel lined areas surrounding the stabilization facility will not be used to stage waste hauler trucks. Parking areas for site personnel vehicles will be designated near the stabilization facility control room.

The control room is positioned centrally along the east wall of the stabilization building. From this vantage point operations personnel will be able to monitor all activities taking place inside the building. Reagent storage tanks and silos are also located on the eastside of the building which permits operations personnel to view reagent delivery activities.

The stabilization building's internal arrangement is centered around the four waste mixing bins. The mixing bins are orientated such that delivery, mixing and loadout operations can take place from either the north or the south sides of the building. Stabilization unit operations are depicted on Drawing No. 34. The 25 ft long by 10 ft wide by 10 ft deep bins can hold a maximum of approximately 100 cy of waste and reagent material. The double lined steel bins are located within a 38 ft wide by 79 ft long by 12 ft deep concrete vault which has a total volume of 1,330 cy. The bin and vault arrangement provides three levels of waste containment with the inner bin liner serving as primary containment, the outer bin as secondary containment, and the vault as final or tertiary containment.

The 118 ft wide by 123 ft long concrete floor is sized to accommodate the backhoe mixer and load out truck operations with adequate clearances. Section 6.2.3 discusses working point distance and clearance radius requirements for this operation.

The vertical dimensions for the stabilization building will be established during the building design/build phase when locations and sizing of the reagent delivery system and ventilation system are finalized.

6.1.3 Bin Liner, Bin Vault, and Floor Design

The stabilization bin arrangement is a double lined system consisting of two concentric steel bins separated by a network of wire rope isolators. The bins must be able to withstand the impacts from mixing with a backhoe bucket and also be relatively compatible with the waste that will be placed in the bins. Since the bins are concentric, the outer bin (secondary containment) can hold 100% of the volume of the inner bin. The wire rope isolators act as shock absorbers to dissipate impact loading to the bins by the mixing action of the backhoe. The wire rope isolators also serve to reduce impact loading transferred to the concrete vault floor and walls. Drawing No. 35 illustrates the inner and outer bin arrangements, bin dimensions, plate thicknesses, reinforcing rib arrangements, and locations of the wire rope isolators. The inner bin is not attached to the outer bin and therefore, can be removed for repair or replacement. The space between the bins provides access for leak detection instrumentation and fluid removal piping. Should a leak in the inner bin occur such that fluids escape into the inter-bin space, the leak detection instrumentation will trigger alarms in the control room immediately notifying the operators. The bin can then be taken out of service, inter-bin fluids removed, bin walls inspected, and repairs made if necessary. The outer bin is attached to the floor of the concrete vault. Drawing No. 33 shows the location of the leak detection and fluid removal piping. Liquid in the leak detection and fluid removal pipes may be monitored using a probe and removed by pumping, if necessary. The design of the bin has been based on a rational assumption of the design mixing and has selected a design thickness based on a reasonable curve of risk for damage. It is fully realized that if a worst case loading condition arose and the bins were cracked or otherwise damaged to the point of not providing containment than the bin would be taken out of service and repaired or replaced. Outline Specification for Proposed Hazardous Waste Mixing Bins at the Triassic Park Facility, presented in Appendix E, describes the steel plate, reinforcing members, and energy absorbing devices intended for the stabilization bin system.

The 1,330 cy concrete vault which will contain the stabilization bins has the capacity to easily contain the volume of all 4 100 cy bins (400 cy total capacity). As mentioned above, the vault serves as a tertiary containment feature should a catastrophic bin failure occur. In addition, the vault also provides access to the bins for inspection purposes and for ancillary reagent delivery piping and ventilation ducts. Construction details will be prepared for the concrete containment vault similar to those provided in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

The concrete floor will be steel reinforced cast-in-place concrete. All joints in the concrete floor will be constructed with chemical resistant water stops and caulking sealer. Drawing No. 44 shows the rebar types and concrete details for the floor. Construction details for the floor will be prepared similar to those provided in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07970, Sealants and Caulking describes the concrete epoxy coating requirements.

6.1.4 Stabilization Process Design

Drawing No. 34 summarizes the major waste processing unit operations and illustrates typical waste and reagent stream flows. Also shown are reagent tank and silo capacities, delivery piping, and control valve and flow meter locations.

