APPLICATION FOR A PERMIT TO

OPERATE A CLASS I LANDFILL

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UTAH DIVISION OF
SOLID & HAZARDOUS WASTE

Prepared for:

BAYVIEW LANDFILL

SOUTH UTAH VALLEY SOLID WASTE DISTRICT
Springville, Utah

Submitted October 2003

Prepared by:

HDR Engineering, Inc.
3995 South 700 East
Salt Lake City, Utah 84107

HDR

Client/Contract No. 008325/CON 0001161

SUVSWD Bayview Landfill
Class I Landfill Permit Modification

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PART I

APPLICATION FOR A PERMIT TO OPERATE A CLASS I LANDFILL

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

PART I

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF SOLID AND HAZARDOUS WASTE

Application for a Permit to Operate a Class I Landfill

PART I — General Data

1. Name of Facility: Bayview Landfill
2. Site Location: 10800 S. State Road 68
   Utah County
3. Facility Owner: South Utah Valley Solid Waste District
4. Facility Operator: South Utah Valley Solid Waste District
5. Contact Person: Richard Henry, District Manager or
   Scott Aitken, Landfill Foreman
   Address: P.O. Box 507, Springville, UT 84663-0507
   Telephone: (801) 489-3027
6. Type of Facility: ( ) Initial Application

   (X) Class I Landfill

   ( ) Class V Landfill (X) Permit Renewal

7. Property Ownership:

   ( ) Presently Owned by Applicant

   ( ) To be Purchased by Applicant

   (X) Leased by Applicant 51-year lease (Utah Division of State Lands)

   Property Owner (if different from Applicant):

   Name: Utah Division of State Lands

   Address: 3 Triad Center
   Salt Lake City, UT 84180

   Telephone: (801) 538-5508

8. Certification of Submitted Information:

Richard Henry
Name of Official

District Manager
Title

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: Richard J Henry Date: 10-1-03

SUBSCRIBED AND SWORN to before this 1st day of October, 2003.

My Commission expires on the 10th day of October, 2006

Dorothy Morse
Notary Public in and for

(SEAL) Utah County, Utah.

NOTARY PUBLIC
DOROTHY O. MORSE
1230 N 1450 W
PROVO, UT 84604
MY COMMISSION EXPIRES
OCTOBER 10, 2006
STATE OF UTAH

SOUTH UTAH VALLEY SOLID WASTE DISTRICT
P.O. BOX 507
SPRINGVILLE, UT 84663
(801)489-3027
FAX (801)491-9367

Dennis R. Downs, Executive Secretary
Utah Solid and Hazardous Waste Control Board

Subject: Authorized Representative:

Dear Mr. Downs:

The South Utah Valley Solid Waste District has appointed their District Manager as the authorized representative. As such he is authorized to represent the district in all dealings with the state and his signature on documents is considered official. Richard Henry is the District Manager and will represent the District . Thank you for your consideration in this matter.

Sincerely,

Sherman Huff, Chairman
South Utah Valley Solid Waste District Board

PART II
General Report

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

SUVSWD Bayview
Class I Landfill Permit Modification - Part II
General Report

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1.0 FACILITY DESCRIPTION

1.1 GENERAL

The South Utah Valley Solid Waste District (the District) was formed in 1989 to own and operate solid waste facilities for the cities of Provo, Salem, Spanish Fork, Springville, Mapleton, and Goshen, Utah. It assumed the existing and previously permitted landfill operations from the City of Provo. These solid waste facilities include:

- A transfer station located in Springville;
- A landfill located north of Elberta (Bayview).

A separate, non-District-owned transfer station in Goshen also provides waste to the Bayview Landfill. This Permit Application applies only to the landfill, and does not include design, construction, or operation of the transfer stations.

The South Utah Valley Solid Waste District added a temporary compost facility at the Bayview Landfill during 2003, and anticipates adding a permanent compost facility at the Landfill during the 5-year period covered by this Permit Application. The permanent compost facility will process a combination of yard waste and biosolids; it will be jointly permitted through the Division of Solid and Hazardous Waste and the Division of Water Quality. Therefore, the Operating Plan for the temporary compost facility is described in Appendix R to this Permit Application. Once a permanent compost facility site is established, the operating plan will be revised and resubmitted to the Utah Department of Environmental Quality (UDEQ).

The Bayview Landfill was located, permitted, designed, and constructed by Provo City Corporation during the 1980s. The City received a Conditional Use Permit for the landfill site through the Utah County Board of Adjustment; several conditions were attached to the Conditional Use Permit. One of these conditions requires that only compacted or baled garbage be accepted at the landfill. A second of these conditions permits disposal of garbage from Provo City Corporation only; this condition was later modified to allow disposal of garbage from the District only. Therefore, no out-of-District wastes can be disposed of in the Bayview Landfill

without approval of the County Board of Adjustment. The Conditional Use Permit conditions are enumerated in Appendix B of this report.

The Bayview Landfill is located in Sections 17 and 18, T9S, R1W approximately 6 miles north of Elberta, Utah, and directly west of State Highway 68. The landfill property includes all 640 acres of Section 17, and a 20-acre parcel in Section 18. All solid waste disposal activities are planned within the Section 17 parcel; the 20-acre Section 18 parcel houses a culinary well, a water storage tank, and an upgradient monitoring well associated with the landfill operations. The Bayview Landfill site is located in the Goshen Valley approximately 2 to 3 miles west of the southwestern-most bay of Utah Lake. The Goshen Valley slopes upward away from the lake toward the East Tintic Mountains some 7 miles southwest of the lake. The landfill site similarly slopes with an approximate 150-foot rise from the eastern to the western boundaries of Section 17. The eastern boundary of the landfill site is approximately 120 feet above the current water elevation of Utah Lake.

The land use surrounding the site is generally rural agricultural, with orchard, grain, hay, and livestock grazing as the predominant land uses in the vicinity of the site. The nearest residence is located more than 1 mile from the northern property boundary, and the nearest town, Elberta, is 5.5 miles south of the site.

1.2 AREA SERVED

The service area for the Bayview Landfill includes the cities of Provo, Salem, Spanish Fork, Springville, Mapleton, Goshen, and some contiguous areas. As stated above, the landfill's Conditional Use Permit prohibits it from receiving wastes generated outside of the service area of the District. The landfill is also prohibited from receiving wastes that have not been compacted or baled. These prohibitions limit the landfill's ability to accept wastes from other areas of the County or adjoining counties. The conditions also restrict use by the general public.

1.3 WASTE TYPES

The Bayview Landfill accepts compacted wastes from the District's transfer station in Springville and a city-owned transfer station in Goshen. The transfer stations provide record keeping, screening and compacting of incoming wastes, and shipping of the compacted solid wastes to the Bayview Landfill. The transfer stations accept residential and commercial solid wastes, including yard wastes, and generally do not accept construction debris (C&D) wastes. The transfer stations also do not accept regulated hazardous wastes. The screening of the wastes at the transfer stations is not covered by this permit application.

Yard wastes arriving at the transfer stations may either be segregated for recycling, or commingled and compacted with the residential and commercial wastes for compacting and disposal. Transfer station personnel will make these decisions based on the quantity and ease of separation of the yard wastes, and the workload at the specific moment in time. Yard wastes that are segregated will be transferred to the closed Spanish Forks Landfill for grinding, then transferred to the compost facility at the Bayview Landfill.

The wastes accepted at the transfer stations are generally compacted, loaded into over-the-road vehicles, and transported to the landfill for disposal. When transfer station staff observe recyclable materials, and when there is time to easily and safely remove the recyclable materials, they will segregate these materials into on-site dumpsters for recycling. The District is also considering implementation of drop-off centers and a centralized recycling center to increase recycling participation, and may implement a more organized recycling program during the period covered by this permit application.

Table 1-1 provides a summary of the wastes disposed in Cell 1 of the Bayview Landfill since it began operation in February 1991. The data reflects actual quantities shipped from the transfer stations during each fiscal year (July 1 through June 30).

Table 1-1: Tonnage Disposed at the Bayview Landfill

Year	Actual Tonnage
90-91	32,713
91-92	82,841
92-93	92,045
93-94	96,899
94-95	106,641
95-96	105,746
96-97	108,305
97-98	119,391
98-99	126,661
99-00	124,286
00-01	127,031
01-02	126,664
02-03	130,521

The District projects closure of Cell 1, and initiation of filling in Cell 2 to occur during fiscal year 2004-5. Part III of this Permit Application describes these activities.

The District has produced two master plans for the Bayview Landfill (see Appendix A). The initial Landfill Master Plan (HDR, 1988) projected seven separate cells with a total waste disposal capacity of 7.64 million tons at the Bayview Landfill. This capacity was calculated based on a conservative in-place density of 1,000 pounds of solid waste per cubic yard. Actual in-place densities based on known weights and surveyed volumes exceed 1,300 pounds per cubic yard (ppcy), thereby increasing the capacity of the 7-cell plan. The Bayview Landfill Master Plan Update (HDR 2002) considered several scenarios to make Cells 2 and 3 more efficient in terms of airspace and footprint utilization. The selected scenario combines Cells 2 and 3 into a single area fill, and deepens the excavation of the combined area fill, resulting in approximately 10.2 million cubic yards of capacity for waste. At 1,400 pounds per cubic yard of in-place waste, this equates to about 7.1 million tons.

Since Cells 2/3 (now identified as Cell 2) combined are expected to remain active through approximately 2020, it is not timely to revise the master plan for the remainder of the Bayview Landfill. However, it is expected that a revised master plan would more than double the capacity calculated in the 1988 Landfill Master Plan, yielding a total capacity of more than 20 million

tons. This means that the Bayview Landfill has an expected useful lifetime of more than 50 years from the date of this Permit Application.

2.0 SOLID WASTE MANAGEMENT PLAN

During 1992, the District participated in the development of the Utah County Solid Waste Management Plan (SWMP). The SWMP was developed in response to Senate Bill 255 to address county-wide planning for solid waste disposal over the next 20-year period. Two copies of this SWMP have previously been submitted to the Utah Division of Solid and Hazardous Waste. All of the activities discussed in this permit application were anticipated in, and are consistent with, the SWMP.

In addition, the District has prepared a Landfill Master Plan (HDR, 1988) and a Bayview Landfill Master Plan Update (HDR, 2002) to guide development of the Bayview Landfill site. A copy of each master plan is attached to this permit as Appendix A.

3.0 LEGAL DESCRIPTION

The Bayview Landfill consists of the following parcels:

- Parcel "A": SW1/4 NW1/4 Section 17, T9S, R1W.
- Parcel "B": That portion of Section 17, T9S, R1W not described in Parcel "A. "
- Parcel "C": S1/2 of the SE1/4 of the NE1/4, Section 18, T9S, R1W.

This land was conveyed by the Utah Division of State Lands to the Provo City Corporation for a term of 51 years under Special Use Lease Agreement No. 498 (Appendix B). The term of this lease agreement extends through the year 2035. The lease agreement contains a clause for extension of the lease beyond the 51-year period.

4.0 OPERATIONS PLAN

The two Operating Plans relevant to the Bayview Landfill site are presented in the Appendices to this Permit Application. Appendix S presents the current Landfill Operating Plan, while Appendix R presents the current Compost Facility Operating Plan for the temporary location.

5.0 FINANCIAL ASSURANCE PLAN

5.1 COST ESTIMATE FOR CLOSURE AND POST-CLOSURE CARE

Federal and State of Utah Rules and Regulations require that the owners of municipal solid waste landfills demonstrate the financial capability to conduct closure, post-closure care, and corrective action (if necessary). To meet these requirements, the owner must place in the operating record for the landfill an estimate of the cost of hiring a third party to perform closure, post-closure care, or corrective action. In addition, the owner must demonstrate that the funding is fully available for any year after 2002 to provide for closure, post-closure care, and corrective action for landfill cells that may require closure, post-closure care, or corrective action within the five year period between permit revisions. Both the cost estimate and the funding mechanism must be updated on an annual basis.

The regulations allow six different funding mechanisms to demonstrate financial assurance including: trust funds, surety bonds, insurance, letters of credit, local government financial tests, or local government guarantees. These funding mechanisms may be used individually or in combination with one another to demonstrate financial assurance. The regulations define specific requirements for each funding mechanism.

Appendix C contains an estimate of the costs associated with closure and post-closure care of Cell 1 and Cell 2 at the Bayview Landfill. The estimates cover Cell 1 and the portion of Cell 2 that is projected to receive wastes during the current 5-year permit period. As calculated in Appendix C, the estimate for third-party closure and post-closure care is $2,449,497.

5.2 PROPOSED FINANCIAL ASSURANCE MECHANISM

The District will use a trust fund to demonstrate financial assurance. In 1992, the District established separate accounts in the State Pool accumulating funds for closure and post-closure care of Cell 1 and corrective action. During 1997, the District transferred these funds into the Closure Trust Fund established by the State Treasurer. As of July 31, 2003, the closure/post-closure account will total $2,550,000, which means that the trust fund will be fully funded.

The District has consistently operated on a cash basis since its inception in 1990. It accumulates funds in advance to finance its capital facilities needs, and pays cash for all capital improvements, equipment, and services. This means that the District has no long-term debt to encumber its resources.

Table 5-1 presents the District's 10-Year Capital Facilities Plan. It shows funds that it has accumulated over the years to finance closure of Cell 1 and construction of Cell 2 during the 03-04 and 04-05 fiscal years. Because it has the funds available, the District intends to finance the closure of Cell 1 from these operating funds, and does not intend to diminish the Trust Fund account during closure of Cell 1. This means that the Trust Fund account will actually be over funded by the end of the first year of the current 5-year permit, and it will remain over funded during the remainder of the current permit.

In fact, the District has already begun closing Cell 1 at the time of submittal of this permit application. During July 2003, District personnel began depositing the cap material on side slopes of Cell 1 as those materials were excavated from Cell 2. This practice will continue as long as the excavated materials meet the description of the cap materials as described in Part III and agreed upon with UDEQ. Therefore, Cell 1 will be partially capped prior to issuance of this permit, thereby reducing the financial assurance required for Cell 1 closure.

Table 5-1 also shows that the District will be accumulating funds to finance the construction of the second stage of Cell 2, and the partial closure of the first stage of Cell 2, during the entire period of this permit, even though these activities are not expected to occur during the current

permit's 5-year period. This means that the District does not intend, at the current time, to diminish the Trust Fund account for closure of the first stage of Cell 2, leaving it in place instead to provide financial assurance far into the future. Since the Trust Fund account will continue to grow as it earns interest, this financial assurance mechanism is also expected to be over funded far into the future, and certainly beyond the period of the current 5-year permit. In any case, the District will continue to report on the status and adequacy of the trust fund in its annual reports to UDEQ.

Table 5-1: District's 10-Year Capital Facilities Plan

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

10 YEAR CAPITAL FACILITIES PLAN

Revenue Sources:	FY03/04	FY04/05	FY05/06	FY06/07	FY07/08	FY08/09	FY09/10	FY10/11	FY11/12	FY12/13
Cash in Accounts	$4,363,195.52	$2,182,987.52	$707,519.36	$885,801.84	$324,073.56	$643,601.56	$1,045,681.86	$1,511,840.13	$1,017,832.28	$1,555,645.17
Cash in Trust Account	$2,431,429.48	$2,480,058.07	$2,529,659.23	$2,580,252.42	$2,631,857.46	$2,684,494.61	$2,738,184.51	$2,792,948.20	$2,848,807.16	$2,905,783.30
Current Year Revenues	$3,554,892.00	$3,860,691.84	$3,937,905.68	$4,016,663.79	$4,096,997.07	$4,178,937.01	$4,262,515.75	$4,347,766.06	$4,434,721.38	$4,523,415.81
Interest	$142,000.00	$144,840.00	$147,736.80	$150,691.54	$153,705.37	$156,779.47	$159,915.06	$163,113.36	$166,375.63	$169,703.14
Total Revenue & Interest	$3,696,892.00	$4,005,531.84	$4,085,642.48	$4,167,355.33	$4,250,702.44	$4,335,716.48	$4,422,430.81	$4,510,879.42	$4,601,097.01	$4,693,118.95
Total Revenue Sources	$10,491,517.00	$8,668,577.43	$7,322,821.07	$7,633,409.58	$7,206,633.46	$7,663,812.65	$8,206,297.18	$8,815,467.75	$8,467,736.47	$9,154,547.42
Total Minus Trust Fund	$8,060,087.52	$6,188,519.36	$4,793,161.84	$5,053,157.16	$4,574,776.00	$4,979,318.04	$5,468,112.67	$6,022,519.55	$5,618,929.31	$6,248,764.12
Capital Projects:										
Land Purchase										
Wheeled Loader		$115,000.00	$115,000.00		$125,000.00	$125,000.00		$130,000.00	$130,000.00	
T.S. Pickup	$27,100.00									
Major Compactor Repair	$50,000.00	$50,000.00			$50,000.00			$10,000.00	$10,000.00	
Replace Gray Compactor										
Transfer Station Construction										
Chip and Seal Transfer Stat.				$10,000.00						$15,000.00
Transfer Station Engineering	$5,000.00		$5,000.00						$10,000.00	$10,000.00
Repair Transfer Station Doors	$25,000.00									
Replace Transfer Station Floor				$50,000.00						
Replace Yard Goat										
Remodel Transfer St. Office	$50,000.00									
Service Vehicle			$5,000.00			$5,000.00			$5,000.00	$80,000.00
Other Capital	$20,000.00	$20,000.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00			$10,000.00	$10,000.00

	FY03/04	FY04/05	FY05/06	FY06/07	FY07/08	FY08/09	FY09/10	FY10/11	FY11/12	FY12/13
Landfill Compactor				$600,000.00				$630,000.00		
Scraper				$350,000.00				$375,000.00		
Landfill Pickup										$35,000.00
Grader			$100,000.00				$125,000.00			
Landfill Expansion	$1,800,000.00	$1,000,000.00								
Gas Collection System		$500,000.00								
Engineering Services	$300,000.00	$150,000.00					$10,000.00			$10,000.00
Chip and Seal at Landfill		$10,000.00				$10,000.00				
Total Capital Projects	$2,277,100.00	$1,845,000.00	$235,000.00	$1,020,000.00	$185,000.00	$150,000.00	$135,000.00	$1,145,000.00	$165,000.00	$160,000.00
Operating Cost	$3,600,000.00	$3,636,000.00	$3,672,360.00	$3,709,083.60	$3,746,174.44	$3,783,636.18	$3,821,472.54	$3,859,687.27	$3,898,284.14	$3,937,266.98
Profit or (Loss)	$96,892.00	$369,531.84	$413,282.48	$458,271.73	$504,528.00	$552,080.30	$600,958.27	$651,192.16	$702,812.88	$755,851.97
Funds Available	$2,182,987.52	$707,519.36	$885,801.84	$324,073.56	$643,601.56	$1,045,681.86	$1,511,640.13	$1,017,832.28	$1,555,645.17	$2,151,497.14

6.0 CLOSURE PLAN

This section describes the closure plan for Landfill Cell 1. Landfill Cell 1 is scheduled to close in 2005. Closure plans for future landfill cells will be coordinated with the liner system designed for those cells.

6.1 FINAL COVER INSTALLATION

An alternate final cover design of the capping system for the Bayview Landfill has been completed. The final contours of Cell 1 were projected in the 1988 Master Plan, and are depicted on Figure 14 in Part IV. It is anticipated that the final waste contours (less the final cover) will be reached in 2004, at which time the final cover will be installed.

The design for the capping system includes the following layers of material from the bottom up:

- 6 inches of intermediate cover placed over the daily cover to provide a 12-inch cushion of soil between the solid waste and the barrier layer.
- 34-inches of evaporative cap constructed from the olive-brown silty sand available on-site. The top six inches of this evaporative cap will be capable of supporting vegetative growth. An additional layer of compost-amended soil will be used to aid in initial seed germination.

The intermediate cover will be compacted with two passes of the compactor. The evaporative cap would be only moderately compacted as performed during placement and grading.

This cap was found to achieve an equivalent reduction in infiltration as the prescriptive cap defined in Utah Solid Waste Regulation R315-303-3 (4) based on modeling performed by Kleinfelder, Inc. in April 2003. A copy of that study is included as Appendix N.

After completion of the final cover installation, a series of metal stakes with plastic fibers attached to the top will be placed in the final cover on 100-foot centers across Cell 1. These metal stakes are commonly referred to as "blue tops" or "whiskers" and will be driven into the final cover until the plastic fibers are just below the completed final cover surface. If used, the

compost-amended soil layer will be placed on top of the final cover. This will provide a visual method (if the fibers begin to show over time) to determine if erosion of the final cover is occurring. Additionally, a series of benchmarks will be located around the perimeter of the landfill to be used to determine when settlement of the waste or cover materials has ceased.

The Landfill Foreman will inspect the completed cap weekly until the vegetative cover is established, and monthly thereafter to ensure that damage to the capping system is detected and repaired early. The vegetation on the landfill cap will be maintained to blend into the surrounding semi-arid landscape.

The Landfill Foreman will also inspect the completed cap to determine that the final contours are maintained, and that the flow of stormwater is unimpeded. Areas in which excessive settlement or erosion of 1 inch as evidenced by the exposure of the blue top survey stakes has occurred will be regraded, mulched, and seeded as specified above.

6.2 SITE CAPACITY

At closure, Cell 1 will contain approximately 1,650,000 tons of solid waste (2.4 million cubic yards of 1,400 pounds per cubic yard). At the current rate of solid waste compaction, the District estimates that Cell 1 will close around mid 2005. As of mid 2003, the District has disposed of approximately 1,400,000 tons of solid waste in Cell 1. The District is also pursuing a compost operation at the Bayview landfill. A temporary location has been identified on the southern portion of partially filled Cell 1. A permanent facility will be designed and permitted as Cell 1 is being filled. An operations plan for the temporary compost facility is included in Appendix R.

The exact impact on the site life of the landfill cannot be determined because yard waste is currently being diverted at the transfer stations.

The reconfigured Cell 2 (formerly Cells 2 and 3) has a capacity for waste of about 5,700,000 tons. Based on the current rate of solid waste receipt of 130,000 tons per year, Cell 2 will last approximately 43 years, assuming no increase in waste generation.

Based on the 1988 Master Plan, Cells 4 through 7, as currently configured, have a capacity of about 4,600,000 tons of waste with a waste density of 1,000 pounds per cubic yard. The Bayview landfill currently achieves about 1,400 pounds per cubic yard of in-place waste. Making this conversion, Cells 4 through 7 would have a capacity for about 6,400,000 tons, equating to an additional 50 years of life at 130,000 tons per year.

6.3 CLOSURE SCHEDULE AND FUNDING

As stated above, Cell 1 will reach capacity in mid 2005.

Final closure construction will begin within 2 months of final receipt of solid waste in Cell 1. Closure construction will proceed on a continuous schedule to provide for completion of the closure cap within 18 months of final receipt of solid waste. The exact schedule cannot be predicted because the closure must be coordinated with both the final receipt of waste, and the beginning of the active growing season to provide cover vegetation an optimal chance of survival. The UDEQ will be notified when closure construction has been completed so that a final inspection can be made.

The closure costs projected in Section 5 assume that the entire closure cap, including intermediate soil cover, will be constructed as part of the closure. This is a very conservative assumption. Further, closure costs are anticipated to be paid from operating funds, leaving the trust fund intact. This is also a very conservative assumption. These assumptions allow the expedited closure of the landfill cell, and ensure that funding will be available to allow a third party to close the landfill under tight time constraints, if needed.

The regulatory agencies will be notified at least 10 working days prior to the intended release of contractor obligations on closure of the landfill cell. This will allow the regulatory agencies time to inspect the closure and to notify the District of deficiencies in the closure.

7.0 POST-CLOSURE CARE PLAN

Post-closure care for Cell 1 of the Bayview Landfill will consist of long-term maintenance of the closure cap and ongoing sampling of the groundwater monitoring wells and gas monitoring stations to ensure that the landfill cell has been closed in accordance with regulations. The post-closure care period will be 30 years unless unexpected environmental contamination or continued subsidence occurs, or a shorter period if it can be proven that it no longer presents a threat to human health or the environment.

7.1 Monitoring and Maintenance

Semi-annual groundwater and quarterly landfill gas monitoring will occur throughout the post-closure period. This frequency will be increased if data indicate that contamination may have occurred. The post-closure monitoring frequency will revert if the more frequent monitoring demonstrates that contamination, if present, is not attributable to the landfill.

Collection and treatment of leachate generated in Cell 1 will continue to be provided by the stormwater/leachate evaporation pond. This leachate collection and treatment system will be inspected as part of the ongoing activities for other landfill cells during the post-closure period for Cell 1. Since the Bayview Landfill has no planned surface water discharge, no surface water monitoring will be required during the post-closure period.

Table 7-1 provides a schedule for conducting inspections and maintenance and for recording these routine activities. The Landfill Foreman will be responsible for conducting the inspections, scheduling maintenance, and recording these activities on forms provided in Appendix I.

Table 7-1: Frequency of Inspection and Maintenance of Facilities During Post-Closure Care

Landfill Facility	Inspection or Maintenance	Frequency
Landfill Cell	Closure cap integrity. Cell perimeter fence integrity.	Quarterly
Stormwater / Leachate Pond	Perimeter fence integrity. Water depth. Liner system integrity.	Quarterly
Other Appurtenances	Entrance gate integrity. Perimeter fence integrity. Monitoring station integrity. Berm integrity. Run-on and Run-off Control Systems.	Quarterly

The above activities will be carried out as a part of ongoing operations during the active life of the site. They will be expanded to include the entire site at final landfill closure and will continue throughout the post-closure monitoring period.