Waste processing unit operations include waste receiving, reagent addition, stabilization mixing, and stabilized waste loadout. Waste receiving involves positioning loaded waste hauler at the end of the bin, dumping the waste load, and washing out any residue left in the truck bed into the bin. Reagent addition involves placing a cover on top of the bin, connecting ventilation and dry reagent delivery ducts, and injecting reagents into the bin. Reagent delivery to the bins will be controlled by a process controller (computer) system which will automatically sequence and deliver the necessary quantities of reagent based on a predetermined waste processing recipe. The bin cover will then be removed and a backhoe type excavator will mix the reagents with the waste. Following mixing, the waste will be sampled and a paint filter test will be conducted to ensure that no free liquids are present. Also, if necessary, samples will be gathered for toxicity characteristic leachate procedure (TCLP) testing. If the paint filter test is passed, the backhoe will load the stabilized waste into a waste hauler (roll-off truck) and the truck's roll-off cover will be positioned over the waste. The truck will either proceed to the landfill for disposal or will stage the roll-off bin in the Truck Roll-Off Area. The stabilized waste will need to be stored temporarily at the roll-off unit while tests are completed to determine how and if the material can be disposed of in the landfill.

Reagent usage will vary with the waste type and the prescribed stabilization recipe. It should be noted that both waste receipt rates and stabilization recipes will vary considerably. Stabilization process flows are discussed further in Section 6.2.4.

Reagent storage and delivery systems for two types of dry reagent and three types of liquid reagent (one being water) are incorporated into the design. Dry reagents including cement and fly will be stored in 25,000 and 50,000 cft silos, respectively, and delivered to the bins by a pneumatic delivery system. Liquid reagents including calcium polysulfate and ferrous sulfide will be batch mixed in individual 10,000 gal reagent tanks and pumped into the bins. Water will also be pumped to the stabilization bins.

For design purposes, a CAT 213B LC type excavator was selected as the backhoe mixer, however, other equipment manufacturer's offer excavators with similar reach, power, and weight characteristics.

In order to ensure no visible fugitive dust emissions during stabilization processing, the bins and the stabilization building will be equipped with an exhausting ventilation system which will maintain a negative pressure inside the building. Slotted ducts located around the perimeter of each bin will provide supply and return air in a push-pull arrangement to remove dust during the waste receiving, mixing, and loadout operations. During reagent delivery operations, the bin cover, which will also be connected to the exhaust system, will control dust. Dust will be removed from the exhaust air in the bag house located on the west side of the building. Collected dust will be processed in the stabilization facility.

Wastes containing VOCs greater than 500 parts per million per weight (ppmw) will not be accepted for stabilization processing.

6.2 STABILIZATION FACILITY DESIGN ANALYSES

6.2.1 Stabilization Bin Structural Analyses

Basic engineering principles in conjunction with finite plate analyses were used to address the preliminary structural design of the steel stabilization bins. Principles of impulse - momentum and conservation of energy were used to establish the mass, velocity and displacement relationships. Then plated stresses were approximated through the use of Sap 90. Finally force and displacement results were scaled up/down to limiting displacements (controlled by the wire rope isolators) and stresses (controlled by the grade of steel).
The fundamental design inputs for the bin analysis are the forces generated by the backhoe mixing action. For the purposes of this design a CAT 213B LC type backhoe was assumed. Critical velocities of the backhoe movements to prevent damage to the bins were determined as a percentage of maximum velocities achievable by the backhoe. These limiting velocities will be implemented in the actual backhoe unit by adjusting the hydraulic system flows. Calculations are presented in Appendix E and summarized in the overview below.

Overview Structural Analysis

1. Calculations establish the structural capacity required to support the static loads from hazardous waste material plus the stabilizing materials. The worst case scenario for the static load case is 80 cubic yards of material weighing 110 lbs/cubic foot.

2. Dynamic analyses for vertical impact loads due to the material dropping into the bin indicate that this is not a significant problem. However, impact from the bucket dropping freely due to a total and instantaneous hydraulic failure from a height of 15 feet would cause stresses in a 1 inch thick inner liner which would far exceed the yield stress of the steel and cause a permanent "dent" in the steel. It does not appear cost effective to design the inner liner for this possibility.

3. Dynamic analyses established a side impact load from the backhoe bucket with contributions from the stick and boom based upon their relative velocity and percent of load transferred to the bucket when it impacts the sidewall of the mixing bin.

    a. Static loads were applied to the wall of the inner liner to establish the relative deflections of points surrounding the point of impact. Then the effectiveness of the inner liner which would act to reduce the momentum of the bucket was established and the conservation of momentum principle was used to determine the reduction in velocity immediately after impact.

    b. After impact the moving bucket plus the effective plate mass has a kinetic energy equal to one half of the total mass times the square of the velocity. That kinetic energy is "gradually" transferred into potential energy from force times displacement (or bending moment times angle change) in the inner liner, the energy absorbing springs and the outer plate support system. When the bucket has been stopped all of the energy has been transferred from the kinetic state to the potential state. It appears that 80 to 90 percent of the energy absorption occurs in the springs.

    c. Through a trial and error process, approximate relationships between initial velocity, displacements and stresses in the structural systems were established. It appears that the controlling factor in the system is the stress in the inner liner when subjected to impact loads.

    d. The impact loads from the weight of the bucket plus contributions from the stick and boom totaling approximately 3,290 pounds results in a kinetic energy in excess of 800,000 lb-inches for the condition where a swing angle of 180 degrees can occur in 3 seconds (approximately 440 inches per second at the outer end of the bin).

    e. In order to limit the stresses in the high strength inner liner plate to an acceptable allowable value, it will be necessary to reduce the side to side velocity of the bucket to 15 percent of the present velocity with a ¾ inch thick plate, 19 percent for a 7/8 inch plate and 23 percent for a 1 inch plate.

4. Preliminary analysis of the dominantly in and out impact loads caused by movement of the boom, stick and bucket were also made. Combinations of circular velocities (Boom + Stick + Bucket) could easily result in velocities and resulting impact loads greater than the capacity of the inner plate to resist. Some of these velocities will probably need to be reduced to limit damage to the inner liner but this will require significantly more detailed calculations. Note that the effective mass at impact varies with each of these elements and the addition of these circular velocities and tributary masses in any particular direction and at any particular point is far from linear. The maximum reduction in velocity for any of these elements appears to be in the order of 50 percent.

Bin steel plate thickness is dependent on the grade of steel selected. The final bin design will determine the optimal steel plate to be used.

Corrosion protection for the bins will be provided by installing grounded cathodes to the inner and outer bins.

6.2.2 Facility Stabilization Concrete Vault

The Stabilization Facility concrete vault is not a secondary containment feature, therefore, regulations pertaining to secondary containment do not apply, however, all joints in the concrete vault of the stabilization building will be constructed with chemical resistant water stops. In addition, a chemical resistant epoxy coating will be placed on the surface of the vault floor and walls to further restrict potential liquid penetration into the concrete.

The concrete vault area will be inspected monthly. If liquids are found, then will be removed with a portable pump and transported to the liquid waste storage unit.

6.2.3 Stabilization Facility Concrete Floor

Waste entering the stabilization building will be contained in the DOT approved waste trucks. Stabilized waste, having undergone treatment, will either be contained in roll-off trucks fashioned with DOT approved truck bed liners or, if treatment standards are met, according to approved testing protocols, the stabilized waste will be transferred directly to the landfill. The floor of the stabilization building will not be exposed to untreated waste material and is not required to serve as a containment system. However, all joints in the concrete floor of the stabilization building will be constructed with chemical resistant water stops. In addition, a chemical resistant epoxy coating will be placed on the surface of the floor to further restrict potential liquid penetration into the concrete.

As shown on Drawing No. 33, stabilization bins are located on 19 ft centers in the middle of the stabilization building. The bins are situated such that adjacent bins alternate mixing and receiving ends allowing for reagent addition operations to take place simultaneously with mixing or loadout operations in two adjacent bins.

During mixing and loadout operations, the center point (rotational axis) of the backhoe unit will be located 8 to 9 ft from the mixing end of the bin. Load out trucks, which can access the building through one of four doorways, will be positioned between 15 to 20 ft from the backhoe center point within the 20 ft wide load out truck lane. A 6.5 ft clearance is provided between the load out truck lane and the north and south building walls. A 27 ft clearance is provided between the outer bins and the east and west building walls. At this distance the backhoe unit will be able to make a full 180° swing angle in the direction of the wall with minimal reach adjustments.

The backhoe unit will be equipped with synthetic rubber track pads covering the steel track ribs. The track pads will allow the backhoe unit to move over the concrete floor without damaging the floor surface.

6.2.4 Stabilization Process Analyses

Solid waste throughputs in the order of 400 tons per day and liquid waste throughputs in the order of 1000 gpd were assumed based on experience at similar operating facilities. Similarly, a typical waste recipe for stabilization of solid and liquid waste was developed.

The 25,000 and 50,000 cft dry reagent storage silos and 10,000 gal tank capacities are based on providing sufficient reagent quantities for one week of normal stabilization operations. Reagent delivery piping sizes shown on Drawing No. 34 are preliminary and will be finalized when selection of the pumps and dry reagent pneumatic system are determined, however, these piping sizes are capable of meeting the daily reagent delivery requirements.