A written summary of the activities performed during each inspection will be maintained. The District will retain the right of entry to the closed landfill, maintain all right-of-ways, and conduct maintenance and/or remediation activities as needed. The landfill will be inspected on a quarterly basis for the following conditions:

- Integrity of the final cover (including erosion, desiccation, subsidence, seeps and settlement)
- Loss of vegetative cover or growth of undesirable plant species
- Visible debris, litter, and waste
- Condition of access roads, gates, and fences
- Integrity of on-site structures
- Integrity of groundwater monitoring system
- Integrity of methane monitoring system
- Integrity of drainage features
- Integrity of the leachate collection system

The final cover will be inspected for erosion or other maintenance problems. Any problems detected during routine site inspections will be corrected as soon as practicable. All eroded areas will be recovered with suitable soil to establish erosion control and infiltration layers, as well as positive drainage to maintain the integrity of the final cover as outlined in Section 6.1. All bare areas in the final cover will be re-vegetated as necessary. The vegetative cover will be maintained as necessary to promote viable plant growth.

The need for final cover system repairs due to differential settlement or subsidence will be determined based on an evaluation of whether the final cover in the affected area has been impaired. Any areas where the integrity of the final cover has been compromised will be repaired as necessary.

Eroded areas in drainage ditches will be repaired and re-graded. Sediment buildup will be removed from areas where flow is restricted. Temporary stormwater control structures will be constructed as needed.

The leachate collection system will be maintained and operated as needed to minimize leachate head on the liner. The District may seek the approval of the UDEQ to cease leachate extraction and treatment if it has demonstrated that leachate generation has diminished and no longer poses a threat to human health and environment.

7.2 Land Title, Land Use, and Zoning Restrictions

The future land use of Cell 1 is reversion to grazing land, which is the historical land use. The title of the land is expected to remain with its current owner, the Utah Division of State Lands. The Utah County Board of Adjustment did not impose zoning restrictions on the site. However, the District will cooperate with the landowner and the County Board of Adjustment in developing zoning restrictions that are in the best interests of the landowner.

7.3 Post Closure Costs

The costs identified in Section 5 for post-closure care have been assumed to be recurring annual costs. The trust fund for this post-closure care has been assumed to be available in its entirety at the beginning of the post-closure care period. This is a very conservative assumption since the landfill is planned to operate for a minimum of 30 years (by term of lease) beyond the expected life of Cell 1. The interest on the principal of the trust fund is expected to cover the limited inspection and maintenance activities currently scheduled as part of the ongoing operation (e.g., leachate collection and evaporation facilities) of the landfill site if the site is unexpectedly closed.

8.0 REFERENCES

HDR Techserv, Inc. 1987. Landfill Approval Assistance Hydrogeologic and Seismic Review, p.37.

HDR Techserv, Inc. 1988. Landfill Master Plan, Bayview Landfill.

South Utah Valley Solid Waste District. 1994. Annual Report, p.6.

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PART III
Technical and Engineering Report

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

SUVSWD Bayview
Class I Landfill Permit Modification - Part III
Technical and Engineering Report

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INTRODUCTION

This Part III – Technical and Engineering Report presents information on geology, hydrology, location restrictions and engineering design for the Bayview Landfill. This information has been updated from previous permits to reflect changes in design of the final cover for Cell 1, as well as Cell 2 liner and configuration. Portions of the text that do not require modifications have been left as originally presented.

1.0 MAPS AND DRAWINGS

1.1 FACILITY MAPS

Figure 1 contains the most recent USGS Topographic Map of the vicinity surrounding and including the Bayview Landfill. The boundaries of the property are shown on this map. Figure 2 is the most recent USGS Topographic Map of just the Bayview landfill property. Figure 3 is a recent topographic map produced from aerial photography performed in July 2002 and updated with ground survey information obtained in April 2003.

Figure 4 is a portion of the state of Utah Earthquake Distribution Map (MF-1856). Figures 5 to 16 contain permit level construction details for the development of revised Cell 2 and the closure of Cell 1. Cell 2 is the combination of previously permitted Cells 2 and 3, as outlined in the January 2002 Master Plan update by HDR, Inc. This Master Plan update, along with the original 1988 Master Plan, is included in Appendix A to this application.

Appendix D will contain the final engineering drawings and specifications for the development of Cell 2 Stage 1 and the closure of Cell 1. These will be developed upon re-issuance of the permit for the Bayview Landfill.

2.0 GEOHYDROLOGICAL EVALUATION

2.1 GENERAL

Several studies are available in the public and nonpublic arenas that describe the geology and hydrogeology of the region and the site. The hydrogeology of the Goshen Valley has been described by Dustin (1978) and Cordova (1970). These studies also describe the general geology of the area including the Bayview Landfill site. Two hydrogeological investigations were commissioned by Provo City Corporation during the original permitting of the site in the 1980s (Chen and Associates, 1980; Rollin, Brown, and Gunnell [RBG], 1983). These investigations provided shallow geological data specific to the landfill site. During litigation regarding permitting of the site, several parties (Hintze and Fuhriman, 1983; Environmental Science and Engineering, 1986; and Danzberger, 1986) re-evaluated and re-interpreted the data presented in the Dustin, Cordova, Chen, and RBG studies, and re-interpreted site-specific geologic and hydrogeologic data. These re-evaluations presented no new data, and do not contribute to the understanding of the site.

During 1986 and 1987, the Utah County Planning Commission evaluated the Bayview Landfill site seismicity. This evaluation included on-site trenching to determine whether lineaments present on the site represented the surface expression of geologic faults. The Planning Commission's geologist concluded that the lineaments were not related to faults or seismic activities at the site (Robison, 1987).

During the original construction of the Bayview Landfill in 1989, the contractor drilled and installed 12 monitoring wells. Six of these wells are deep wells (170 to 310 feet below ground surface) that provide geological data from regions deeper than earlier Provo studies. These wells also provide hydrogeological data specific to the site. In April 1994, the District published an evaluation of two years of hydrograph and laboratory analytical data. Groundwater monitoring has been ongoing at the site with evaluations submitted to the UDEQ. The Districts Groundwater Monitoring Plan is included as Appendix F. Boring logs for monitoring wells are included as Appendix E.

During 1993, the U.S. Geological Survey (U.S.G.S.) conducted an evaluation of the aquifers in Utah and Goshen Valleys. A summary of selected data collected during this evaluation has been published as Utah Hydrologic Data Report No. 50, and is attached to this permit application as Appendix G.

2.2 GEOLOGY

2.2.1 Stratigraphy

The Bayview Landfill site is located in Goshen Valley between the East Tintic Mountains and Utah Lake. The Goshen Valley is bounded on the north by the Lake Mountains, on the west by the Mosida Hills and the East Tintic Mountains, on the south by Long Ridge, and on the east by Utah Lake and West Mountain. The site lies on the eastern slope of the East Tintic Mountains as the slope approaches Utah Lake. The terrain in the vicinity of the landfill site slopes toward the lake at approximately 2.5%; the terrain is steeper to the west and shallower to the east of the site.

The Goshen Valley is underlain by a thick sequence of consolidated and unconsolidated sediments overlying sedimentary Paleozoic limestone and dolomitic basement rock. The surficial materials at the site consist of heterogeneous deposits of gravel, sand, silt, and clay laid down in Lake Bonneville. These deposits were derived from erosion of the East Tintic Mountains, and were dropped into the lake as beach, bar, and spit deposits along the fluctuating shoreline. The materials are poorly to moderately well sorted and are derived from a mixture of Paleozoic sedimentary (limestone and quartzite) and Tertiary volcanic outcrops. In some places, these lake sediments are overlain by beach and dune sands representing Lake Bonneville shoreline and Quaternary deposits, respectively. The western portion of the landfill site exhibits dune and beach sand deposits. The thickness of these strata is discussed in Section 2.3.2.1.

Two other Pleistocene deposits underlie the Lake Bonneville Group sediments: the Terrace gravel, and the Older Alluvium. The Terrace gravel consists of gravel and sand benches and contains an aquifer referred to as the Upper Pleistocene aquifer. The Older Alluvium consists of cemented gravel and sand (fanglomerate) and contains an aquifer referred to as the

Lower Pleistocene aquifer. Miocene latites and conglomerates reportedly underlie the Pleistocene deposits; the conglomerates reportedly consist of cobbles and boulders in a sandy matrix. It does not appear that the deep monitoring wells constructed at the Bayview Landfill site penetrate into the Lower Pleistocene aquifer.

2.2.2 Instability and Seismicity

No unstable slopes or subsidence areas have been mapped in the vicinity of the Bayview Landfill site. However, the Utah County Planning Commission has not prepared landslide, unstable area, or subsidence maps for this portion of the county. To the best recollection of Commission personnel, the Planning Commission has received no reports of landslides or subsidence. The site is relatively flat and is not subject to steep cuts that would create slope stability problems. There does not appear to be any surface observable evidence that the site is located in a floc type land stability problem area.

Numerous faults traverse the Goshen Valley. Most of these faults are believed to be inactive; however, more than 25 earthquake epicenters have been plotted within approximately 5 miles of the landfill site. Most of these epicenters are located south, southeast, or southwest of the site. These epicenters include one with a reported intensity of VII on the Modified Mercali Intensity Scale, and several with reported intensities of IV or V (U.S.G.S, 1986).

The Utah County Planning Commission has not prepared seismicity maps for this portion of the county. The Uniform Building Code (1994) classifies this portion of Utah as a Class 3 Seismic Zone, and requires use of a horizontal acceleration of 0.3g in the design of engineered structures. This classification places the Bayview Landfill site in a seismic impact zone as defined under the Utah Solid Waste Permitting and Management Rules.

2.3 HYDROLOGY

2.3.1 Surface Water

Three surface water channels cross the landfill site (see Figure 2). These surface water channels flow intermittently from watersheds upslope and west of the landfill site. The northern and central channels originate about 2 miles west of the site in Section 14. Each of these channels has a drainage basin of less than 1,000 acres. The southern channel originates less than 1 mile west of the site in Section 18, and has a drainage basin of less than 200 acres.

The northern and central channels have cut gullies approximately 5 feet deep and 30 feet wide through the dune sands on the steep, western portion of the landfill site. These channels decrease in size to less than 3 feet in depth and less than 10 feet in width on the eastern portion of the site. The southern channel is only 1 to 2 feet in depth.

The drainage channels appear to be completely dry during most years. These channels carry water only during storm events and during spring run-off from the foothills west of the site. The sandy nature of the area and of the channel bottoms allows water to percolate into subsoils during routine storm events.

2.3.2 Hydrogeology

2.3.2.1 Aquifers

Previous studies (Cordova, 1980; Dustin, 1978) have defined four aquifers underlying the Goshen Valley; however, not all of these aquifers appear to be present at the Bayview Landfill site (Brook, 1994; Carpenter, 1994a). As identified in previous reports, the uppermost aquifer, the water table aquifer, is contained in the Lake Bonneville group, and is commonly found at depths of less than 25 feet below ground level (bgl). The second aquifer, the Upper Pleistocene aquifer, is contained in a sand and gravel deposit, the Terrace gravel, at depths of 150 to 300 feet bgl in the Goshen Valley. The Upper Pleistocene aquifer reportedly ranges from 75 to 100 feet in thickness. The Upper and Lower Pleistocene aquifers are separated by a 50- to 100-foot thick cemented sand and gravel confining layer. This confining layer is thought to partially separate the two Pleistocene aquifers. The Lower Pleistocene aquifer is reported to vary in

thickness from 25 to 175 feet. The third aquifer, the Tertiary aquifer, is reportedly found at 200 to 500 feet bgl; its thickness is unknown, but may exceed 1,500 feet in the Goshen Valley.

Eight shallow soil borings, six shallow monitoring wells, and six deep monitoring wells indicate that the Lake Bonneville group water table aquifer is not present at the site (Carpenter, 1994a). The six shallow monitoring wells are constructed with a 20-foot screen and a 1-foot sump below 49 feet of casing. The wells contain dedicated pumps mounted at 65 feet bgl. Boring logs are attached to this permit application as Appendix E. All of the shallow wells have contained small amounts of water during most sampling events; however, none of the wells have contained sufficient water to allow purging or sampling. The water in these wells is believed to be condensation within the well, rather than perched groundwater (Carpenter, 1994a).

The six deep monitoring wells appear to be screened in the Upper Pleistocene aquifer (Carpenter, 1994a). The six deep monitoring wells do not appear to have penetrated through the Upper Pleistocene aquifer into the Lower Pleistocene aquifer. Boring logs for these wells are presented in Appendix E. This aquifer is the uppermost usable aquifer in the immediate vicinity of the landfill site.

The landfill culinary well appears to be screened in the Lower Pleistocene aquifer (Carpenter, 1994a). The well log indicates that the partially confining layer between Upper and Lower Pleistocene aquifers is not present at the site. This is consistent with the interpretation of the U.S. Geological Survey for this portion of the Goshen Valley (Brook, 1994). The Upper and Lower Pleistocene aquifers appear to represent a single, water table (unconfined) aquifer in the vicinity of the Bayview Landfill.

2.3.2.2 Water Rights

The Utah Department of Natural Resources Water Rights Division lists only one active water right within 2,000 feet of the Bayview Landfill site boundary. This active water right is the culinary water well for the landfill. This well is located upgradient of the site, and is screened in the Lower Pleistocene aquifer.

Based on a review of the USGS topographic maps for the site, approximately 7 wells are located up to 2 miles from the site boundary (USGS, 1993) including the landfill culinary well. Figure 1 in Part IV shows the wells in relation to the site.

2.3.2.3 Groundwater Flow

The previous studies indicate that groundwater flow enters the Goshen Valley from the south through Current Creek Gap, and from the northwest through the Mosida Hills. These groundwater flows converge near the Bayview Landfill site. The groundwater underlying the site is expected to flow northeast toward Utah Lake. Cordova (1970) estimated transmissivity of the Pleistocene aquifer to be between 50,000 and 300,000 gallons per day per foot (gpd/ft). Earthfax (1984) estimated the velocity of groundwater flow north of Elberta to be 24 feet per year (ft/yr).

In April 1994, the District issued a report on the results of the District's background monitoring program (Carpenter, 1994b). This report provided an assessment of the background water quality and flow direction in the immediate vicinity of landfill. This report stated that the groundwater flow at the site moves northeasterly toward Utah Lake, and estimated the velocity of this flow at 1.8 ft/yr. The report in Appendix F has been updated to include recent groundwater monitoring events.

The discrepancy between the published values and the apparent velocity at groundwater at the site is unexplained. However, this does not seem to be important since the upper aquifer is more than 100 feet below the bottom of the landfill.

2.3.2.4 Groundwater Chemistry

Groundwater in the uppermost aquifer (the Upper Pleistocene aquifer) underlying the Bayview Landfill site is classified as a Class II aquifer. Appendix F summarizes groundwater monitoring on 13 groundwater samples collected from each well during the District's 2-year background monitoring period. Appendix F also includes all detection monitoring

events that have been performed since background monitoring was completed. The analyses show no contamination of the groundwater by inorganic or organic chemicals. Statistical evaluation of the data shows a general trend of increasing concentration for total dissolved solids, sulfate, chloride, calcium, magnesium, sodium, and bicarbonate from southwest to northeast below the site. This is consistent with the regional trend of increased concentration of inorganic chemicals as they move toward Utah Lake through the shallow Pleistocene aquifer (Carpenter, 1994). Groundwater analytical results are submitted to UDEQ annually.

3.0 ENGINEERING REPORT

3.1 LOCATION STANDARDS

UDEQ has adopted specific locational restrictions that include the locational criteria specified in the federal Subtitle D regulations. The Utah location restrictions for municipal solid waste landfills are outlined below. Subtitle D criteria are highlighted with an asterisk (*).

Location Restriction Compliance was previously analyzed as part of the 1996 permit application. The following portions of Section 3.1 are excerpted from that application.

1. Land Use Compatibility (R315-302-1(2)(a))
    - Parks and protected areas
    - Ecologically and scientifically significant areas
    - Prime farmland
    - Dwellings and structures*
    - Airport runways*
    - Archeological sites
    - Land use planning or zoning
2. Geology (R315-302-1(2)(b))
    - Fault areas*
    - Seismic impact zones*
    - Unstable areas*
3. Surface Water (R315-302-1(2)(c)
    - Floodplains*
    - Wetlands*
4. Groundwater (R315-302-1(2)(e))
    - Groundwater/landfill separation
    - Sole source aquifer
    - Groundwater quality
    - Source protection areas

The following sections present the State of Utah location restrictions and discuss the Bayview Landfill's compliance with those requirements.

3.1.1 Land Use Compatibility

The Utah Solid Waste Permitting and Management Rules state that no municipal solid waste landfill shall be located within the following restriction zones:

- One thousand feet of a national, state, or county park, monument, or recreation area; designated wilderness or wilderness study area; or wild and scenic river area.
- Ecologically and scientifically significant natural areas, including wildlife management areas and habitat for listed or proposed endangered species as designated pursuant to the Endangered Species Act of 1982.
- Farmland classified as prime, unique or of statewide importance by the U.S. Department of Agriculture Soil Conservation Service under the Prime Farmland Protection Act.
- One-fourth mile of existing permanent dwellings, residential areas, and other incompatible structures such as schools, churches, and historic structures or properties listed or eligible to be listed in the State or National Register of Historic Places.
- Ten thousand feet of any airport runway end used by turbojet aircraft, or 5,000 feet of any airport runway end used by only piston-type aircraft.
- Areas with respect to archeological sites that would violate R9-8-404.
- An area that is at variance with any locally adopted land use plan or zoning requirement unless otherwise provided by local law or ordinance.

The Bayview Landfill is not located within any of these restriction zones. The land use directly adjacent to the landfill is primarily agrarian. The nearest residence is located more than 1 mile north of the site boundary, and the nearest town, Elberta, is located approximately 5.5 miles south of the site. The nearest airport is located approximately 17 miles from the site. No parks, ecologically significant areas, prime farmland, or archeological sites are known to exist

near the site. The Bayview Landfill site is surrounded on the north and west by land zoned mining and grazing (MEG1), and on the south and east by land zoned agricultural (A1). The landfill is not inconsistent with these planned land uses. In any case, the site was permitted by the Utah County Board of Adjustment under a Conditional Use Permit, and therefore, is consistent with the local zoning and land use planning.

3.1.2 Geology

The Utah Solid Waste Permitting and Management Rules state that no municipal solid waste landfill shall be located in a subsidence area, in a dam failure flood area, over an underground mine or salt bed, or on or adjacent to geologic features that could compromise the structural integrity of the facility.

- Fault Areas. A new facility or a lateral expansion of an existing facility shall not be located within 200 feet of a Holocene fault.
- Unstable Areas. Unstable areas require demonstration that the site has been engineered to ensure that the integrity of the structural components of the facility will not be damaged by the unstable conditions.
- Seismic Impact Zones. A new facility of a lateral expansion of an existing facility shall not be located in seismic impact zones unless all containment structures are designed to resist the maximum anticipated horizontal acceleration for the site.

The Bayview Landfill site does not include known Holocene faults, and all solid waste containment will occur more than 200 feet from the property boundary. A trenching study was conducted to determine whether apparent lineaments represented the surface expression of faults. This study concluded that the lineaments were not related to faults (see Appendix H). The Bayview Landfill is not located within a known unstable area as defined in the regulations.

Historic seismic records indicate that more than 25 earthquake events have occurred with epicenters within approximately 5 miles of the Bayview Landfill site. These earthquake events

have occurred south, southwest, and southeast of the site. These earthquake events are presented in USGS Miscellaneous Field Studies Map MF-1856 and are summarized in Figure 4.

The Utah County Planning Department has not mapped the western portions of Utah County for seismic activity. The Uniform Building Code (1991) appears to classify all of Utah County as a Class 3 Seismic Zone. Structures in a Class 3 Seismic Zone are required to use an horizontal acceleration of 0.3g unless studies demonstrate that another horizontal acceleration is more appropriate.

The Bayview Landfill was designed and constructed during the late 1980s, prior to the promulgation of federal and State of Utah solid waste regulations requiring that designs consider the seismic activity of the region surrounding a landfill site. However, the new design for Cell 2 has been analyzed considering seismic activity and has been found to be stable with an adequate factor of safety. See Appendix J.

Seismic stability analyses have been conducted to demonstrate that the proposed landfill components can resist the maximum horizontal acceleration expected at the site. These analyses were conducted in accordance with the State of Utah Administrative Rules and EPA guidance presented in *RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Facilities, (EPA, 1995).*

The landfill components considered in these analyses included: linear systems, leachate collection and delivery systems, the leachate collection and run-on/run-off control systems and the final cover.

The scope of the analyses included a review of regional and local soils, geology and seismic selection of the design earthquake and the site specific earthquake acceleration; static and pseudo-static stability analyses for each landfill component: and evaluation of stability and potential deformations for each landfill component.

The results of these analyses are presented in Appendix J. The results of these analyses indicate the following:

- The Bayview Landfill site is located in a Seismic Impact Zone. Both deterministic and probabilistic methods indicate a peak bedrock acceleration of 0.5g. The dense granular soils offer little amplification or attenuation of the bedrock acceleration through the overlying soil column.
- The cut and fill slopes and run-on/run-off structures have adequate static factor of safety and indicate minimal permanent deformations (U<1 cm) in response to the design seismic event.
- The side slope liner and leachate collection/recovery system will require a geosynthetic reinforcement to increase the static factor of safety and limit permanent deformations in response to the design seismic event.
- The closure cap system has an adequate static factor of safety and indicates acceptable permanent deformation (U<10 cm) in response to the design seismic event. No reinforcement is required for the final cover.

These demonstration analyses indicate that the proposed Bayview landfill components are designed to resist the "maximum horizontal acceleration" at the site.

3.1.3 Surface Water

The Utah Solid Waste Permitting and Management Rules state that no municipal solid waste landfill shall be located within a public water system watershed, a floodplain, or a wetlands without specific approval of the Executive Secretary.

The Bayview Landfill site is not located within a public water system watershed or 100-year floodplain. Three surface water drainage features cross the site from west to east. The Landfill Master Plan provides that the three drainage areas will be improved to divert run-on from the active landfill cells. The drainage features do not contain vegetation that is characteristic of

wetlands areas. No other areas of wetlands have been identified on the site. Calculations for run-on and run-off ditches can be found in Appendix M.

3.1.4 Groundwater

The Utah Solid Waste Permitting and Management Rules state that no municipal solid waste landfill shall be located within the following restriction zones:

- Within 5 feet of the historical high groundwater elevation.
- Within 100 feet vertically (50 feet for high total dissolved solids [TDS between 1,000 and 3,000 mg/l] aquifers) of an aquifer that could be used for drinking water unless constructed with a composite liner system.
- Over an aquifer designated as a sole source aquifer or a 1B aquifer.
- In a drinking water source protection area.

The Bayview Landfill is not located within a sole source or IB aquifer, or in a drinking water source protection area. Landfill cells will not be constructed within 5 feet of the historical high groundwater elevation. The shallowest groundwater at the site, the Upper Pleistocene aquifer, is located more than 100 feet below the bottom of the proposed liner system. A composite liner system consisting of a geosynthetic clay liner (GCL) and an HDPE geomembrane is proposed for the bottom of Cell 2.

3.2 ENGINEERING DESIGN

3.2.1 Existing Landfill Cell

In 1987, the District prepared a Landfill Master Plan (HDR, 1987) to guide development of the site over its active life, which is expected to exceed 50 years. Figure 5 in Part IV illustrates the landfill facilities, which include the following:

- Six landfill cells (previous Cells 2 and 3 have been combined into Cell 2). Cell 2 will be approximately 82 acres in size. The cells are further subdivided into smaller areas, called

"stages," to facilitate construction and to minimize the area open to receiving stormwater at any time. Each stage represents approximately 15 acres.

- Two stormwater/leachate evaporation ponds, one already constructed to receive contact stormwater and leachate from the northern half of the site, and one future pond to receive contact stormwater and leachate from the southern half of the site.
- Screening berms to provide visual screening of the active landfill cells from State Highway 68.
- Three stormwater diversion channels using the existing intermittent surface water drainage channels.
- A maintenance building.
- A future scale pad.

The Master Plan was updated in 2002 (HDR) to show a combined Cell 2 and 3, and to increase excavation depths in this new Cell 2. Excavation depths remain over 100 feet above the uppermost aquifer. Both Landfill Master Plans are attached to this permit application as Appendix A.

Landfill Cell 1 - Stage 1 was designed and constructed during 1988 and 1989 using the Landfill Master Plan as a basis of design. The design of this half-cell was accomplished prior to the State of Utah regulations requiring submission of engineering drawings, specifications, and engineering reports describing the landfill features. Landfill Cell 1 – Stage 2 was constructed in 1996. Cell 1 is nearing final contour elevations.

3.2.2 Landfill Cell 2 - Stage 1

Stage 1 of Landfill Cell 2 consists of a 15-acre, geosynthetic clay and HDPE-lined area located in the E1/2 of the NW1/4 of Section 17. The excavation for this half-cell is ongoing, and the excavated soils have been used for daily cover, with a portion used to close Cell 1 or placed in a stockpile north of Cell 1. The soil in this stockpile will also be used for the final cap over Cell 1.

Excavation side slopes will be constructed on a 4:1 (H:V) slope. Generally, the bottom slope is 2.5% west to east and 2% south to north. The excavation will be constructed with a leachate collection trench along the eastern edge of the excavation bottom. The leachate collection swale is graded at a 2.0% slope south to north. An intercell berm will be constructed along the eastern edge of the cell to contain leachate and direct it to a collection sump for removal.