Ventilation system requirements will be determined in conjunction with the final design of the stabilization building. As previously mentioned, the building will be maintained under negative pressure during processing operations to ensure no visible dust is emitted. Additionally, each bin will have its own push-pull ventilation system to control dust inside the building during waste receiving, mixing, and loadout operations.

6.2.5 Compatibility

The steel bins of the stabilization unit will not be completely compatible with all possible wastes. However, steel bins are considered to be the best material to withstand the impacts of the mixing operations. In addition, the bins are accessible and can be inspected for corrosion that could impact their containment capabilities. If excessive corrosion or wear is noted during the inspections the tanks could be prepared or replaced.

7.0 DRUM HANDLING FACILITY

7.1 DRUM HANDLING FACILITY DESIGN

7.1.1 General

The purpose of the drum handling facility is to provide storage capacity for drummed waste streams which will either be processed in the stabilization facility, placed in the landfill, or shipped to other waste processing centers such as incinerators or solvent recovery plants.

Drum handling facility design elements include drum facility layout, subgrade design; liner design; concrete floor design, and drainage sump design. This section describes each of these design elements.

7.1.2 Facility Layout

Drawing No. 37 shows the layout of the drum handling facility floor and surrounding area. Additional details for the floor and floor drains are illustrated on Drawing No. 38.

As previously discussed, the drum handling facility entrance faces the north access road. Incoming trucks will enter the gravel lined apron and will back up to the loading dock areas. Once the truck unloading (or loading) operation is complete, the trucks will exit the facility via the same north access road. Parking areas for site personnel vehicles will be designated near the Drum Handling Facility Office. The gravel apron in front of the facility will not be used to stage waste haul trucks.

The drum handling building will be an open walled building with a roof which extends over the entire floor and truck docking areas. The roof structure will eliminate rain water from entering the drum handling area. The open walls will provide ample ventilation inside the building, however, personnel involved with drum sampling and decanting activities will still be required to use supplied air respiratory systems. As discussed in Section 1.6, during winter months the site will experience temperatures as low as 14°F, with average daily temperatures of 36°F. Under the most severe conditions, freezing of liquids in the drums may be possible. Therefore, during periods of extended low temperatures, drums will be monitored for any sign of leakage or damage due to freezing. Damaged drums will be immediately placed in over pack units to ensure containment.

The 49,265 sf total floor area is divided into 7 drum storage cells with each cell having a separate drain, collection sump, and leak detection sump. Each 63-ft long by 52-ft wide cell is capable of storing 160 drums. Two of the cells are designated as TSCA-PCB cells and as such are required to be isolated from other drum storage cells. The 6-inch high by 41 inch wide berm walkway which surrounds the TSCA –PCB cell provides the necessary isolation. The remaining five cells are also separated by berm walkways. As shown on Drawing No. 38, drums will be placed in four rows, two drums deep. Two 12-ft wide aisles will provide access for the forklift to place and remove drums. Any drum spills or leakage will flow to the deep drain located along the center line of the cell. The drain bottom slopes at 2 percent to the sumps located on the south side (rear) of the building. The berms in combination with the sloping floors to the sumps for each cell will provide separation of the incompatible wastes. Any fluids in the sump will be removed though the sump riser pipes using a vacuum truck which can access the pipes from the rear of the building.

The perimeter of the drum storage unit will be graded to drain away from the facility foundation.

7.1.3 Subgrade Excavation, Liner System, Leachate Collection Sump, and Leak Detection Sump Design

Subgrade Excavation

The subgrade surface will be compacted to provide a suitable foundation for overlying drainage soils, geosynthetics, and the concrete floor and building foundation. Soft areas will be over excavated and replaced with compacted structural fill. Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

Liner System

Drawing No. 37 indicates the area extent of the liner system and the basal liner components intended for the floor, drainage trenches and sumps, and anchor trench areas. In the floor area of the drum handling facility, the liner system is a double lined system consisting of (from bottom up), a prepared subgrade, a geomembrane secondary liner, a composite geotextile and sand leachate collection drainage layer, and the epoxy coated concrete floor which serves as the primary containment element. In the drainage trench areas, the liner system is a double lined system consisting of (from bottom up), a prepared subgrade, a secondary geomembrane liner, a geonet leak detection and removal layer, and a primary geomembrane liner. Details of each liner component of the floor and drainage trench areas (from bottom up) are discussed below.

Floor Liner System

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (smooth)*

  The 60-mil HDPE liner placed on top of the prepared subgrade is the secondary liner component. The HDPE liner is a highly efficient barrier layer to restrict percolation of leachate into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *12-oz non-woven cushion geotextle*

  The 12-oz non-woven geotextile layer placed on top of the geomembrane will provide cushion, as well as filtration qualities to protect the geomembrane from puncture and allow liquids percolating through the concrete floor and select subbase to drain to the sump area. Specification Section 02714, Filter or Cushion Geotextile, describes minimum geotextile properties required, material transportation and handling procedures, deployment and seaming requirements, and material CQA.