The liner system for Cell 2, Stage 1 consists of the following components (from bottom to top):

- A 20-ounce non-woven, needle punched polypropylene geotextile. The excavation specification will allow 4-inches minus material to remain on the surface of the excavation. A heavy geotextile will provide puncture resistance for the overlying geomembrane. Alternately, a sand cushion may be used in lieu of the geotextile cushion.
- A bentonite impregnated geotextile (geosynthetic clay liner – GCL). The GCL provides a barrier to leachate and landfill gas migration.
- A 60-mil HDPE flexible membrane liner.
- A woven reinforced geotextile. The geotextile will provide the tensile strength necessary to resist the sliding forces generated on a 4:1 slope by the 2-foot-thick soil protective layer.
- A 2-foot thick protective cover layer. This soil layer will protect the geotextile, HDPE and GCL during placement of the first lift of solid waste. It is also intended to provide a pathway for leachate movement above the HDPE toward the leachate collection and removal system.

Appendix O contains a Construction Quality Assurance Plan (CQA). This CQA plan requires the installation contractor to conduct a construction quality control program during installation. As a result, all seams will be tested for continuity. In addition, periodic samples will be removed from the rolls and subjected to tensile testing at a third party laboratory. Third party personnel will be on-site at all times during HDPE, GCL and geotextile installation, and during placement of the 2-foot thick protective layer. These personnel will provide a CQA review of the construction and installation of the liner system.

3.2.3 Leachate Management

Leachate, including stormwater falling in the active landfill cell that comes into contact with solid waste or daily cover, will be transmitted through the 2-foot thick protective cover soil to a leachate collection pipe installed along the eastern boundary of the cell. (See Figures 7 and 9). The leachate collection pipe will consist of an 8-inch diameter perforated PVC or HDPE pipe encased in a granular fill wrapped with a geotextile. The pipe trench will be approximately 2 feet in depth, matching the thickness of the protective cover. Leachate will be managed by this system during filling and after closure.

The EPA's Hydrologic Evaluation of Landfill Performance (HELP) model, Version 3.07 was applied to several operational and closure scenarios to evaluate infiltration into Cell 2 and subsequent leachate generation. See Appendix K. Although the HELP Model indicated that no leachate would be generated, observations at the site show contaminated water is entering the pond. Additional analyses are discussed below. The 8-inch pipe on a 2% slope is capable of conveying 1.114 cfs or 719,824 gpd.

Soil, waste and geosynthetic characteristics were modeled with the default soil properties. The initial moisture content of the waste was adjusted to reflect the drier waste conditions observed at other Utah landfills. Information from the Wasatch Energy Systems (a.k.a., Davis County Solid Waste Management and Energy Recovery Special Service District) indicates waste moisture contents in the 12-18% by weight range.

Site-specific design data was obtained from Figures 6-11. The proposed leachate collection header pipe extending south from the Stage 2 clean out was modeled at a 2.0% slope. The cross-slope on the bottom of the Stage 2 excavation was modeled at a 2.5% slope resulting in a slope toward the leachate pipe of approximately 3%.

The following scenarios were considered representative of the life cycle for Cell 2, Stage 1:

- Ten feet of waste and a 6-inch daily cover for 1 year, simulating initial filling.

- 130 feet of waste and no final cover for 4 years, simulating the anticipated 4-year life of Cell 2, Stage 1.
- 130 feet of waste and no final cover for 30 years, simulating the 30-year post closure period.

Although the last scenario would not occur, it was modeled as a worst-case condition. The same result was obtained under each case indicating no leachate generation. Based on this condition, no hydraulic head will occur on the liner.

Based on site-specific information, leachate or stormwater that has come into contact with waste is indeed generated. As such, additional analyses have been performed on the capacity of the leachate/stormwater evaporation pond. This analysis can be found in Appendix L. The results indicated that the pond has sufficient capacity (909,000 cubic feet) to handle the 25-year, 24-hour run-off from the entire 82 acres that make up Cell 2. This is considered a very conservative assumption since portions of Cell 2 would be closed prior to the development of the entire 82 acres, resulting in less than 82 acres requiring stormwater containment and providing capacity for any incidental leachate development from the closed Cell 1 or portions of Cell 2.

The perforated leachate collection pipe will enter a gravel-filled sump located in the northeast corner of Cell 2, Stage 1. The pipe (solid wall) will continue up the side slope and terminate at the top of excavation as a clean-out. An 18-inch HDPE pipe will be installed in the sump and will also continue up the side slope. The bottom of the pipe will be perforated so that leachate can enter. A submersible pump capable of pumping a minimum of 50 gallons per minute will be lowered down the 18-inch pipe to pump leachate out of the cell into another pipe where it will be conveyed to the existing leachate drain line from Cell 1 and finally to the evaporation pond.

The leachate evaporation pond was constructed, tested, and inspected using the same personnel and techniques as used for Cell 1, Stage 1. The evaporation pond liner system consists of the following layers (from bottom to top):

- A 12-ounce non-woven, needle punched polypropylene geotextile.

- A 60-mil HDPE geomembrane.
- A 40-mil HDPE geomembrane. This geomembrane is a sacrificial layer intended to protect the underlying geotextile and geomembrane layers from weathering. The 40-mil HDPE replaced a 6-inch soil cement protective layer as originally shown on the construction drawings. A sample of the existing 40-mil geomembrane sacrificial layer was tested in May 2003 to determine its current characteristics. A letter of the findings report is included at the end of Appendix L. Based on the testing, the tensile strength differences in the material are directly related to differences in thickness. However, the strength is within the acceptable range of newly fabricated liner material.
- A 6-inch layer of concrete (bottom only). The concrete was placed to allow the District to enter the pond and remove accumulated sediment using a front-end loader. The concrete extends up the sideslopes approximately 10 linear feet; on the 3:1 slopes, corresponding to approximately 3 vertical feet.

The pond is also provided with a concrete ramp to allow access to the bottom of the pond. The pond was designed to receive stormwater and leachate from the active landfill cell(s), and to evaporate this liquid during the hot, summer months (p. 37, HDR, 1988). As a point of reference, site personnel have reported that the pond has either completely or nearly dried during the Fall of several years since it began receiving leachate in 1991. According to site personnel, the concrete bottom has never been fully submerged; therefore, there has never been over three feet of liquid in the pond.

Analyses have been conducted to evaluate the sizing and capacity of the leachate evaporation pond for the combination of stormwater run-off from the contributing cell area and leachate generation from Cell 2 Stages 1 and 2. Only Cell 2 leachate generation was considered in these analyses, since it is anticipated that additional cell construction and resulting pond capacity requirements would be evaluated under a subsequent permit application. Leachate generation from Cell 1 should be minimal since final cover will be constructed shortly after Cell 2 is developed for waste disposal.

The 25-year, 24-hour storm event was used to compute run-off. The results of the HELP modeling (Appendix K) were used to estimate leachate generation. The results of the analysis, presented in Appendix L, indicate the current leachate evaporation pond is sized adequately to hold the leachate generated from Cell 1 and the contaminated storm water run-off from Cell 2.

However, within 5 years of the permit renewal resulting from this modification, a new leachate evaporation pond will be designed and constructed to contain a double liner with a leak detection system approved by the Division of Water Quality and the Division of Solid and Hazardous Waste. In addition, the leachate line, up to the manhole nearest the existing evaporation pond will be replaced with a dual contained line at the time that the new leachate pond is constructed. If Cell 2 is expanded to the north sometime in the future, then the existing leachate line will also be replaced with a new dual contained line up to the manhole constructed as part of Cell 2, Stage 1.

3.2.4 Surface Water Controls

The Bayview Landfill site and its vicinity generally drains from west to southeast. Stormwater originating west of the site is routed through three existing surface water channels. See Figure 2. Construction of Landfill Cell 1 or its appurtenant facilities has not altered the existing stormwater drainage route. Additionally, the construction of Cell 2 will not alter these drainage conditions.

Stormwater originating on-site is managed as non-contact or contact stormwater depending on its source. Non-contact stormwater is water falling on unimproved portions of the site, or on improved portions of the site that have no contact with solid waste (e.g., the maintenance building vicinity) or on Cell 1 once final cover has been placed. Run-on control structures divert this water from the active landfill cell and stormwater/leachate pond and route this water into the existing surface water channels. Run-off control structures divert water falling on the active landfill cell into the leachate collection system. Ultimately, contact stormwater is stored and evaporated in the evaporation pond. Neither leachate nor contact stormwater are discharged from the site in surface waters.

Analyses have been conducted for run-on and run-off control systems around Cell 2. These analyses were conducted for a 25-year storm event and the associated time of concentration that produced peak flow. The analyses, presented in Appendix M, indicate that a triangular ditch, nominally 1 foot deep, provides adequate flow capacity. This ditch geometry will be constructed concurrent with the Cell 2 construction.

3.2.5 Closure and Post-Closure

The closure of Cell 1 will occur in the year 2005. An alternate final cap consisting of 34 inches of on-site, olive-brown silty sand will be used at the Bayview Landfill. A seed mix similar to that shown in Table 3-1 will be used to establish vegetation. Proposed final contours for Cell 1 can be seen on Figure 14. The side slopes of the landfill will be constructed at a 4:1 (H:V) slope, with the top being approximately 5%.

Table 3-1: Seed Mix for Bayview Landfill

% Mix	Type of Grass
0.50%	Sand Drop Seed
1.50%	Alkali Sacaton
3.50%	Blue Grama
17.50%	Blue Bunch Wheat Grass
17.50%	Indian Rice Grass
3.00%	Sandberg Blue Grass
4.00%	Sheep Fescue
16.25%	Slender Wheat Grass
16.25%	Stream Bank Wheat Grass
20.00%	Western Wheat Grass
100.00%	

This proposed capping system varies from the requirements of the Utah Administrative Code at R315-303-3(4). However, based on modeling performed by Kleinfelder, the proposed cap is equivalent to the prescriptive cap in preventing infiltration. A copy of this analysis is included in Appendix N.

A series of gas extraction wells will be installed prior to construction of the final cover system on Cell 1. A conceptual design of the gas system is included in Appendix Q. This is being done in advance in order to minimize disturbance of the final cover in the future. At such time as active extraction is needed to prevent odor or gas migration, the wells will be connected by header pipes and the system will be connected to a blower and the landfill gas burned in a flare.

Post-closure care is expected to consist of the following tasks:

- Quarterly inspections of the cap to determine whether significant erosion or differential settlement has occurred.
- Quarterly inspections of the stormwater/leachate evaporation pond.
- Quarterly monitoring of landfill gases at the extraction wells.
- Quarterly inspection of groundwater well integrity.
- Semi-annual monitoring and sampling of groundwater wells.

These activities will take place on Cell 1 after it has received final cover and will be expanded to all closed areas at the appropriate time. A maintenance program will be developed for the landfill gas recovery system when the system is activated. Closure and post-closure is discussed in more detail in Sections 6 and 7 of Part II of this application.

4.0 COMPOSTING

A temporary composting facility is planned to be constructed on portions of Cell 1, prior to closure. Once Cell 1 is completed, the compost operation will be relocated to a permanent location. An operations plan for the temporary compost facility is included in Appendix R. A revised Appendix R will be submitted once the permanent compost facility is designed.

5.0 REFERENCES

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SUVSWD Bayview
Class I Landfill Permit Modification - Part IV
Figures

Figure 01 – USGS Topographic Map with 2-mile Boundary

Figure 02 – Cells 1 & 2 USGS Topographic Map of Bayview Landfill

Figure 03 – Cell 2 Existing Site Contours

Figure 04 – Earthquake Distribution Map

Figure 05 – Landfill Facilities

Figure 06 – Cell 2 Final Contours

Figure 07 – Cell 2 Liner/Excavation Contours

Figure 08 – Cell 2 Cross Sections

Figure 09 – Cell 2, Stage 1 & 2 Excavation/Liner Grades

Figure 10 – Cell 2 Liner Details

Figure 11 – Cell 2 Leachate Collection System and Liner Details

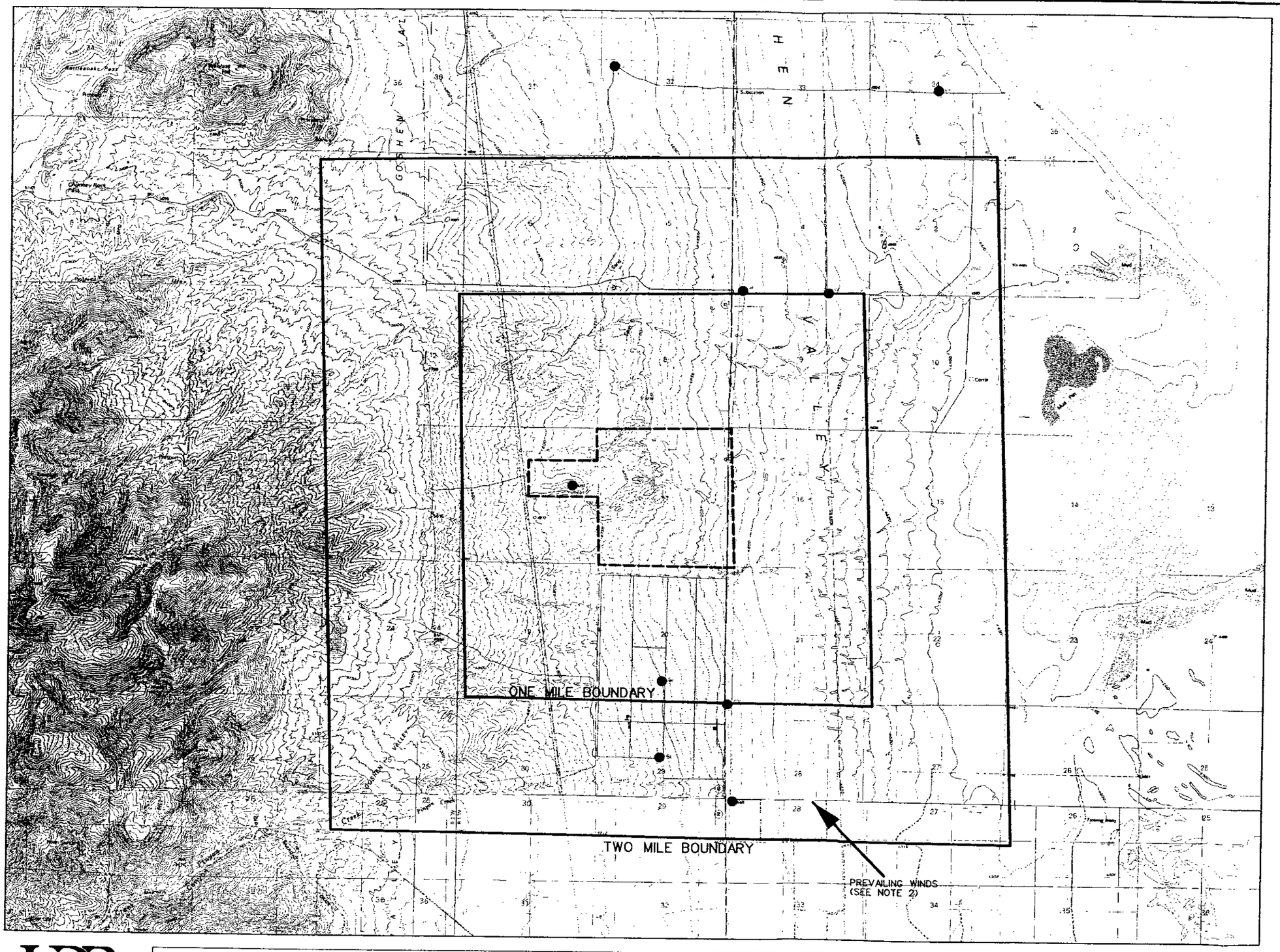
Figure 12 – Cell 2 Leachate Collection System, Sump Plan, and Section Details

Figure 13 – Cell 1 Existing Contours

Figure 14 – Cell 1 Final Contours

Figure 15 – Cell 1 Cross Section

Figure 16 – Cell 1 Final Cover / Liner Tie-in



N

0 2000 4000

SCALE IN FEET

LEGEND

- SITE BOUNDARY
- ONE & TWO MILE BOUNDARY
- WATER WELL

SOURCE

TOPOGRAPHIC MAP IS A COMBINATION OF THE FOLLOWING USGS 7.5 MINUTE QUADRANGLES:

GOSHEN VALLEY NORTH 9S:1W
GOSHEN 10S:1W
EUREKA 10S:2W
ALLENS RANCH 9S:2W

NOTES

1. FIGURES 01 AND 02 ARE INTENDED TO MEET THE TOPOGRAPHIC SURVEY REQUIREMENTS OF THIS APPLICATION
2. PREVAILING WINDS ARE FROM THE SOUTH-SOUTHEAST

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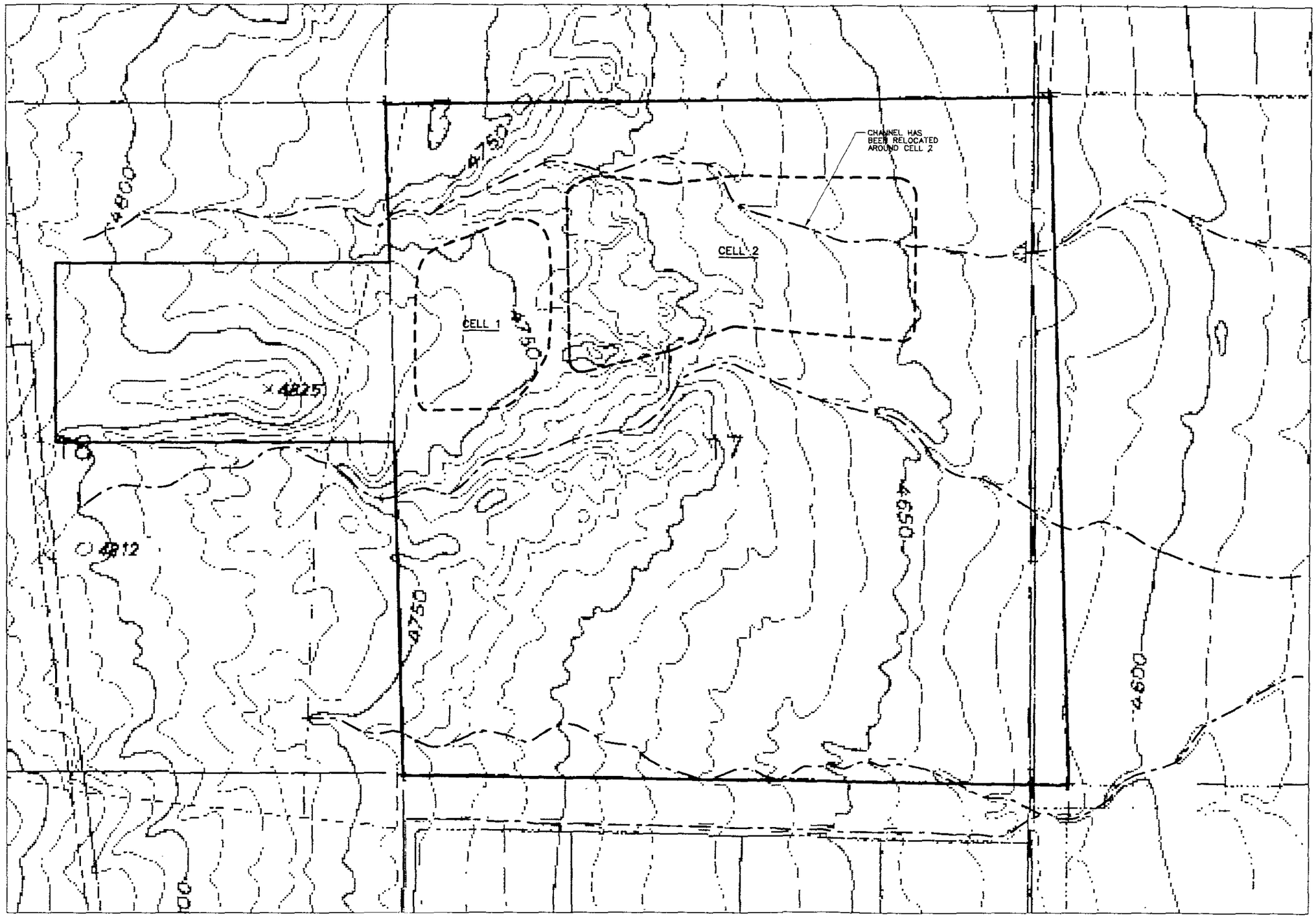
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL
PERMIT MODIFICATION

USGS TOPOGRAPHIC MAP WITH TWO MILE BOUNDARY

Date	Project No.	Figure No.	Issue
SEPTEMBER, 2003	03879-143	01	0

Scale: AS SHOWN



N

0 400 800
SCALE IN FEET

LEGEND

- SITE BOUNDARY
- CELL BOUNDARY
- ON-SITE DRAINAGE CHANNEL

SOURCE

TOPOGRAPHIC MAP IS A COMBINATION OF THE FOLLOWING USGS 7.5 MINUTE QUADRANGLES:

GOSHEN VALLEY NORTH 9S:1W
GOSHEN 10S:1W
EUREKA 10S:2W
ALLENS RANCH 9S:2W

NOTE:
FIGURES 01 AND 02 ARE INTENDED TO MEET THE TOPOGRAPHIC REQUIREMENTS OF THIS APPLICATION

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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL
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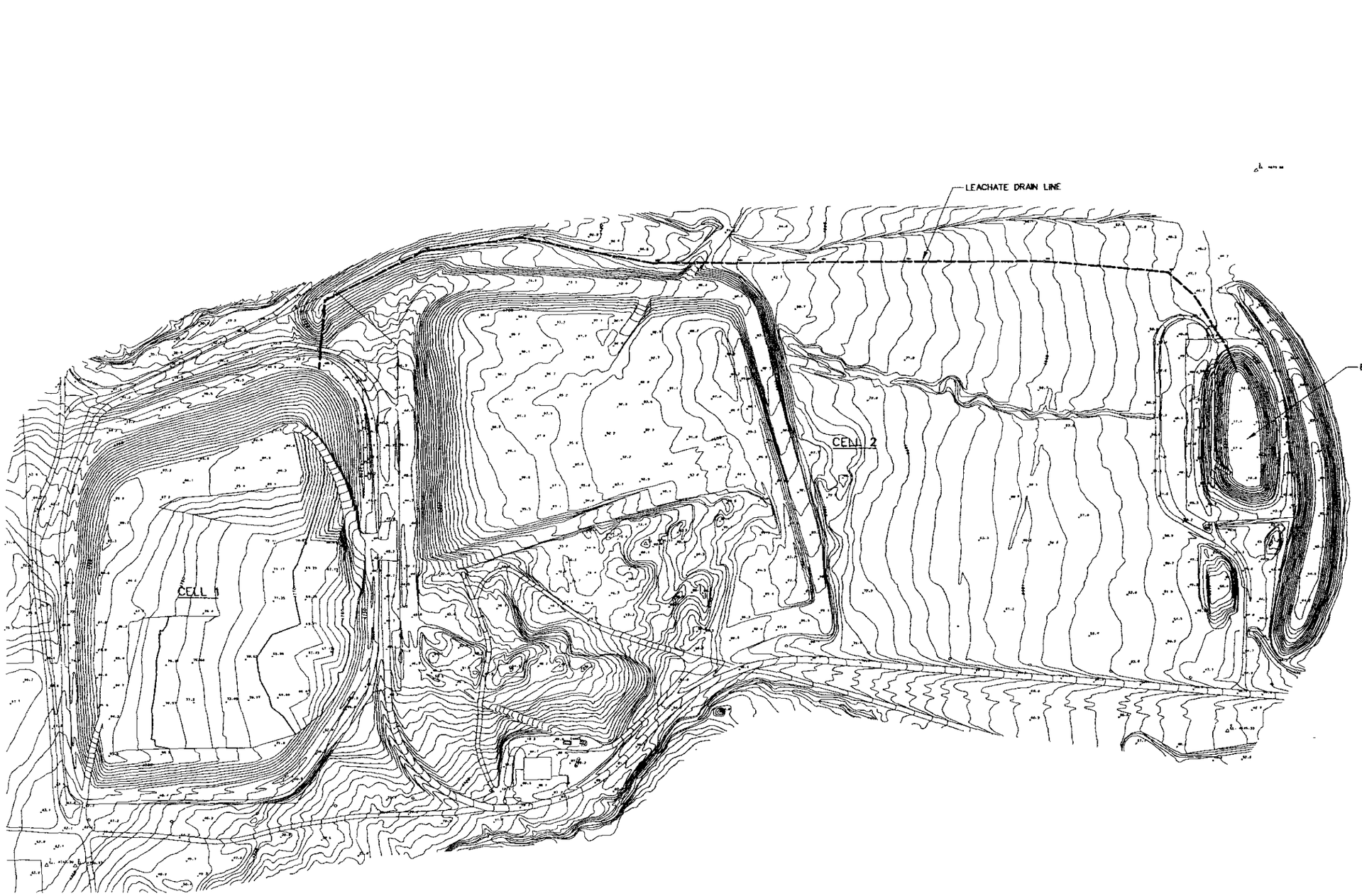
USGS TOPOGRAPHIC MAP OF BAYVIEW LANDFILL

Date	Project No.	Figure No	Issue
SEPTEMBER, 2003	03879-143	02	0

Scale: AS SHOWN



N

0 200 400
SCALE IN FEET

LEGEND

- EXISTING CONTOURS
- CELL FOOTPRINT BOUNDARY
- LEACHATE DRAIN LINE

NOTES:
1. CONTOURS BASED ON AERIAL PHOTOGRAPHY DATED JULY 2002. PORTIONS OF CELL 1 AREA HAVE BEEN UPDATED WITH GROUND SURVEY IN APRIL 2003
2. THE EASTERN PORTION OF CELL 2 WILL SERVE AS THE SOURCE OF BORROW SOIL WHILE FILLING THE WEST PORTION OF CELL 2

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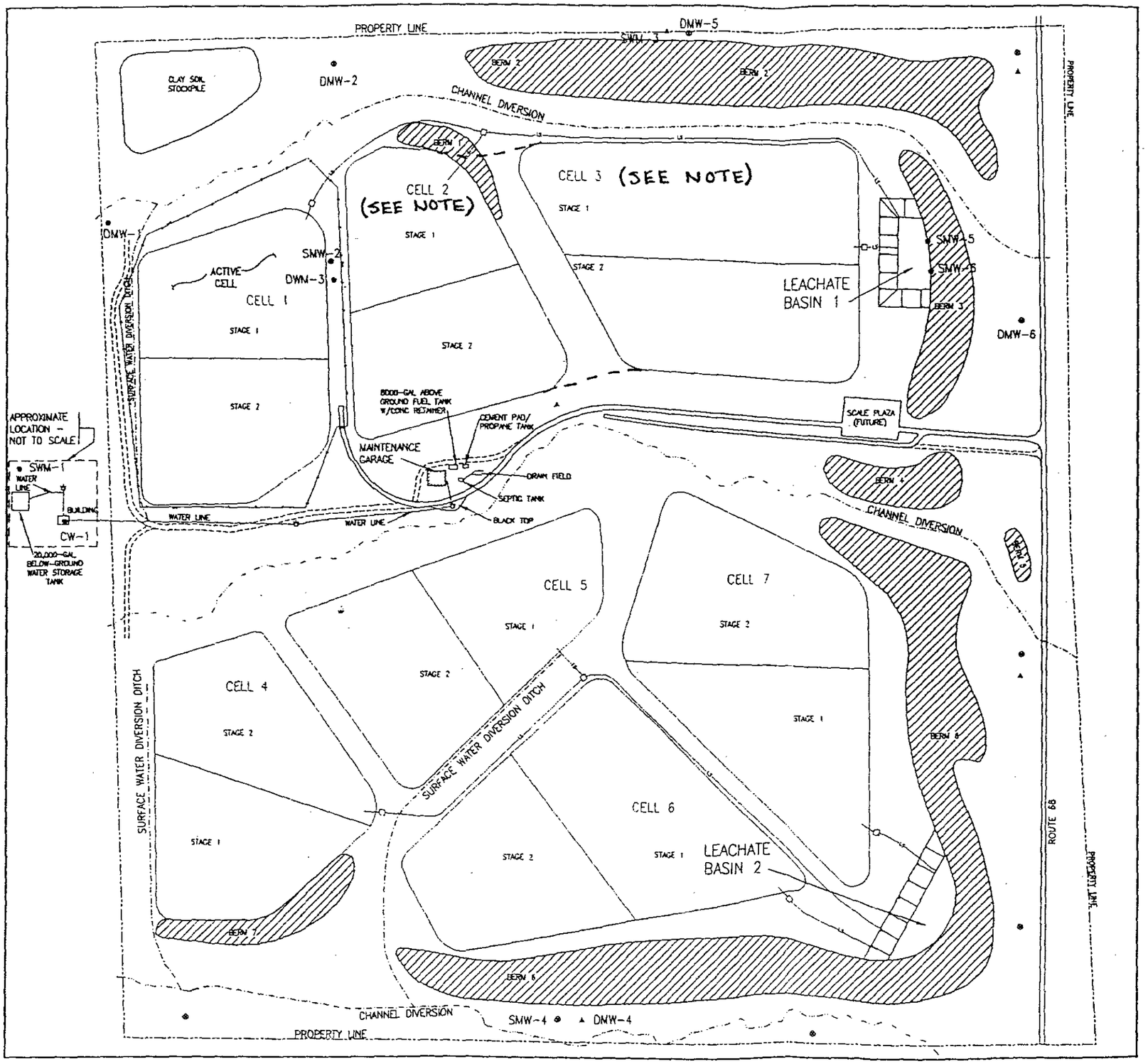
BAYVIEW LANDFILL
PERMIT MODIFICATION

CELL 2

EXISTING SITE CONTOURS

Date	Project No.	Figure No.	Issue
SEPTEMBER, 2003	03879-143	03	0

Scale: AS SHOWN



EXPLANATION

- PROPERTY LINE
- LEACHATE GRAVITY SEWER
- STRUCTURES
- MONITORING WELL, PERCHED WATER TABLE
- MONITORING WELL, SHALLOW PLEISTOCENE AQUIFER
- MONITORING WELL, APPROXIMATE LOCATION
- LEACHATE COLLECTION MANHOLE STRUCTURE
- BERM
- CHAIN LINK FENCE
- SLOPE INDICATOR
- UNIMPROVED ROAD
- WATER LINE (APPROXIMATE LOCATION)
- FIRE HYDRANT
- STREAM
- CHANNEL DIVERSION

NOTE: THIS FIGURE WAS OBTAINED FROM THE BAYVIEW LANDFILL 1996 PERMIT APPLICATION. NOTHING HAS CHANGED WITH THE EXCEPTION OF CELLS 2 AND 3 WHICH HAVE SINCE COMBINED.

-N-

0 600' 1200'

SCALE: 1" = 600'

WESTON
MANAGERS DESIGNERS/CONSULTANTS
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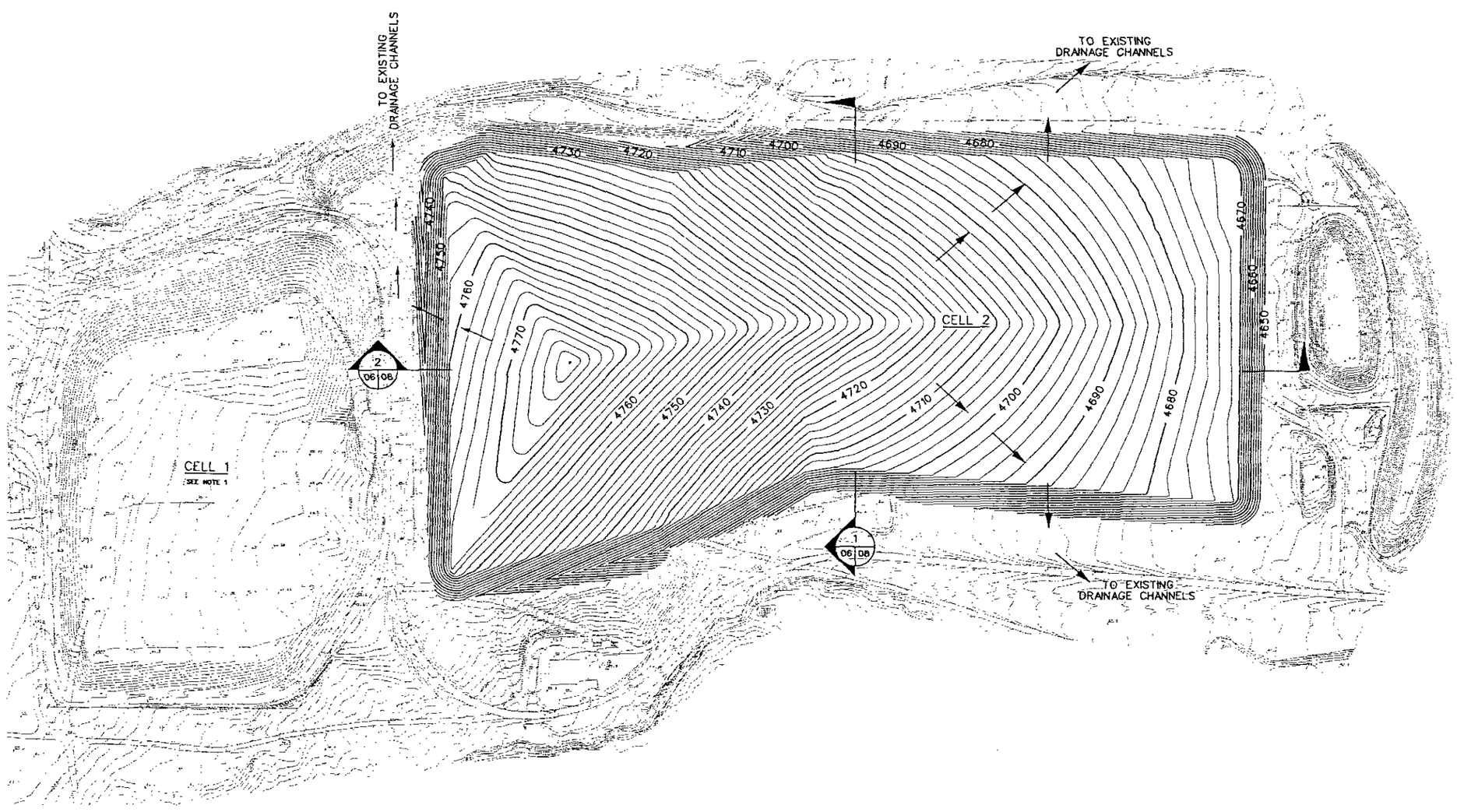
BAYVIEW LANDFILL
SOUTH UTAH VALLEY
SOLID WASTE DISTRICT

FIGURE 7

PLANNED AND EXISTING
LANDFILL FACILITIES



N

0 200 400

SCALE IN FEET

LEGEND

- EXISTING CONTOURS
- 4670 PROPOSED CONTOURS
- CELL FOOTPRINT BOUNDARY
- DRAINAGE PATH

NOTE:

1. SEE FIGURE 14 FOR CELL 1 FINAL CONTOURS.

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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

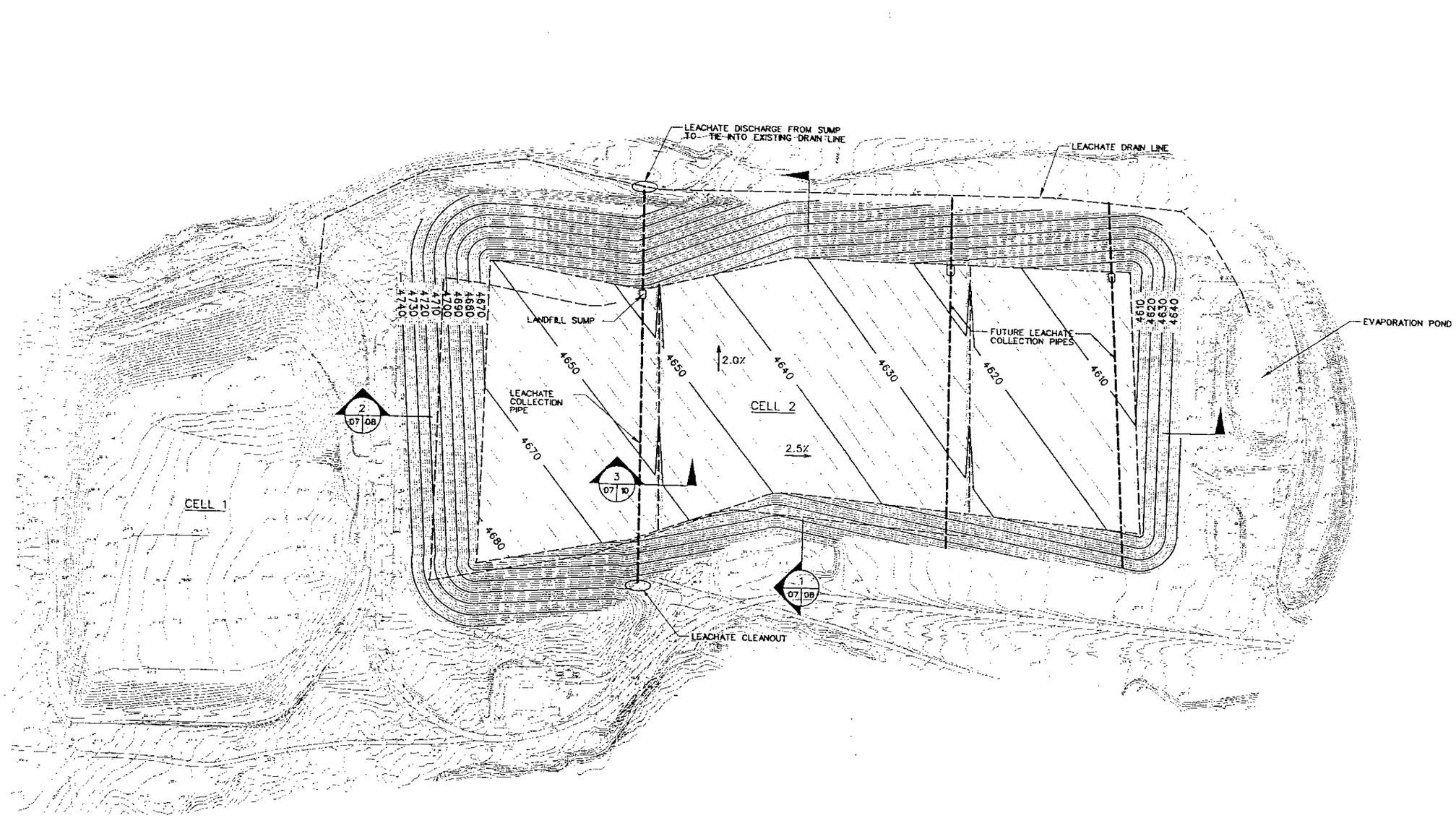
BAYVIEW LANDFILL PERMIT MODIFICATION

CELL 2

FINAL CONTOURS

Date	Project No	Figure No	Issue
SEPTEMBER, 2003	03879-143	06	0

Scale: AS SHOWN



N

0 200 400
SCALE IN FEET

LEGEND

- EXISTING CONTOURS
- CELL FOOTPRINT BOUNDARY
- LEACHATE DRAIN LINE
- INTERCELL BERM
- LANDFILL SUMP

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SOLID WASTE DISTRICT

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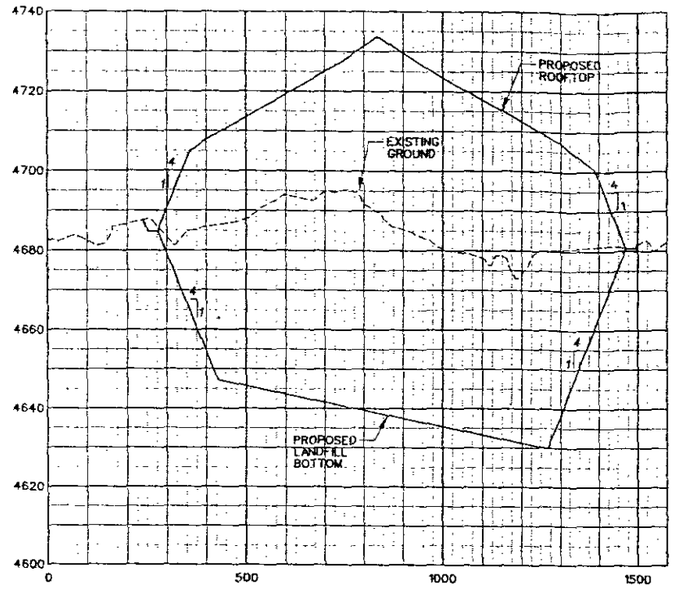
PERMIT MODIFICATION

CELL 2

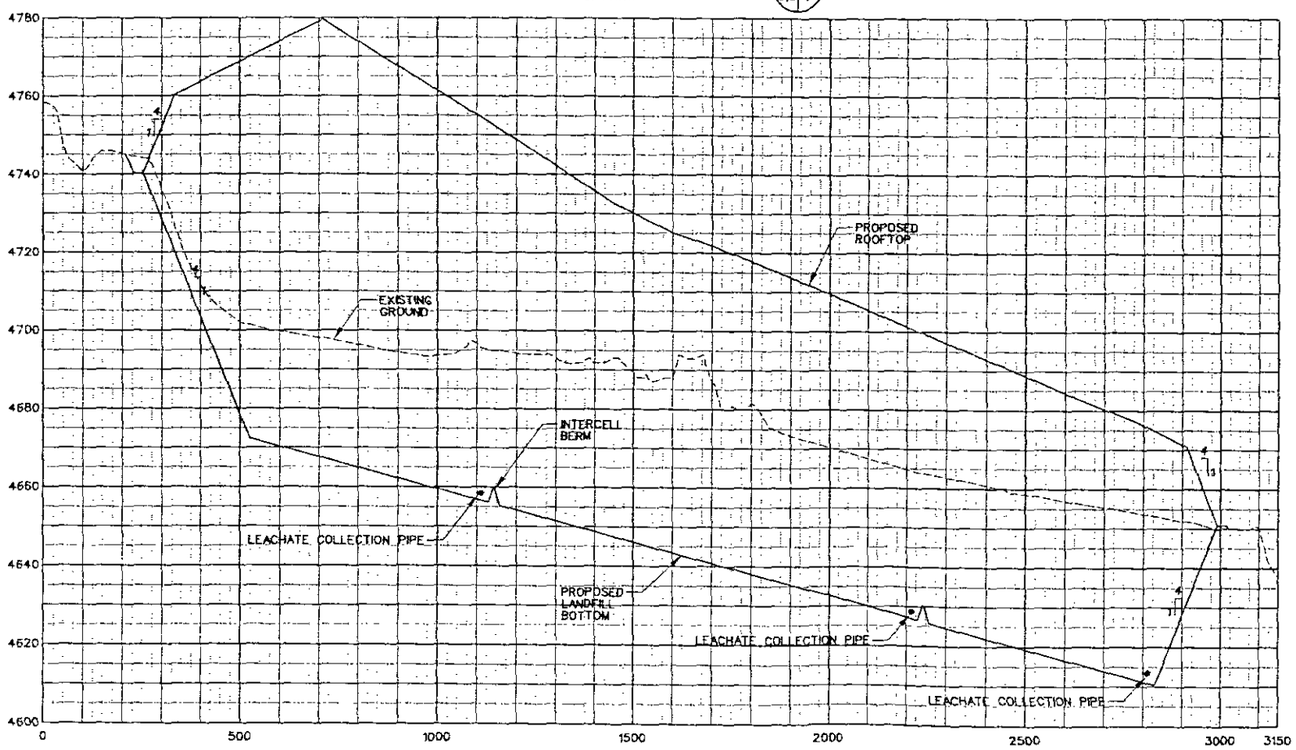
LINER/EXCAVATION CONTOURS

Date	Project No	Figure No.	Issue
SEPTEMBER, 2003	03879-143	07	0

Scale: AS SHOWN



CROSS SECTION LOOKING WEST (1 / 5,6 7)
AS SHOWN



CROSS SECTION LOOKING NORTH (2 / 5,6 7)
AS SHOWN

0 200 400
SCALE IN FEET

0 20 40
SCALE IN FEET

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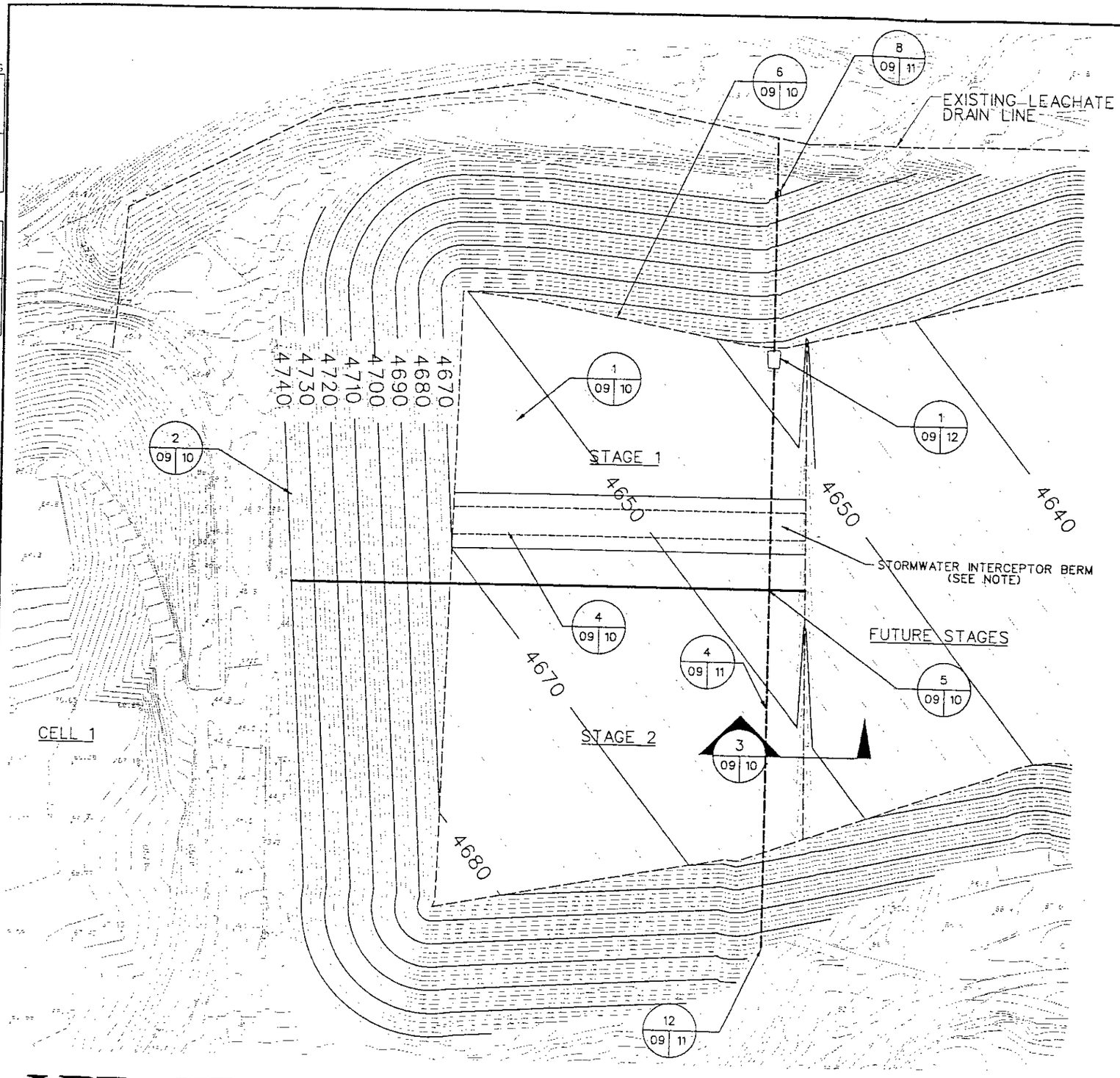
SOUTH UTAH VALLEY
SOLID WASTE DISTRICT

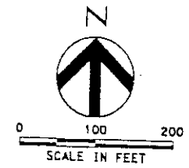
BAYVIEW LANDFILL
PERMIT MODIFICATION

CROSS SECTIONS

Date	Project No	Figure No	Issue
SEPTEMBER, 2003	03879-143	08	0

Scale: AS SHOWN





LEGEND

—4640—	EXISTING CONTOURS
———	CELL FOOTPRINT BOUNDARY
- - - -	LEACHATE DRAIN LINE
- - - -	INTERCELL BERM
□	LANDFILL SUMP

NOTE:

1. STORMWATER INTERCEPTOR BERM TO BE RELOCATED AS NEEDED.

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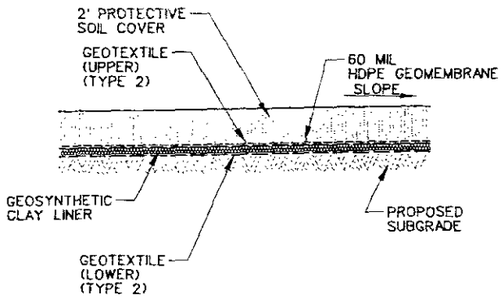
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL PERMIT MODIFICATION

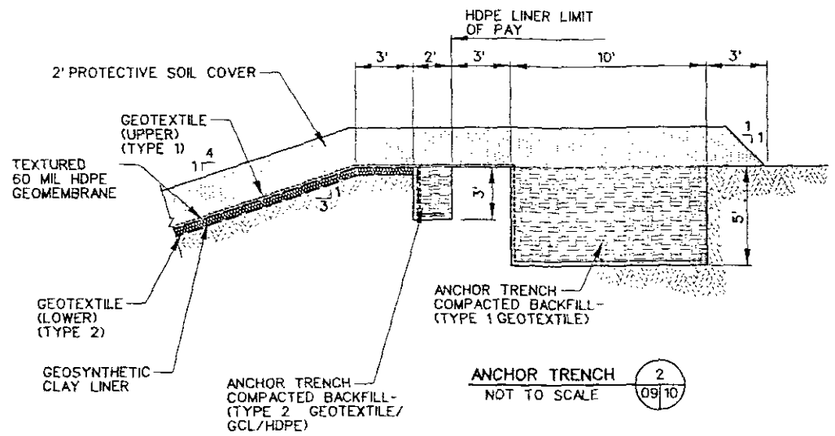
CELL 2

STAGE 1 AND 2 EXCAVATION/LINER GRADES

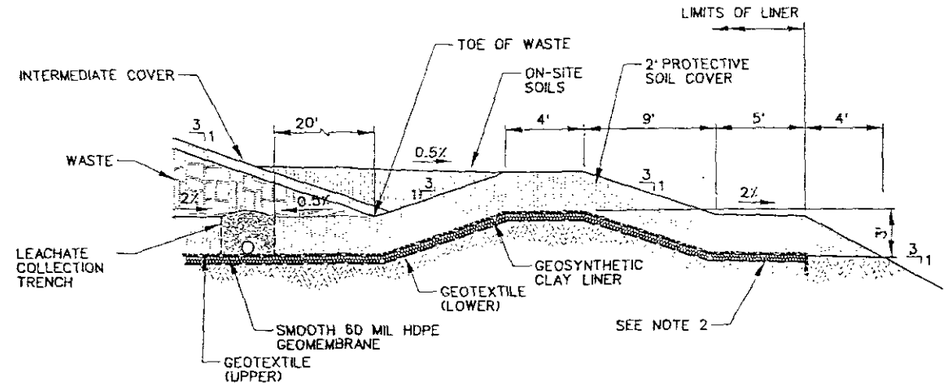
Date: SEPTEMBER, 2003
Scale: AS SHOWN
Project No: 03879-143
Figure No: 09
Issue: 0



TYPICAL LANDFILL LINER DETAIL (1 / 09|10)
NOT TO SCALE



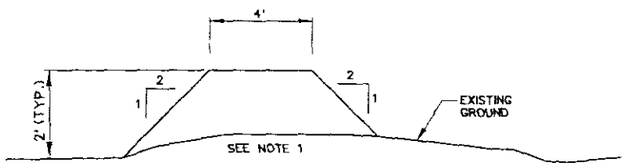
ANCHOR TRENCH (2 / 09|10)
NOT TO SCALE



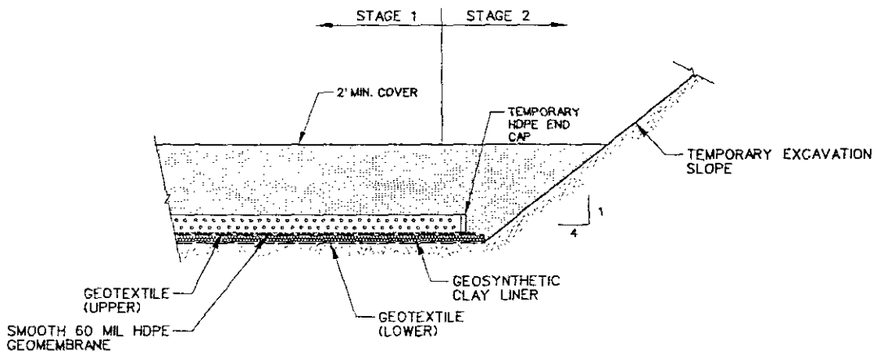
FUTURE LINER TIE-IN/INTERCELL BERM (3 / 07,09|10)
NOT TO SCALE

NOTES:

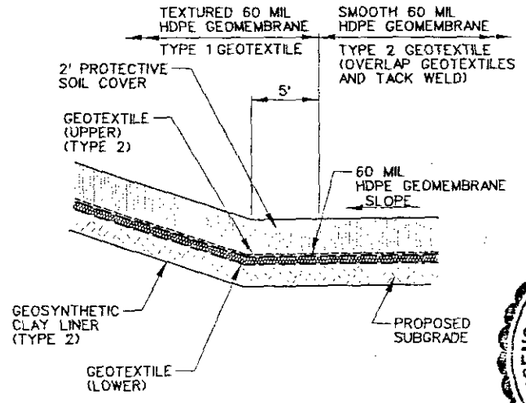
1. TEMPORARY STORMWATER INTERCEPTER BERM TO BE PLACED IN FRONT OF WORKING AREA TO DIVERT STORMWATER AWAY FROM ACTIVE FACE. RELOCATE AS NEEDED.
2. FUTURE GEOMEMBRANE TO BE WELDED TO EXISTING. OTHER GEOSYNTHETIC COMPONENTS TO BE OVER LAPPED AND SECURED.
3. TYPE 1 GEOTEXTILE IS REINFORCED AND REQUIRED ON SIDE SLOPES ONLY, ABOVE HDPE LINER. TYPE 2. GEOTEXTILE IS NON-REINFORCED AND IS TO BE USED BETWEEN SUBGRADE AND GCL. A SAND CUSHION MAY BE USED IN LIEU OF THE LOWER TYPE 2 GEOTEXTILE.