- *one-foot thick select subbase*

  The select subbase will provide a stable foundation for the overlying concrete floor while allowing liquids for the overlying concrete floor while allowing liquids percolating through the concrete to drain to the sump area. Specification Section 02229, Select Subbase, presents material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *6-inch thick epoxy coated concrete floor*

  The concrete drum handling facility concrete floor slopes towards one of the seven drainage trenches located within each cell. The drum handling facility secondary liner system completely encompass the floor so that any leakage through the pad will also drain back into one of the drainage trenches. The concrete floor will be steel reinforced cast-in-place concrete. All joints in the concrete floor will be constructed with chemical resistant water stops and caulking sealer. Drawing No. 45 shows the rebar types and concrete details for the floor. Construction details for the floor are also called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.

<u>Drainage Trench Liner System</u>

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *60-mil thick high density polyethylene (HDPE) secondary geomembrane liner (smooth)*

  The 60-mil HDPE liner placed on top of the prepared subgrade is the secondary liner component. The HDPE liner is a highly efficient barrier layer to restrict percolation of leachate into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material and CQA.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *Geonet leak detection drainage layer (transmissivity $\geq 5x10^{-3}$ m^2/sec)*

  The high transmissivity geonet drainage layer provides a means to transmit and remove fluids percolating through the primary geomembrane layer. Flow calculations discussed in Section 7.2.1 and presented in Appendix E indicate that the geonet is capable of removing fluids such that ponding on the secondary liner can be avoided. Specification Section 02712, Geonet, describes minimum geonet properties required, material transportation and handling procedures, deployment and seaming requirements, and material and construction quality assurance.

- *60-mil thick high density polyethylene (HDPE) primary geomembrane liner (smooth)*

  The 60-mil HDPE liner placed on top of the geonet layer serves as the primary liner component in the drainage trench area. The HDPE liner is a highly efficient barrier layer to restrict percolation of fluids from entering the into the geosynthetic layers below. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material and CQA.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

<u>Leachate Collection Sump and Leak Detection Sump Design</u>

The leachate collection system and leak detection system each have a separate sump from which fluids can be collected and removed. The liner components in the drainage trench system continue into the sumps, however, in order to provide adequate volume to efficiently operate removal pumps, gravel thicknesses are incorporated in the sumps. Drawing No. 39 illustrates the sump layout and cross-sections and the geosynthetic component arrangements. As shown on the drawings, the sumps are rectangular pyramidal shapes which lie concentrically above one another. The slope riser pipes enter their respective sumps at the sump base and are in the same vertical plane. The slope riser trench arrangement enables the leachate collection and leak detection slope riser pipes to penetrate overlying geosynthetic liner elements at the crest of the sump rather than at its base. The leachate collection sump and drain has a total fluid capacity of 2,110 gallons (after accounting for gravel). Ten percent of the cell water volume is 880 gallons based on a storage capacity of 160 55-gallon drums. The leak detection sump and drain has a total fluid capacity of 41 gallons (after accounting for gravel). Because theses sumps are close to the surface and any fluids in the sump can be observed by looking down the riser pipes, fluid level instrumentation is not required.

7.2 DRUM HANDLING FACILITY DESIGN ANALYSES

7.2.1 Geosynthetics Strength and Performance Analyses

7.2.1.1 Geomembranes

The 60 mil geomembrane located beneath the concrete floor area of the drum handling building is protected by a an overlying geotextile and fine grained foundation sand. Below this geomembrane is a 6-inch thickness of prepared subbgrade. Specification No. 02119, Prepared Subgrade, requires this subgrade material to have a maximum particle size of 1 inch. Specification No. 02775, Geomembrane Liners, requires that the surface of the prepared subgrade be smooth drum compacted and free of any foreign objects which might damage the overlying geomembrane. Considering that the loading conditions of the geomembrane in this arrangement due to the overlying sand, concrete floor, drums, and forklift wheeling loading do not approach the loading conditions evaluated in Calculation No. E-18, Geomembrane Puncture Resistance, the geomembrane will be adequately protected against puncture.

The geomembranes located in the drain areas and the drain sumps will not be subjected to significant overburden pressures. Gravel in the sump will not be compacted.

7.2.1.2 Geonet

The geonet layer in the drain areas and the drain sumps will not be subjected to significant overburden pressures which might reduce flow capacity. Additionally, the 2 percent slope of the drain system provides adequate relief to cause fluid flow to the sumps.

7.2.1.3 Geotextiles

Calculation No. E-20, Geotextile/Geocomposite Filtration, evaluates the AOS of several available geotextile products with respect to the silty sands and Upper Dockum materials found at the site. Based on this calculation, the 7 oz non woven geotextile called for in the specifications will adequately filter fines from the foundation sand material (SM) .

7.2.1.4 Anchor Trench Design

The purpose of the anchor trench in the drum handling facility is to restrict movement of the geosynthetics during installation of the sand and concrete layers. Pullout capacity due to settlement is not a relevant concern for this facility.

7.2.2 Drum Handling Facility Concrete Floor

The floor of the drum handling building may be exposed to untreated waste material and is required to serve as the primary containment system. All joints in the concrete floor of the stabilization building will be constructed with chemical resistant water stops. In addition, a chemical resistant epoxy coating will be placed on the surface of the floor to further restrict potential liquid penetration into the concrete.

Drawing No. 45 shows the rebar types and concrete details for the floor. Construction details for the floor are also called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.

8.0 LIQUID WASTE STORAGE FACILITY

8.1 LIQUID STORAGE FACILITY DESIGN

8.1.1 General

The purpose of the liquid waste storage facility is to provide storage capacity for bulk liquid wastes which will either be processed in the stabilization facility or be placed in the evaporation pond. The tanks will not be used to manage wastes containing volatile organic concentrations greater than 500 parts per million by weight (ppmw).

Liquid waste storage facility design elements include liquid storage facility layout, storage tank leak containment design; piping and pumping design; and concrete tank pad. This section describes each of these design elements.

8.1.2 Facility Layout

Drawing No. 40 shows the arrangement of the liquid waste storage tanks, piping , and tank containment pad and surrounding area. The four double lined HDPE poly tanks (9,000 gallon capacity) will each have its own concrete pad area, discharge and intake pump, and piping and control system.

As previously discussed, access to the liquid waste storage area is provided on the east, west, and north sides of concrete tank pads. Tanker trucks can use either the north access road or the road to the east of the liquid waste storage area.

The concrete pad is included to prevent the spread of fluid should leaks or spills occur at discharge piping connections and pumps located within the pad.

A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped providing drainage toward the sump areas.

8.1.3 Tank Leakage Containment Design

Drawing No. 40 illustrates the double walled poly tank system. The outer tank will be covered to prevent the precipitation infiltration. The inner tank will not be covered. The tanks will be equipped with flexible connections at pipe penetrations between the inner and outer tanks and drainage ports in the outer tank. Chemical resistant gaskets will be used at all tank flanges. Liquids containing solvents such as MEK, toluene, zylene, diesel, or gasoline in concentrations greater than 15% will not be placed in the tanks. Tank tie down details will be developed from manufacturer's shop drawings when the tank is purchased.

The 15,500 gallon outer tank will contain the total volume of the 9,000 gallon inner tank should a leak in the inner tank occur. Each tank system will be equipped with graduated sight gauges allowing visual determination of fluid volume in the inner tank. In addition, to prevent tank overfilling or unnecessary pumping, high level and low level cutoff switches are included.

The tanks will be vented to the atmosphere to prevent internal pressure buildup. Protected ladders running up the outside of the outer tank will provide access to openings in the top tank.

Specification Section 13205, Polyethylene Tank (see Volume IV, Appendix C for Construction Specifications), discusses the tank material and installation requirements. Construction details for the concrete tank pad are called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement

Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete.

8.2 LIQUID WASTE STORAGE FACILITY DESIGN ANALYSES

8.2.1 Tank Design, Testing, and Quality Control Standards

The liquid waste storage facility poly tanks will be manufactured by Central California Container Inc. Performance tests, material property tests, and design standards provided by the manufacturer include the following:

- **Performance Requirement Tests**
  Low Temperature Dart Impact Test (ASTM D-1998)
  O-xylene-Insoluble Faction (Gel Test) (ASTM D-1998)
  Ultrasonic Gauge Wall Thickness Test (ASTM D-1998)
  Hydrostatic Pressure Test (ASTM D1998)

- **Material Properties Tests**
  Environmental Stress Crack Resistance (ASTM D-1693)
  Elongation @ Break, Tensil Strength (ASTM D-638)
  Uv Stabilizer Compounded into Resin (ASTM D-1998)

- **Design Standards**
  Wall Thickness Calculations (ASTM D01998)
  Seismic & Wind Restrain (UBC)
  Finite Element Analysis (ADE-92)

The tank manufacturer has provided recommended tank tie down details. The details should be reviewed and approved by a registered professional engineer prior to tank installation.