TEMPORARY STORMWATER INTERCEPTER BERM (4 / 09|10)
NOT TO SCALE



LEACHATE PIPE TERMINATION (5 / 09,12|10)
NOT TO SCALE



LINER AT SLOPE TRANSITION (6 / 09|10)
NOT TO SCALE

NOTE: THICKNESS MEASURED PERPENDICULAR TO EXCAVATION SURFACE.

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Designed: M. DAVISON | Drawn By: J. ZEPEDA

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

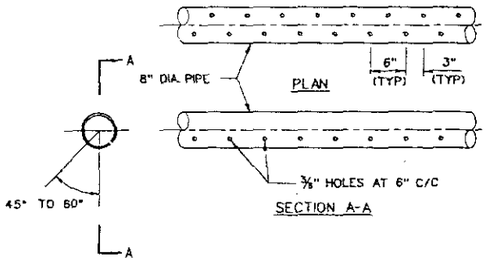
BAYVIEW LANDFILL PERMIT MODIFICATION

CELL 2

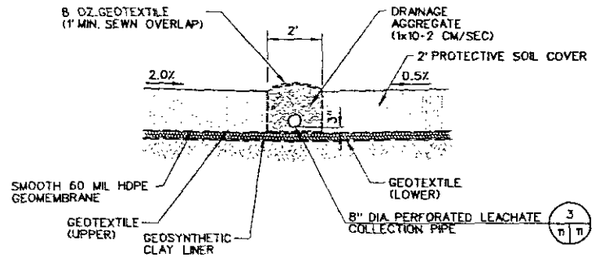
LINER DETAILS

Date	Project No	Figure No	Issue
SEPTEMBER, 2003	03879-143	10	0

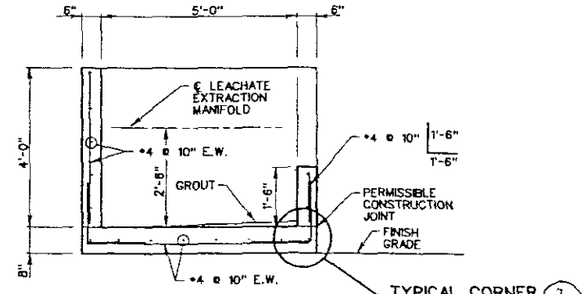
Scale: AS SHOWN



8" DIA. PERFORATED LEACHATE COLLECTION PIPE (3 | 11 | 11)
NOT TO SCALE



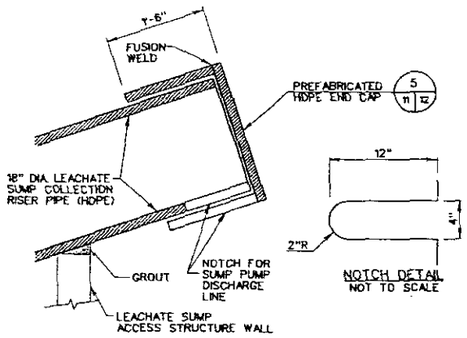
LEACHATE COLLECTION TRENCH (4 | 09 | 10)
NOT TO SCALE



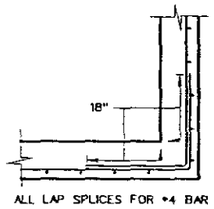
LEACHATE SUMP ACCESS STRUCTURE- SECTION (5 | 12 | 11)
NOT TO SCALE

CONCRETE NOTES:

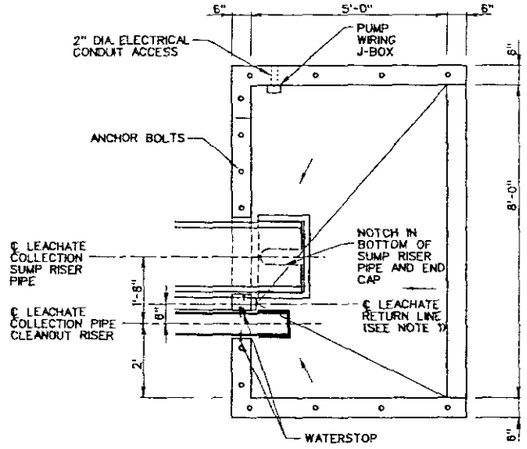
1. ALL CONCRETE SHALL HAVE 4000PSI COMPRESSIVE STRENGTH @ 28 DAYS, NORMAL WEIGHT.
2. ALL CONCRETE SHALL BE IN ACCORDANCE WITH THE "BUILDING CODE REQUIREMENT OR REINFORCED CONCRETE" ACI-318 LATEST EDITION.
3. REINFORCING BARS SHALL CONFORM TO SPECIFICATIONS FOR "DEFORMED BILLET-STEEL FOR CONCRETE REINFORCEMENT" WITH 60KSI YIELD STRENGTH; ASTM A615 GRADE 60.
4. REINFORCING BARS TO BE WELDED SHALL COMPLY WITH THE REQUIREMENT OF ASTM A706 GRADE 60.
5. COVER ON ALL REINFORCEMENT SHALL BE AS FOLLOWS, UNLESS OTHERWISE NOTED:
   i CONCRETE PLACED AGAINST GROUND 3 IN
   ii EXPOSED FORMED SURFACES
      A. #5 AND SMALLER 1.5 IN
      B. #6 AND LARGER 2 IN
6. ALL EXPOSED CORNERS SHALL HAVE 1 IN CHAMFER, UNLESS OTHERWISE NOTED.
7. SAWED GROOVES SHOULD BE MADE WITHIN APPROXIMATELY 4 TO 12 HOURS OF SLAB OR PAVEMENT FINISHING. IF THIS IS NOT PRACTICABLE, USE PREMOLDED STRIPS.
8. AS AN ALTERNATIVE, A PRECAST CONCRETE BOX MAY BE USED. THE PRECAST BOX SHOULD HAVE A MINIMUM CONCRETE COMPRESSIVE STRENGTH OF 5000 PSI @ 28 DAYS.



18" DIA. SUMP RISER PIPE (6 | 12 | 11)
NOT TO SCALE

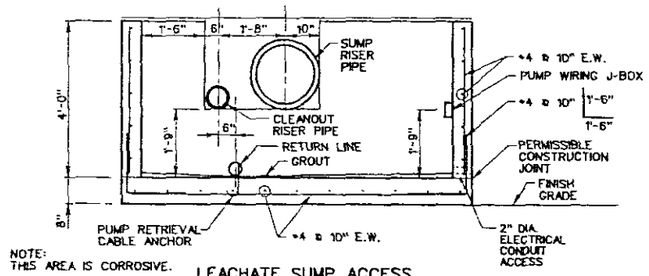


TYPICAL CORNER REINFORCING (7 | 11 | 11)
NOT TO SCALE



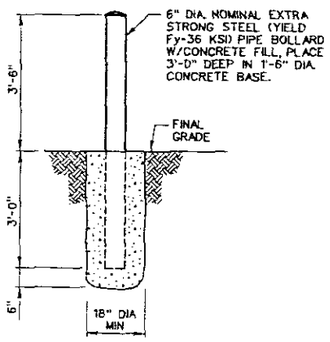
LEACHATE SUMP ACCESS STRUCTURE- PLAN (8 | 09 | 11)
NOT TO SCALE

NOTES:
1. LEACHATE RETURN LINE IS TO ALLOW ANY SPILLAGE OR RAINWATER ACCUMULATION IN SUMP ACCESS STRUCTURE TO RETURN TO LANDFILL SUMP FOR REMOVAL.

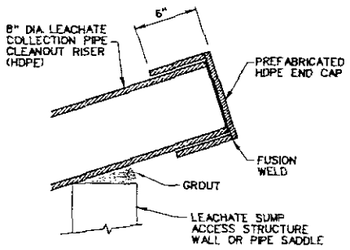


NOTE:
THIS AREA IS CORROSIVE.

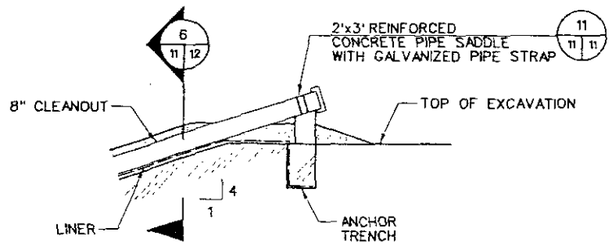
LEACHATE SUMP ACCESS STRUCTURE- SECTION (9 | 12 | 11)
NOT TO SCALE



TYPICAL BOLLARD (10 | 12 | 11)
NOT TO SCALE



8" DIA. CLEANOUT RISER PIPE END CAP (11 | 12 | 11)
NOT TO SCALE



LEACHATE CLEANOUT PIPE TERMINATION (12 | 09 | 11)
NOT TO SCALE

LICENSED PROFESSIONAL ENGINEER
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No. 369338
STATE OF UTAH

FOR INFORMATION ONLY

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Project Manager: M.ODEN
Architect | I&C/Process
Civil | Mechanical
Electrical | Structural
Designed: M. DAVISON | Drawn By: J. ZEPEDA

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

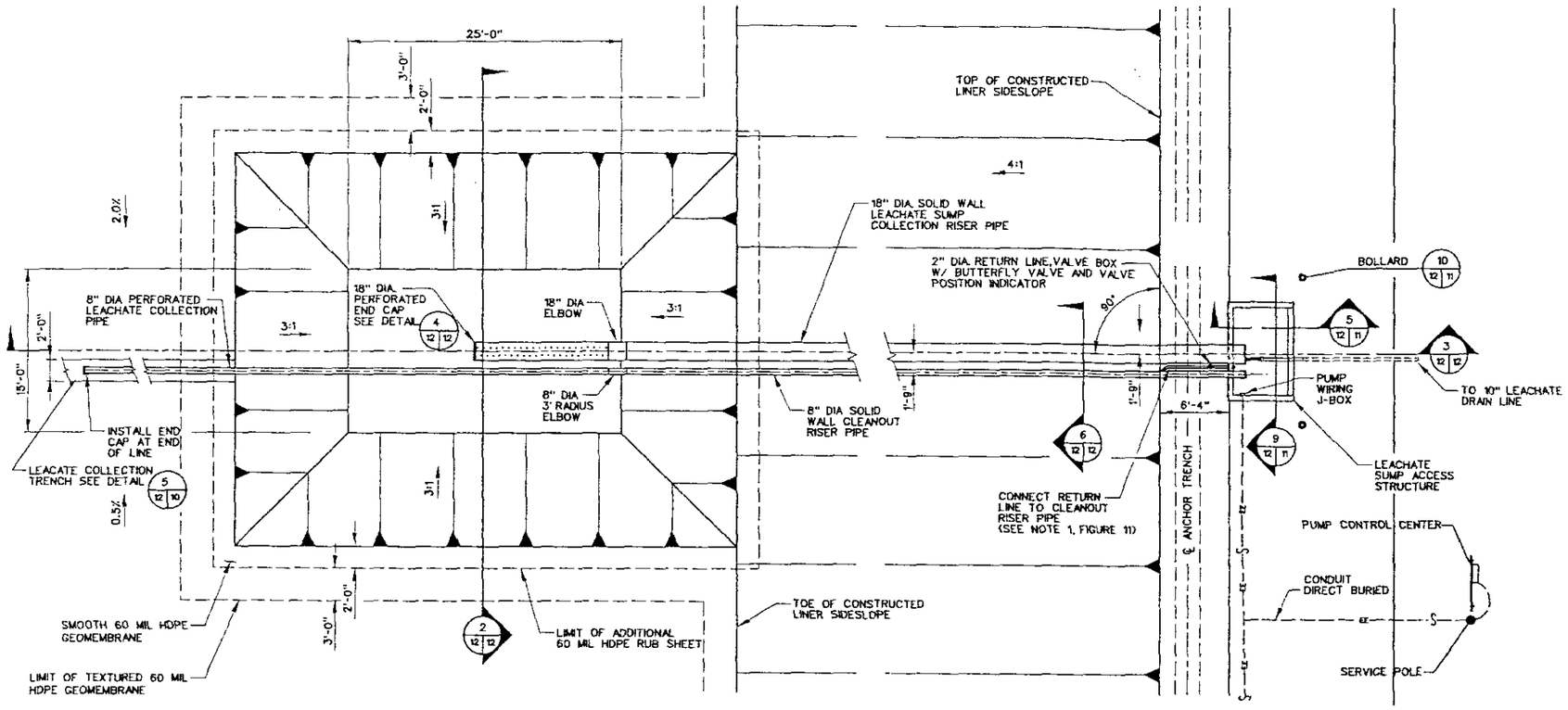
BAYVIEW LANDFILL PERMIT MODIFICATION

CELL 2

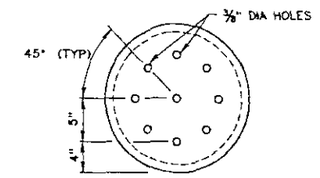
LEACHATE COLLECTION SYSTEM, AND LINER DETAILS

Date	Project No.	Figure No.	Issue
SEPTEMBER, 2003	03879-143	11	0

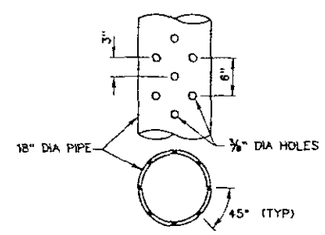
Scale: AS SHOWN



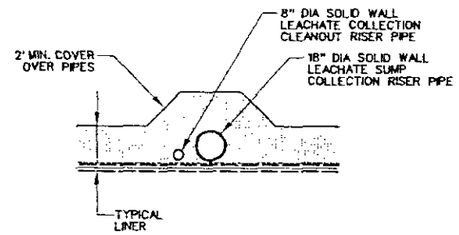
LEACHATE SUMP- PLAN (1 / 09|12)
NOT TO SCALE



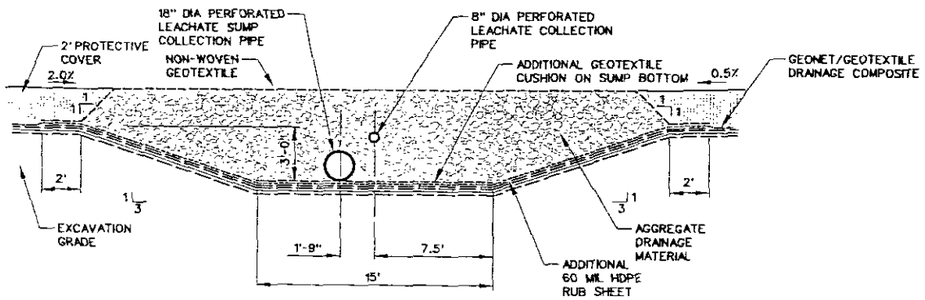
18" DIA. PERFORATED END CAP (4 / 12|12)
NOT TO SCALE



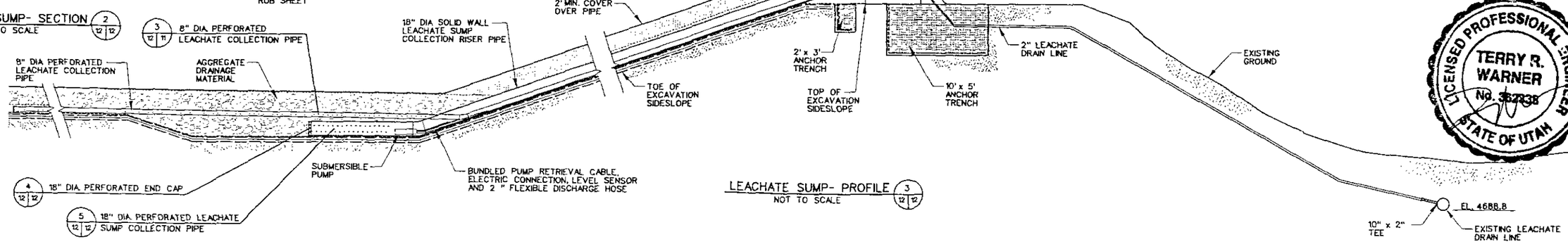
18" DIA. PERFORATED LEACHATE SUMP COLLECTION PIPE (5 / 11,12|12)
NOT TO SCALE



LEACHATE SUMP RISER- SECTION (6 / 11|12)
NOT TO SCALE



LEACHATE SUMP- SECTION (2 / 12|12)
NOT TO SCALE



LEACHATE SUMP- PROFILE (3 / 12|12)
NOT TO SCALE

FOR INFORMATION ONLY

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Civil | Mechanical
Electrical | Structural
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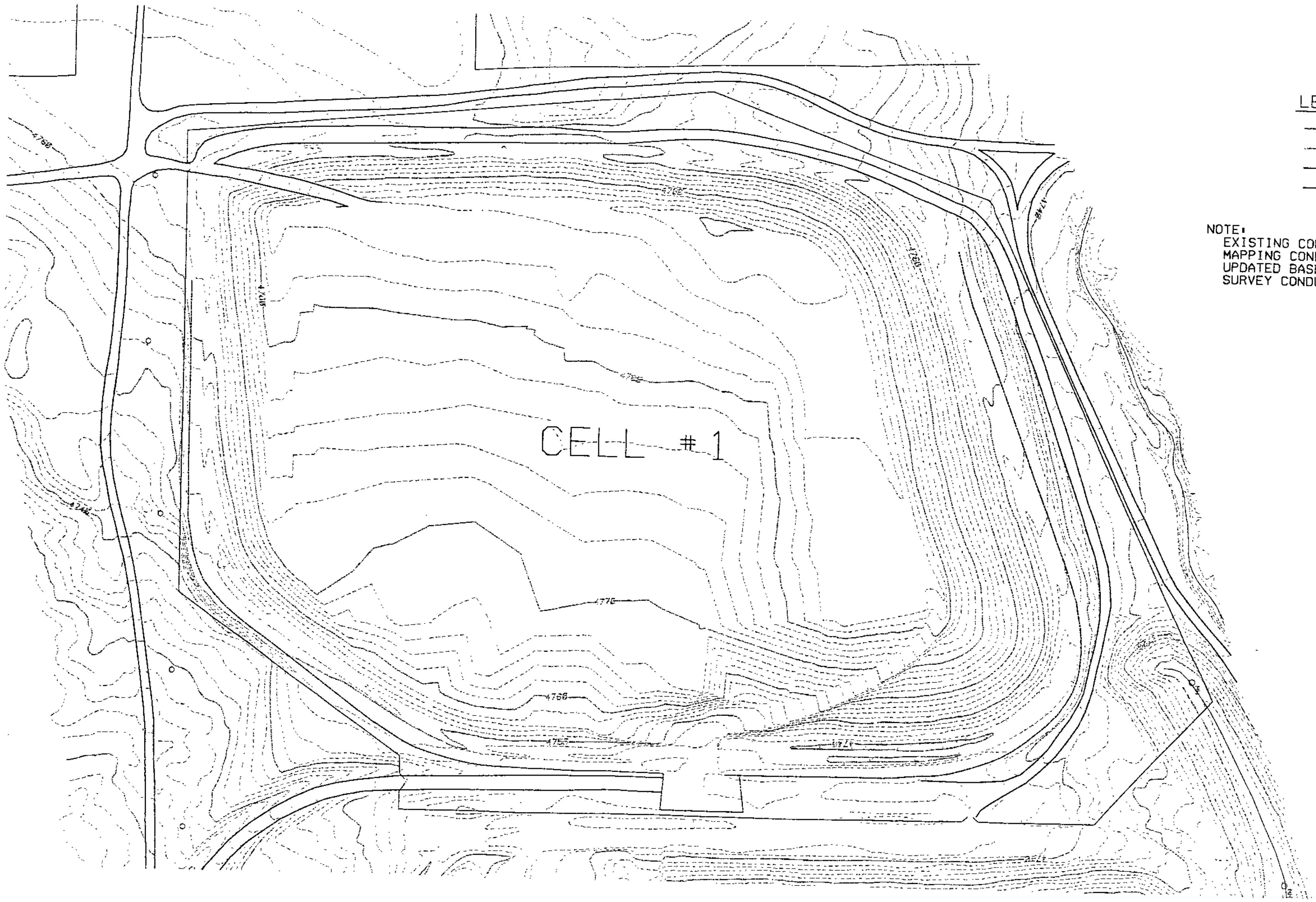
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL PERMIT MODIFICATION

CELL 2
LEACHATE COLLECTION SYSTEM SUMP PLAN, AND SECTION DETAILS

Date	Project No.	Figure No	Issue
SEPTEMBER, 2003	03879-143	12	0

Scale: AS SHOWN



N

0 100 200
SCALE IN FEET

LEGEND

- MAJOR CONTOURS
- MINOR CONTOURS
- ROADS
- LITTER FENCE

NOTE:
EXISTING CONTOURS BASED ON AERIAL MAPPING CONDUCTED IN JULY, 2002 AND UPDATED BASED ON ON SURFACE ELEVATION SURVEY CONDUCTED IN APRIL, 2003.

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ARCHITECT	I&C/PROCESS
CIVIL	MECHANICAL
ELECTRICAL	STRUCTURAL
DESIGNED	DRAWN BY

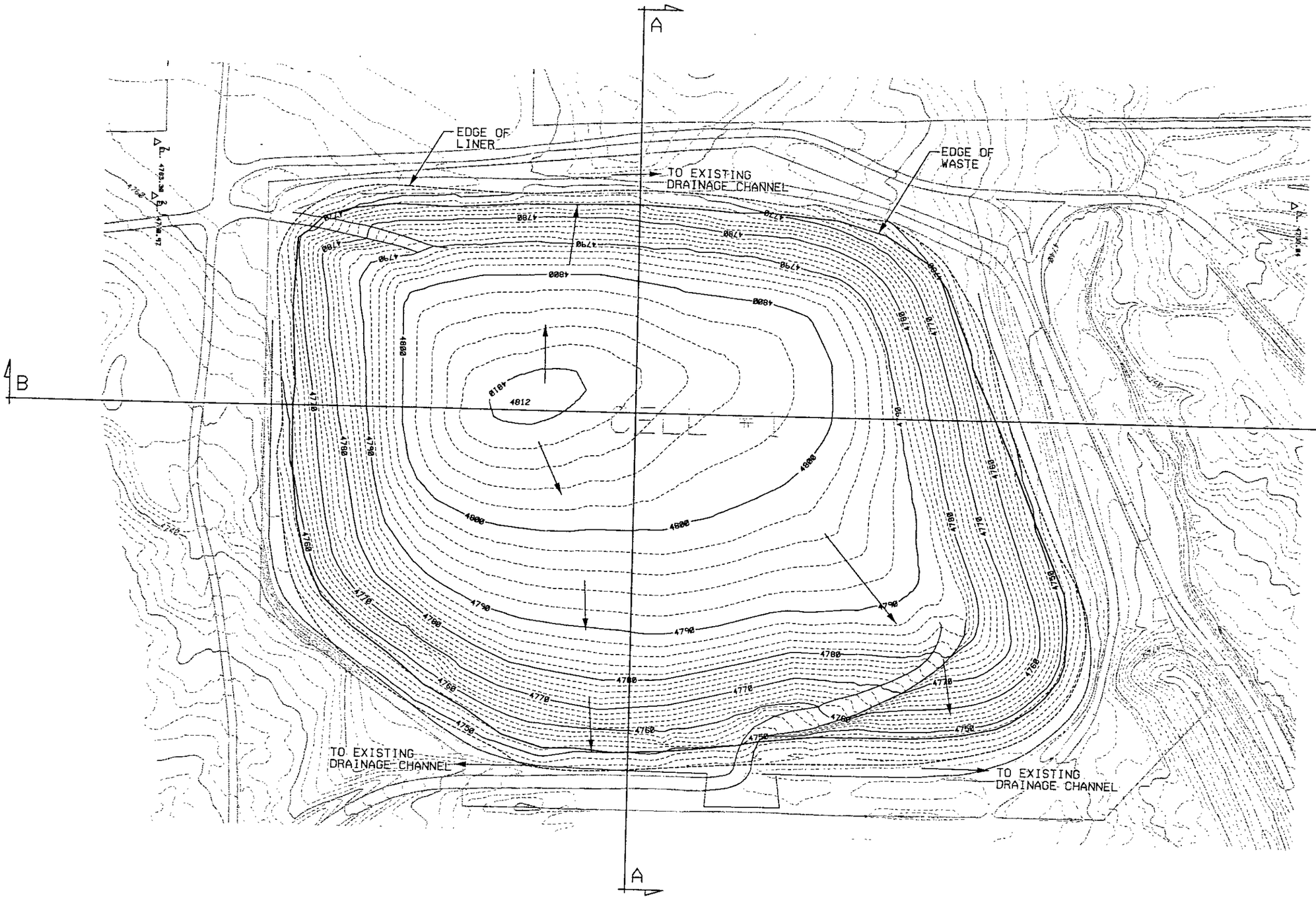
SOUTH UTAH VALLEY
SOLID WASTE DISTRICT

BAYVIEW LANDFILL
PERMIT MODIFICATION

NOT FOR CONSTRUCTION

CELL 1
EXISTING CONTOURS

DATE	PROJECT NO.	FIGURE NO.	ISSUE
SEPTEMBER 2003	03879	13	0
SCALE 1" = 200' _E			



LEGEND

- PROPOSED MAJOR CONTOURS
- PROPOSED MINOR CONTOURS
- PROPOSED ACCESS ROADS
- LITTER FENCE
- DRAINAGE PATH

NOTES:

1. ACRES OF COVER - 31.3 (TO EDGE OF WASTE)
2. ACRES OF COVER - 35.2 (TO EDGE OF LINER)
3. LITER FENCE TO BE RELOCATED.
4. SEE FIGURE 15 FOR CROSS SECTIONS.

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PROJECT MANAGER
ARCHITECT | I&C/PROCESS
CIVIL | MECHANICAL
ELECTRICAL | STRUCTURAL
DESIGNED | DRAWN BY

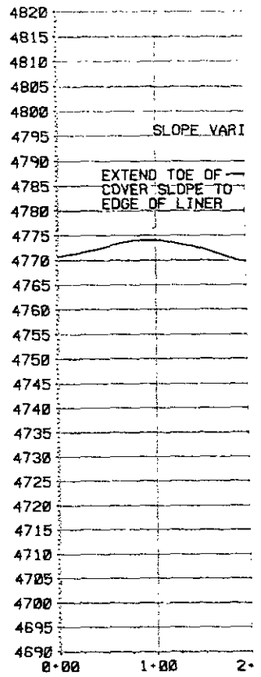
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

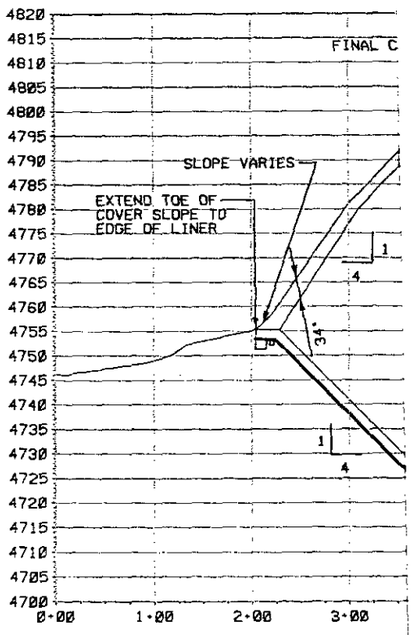
BAYVIEW LANDFILL
PERMIT MODIFICATION

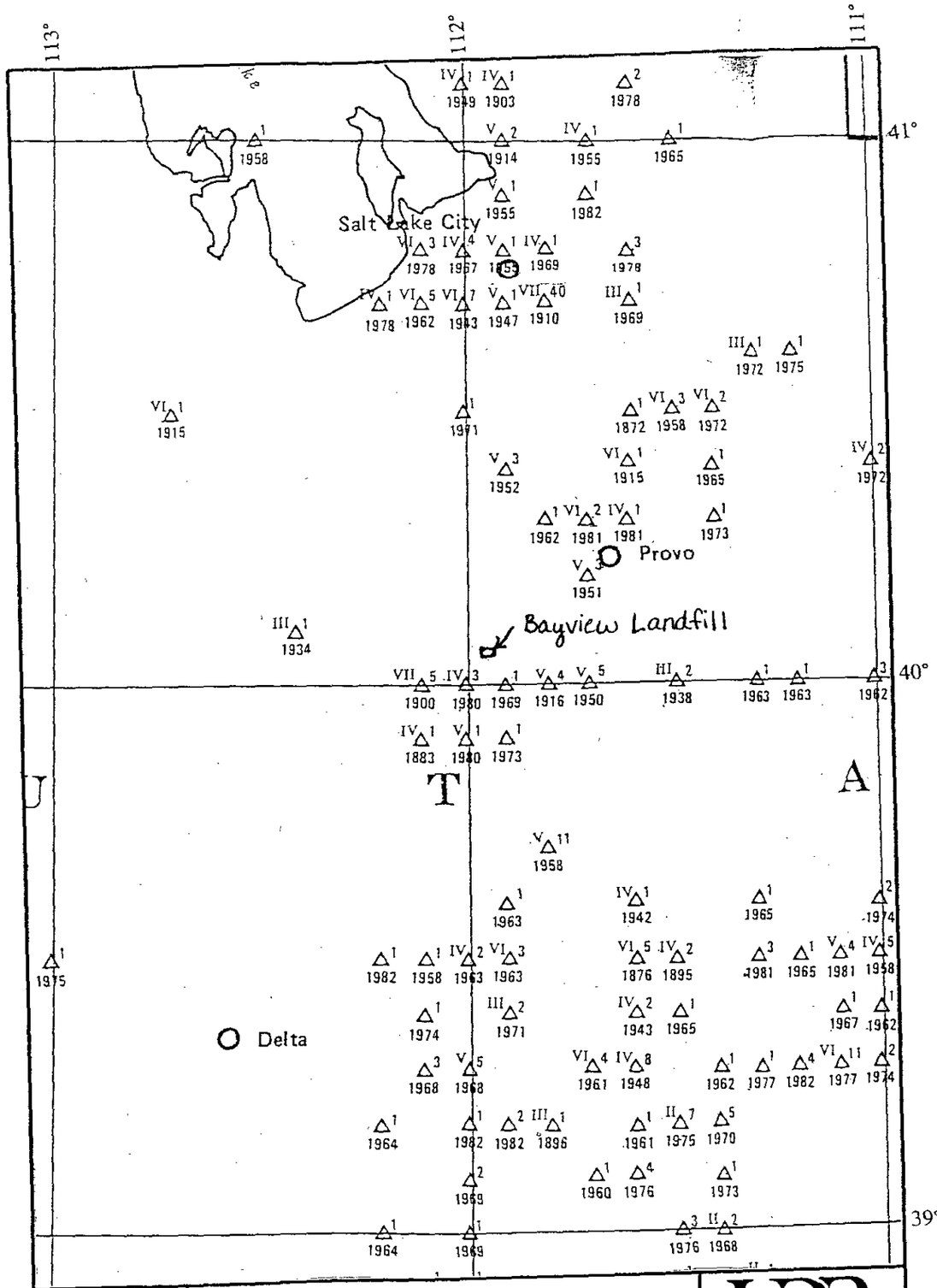
CELL 1
FINAL CONTOURS

DATE	PROJECT NO.	FIGURE NO.	ISSUE
SEPTEMBER 2003	03879	14	0

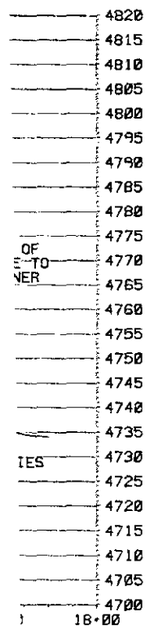
SCALE 1" = 200' E







NOTE:
VERTICAL IS SCALED
5 TIMES HORIZONTAL.



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DALLAS, TEXAS 75248

REVISION NO.	DESCRIPTION

REFERENCE:
SEISMICITY MAP OF THE STATE OF UTAH, MAP MF-1856

BAYVIEW LANDFILL
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

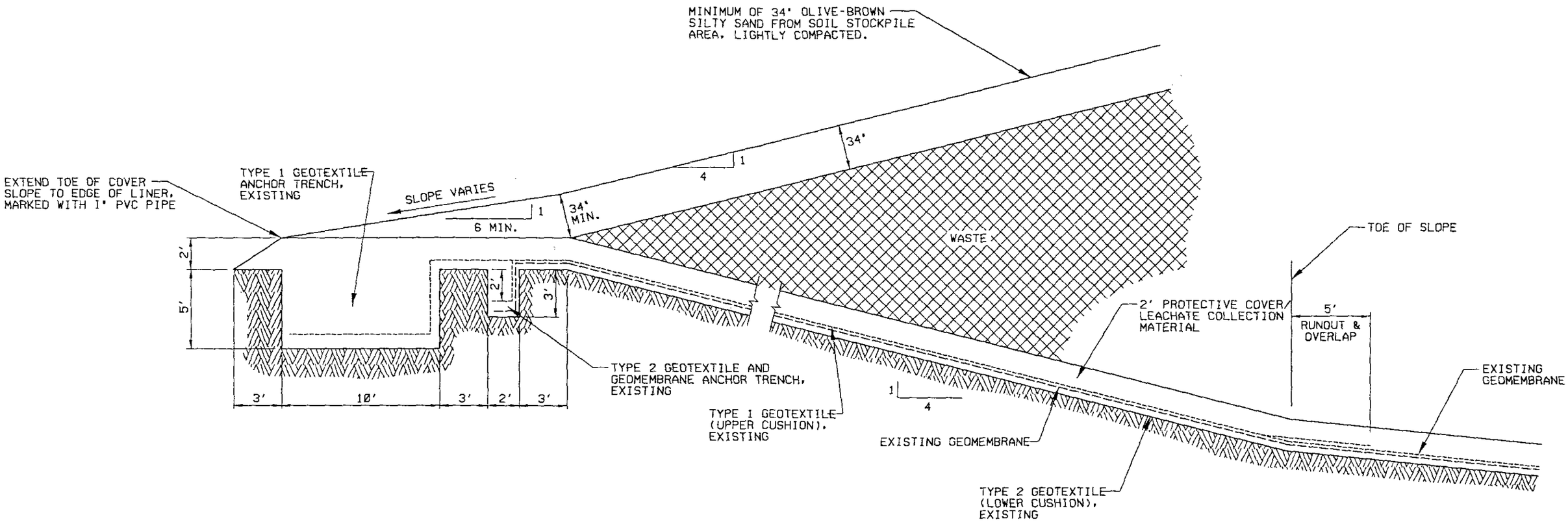
EARTHQUAKE DISTRIBUTION MAP

HDR

Figure No. 4

CELL 1
CROSS SECTIONS

	PROJECT NO.	FIGURE NO.	ISSUE
BER 2003	03879	15	0
SCALE			



NOTES:
SUBJECT TO APPROVAL OF ALTERNATIVE FINAL COVER
REFER TO LANDFILL PERMIT APPENDIX N.

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PROJECT MANAGER
ARCHITECT | I&C/PROCESS
CIVIL | MECHANICAL
ELECTRICAL | STRUCTURAL
DESIGNED | DRAWN BY

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL
PERMIT MODIFICATION

CELL 1
FINAL COVER
LINER TIE-IN

DATE	PROJECT NO.	FIGURE NO.	ISSUE
SEPTEMBER 2003	03879	16	0

SCALE NOT TO SCALE

APPENDIX A

LANDFILL MASTER PLAN (2002 & 1988)

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

BAYVIEW LANDFILL
MASTER PLAN UPDATE

Prepared For:

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

Prepared By:

HDR ENGINEERING, INC.

January 2002

SOUTH UTAH VALLEY SOLID WASTE DISTRICT
BAYVIEW LANDFILL
MASTER PLAN UPDATE

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VI.	OPERATIONAL CONSIDERATIONS	16
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SOUTH UTAH VALLEY SOLID WASTE DISTRICT
BAYVIEW LANDFILL
MASTER PLAN UPDATE

Appendix A

Figure 1 – Vicinity Map
Figure 2 – Existing Contours
Figure 3 – Phasing Plan & Final Contours
Figure 4 – Cross Sections
Figure 5 – Cross Sections
Figure 6 – Leachate Collection Details
Figure 7 – Leachate Collection Details

SOUTH UTAH VALLEY SOLID WASTE DISTRICT
BAYVIEW LANDFILL
MASTER PLAN UPDATE

I. SCOPE OF SERVICES

This project was undertaken by the South Utah Valley Solid Waste District (SUVSWD) to determine the most feasible design for Cells 2 and 3 at the Bayview Landfill. The analysis was based on current conditions and potential future changes to waste flows expected at the landfill. The evaluation of Cells 2 and 3 included the elements listed below, as well as waste acceptance rates of approximately 400 tons per day (current) and 800 tons per day (potential future). The potential future waste acceptance rate assumes delivery of waste from the North District.

Three options were evaluated to address the design of Cells 2 and 3, which includes the area north of the existing access road. The options evaluated are:

Option 1 – Use the existing design, but remove the intercell berm between Cells 2 and 3;

Option 2 – Similar to Option 1 with the base of Cells 2 and 3 lowered approximately 20 feet; and

Option 3 – Similar to Options 1 and 2 with the base lowered to maintain a 100 foot separation from groundwater. (approximately 10-20 feet below option 2)

The existing design of Cells 2 and 3 was included in the review to provide a comparison. This is considered the base design in this evaluation. For the three options, the amount of soil to be removed from the existing intercell berm and the lowering of the base grades were determined. The space available for waste in the cells was also determined. No increase in fill height was included in the calculations. The following information was developed during the evaluations.

a. Capacity/air space
b. Phasing/schedule for development
c. Earthwork quantities/Soil balance

d. Cost to develop

e. Impact on leachate management system

f. Placement of wind fence

g. Operational impacts

II. FACILITY DESCRIPTION

The SUVSWD was formed in 1989 to own and operate solid waste facilities for the cities of Provo, Salem, Spanish Fork, Springville and Mapleton, Utah. It assumed the existing and previously permitted landfill operations from the City of Provo. These solid waste facilities include a transfer station located in Springville and a landfill located north of Elberta. An additional transfer station owned and operated by the City of Goshen also provides waste to the Bayview Landfill. A vicinity map showing the site is included as Figure 1 in Appendix A.

The Bayview Landfill was located, permitted, designed, and constructed by Provo City Corporation during the 1980's. The City received a Conditional Use Permit in 1989 for the landfill site through the Utah County Board of Adjustment. Several conditions were attached to the Conditional Use Permit. One of these conditions required that only compacted or baled waste be accepted at the landfill. A second of these conditions permits disposal of waste from Provo City Corporation only. This condition was later modified to allow disposal of waste from the District only. Therefore, no out-of District wastes can be disposed of in the Bayview Landfill without approval of the County Board of Adjustment.

In 1989-1990, Cell 1 - Phase 1 of the Landfill was constructed. This provided disposal capacity for approximately 6 years. Cell 1 - Phase 2 was constructed in 1996. In addition to these two major construction programs at the landfill, the Landfill Permit was renewed during 1996-1998, being approved by the State of Utah in 1998. This permit requires renewal every 5 years, placing the next renewal in 2003.

The Bayview Landfill is located in Sections 17 and 18, T9S, R1W approximately 5.5 miles north of Elberta, Utah, and directly west of State Highway 68. The landfill property includes all 640 acres of Section 17, and a 20-acre parcel in Section 18. All solid waste disposal activities are planned within the Section 17 parcel; the 20-acre Section 18 parcel houses a culinary well, a water storage tank, and an upgradient monitoring well associated with the landfill operations.

The Bayview Landfill sits in the Goshen Valley approximately 2 miles west of the southwestern-most bay of Utah Lake. The Goshen Valley slopes upward away from the lake toward the East Tintic Mountains some 7 miles southwest of the lake. The landfill site similarly slopes with an approximate 150-foot rise from the eastern to the western boundaries of Section 17. The eastern boundary of the landfill site is approximately 120 feet above the current water surface elevation of Utah Lake.

The land use surrounding the site is generally rural agricultural, with orchards, grain and hay crops, and livestock grazing as the predominant land uses in the vicinity of the site. The nearest residence is located more than 1 mile from the property boundary, and the nearest town, Elberta, some 5.5 miles south of the site.

III. AREA SERVED

The service area for the Bayview Landfill includes the cities of Provo, Salem, Spanish Fork, Springville, Mapleton, and Goshen, and some contiguous areas. As stated above, the landfill's Conditional Use Permit prohibits it from receiving wastes generated outside of the service area of the District. The landfill is also prohibited from receiving wastes that have not been compacted or baled. These prohibitions limit the landfill's ability to accept wastes from other areas of the County or adjoining counties. The conditions also restrict use by the general public.

IV. WASTE TYPES

The Bayview Landfill accepts compacted wastes from the District's transfer station in Springville and a city-owned transfer station in Goshen. The transfer stations provide screening

and compacting of incoming wastes, and ship the compacted solid wastes to the Bayview Landfill. The transfer stations accept residential and commercial solid wastes, including yard wastes, and generally do not accept C&D wastes or regulated hazardous wastes.

The wastes accepted at the transfer stations are compacted, loaded into over-the-road vehicles, and transported to the landfill for disposal. All wastes shipped to the landfill are disposed of at the landfill. No wastes arriving at the landfill site are segregated, recycled, or otherwise diverted from the active landfill cell.

The Quantity of wastes received at the landfill from 1999 – 2002 is presented in Table 1.

Table 1: SUVSWD Waste Quantities

YEAR*	TONS
1999-2000	124,480
2000-2001	127,031
2001-2002	128,312**

* - July 1 – June 30
** - Tons estimated for 2001-2002 based on a 1% increase over previous year.

The Landfill Master Plan (HDR, 1988) projected a waste disposal capacity of 7.6 million tons at the Bayview Landfill, which was to provide approximately 50 years of site life assuming 2% per year increase in tonnage received for disposal. This capacity was calculated based on an assumed in-place density of 1,000 pounds of solid waste per cubic yard of in-place waste. Actual in-place densities based on known weights and surveyed volumes exceed 1,300 pounds per cubic yard (lbs/cy) (Bayview Annual report, 1994).

To arrive at an estimated site life for current and future conditions at the landfill the following assumptions have been used.

- In-place waste density – 1,300 lbs/cy
- In-place waste to daily cover soil ratio – 4:1
- Waste tonnage annual increase – 2%
- Waste tonnage rate increase with North District – 110% of current waste acceptance rate.

Using the above assumptions, Tables 2 through 9 have been prepared noting anticipated waste tonnage acceptance rates, soil usage, airspace consumption, and site life for the options being considered by the SUVSWD. These options are discussed further below.

V. CELL DEVELOPMENT OPTIONS

As discussed briefly above, this evaluation reviews the existing design of Cells 2 and 3 (74+/- acres) of the Bayview Landfill in comparison to three alternative designs. Option 1 calls for the removal of the soil berm between Cell 2 and Cell 3, resulting in approximately 82 acres for disposal of waste. Option 2 includes the removal of the soil berm between Cell 2 and Cell 3 and lowering the base grade an additional 20 feet. Option 3 also includes the removal of the soil berm between Cell 2 and Cell 3 and lowering the base grade to an elevation approximately 100 feet above groundwater. Figure 2 in Appendix A shows the existing contours of the site in the area of Cells 2 and 3. This figure includes a plan view of the landfill footprint for the base condition and the three options. Figure 3 shows proposed final contours of the options. Cross sections associated with the options are included on Figures 4 and 5.

For purposes of the study, it has been assumed that there is no increase in excavation effort with increased depth. As additional soil is excavated, increased capacity for waste and increased soil surplus are created. Disposal of the surplus soil is assumed to take place onsite. A cost for spreading the soil is included for comparison in Table 10. No increase in final height of the landfill was assumed. An increase in final landfill height would require additional daily cover soil and would decrease any soil surplus. This option may be considered in future permitting efforts.

The liner system assumed for the options under consideration include (from bottom to top) a prepared subgrade, 2-foot thick layer of compacted clay, 60-mil HDPE liner, a 12-ounce, non-woven geotextile and two feet of protective soil cover. See Detail 1 on Figure 6 in Appendix A. For purposes of this report, it has been assumed that all clay required for site development will be imported and compacted in place at a cost of $10.00 per cubic yard. Consideration should be given to permitting an alternate liner design such as a geosynthetic clay liner (GCL). This could be proposed during the next permitting process and could save approximately $10,000 per acre, if approved.

A leachate collection system (LCS) will be required for all options under consideration. However, the operation of the LCS will vary slightly from one option to another. See Figures 6 and 7 for typical leachate collection details. The costs presented in Table 10 also assume that daily operations will not be impacted by any of the options, with the exception of operation of the LCS.

According to federal regulations, a landfill final cover system is required to be as impervious as the liner system beneath it. This is to prevent a "bathtub" effect from occurring. Therefore, if a landfill liner contains a synthetic component, a similar component is typically required in the final cover. For purposes of this comparison, a two-foot thick layer of compacted clay and a synthetic membrane component has been used. Six-inches of soil capable of supporting vegetation will be placed over the synthetic cover. It may be advantageous to pursue an alternative final cover system during the next permit application. Other sites in similar climatic regions have shown that four feet of on-site soils can provide equivalent protection due to the amount of evapotranspiration that occurs. If allowed, this alternate final cover could save approximately $ 36,000 per acre in development costs.