The manufacturer information on the tank compatibility is provided in Appendix H-3. This assessment indicates that the tanks are compatible with a wide variety of waste liquids.

8.2.2 Pumping and Piping

Drawing No. 40 illustrates the pumping, piping, and control feature arrangement for the liquid waste receiving and storage area. High and low level cutoffs will prevent tank overfilling and pump burnout. The flow meter will record fluid volumes pumped into and out of the tank.

The Piping system will be installed according to API publication 1625 (November 1979) or ANSI standard B31.2 and ANSI standard B31.4.

All piping installed at the liquid waste storage facility will be double walled.

8.2.3 Tank Concrete Pad

The concrete pad will provide secondary containment for the ancillary facilities.

Drawing Nos. 40 and 45 show the rebar types and concrete details for the floor. Construction details for the floor are also called out in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking, describes the concrete epoxy coating requirements.

9.0 TRUCK WASH FACILITY

9.1 TRUCK WASH FACILITY DESIGN

9.1.1 General

DOT approved roll-off trucks delivering bulk solid waste for landfill disposal will have plastic bed liners which will isolate the waste from the roll-off bin interior. As waste loads are dumped, these bed liners can become damaged exposing the roll-off bin to the waste material. If this material cannot be removed from the roll-off bin at the landfill waste placement face, then the truck will be required to proceed to the truck wash facility, where the bin will be washed out. Also, during rainy periods, mud from access roads or daily cover soil can collect on the wheels and undercarriages of waste haul trucks exiting the landfill. Similarly, if this material cannot be removed from the truck while in the landfill, then the truck will be required to proceed to the truck wash facility for cleanup prior to exiting the site. Landfill operations equipment such as waste compactors, scrapers, water trucks, and other vehicles may also require similar cleanup upon exiting the landfill. Because potentially contaminated materials may be washed from the roll-off bin or from undercarriage recesses while at the truck wash facility, a double liner containment system has been designed to contain wash water and wash residues.

The truck wash facility design elements presented here include the facility layout, liner system, and sump and leak detection system.

9.1.2 Facility Layout

Drawing No. 44 illustrates the truck wash facility layout. As previously discussed, access to the truck wash facility is from the west landfill perimeter road. Exiting traffic will proceed to the north access road. The facility is designed with two wash bays: a heavy equipment bay and a roll-off truck bay; and a water storage area. Both wash bays drain to a common sump area which will collect wash water and residue. Poly tanks and pumps, located in the water storage area provide storage and pumping capacity for clean and used wash water.

The truck wash sump drains to a collection point at its north end where water will be pumped from the sump into a clarifier. The sump and sediment bins will be inspected weekly for the accumulation of sediment and liquids and will be removed to the wash water storage tanks. Residues remaining in the sump can be removed using a front-end-loader which has access from the heavy equipment wash bay. Oils, grease, and fine sediments will be removed from the wash water in the clarifier before being pumped to a double lined poly tank. Wash water and residues will be chemically analyzed and handled in an appropriate manner.

The entire extent of the truck wash facility concrete, which acts as primary containment, is designed with a geosynthetic secondary liner and leak detection system. The concrete will be coated with epoxy similar to the drum handling facility.

The roll-off truck bay is equipped with a truck barrier, tail gate lift, moveable wash platforms, and three high pressure hose reel and nozzle assemblies. The high pressure pump and delivery system can either be a single fixed installation or be made up of several portable units. Roll-off trucks will back into the bay to the truck barrier and lift the truck bed as if to dump. The trail gate lift will be attached and the tail gate raised to expose the inside of the roll-off bin. Truck wash personnel will then wash out the inside of the bin using the high pressure wash system. Wash water and residue will then be washed from the concrete floor into the sump area. If necessary, moveable platforms can be positioned next to the truck and the truck bed can be washed from openings in its top surface.

The heavy equipment wash bay will be constructed with steel rail or I-beams incorporated into the concrete floor of this bay to resist damage by heavy equipment tracks. Wash water and residue will flow to the sump area and will be removed as discussed above.

A concrete pad will be placed in the loading/unloading areas for the tanker trucks. This pad will be sloped, providing drainage towards the sump areas.

9.1.3 Subgrade Excavation, Liner System, Sump and Leak Detection System Design

- *Subgrade Excavation*

  The subgrade surface will be compacted to provide a suitable foundation for overlying drainage soils, geosynthetics, and the concrete floor and building foundation. Soft areas will be overexcavated and replaced with compacted structural fill. Specification Section No. 02110, Site Preparation and Earthwork, describes site preparation, excavated soil classification and stockpiling, subgrade surface preparation and inspection, structural fill placement and compaction requirements, survey and quality control, and erosion control features.