Table 2: Base Option – Cells 2 and 3 as Permitted
Current Waste Volumes

INPUTS

Initial Tonnage	**127,031**	Annual Increase	**2%**	Waste Density [LB/CY]	**1,300**	Waste:Soil	**4**	**1**
Total Volume [CY]	**5,976,000**	Excavation Volume [CY]	**2,079,000**	Site Area [ACRE]	**74.4**	Clay Cap/Cover Depth [FT]	**2.5**	Liner/Prot. Cover Depth [FT] **4**

CALCULATIONS

Soil For Liner/Cover [CY]	**780,208**	Initial Airspace [CY]	**5,195,792**

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required [CY]	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	127,031	127,031	195,432	195,432	48,858	48,858	244,290	244,290	4,951,502	20.3	136,159
2002	129,572	256,603	199,341	394,773	49,835	98,693	249,176	493,467	4,702,325	18.9	140,060
2003	132,163	388,766	203,328	598,101	50,832	149,525	254,160	747,626	4,448,166	17.5	144,206
2004	134,806	523,572	207,394	805,495	51,849	201,374	259,243	1,006,869	4,188,923	16.2	148,641
2005	137,502	661,074	211,542	1,017,038	52,886	254,259	264,428	1,271,297	3,924,495	14.8	153,426
2006	140,252	801,327	215,773	1,232,811	53,943	308,203	269,716	1,541,013	3,654,779	13.6	158,648
2007	143,058	944,384	220,089	1,452,899	55,022	363,225	275,111	1,816,124	3,379,668	12.3	164,434
2008	145,919	1,090,303	224,490	1,677,389	56,123	419,347	280,613	2,096,737	3,099,055	11.0	170,987
2009	148,837	1,239,140	228,980	1,906,370	57,245	476,592	286,225	2,382,962	2,812,830	9.8	178,658
2010	151,814	1,390,954	233,560	2,139,929	58,390	534,982	291,950	2,674,912	2,520,880	8.6	188,129
2011	154,850	1,545,804	238,231	2,378,160	59,558	594,540	297,789	2,972,700	2,223,092	7.5	201,049
2012	157,947	1,703,751	242,996	2,621,156	60,749	655,289	303,744	3,276,445	1,919,347	6.3	223,362
2013	161,106	1,864,857	247,855	2,869,011	61,964	717,253	309,819	3,586,264	1,609,528	5.2	
2014	164,328	2,029,185	252,813	3,121,824	63,203	780,456	316,016	3,902,279	1,293,513	4.1	
2015	167,615	2,196,800	257,869	3,379,692	64,467	844,923	322,336	4,224,615	971,177	3.0	
2016	170,967	2,367,767	263,026	3,642,719	65,757	910,680	328,783	4,553,398	642,394	2.0	
2017	174,386	2,542,153	268,287	3,911,005	67,072	977,751	335,358	4,888,757	307,035	0.9	
2018	177,874	2,720,027	273,652	4,184,658	68,413	1,046,164	342,066	5,230,822	(35,030)	-0.1	
2019	181,432	2,901,459	279,125	4,463,783	69,781	1,115,946	348,907	5,579,729	(383,937)		
2020	185,060	3,086,519	284,708	4,748,491	71,177	1,187,123	355,885	5,935,614	(739,822)		
										Total =	2,007,757

SOIL BALANCE *

259,634 Surplus [CY] 2.2 feet additional fill over 74.4 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table 3: Base Optio[illegible]s 2 and 3 as Permitted
Increased Waste Volumes from North District

INPUTS

Initial Tonnage	266,765	Annual Increase	2%	Waste Density [LB/CY]	1,300	Waste:Soil	4	1
Total Volume [CY]	5,976,000	Excavation Volume [CY]	2,079,000	Site Area [ACRE]	74.4	Clay Cap/Cover Depth [FT]	2.5	Liner/Prot. Cover Depth [FT]	4

CALCULATIONS

Soil For Liner/Cover [CY]	780,208	Initial Airspace [CY]	5,195,792

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required [CY]	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	266,765	266,765	410,408	410,408	102,602	102,602	513,010	513,010	4,682,782	9.1	503,626
2002	272,100	538,865	418,616	829,024	104,654	207,256	523,270	1,036,279	4,159,513	7.9	534,192
2003	277,542	816,408	426,988	1,256,012	106,747	314,003	533,735	1,570,015	3,625,777	6.8	580,623
2004	283,093	1,099,501	435,528	1,691,540	108,882	422,885	544,410	2,114,425	3,081,367	5.7	697,801
2005	288,755	1,388,256	444,238	2,135,778	111,060	533,945	555,298	2,669,723	2,526,069	4.5	
2006	294,530	1,682,786	453,123	2,588,901	113,281	647,225	566,404	3,236,127	1,959,665	3.5	
2007	300,421	1,983,207	462,186	3,051,087	115,546	762,772	577,732	3,813,859	1,381,933	2.4	
2008	306,429	2,289,636	471,429	3,522,517	117,857	880,629	589,287	4,403,146	792,646	1.3	
2009	312,558	2,602,193	480,858	4,003,375	120,215	1,000,844	601,073	5,004,218	191,574	0.3	
2010	318,809	2,921,002	490,475	4,493,850	122,619	1,123,462	613,094	5,617,312	(421,520)		
2011	325,185	3,246,187	500,285	4,994,134	125,071	1,248,534	625,356	6,242,668	(1,046,876)		
2012	331,689	3,577,876	510,290	5,504,425	127,573	1,376,106	637,863	6,880,531	(1,684,739)		
2013	338,323	3,916,199	520,496	6,024,921	130,124	1,506,230	650,620	7,531,151	(2,335,359)		
2014	345,089	4,261,288	530,906	6,555,827	132,727	1,638,957	663,633	8,194,784	(2,998,992)		
2015	351,991	4,613,278	541,524	7,097,351	135,381	1,774,338	676,905	8,871,689	(3,675,897)		
2016	359,031	4,972,309	552,355	7,649,706	138,089	1,912,427	690,443	9,562,133	(4,366,341)		
2017	366,211	5,338,520	563,402	8,213,108	140,850	2,053,277	704,252	10,266,385	(5,070,593)		
2018	373,535	5,712,056	574,670	8,787,778	143,667	2,196,944	718,337	10,984,722	(5,788,930)		
2019	381,006	6,093,062	586,163	9,373,941	146,541	2,343,485	732,704	11,717,426	(6,521,634)		
2020	388,626	6,481,688	597,887	9,971,827	149,472	2,492,957	747,358	12,464,784	(7,268,992)		
										Total =	2,316,243

SOIL BALANCE *

259,634 Surplus [CY] 2.2 feet additional fill over 74.4 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Tabl[illegible]ption 1
Current Waste Volumes

INPUTS

Initial Tonnage	127,031	Annual Increase	2%	Waste Density [LB/CY]	1,300	Waste:Soil	4	1
Total Volume [CY]	8,172,000	Excavation Volume [CY]	2,851,000	Site Area [ACRE]	81.6	Clay Cap/Cover Depth [FT]	2.5	Liner/Prot. Cover Depth [FT]	4

CALCULATIONS

Soil For Liner/Cover [CY]	855,712	Initial Airspace [CY]	7,316,288

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required [CY]	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	127,031	127,031	195,432	195,432	48,858	48,858	244,290	244,290	7,071,998	28.9	119,044
2002	129,572	256,603	199,341	394,773	49,835	98,693	249,176	493,467	6,822,821	27.4	122,063
2003	132,163	388,766	203,328	598,101	50,832	149,525	254,160	747,626	6,568,662	25.8	125,207
2004	134,806	523,572	207,394	805,495	51,849	201,374	259,243	1,006,869	6,309,419	24.3	128,488
2005	137,502	661,074	211,542	1,017,038	52,886	254,259	264,428	1,271,297	6,044,991	22.9	131,921
2006	140,252	801,327	215,773	1,232,811	53,943	308,203	269,716	1,541,013	5,775,275	21.4	135,524
2007	143,058	944,384	220,089	1,452,899	55,022	363,225	275,111	1,816,124	5,500,164	20.0	139,319
2008	145,919	1,090,303	224,490	1,677,389	56,123	419,347	280,613	2,096,737	5,219,551	18.6	143,335
2009	148,837	1,239,140	228,980	1,906,370	57,245	476,592	286,225	2,382,962	4,933,326	17.2	147,607
2010	151,814	1,390,954	233,560	2,139,929	58,390	534,982	291,950	2,674,912	4,641,376	15.9	152,185
2011	154,850	1,545,804	238,231	2,378,160	59,558	594,540	297,789	2,972,700	4,343,588	14.6	157,134
2012	157,947	1,703,751	242,996	2,621,156	60,749	655,289	303,744	3,276,445	4,039,843	13.3	162,548
2013	161,106	1,864,857	247,855	2,869,011	61,964	717,253	309,819	3,586,264	3,730,024	12.0	168,570
2014	164,328	2,029,185	252,813	3,121,824	63,203	780,456	316,016	3,902,279	3,414,009	10.8	175,427
2015	167,615	2,196,800	257,869	3,379,692	64,467	844,923	322,336	4,224,615	3,091,673	9.6	183,521
2016	170,967	2,367,767	263,026	3,642,719	65,757	910,680	328,783	4,553,398	2,762,890	8.4	193,662
2017	174,386	2,542,153	268,287	3,911,005	67,072	977,751	335,358	4,888,757	2,427,531	7.2	207,916
2018	177,874	2,720,027	273,652	4,184,658	68,413	1,046,164	342,066	5,230,822	2,085,466	6.1	234,825
2019	181,432	2,901,459	279,125	4,463,783	69,781	1,115,946	348,907	5,579,729	1,736,559	5.0	
2020	185,060	3,086,519	284,708	4,748,491	71,177	1,187,123	355,885	5,935,614	1,380,674	3.9	
										Total =	2,828,296

SOIL BALANCE *

532,030 Surplus [CY] 4.0 feet additional fill over 81.6 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table [illegible] Option 1
Increased Waste Volumes from North District

INPUTS

Initial Tonnage	266,765	Annual Increase	2%	Waste Density [LB/CY]	1,300	Waste:Soil	4	1
Total Volume [CY]	8,172,000	Excavation Volume [CY]	2,851,000	Site Area [ACRE]	81.6	Clay Cap/Cover Depth [FT]	2.5	Liner/Prot. Cover Depth [FT]	4

CALCULATIONS

Soil For Liner/Cover [CY]	855,712	Initial Airspace [CY]	7,316,288

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required [CY]	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	266,765	266,765	410,408	410,408	102,602	102,602	513,010	513,010	6,803,278	13.3	345,095
2002	272,100	538,865	418,616	829,024	104,654	207,256	523,270	1,036,279	6,280,009	12.0	357,911
2003	277,542	816,408	426,988	1,256,012	106,747	314,003	533,735	1,570,015	5,746,273	10.8	372,518
2004	283,093	1,099,501	435,528	1,691,540	108,882	422,885	544,410	2,114,425	5,201,863	9.6	389,782
2005	288,755	1,388,256	444,238	2,135,778	111,060	533,945	555,298	2,669,723	4,646,565	8.4	411,467
2006	294,530	1,682,786	453,123	2,588,901	113,281	647,225	566,404	3,236,127	4,080,161	7.2	442,103
2007	300,421	1,983,207	462,186	3,051,087	115,546	762,772	577,732	3,813,859	3,502,429	6.1	500,882
2008	306,429	2,289,636	471,429	3,522,517	117,857	880,629	589,287	4,403,146	2,913,142	4.9	
2009	312,558	2,602,193	480,858	4,003,375	120,215	1,000,844	601,073	5,004,218	2,312,070	3.8	
2010	318,809	2,921,002	490,475	4,493,850	122,619	1,123,462	613,094	5,617,312	1,698,976	2.8	
2011	325,185	3,246,187	500,285	4,994,134	125,071	1,248,534	625,356	6,242,668	1,073,620	1.7	
2012	331,689	3,577,876	510,290	5,504,425	127,573	1,376,106	637,863	6,880,531	435,757	0.7	
2013	338,323	3,916,199	520,496	6,024,921	130,124	1,506,230	650,620	7,531,151	(214,863)		
2014	345,089	4,261,288	530,906	6,555,827	132,727	1,638,957	663,633	8,194,784	(878,496)		
2015	351,991	4,613,278	541,524	7,097,351	135,381	1,774,338	676,905	8,871,689	(1,555,401)		
2016	359,031	4,972,309	552,355	7,649,706	138,089	1,912,427	690,443	9,562,133	(2,245,845)		
2017	366,211	5,338,520	563,402	8,213,108	140,850	2,053,277	704,252	10,266,385	(2,950,097)		
2018	373,535	5,712,056	574,670	8,787,778	143,667	2,196,944	718,337	10,984,722	(3,668,434)		
2019	381,006	6,093,062	586,163	9,373,941	146,541	2,343,485	732,704	11,717,426	(4,401,138)		
2020	388,626	6,481,688	597,887	9,971,827	149,472	2,492,957	747,358	12,464,784	(5,148,496)		
										Total =	2,819,757

SOIL BALANCE *

532,030 Surplus [CY] 4.0 feet additional fill over 81.6 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table [illegible]ption 2
Current Waste Volumes

INPUTS

Initial Tonnage	**127,031**	Annual Increase	**2%**	Waste Density [LB/CY]	**1,300**	Waste:Soil	**4**	**1**
Total Volume [CY]	**10,078,000**	Excavation Volume [CY]	**4,757,000**	Site Area [ACRE]	**81.6**	Clay Cap/Cover Depth [FT]	**2.5**	Liner/Prot. Cover Depth [FT] **4**

CALCULATIONS

Soil For Liner/Cover [CY]	**855,712**	Initial Airspace [CY]	**9,222,288**

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required [CY]	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	127,031	127,031	195,432	195,432	48,858	48,858	244,290	244,290	8,977,998	36.8	149,820
2002	129,572	256,603	199,341	394,773	49,835	98,693	249,176	493,467	8,728,821	35.0	153,416
2003	132,163	388,766	203,328	598,101	50,832	149,525	254,160	747,626	8,474,662	33.3	157,133
2004	134,806	523,572	207,394	805,495	51,849	201,374	259,243	1,006,869	8,215,419	31.7	160,983
2005	137,502	661,074	211,542	1,017,038	52,886	254,259	264,428	1,271,297	7,950,991	30.1	164,973
2006	140,252	801,327	215,773	1,232,811	53,943	308,203	269,716	1,541,013	7,681,275	28.5	169,115
2007	143,058	944,384	220,089	1,452,899	55,022	363,225	275,111	1,816,124	7,406,164	26.9	173,423
2008	145,919	1,090,303	224,490	1,677,389	56,123	419,347	280,613	2,096,737	7,125,551	25.4	177,912
2009	148,837	1,239,140	228,980	1,906,370	57,245	476,592	286,225	2,382,962	6,839,326	23.9	182,601
2010	151,814	1,390,954	233,560	2,139,929	58,390	534,982	291,950	2,674,912	6,547,376	22.4	187,510
2011	154,850	1,545,804	238,231	2,378,160	59,558	594,540	297,789	2,972,700	6,249,588	21.0	192,668
2012	157,947	1,703,751	242,996	2,621,156	60,749	655,289	303,744	3,276,445	5,945,843	19.6	198,107
2013	161,106	1,864,857	247,855	2,869,011	61,964	717,253	309,819	3,586,264	5,636,024	18.2	203,872
2014	164,328	2,029,185	252,813	3,121,824	63,203	780,456	316,016	3,902,279	5,320,009	16.8	210,016
2015	167,615	2,196,800	257,869	3,379,692	64,467	844,923	322,336	4,224,615	4,997,673	15.5	216,616
2016	170,967	2,367,767	263,026	3,642,719	65,757	910,680	328,783	4,553,398	4,668,890	14.2	223,773
2017	174,386	2,542,153	268,287	3,911,005	67,072	977,751	335,358	4,888,757	4,333,531	12.9	231,638
2018	177,874	2,720,027	273,652	4,184,658	68,413	1,046,164	342,066	5,230,822	3,991,466	11.7	240,439
2019	181,432	2,901,459	279,125	4,463,783	69,781	1,115,946	348,907	5,579,729	3,642,559	10.4	250,552
2020	185,060	3,086,519	284,708	4,748,491	71,177	1,187,123	355,885	5,935,614	3,286,674	9.2	262,662
										Total =	3,907,231

SOIL BALANCE *

2,056,830 Surplus [CY] 15.6 feet additional fill over 81.6 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table [illegible]ption 2
Increased Waste Volumes from North District

INPUTS

Initial Tonnage	266,765	Annual Increase	2%	Waste Density [LB/CY]	1,300	Waste:Soil	4	1
Total Volume [CY]	10,078,000	Excavation Volume [CY]	4,757,000	Site Area [ACRE]	81.6	Clay Cap/Cover Depth [FT]	2.5	Liner/Prot. Cover Depth [FT]	4

CALCULATIONS

Soil For Liner/Cover [CY]	855,712	Initial Airspace [CY]	9,222,288

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required [CY]	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	266,765	266,765	410,408	410,408	102,602	102,602	513,010	513,010	8,709,278	17.0	397,183
2002	272,100	538,865	418,616	829,024	104,654	207,256	523,270	1,036,279	8,186,009	15.6	409,605
2003	277,542	816,408	426,988	1,256,012	106,747	314,003	533,735	1,570,015	7,652,273	14.3	423,061
2004	283,093	1,099,501	435,528	1,691,540	108,882	422,885	544,410	2,114,425	7,107,863	13.1	437,824
2005	288,755	1,388,256	444,238	2,135,778	111,060	533,945	555,298	2,669,723	6,552,565	11.8	454,307
2006	294,530	1,682,786	453,123	2,588,901	113,281	647,225	566,404	3,236,127	5,986,161	10.6	473,183
2007	300,421	1,983,207	462,186	3,051,087	115,546	762,772	577,732	3,813,859	5,408,429	9.4	495,666
2008	306,429	2,289,636	471,429	3,522,517	117,857	880,629	589,287	4,403,146	4,819,142	8.2	524,295
2009	312,558	2,602,193	480,858	4,003,375	120,215	1,000,844	601,073	5,004,218	4,218,070	7.0	565,965
2010	318,809	2,921,002	490,475	4,493,850	122,619	1,123,462	613,094	5,617,312	3,604,976	5.9	654,464
2011	325,185	3,246,187	500,285	4,994,134	125,071	1,248,534	625,356	6,242,668	2,979,620	4.8	
2012	331,689	3,577,876	510,290	5,504,425	127,573	1,376,106	637,863	6,880,531	2,341,757	3.7	
2013	338,323	3,916,199	520,496	6,024,921	130,124	1,506,230	650,620	7,531,151	1,691,137	2.6	
2014	345,089	4,261,288	530,906	6,555,827	132,727	1,638,957	663,633	8,194,784	1,027,504	1.5	
2015	351,991	4,613,278	541,524	7,097,351	135,381	1,774,338	676,905	8,871,689	350,599	0.5	
2016	359,031	4,972,309	552,355	7,649,706	138,089	1,912,427	690,443	9,562,133	(339,845)		
2017	366,211	5,338,520	563,402	8,213,108	140,850	2,053,277	704,252	10,266,385	(1,044,097)		
2018	373,535	5,712,056	574,670	8,787,778	143,667	2,196,944	718,337	10,984,722	(1,762,434)		
2019	381,006	6,093,062	586,163	9,373,941	146,541	2,343,485	732,704	11,717,426	(2,495,138)		
2020	388,626	6,481,688	597,887	9,971,827	149,472	2,492,957	747,358	12,464,784	(3,242,496)		
										Total =	4,835,554

SOIL BALANCE *

2,056,830 Surplus [CY] 15.6 feet additional fill over 81.6 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table [illegible]ption 3
Current Waste Volumes

INPUTS

Initial Tonnage	127,031	Annual Increase	2%	Waste Density [LB/CY]	1,300	Waste:Soil	4	1
Total Volume [CY]	11,064,000	Excavation Volume [CY]	5,742,500	Site Area [ACRE]	81.6	Clay Cap/Cover Depth [FT]	2.5	Liner/Prot. Cover Depth [FT]	4

CALCULATIONS

Soil For Liner/Cover [CY]	855,712	Initial Airspace [CY]	10,208,288

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	127,031	127,031	195,432	195,432	48,858	48,858	244,290	244,290	9,963,998	40.8	160,461
2002	129,572	256,603	199,341	394,773	49,835	98,693	249,176	493,467	9,714,821	39.0	164,237
2003	132,163	388,766	203,328	598,101	50,832	149,525	254,160	747,626	9,460,662	37.2	168,133
2004	134,806	523,572	207,394	805,495	51,849	201,374	259,243	1,006,869	9,201,419	35.5	172,157
2005	137,502	661,074	211,542	1,017,038	52,886	254,259	264,428	1,271,297	8,936,991	33.8	176,318
2006	140,252	801,327	215,773	1,232,811	53,943	308,203	269,716	1,541,013	8,667,275	32.1	180,624
2007	143,058	944,384	220,089	1,452,899	55,022	363,225	275,111	1,816,124	8,392,164	30.5	185,086
2008	145,919	1,090,303	224,490	1,677,389	56,123	419,347	280,613	2,096,737	8,111,551	28.9	189,717
2009	148,837	1,239,140	228,980	1,906,370	57,245	476,592	286,225	2,382,962	7,825,326	27.3	194,531
2010	151,814	1,390,954	233,560	2,139,929	58,390	534,982	291,950	2,674,912	7,533,376	25.8	199,543
2011	154,850	1,545,804	238,231	2,378,160	59,558	594,540	297,789	2,972,700	7,235,588	24.3	204,775
2012	157,947	1,703,751	242,996	2,621,156	60,749	655,289	303,744	3,276,445	6,931,843	22.8	210,249
2013	161,106	1,864,857	247,855	2,869,011	61,964	717,253	309,819	3,586,264	6,622,024	21.4	215,995
2014	164,328	2,029,185	252,813	3,121,824	63,203	780,456	316,016	3,902,279	6,306,009	20.0	222,048
2015	167,615	2,196,800	257,869	3,379,692	64,467	844,923	322,336	4,224,615	5,983,673	18.6	228,454
2016	170,967	2,367,767	263,026	3,642,719	65,757	910,680	328,783	4,553,398	5,654,890	17.2	235,270
2017	174,386	2,542,153	268,287	3,911,005	67,072	977,751	335,358	4,888,757	5,319,531	15.9	242,575
2018	177,874	2,720,027	273,652	4,184,658	68,413	1,046,164	342,066	5,230,822	4,977,466	14.6	250,474
2019	181,432	2,901,459	279,125	4,463,783	69,781	1,115,946	348,907	5,579,729	4,628,559	13.3	259,119
2020	185,060	3,086,519	284,708	4,748,491	71,177	1,187,123	355,885	5,935,614	4,272,674	12.0	268,740
										Total =	4,128,507

SOIL BALANCE *

2,845,130 Surplus [CY] 21.6 feet additional fill over 81.6 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table [illegible]ption 3
Increased Waste Volumes from North District

INPUTS

Initial Tonnage	266,765	Annual Increase	2%	Waste Density [LB/CY]	1,300	Waste:Soil	4	1
Total Volume [CY]	11,064,000	Excavation Volume [CY]	5,742,500	Site Area [ACRE]	81.6	Clay Cap/Cover Depth [FT]	2.5	Liner/Prot. Cover Depth [FT]	4

CALCULATIONS

Soil For Liner/Cover [CY]	855,712	Initial Airspace [CY]	10,208,288

Year	Annual Tonnage Received	Cumulative Tonnage Received	Waste Volume Received [CY]	Cumulative Waste Volume Received [CY]	Daily Soil Cover Volume Required [CY]	Cumulative Daily Soil Cover Required	Airspace Consumed [CY]	Cumulative Airspace Consumed [CY]	Remaining Airspace - Cells 2 & 3 [CY]	Remaining Life - Cells 2 & 3 [YR]	Excavation Rate ** [CY/year]
2001	266,765	266,765	410,408	410,408	102,602	102,602	513,010	513,010	9,695,278	18.9	413,164
2002	272,100	538,865	418,616	829,024	104,654	207,256	523,270	1,036,279	9,172,009	17.5	425,385
2003	277,542	816,408	426,988	1,256,012	106,747	314,003	533,735	1,570,015	8,638,273	16.2	438,457
2004	283,093	1,099,501	435,528	1,691,540	108,882	422,885	544,410	2,114,425	8,093,863	14.9	452,558
2005	288,755	1,388,256	444,238	2,135,778	111,060	533,945	555,298	2,669,723	7,538,565	13.6	467,942
2006	294,530	1,682,786	453,123	2,588,901	113,281	647,225	566,404	3,236,127	6,972,161	12.3	484,983
2007	300,421	1,983,207	462,186	3,051,087	115,546	762,772	577,732	3,813,859	6,394,429	11.1	504,274
2008	306,429	2,289,636	471,429	3,522,517	117,857	880,629	589,287	4,403,146	5,805,142	9.9	526,833
2009	312,558	2,602,193	480,858	4,003,375	120,215	1,000,844	601,073	5,004,218	5,204,070	8.7	554,652
2010	318,809	2,921,002	490,475	4,493,850	122,619	1,123,462	613,094	5,617,312	4,590,976	7.5	592,495
2011	325,185	3,246,187	500,285	4,994,134	125,071	1,248,534	625,356	6,242,668	3,965,620	6.3	657,349
2012	331,689	3,577,876	510,290	5,504,425	127,573	1,376,106	637,863	6,880,531	3,327,757	5.2	
2013	338,323	3,916,199	520,496	6,024,921	130,124	1,506,230	650,620	7,531,151	2,677,137	4.1	
2014	345,089	4,261,288	530,906	6,555,827	132,727	1,638,957	663,633	8,194,784	2,013,504	3.0	
2015	351,991	4,613,278	541,524	7,097,351	135,381	1,774,338	676,905	8,871,689	1,336,599	2.0	
2016	359,031	4,972,309	552,355	7,649,706	138,089	1,912,427	690,443	9,562,133	646,155	0.9	
2017	366,211	5,338,520	563,402	8,213,108	140,850	2,053,277	704,252	10,266,385	(58,097)		
2018	373,535	5,712,056	574,670	8,787,778	143,667	2,196,944	718,337	10,984,722	(776,434)		
2019	381,006	6,093,062	586,163	9,373,941	146,541	2,343,485	732,704	11,717,426	(1,509,138)		
2020	388,626	6,481,688	597,887	9,971,827	149,472	2,492,957	747,358	12,464,784	(2,256,496)		
										Total =	5,518,093

SOIL BALANCE *

2,845,130 Surplus [CY] 21.6 feet additional fill over 81.6 acres

* Soil balance does not include other site needs, such as berms, etc..

** Excavation rate assumes all soil excavated 5 years before end of site life.

Table 10:
Cells 2 and 3 Development Costs (2001 Dollars)

			Base		Option 1		Option 2		Option 3	
Items	**Unit**	**Unit Price**	**Quantity**	**Price**	**Quantity**	**Price**	**Quantity**	**Price**	**Quantity**	**Price**
Excavation	CY	$ 1.50	2,079,000	$ 3,118,500	2,851,000	$ 4,276,500	4,757,000	$ 7,135,500	5,752,500	$ 8,628,750
Clay Liner (2.0') *	CY	$ 10.00	238,773	$ 2,387,733	264,587	$ 2,645,867	264,587	$ 2,645,867	264,587	$ 2,645,867
Bottom Liner (FML)	SF	$ 0.50	3,223,440	$ 1,611,720	3,571,920	$ 1,785,960	3,571,920	$ 1,785,960	3,571,920	$ 1,785,960
Geotextile	SF	$ 0.25	3,223,440	$ 805,860	3,571,920	$ 892,980	3,571,920	$ 892,980	3,571,920	$ 892,980
Liner Protective Cover (2.0')	CY	$ 2.50	238,773	$ 596,933	264,587	$ 661,467	264,587	$ 661,467	264,587	$ 661,467
Leachate sump and pumps	LS	$ 65,000	-	$ -	4	$ 260,000	4	$ 260,000	4	$ 260,000
Clay Final Cover (2.0') *	CY	$ 10.00	238,773	$ 2,387,733	264,587	$ 2,645,867	264,587	$ 2,645,867	264,587	$ 2,645,867
Synthetic Cover **	SF	$ 0.50	3,223,440	$ 1,611,720	3,571,920	$ 1,785,960	3,571,920	$ 1,785,960	3,571,920	$ 1,785,960
Topsoil (0.5')	CY	$ 2.50	59,693	$ 149,233	66,147	$ 165,367	66,147	$ 165,367	66,147	$ 165,367
Soil Surplus Disposal	CY	$ 1.00	259,600	$ 259,600	532,000	$ 532,000	2,057,000	$ 2,057,000	2,845,000	$ 2,845,000
Fence Relocation	LS	$ 380,000	2	$ 760,000	4	$ 1,520,000	4	$ 1,520,000	4	$ 1,520,000
Power Supply to Pumps	LF	$ 2.25		$ -	4,600	$ 10,350	4,600	$ 10,350	4600	$ 10,350
Pump O & M ***	Unit-YR	$ 5,000		$ -	120	$ 600,000	120	$ 600,000	120	$ 600,000
Contingencies	25%			$ 3,422,258		$ 4,445,579		$ 5,541,579		$ 6,111,892
Totals				**$ 17,111,292**		**$ 22,227,896**		**$ 27,707,896**		**$30,559,458**
Cost Per Acre	Acres		74	$ 231,234	82	$ 271,072	82	$ 337,901	82	$ 372,676
Airspace available for waste [CY]				4,156,634		5,853,030		7,377,830		8,166,630
Tonnage @ 1,300 LB/CY				2,701,812		3,804,470		4,795,590		5,308,310
Cost / Ton				**$ 6.33**		**$ 5.84**		**$ 5.78**		**$ 5.76**

- Base Option assumes 74 acres of liner and final cover. Options 1 - 3 assumes 82 acres.