- *Liner System*

  Drawing No. 44 indicates the aerial extent of the liners system and the basal liner components intended for the floor, drainage trenches and sumps, and anchor trench areas. In the floor areas, the liner system consists of (from bottom up), a prepared subgrade, a geomembrane secondary liner, a geocomposite drainage layer, a foundation sand layer, and the epoxy coated concrete floor which serves as the primary containment element. Details of each liner component are discussed below.

<u>Floor Liner System</u>

- *6-inch thickness of prepared subgrade*

  The prepared subgrade component will provide a smooth stable surface suitable for placement of overlying geosynthetic materials. Specification Section 02119, Prepared Subgrade, presents subgrade material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *60-mil thick high density polyethylene (HDPE) geomembrane liner (textured)*

  The 60-mil HDPE liner placed on top of the prepared subgrade is the secondary liner component. The HDPE liner is a highly efficient barrier layer to restrict percolation of leachate into the subgrade. Specification Section 02775, Geomembrane Liners, describes minimum geomembrane properties required, subgrade preparation and inspection, material transportation and handling procedures, deployment and seaming requirements, and material construction quality assurance.

  Site specific compatibility tests will be conducted on a synthetic leachate and the proposed liner prior to operation of the facility.

- *Geocomposite*

* A geocomposite drainage layer (transvissivity ≥ 2.2 x 10^{-4} m^2/sec) consisting of:
    - ◊ A7 oz. geotextile (non-woven)
    - ◊ A geonet
    - ◊ A 7 oz. geoxtile (non-woven)

The high transmissivity geocomposite drainage layer provides a means to transmit and remove fluids percolating through the epoxy coated concrete floor. Flow calculations discussed in Section 3.2.8 and presented in Appendix E indicate that the geocomposite is capable of removing fluids such that ponding on the geomembrane liner can be avoided. Specification Section 02712, Geocomposites, describes minimum geonet properties required, material transportation and handling procedures, deployment and seaming requirements, and material and construction quality assurance.

- *A 12-inch thick foundation sand layer*

  Specification Section 02231, Foundation Sand, presents foundation sand material requirements including particle size and moisture content, placement and compaction requirements, and survey and field quality control requirements.

- *One foot thick epoxy coated concrete floor*

  The truck wash facility floor slopes towards sump located between the two bay areas. The truck wash facility secondary liner system completely encompass the floor so that any leakage through the floor will be captured in the leak detection system. The concrete floor will be steel reinforced cast-in-place concrete. All joints in the concrete floor will be constructed with chemical resistant water stops and caulking sealer. Construction details for the floor will be provided similar to those presented in Specification Section 03100, Concrete Formwork, Section 03200, Reinforcement Steel, Section 03290, Joints in Concrete, and Section 03300, Cast-in-Place Concrete. Specification Section 07920, Sealants and Caulking describes the concrete epoxy coating requirements.

Leak Detection Sump (LDRS) Design

The leak detection system geocomposite drains to a separate sump from which fluids can be detected and removed. In order to provide adequate volume to efficiently operate removal pumps, a gravel thickness has been incorporated in the sump. Drawing No. 44 illustrates the sump layout and cross sections and the geosynthetic component arrangements. A vertical riser pipe is located in the center of the sump and provides space for the fluid removal pump. The leak detection sump has a total fluid capacity of 72 gallons (after accounting for gravel). Because this sump is close to the surface and any fluids in the sump can be observed by looking down the riser pipe, fluid level instrumentation is not required. Fluids in the sump will be removed by pumping into the clarified or by vacuum truck.

9.2 TRUCK WASH FACILITY DESIGN ANALYSES

9.2.1 Geosynthetics Strength and Performance

Geomembrane, geocomposite, and geotextile material installation in the truck wash facility is similar to the installations in the drum pad facility. Rationale and computations pertaining to geomembrane puncture and tearing, geocomposite flow capability, and geotextile cushioning and filtration performed for the drum pad, which are applicable to the truck wash facility, are not repeated.

9.2.2 Tank Design, Testing, and Quality Control Standards

Tanks and piping intended to store and convey potentially contaminated wash water will be double lined installations similar to the liquid waste storage area tanks. Section 8.2 presents a discussion of this equipment which also applies to the truck wash facility. Control features for this system are identified on Drawing No. 44.

Piping system will be installed according to API publication 1615 (November 1979) or ANSI B31.2 and ANSI standard B31.4.

The clean water supply tank and piping will be single walled installations.

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