* - Clay assumed to be imported. Placement costs alone estimated at $3.50 per cubic yard.
Clay liner may be replaced with a GCL (negotiated with State) at a cost of $0.50 per Square Foot.

** - Clay and Synthetic cover may be replaced by 4 feet of native soils (negotiated with State) for a cost of $19,360 per acre ($3.00 per cubic yard).

*** - Assumes 4 pumps operating for 30 years and $5,000 per unit per year in O&M and replacement costs

VI. OPERATIONAL CONSIDERATIONS

By lowering the base grade of Cells 2 and 3, the existing leachate transmission main will no longer function under gravity flow conditions. Therefore, leachate sumps and extraction pumps are required within the cells. Leachate will be pumped out of the cell and conveyed to a location where it can be introduced into the transmission main and delivered to the evaporation pond at the east end of the site. A typical leachate extraction system is included on Figures 6 and 7 in Appendix A.

The base and final design grades for this analysis were approximated from the permit drawings. These grades were not developed in detail for construction, rather to allow a comparison of the options for decision making purposes. The quantities used in the comparison can be updated, if desired, once more precise topographic and cell design information is available. Existing ground contours were taken from the aerial survey performed in 1996, supplemented with an onsite survey of the excavated portion of the Cell 2 area in September 2001. This survey was performed to obtain a reasonable approximation of remaining excavation requirements since landfill personnel have been removing soil from Cell 2 for use in daily operations. Figure 2 in Appendix A shows the existing ground contours. The limits of the various options under consideration are shown on Figure 3. Tables 2 to 9 contain excavation and soil balance calculations for the base condition and the three options. Site life calculations for Cells 2 and 3 under the various cell configurations are also included based on existing waste acceptance rates and an increased rate, assuming the North District chooses to use the Bayview Landfill for disposal. The calculations are summarized in Table 11 below, assuming a 2% growth per year.

Table 11: Volume Summary

Option	Remaining Excavation (CY) *	Excess Soil Balance (CY)	Aerial Waste Fill (CY)	Total Waste Fill (CY)	Site Life Current Waste Volume (Years)**	Site Life with North District Volume (Years)**
Base	2,172,000	400,600	3,084,000	5,256,000	18	9
1	2,944,000	590,000	4,878,000	7,822,000	24	13
2	4,850,000	2,325,000	4,878,000	9,728,000	28	16
3	5,835,000	3,113,000	4,878,000	10,713,000	30	17

* The remaining excavation accounts for the 300,000 cubic yards already excavated from Cell 2.
** The Site Life calculated in Table 2 is for Cells 2 and 3 only and is based on the anticipated waste acceptance rate for 2001 as shown in Table 1 and a 2% annual growth. Acceptance rates from the North District are assumed to be 110% of the current rate.

Referencing Table 11 above, Cells 2 and 3 provide between 9 and 30 years of capacity, depending on the development option selected and the waste acceptance rate. In addition, the area south of the current access road (Cells 4, 5, 6 and 7) could provide an additional 42 years of capacity if the entire 175 acres were developed as a progressive area fill (average waste depth of 60 feet – 30 feet above and 30 feet below existing grade) with no separation berms between the cells. This capacity is based on the current waste acceptance rate and 2% annual growth, an in-place waste density of 1,300 pounds per cubic yard and a waste to daily cover soil ratio of 4:1. The potential development of this area could provide significant flexibility to SUVSWD and should be considered in future permit renewals.

VII. PHASING

Fill phasing for a typical landfill is planned to begin fill at the lowest end of a particular cell (leachate sump area) with progressive fill toward the upper end of the site. This maximizes the ability to contain any leachate generated. However, since a large portion of Cell 2 has already been excavated at the upper end, it would be advantageous to begin the next fill area in this location; reducing immediate cell development costs. This phasing approach will require the construction of temporary interior leachate sumps to provide a means to extract leachate and

prevent its accumulation within the cell. Due to the size of Cells 2 and 3, multiple leachate sumps would probably be required. The quantity of soil already removed from Cell 2 (300,000 cubic yards) represents a cost deferral of approximately $450,000 based on an excavation cost of $1.50 per cubic yard. Although all soil will eventually be excavated and total costs incurred over time, by developing the next cell in the area that has already been partially excavated, some of the excavation costs can be postponed to future years. A suggested phasing plan for Cells 2 and 3 is shown on Figure 3 in Appendix A.

By dividing the excavation required by the anticipated life, an approximate cubic yards of excavation per year can be obtained. Based on current waste acceptance rates, Option 1 would require removal of approximately 119,000 cubic yards per year to stay ahead of development needs. The base option would require 136,000 cubic yards per year of excavation. These rates assume that all excavation is completed five years before the end of the life of Cells 2 and 3. If ongoing daily soil needs are excavated from future cells, development costs can be minimized.

Since the landfill permit must be renewed every five years, it is recommended that cells be constructed to accommodate around five years of capacity. Since waste acceptance is assumed to increase over time, cells in later years will be larger than those constructed initially. Using an average useable fill depth of 60 feet, a 13-acre cell should last approximately five years based on the current waste acceptance rate and a 2% annual increase. If the North District is included, the size of the cell would double to meet the same life span. Smaller cells can be constructed to spread out expenditures; however, this would require more frequent construction events, mobilization charges and possibly additional leachate sumps. A suggested Phasing Plan for Cells 2 and 3 is included on Figure 3 in Appendix A.

Another major capital investment at the Bayview Landfill is contained in the litter control fence currently located along the north and east sides of Cell 1. This fence is approximately 2,500 feet in length. This fence is secured to 40-foot tall posts positioned on 25 to 35-foot centers. To reduce future costs, it is anticipated that the fence netting and poles will be relocated around the

site as needed on approximate 40-foot centers. Since the prevailing winds are from the southwest, the fence relocation is planned for the north and east sides of the cells being used. If Cells 2 and 3 are combined, the fence may require relocation several times in order to adequately contain wind-blown debris. A proposed fence relocation plan for the next phase of construction is also included on Figure 3 in Appendix A.

VIII. COST IMPLICATIONS

The major cost difference between the options evaluated is due to the increased excavation. However, this increased excavation corresponds directly to an increase in available airspace for waste. Ideally, the amount of excavation on the site should match the soil needs. If insufficient soil is removed for the operational needs of the site, soil will have to be imported, which can be quite costly. If more soil is excavated than needed, it may have to be handled more than once to make room for disposal operations. Given the site layout, it is anticipated that extra excavated soil can be easily spread around the site or used for screening berms or increased vegetative layer on the final cover. A 20 to 30 % soil surplus can be easily accommodated. It may also be advantageous to increase the above ground fill elevations to utilize the surplus soil that is generated.

Some of the costs included for this evaluation include excavation, liner construction, leachate collection and removal systems and wind fence relocation costs. The wind fence poles currently are spaced 25 to 35 feet apart. Assuming a total of 2,500 linear feet of fence, 63 poles will be relocated if placed on 40-foot centers. Based on discussions with Mr. Ken Jones of Coastal Netting in Bakersfield California, a cost of $380,000 has been estimated. This includes replacing the netting and cable, constructing new foundations and relocation of the existing poles.

Table 10 in shows a general comparison of the development costs associated with the options being considered. This is not meant to represent all the costs of operating the site rather a review of cost components that deviate from current operations. By dividing the development costs by the capacity of the option, a more direct comparison can be seen, as shown in Table 12 below.

Table 12: Development Costs Summary
(2001 Dollars)

Option	Cells 2 and 3 Waste Capacity		Capital Cost $	Capital Cost per Ton	Total Revenue **	Net Revenue ***
	Cubic Yards	Tons *				
Base	4,156,600	2,701,800	17,111,000	6.33	32,421,600	15,310,600
1	5,853,000	3,804,500	22,228,000	5.84	45,654,000	23,426,000
2	7,377,800	4,795,600	27,708,000	5.78	57,547,200	29,839,200
3	8,166,600	5,308,300	30,559,000	5.76	63,699,600	33,140,600

* Based on 1,300 pounds per cubic yard waste density
** Revenue is based on $12.00/ton.
*** Operational costs of $3 to $5 per ton have not been included in this analysis.

Although capital costs make up the major portion of expenditures for cell construction, a line item has been included on Table 10 for operating, maintenance and replacement costs for the leachate extraction pumps. A change in landfill operational costs would be seen to switch to any of the proposed options and are included for comparison.

The estimates presented in Table 10 address some items that should be negotiated with the State during permit renewals. These include excavation grades, liner, and final cover design. For this study, we have assumed the default EPA/State approved guidelines for liner and final cover design. If alternative designs are approved for use at the Bayview Landfill, SUVSWD could realize $ 46,000 per acre in cost savings for cell development. If desired, these alternative designs should be included in the upcoming permit renewal application. Table 13 below itemizes the potential cost savings associated with the 82 acres associated with Cells 2 and 3.

Table 13: Cost Savings – Alternative Designs (Cells 2 and 3)
(Based on 82 acres and 2001 Dollars)

Liner		Final Cover	
Default	Alternative	Default	Alternative
$ 5,986,274	$ 5,126,367	$ 4,597,194	$ 1,587,520
$ 73,000/acre	$ 62,500/acre	$ 56,000/acre	$ 19,360/acre

Additionally, Table 14 lists comparative costs that would be incurred to develop the next 13 acres (Cell 2 – Phase 1), given the options under consideration. The costs associated with the option chosen for development should be included in the District's 2002-2004 budgets since available capacity is anticipated to be depleted by 2004.

Since Cell 1 is anticipated to be full by 2004, closure will be required in the near future, possibly 2003 to 2005. Construction of the final cap will require placement of two-feet of clay soil, a synthetic membrane and a vegetative layer. If approved by the State, an alternative final cap consisting of four feet of soil and no synthetic component may be used. As indicated in Table 13, the standard final cover configuration for Cell 1 (33 acres) will cost approximately $1,848,000 with an alternative cover costing $ 638,880. This cost should be included in the 2003-2005 budgets.

IX. SCHEDULE

To aid the SUVSWD in decision making for the site, a schedule of events has been developed. This schedule assumes that existing capacity in Cell 1 will be exhausted by the end of 2004 at the current rate of waste acceptance. Tasks for permitting, cell development and closure are included. If waste from the North District is accepted at the Bayview Landfill for disposal, the schedule should be revised accordingly.

Table 14: Cell 2 - Phase 1 Development Costs (2001 Dollars)

			Base		Option 1		Option 2		Option 3	
Items	**Unit**	**Unit Price**	**Quantity**	**Price**	**Quantity**	**Price**	**Quantity**	**Price**	**Quantity**	**Price**
Cell Area	Acre		13							
Excavation *	CY	$ 1.50	242,300	$ 363,450	302,400	$ 453,600	721,900	$ 1,082,850	995,200	$ 1,492,800
Clay Liner (2') **	CY	$ 10.00	41,947	$ 419,467	41,947	$ 419,467	41,947	$ 419,467	41,947	$ 419,467
Bottom Liner (FML)	SF	$ 0.50	566,280	$ 283,140	566,280	$ 283,140	566,280	$ 283,140	566,280	$ 283,140
Geotextile	SF	$ 0.25	566,280	$ 141,570	566,280	$ 141,570	566,280	$ 141,570	566,280	$ 141,570
Leachate sump and pumps	LS	$ 65,000	-	$ -	1	$ 65,000	1	$ 65,000	1	$ 65,000
Liner Protective Cover (2')	CY	$ 2.50	41,947	$ 104,867	41,947	$ 104,867	41,947	$ 104,867	41,947	$ 104,867
Fence Relocation	LS	$ 380,000	1	$ 380,000	1	$ 380,000	1	$ 380,000	1	$ 380,000
Power Supply	LF	$ 2.25		$ -	4,600	$ 10,350	4,600	$ 10,350	4600	$ 10,350
Contingencies	25%			$ 423,123		$ 464,498		$ 621,811		$ 724,298
Totals				**$ 2,115,617**		**$ 2,322,492**		**$ 3,109,054**		**$ 3,621,492**
Cost Per Acre	Acre		13	$ 162,740	13	$ 178,653	13	$ 239,158	13	$ 278,576
Airspace available for waste [CY]				1,066,732		1,114,819		1,344,051		1,489,093
Tonnage @ 1,300 LB/CY				693,376		724,632		873,633		967,910
Cost / Ton				**$ 3.05**		**$ 3.21**		**$ 3.56**		**$ 3.74**

* - Depending on the timing of future cell development, landfill operations can remove a significant amount of remaining soil.

** - Clay assumed to be imported. Placement costs estimated at $3.50 per cubic yard.
Clay liner may be replaced with a GCL (negotiated with State) at a cost of $0.50 per Square Foot.

Schedule of Events

X. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

- The 1988 Landfill Master Plan provided for a site life of 52 years in the entire landfill, based on receiving an average of 165,000 tons per year. The proposed revisions in this report could provide an additional 72 years for the remaining cells.
- The design options being considered for Cell 2 & 3 would increase the site life as noted below.

Table 15: Volume and Life Comparison for Cells 2 and 3

Option	Available Cubic Yards (for waste)	Site Life (current waste flow)	Site Life (with North District Volumes)
Base	4,156,600	18	9
1	5,853,000	24	13
2	7,377,800	28	16
3	8,166,600	30	17

- The capital costs of the options for development of Cells 2 & 3 are as follows:

Current Design (Base)	$17,111,000
Option 1	$22,228,000
Option 2	$27,708,000
Option 3	$30,559,000

RECOMMENDATIONS

- The SUVSWD should select the preferred design option for Cells 2 & 3
- After selecting the preferred option for Cells 2 & 3 the SUVSWD should meet with the State to initiate discussions about the design of Cells 2 & 3 and the renewal of the landfill permit.

- An aerial survey should be completed for the entire site to be used for design and permit renewal.
- Closure of Cell 1 should be programmed to start in 2003 and completed in 2005. The timing of this closure may be adjusted based on the total waste received at the site.
- A landfill permit renewal should be prepared in 2002 with approval scheduled for 2003. This would include the design information for Cells 2 and 3.
- Construction plans and specifications for Cell 2: Phase 1 should be prepared in 2002.
- Excavation in Cell 2 should be continued throughout 2002. Final base grades will be generated as part of the permit submittal. Soil taken from this area should be used for daily cover and closure of Cell 1.

Appendix A

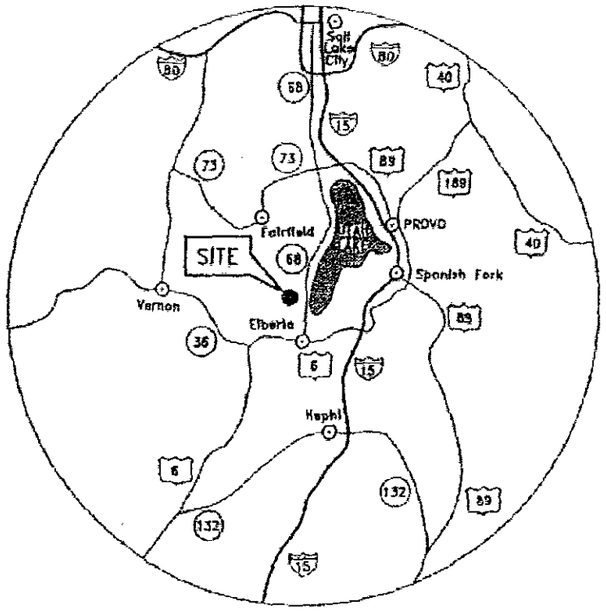
Figures

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

CELL 2 & 3

JANUARY, 2002



Vicinity Map
Scale 1"=20 Miles

DRAWING SCHEDULE

1 COVER SHEET
2 EXISTING CONTOURS
3 PHASING PLAN & FINAL CONTOURS
4 CROSS SECTION A
5 CROSS SECTION B & C
6 LEACHATE COLLECTION SYSTEM DETAILS
7 LEACHATE COLLECTION SYSTEM DETAILS

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Electrical	Structural
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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

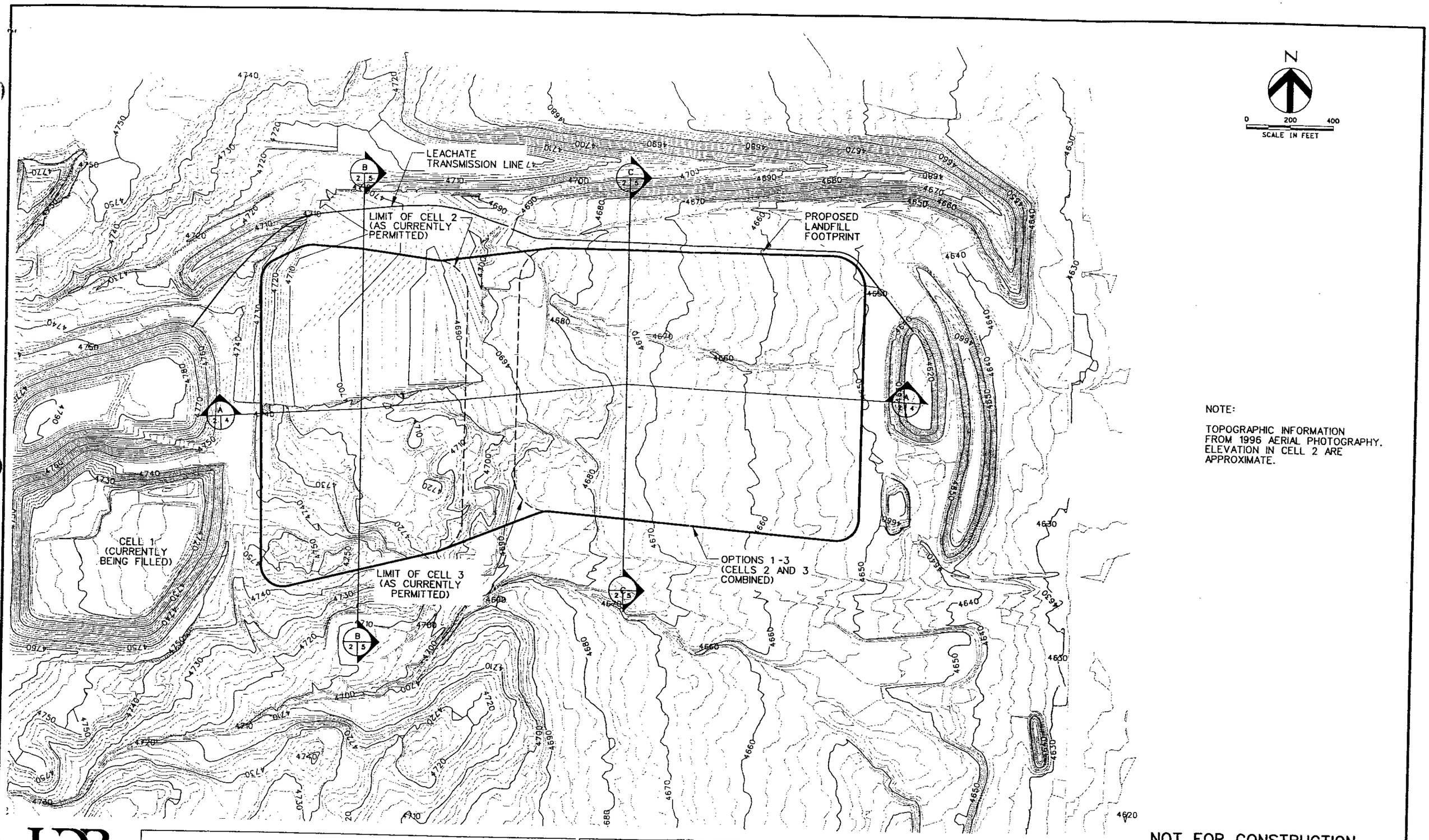
BAYVIEW LANDFILL MASTER PLAN UPDATE

CELL 2 & 3

COVER SHEET

Date	Project No.	Figure No.	Issue
JANUARY, 2002	08325-001-044	1	0

Scale: Not To Scale



NOTE:

TOPOGRAPHIC INFORMATION FROM 1996 AERIAL PHOTOGRAPHY. ELEVATION IN CELL 2 ARE APPROXIMATE.

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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

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CELL 2 & 3
EXISTING CONTOURS

Date: DECEMBER, 2001
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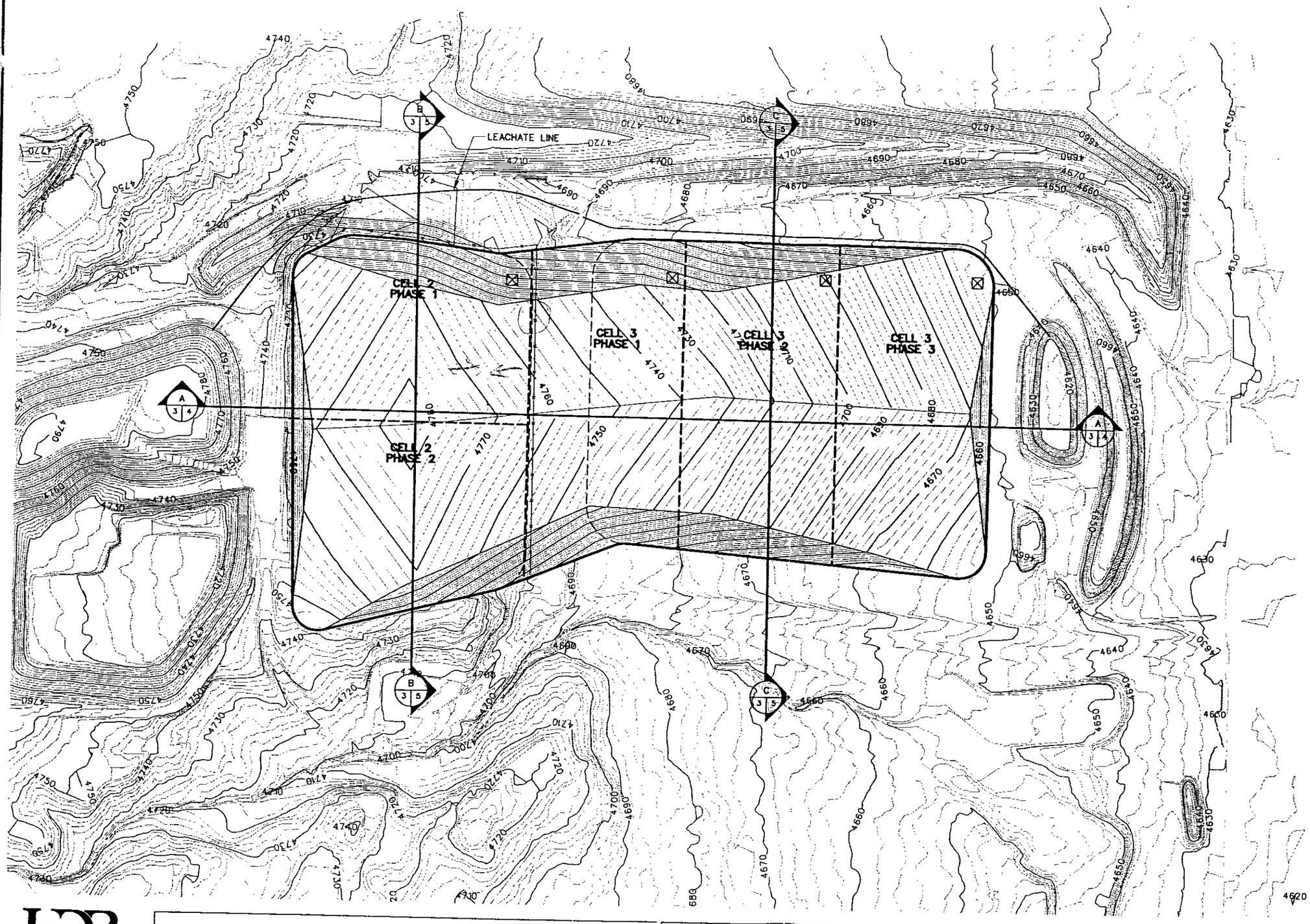
Project No.: 08325-001-044
Figure No.: 2
Issue: 0



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0 200 400
SCALE IN FEET

LEGEND

- TYPICAL LEACHATE SUMP
- LITTER CONTROL FENCING
- PHASE BOUNDARY

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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

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CELL 2 & 3
PHASING PLAN
&
FINAL CONTOURS

Date	Project No.	Figure No.	Issue
DECEMBER, 2001	08325-001-044	3	0

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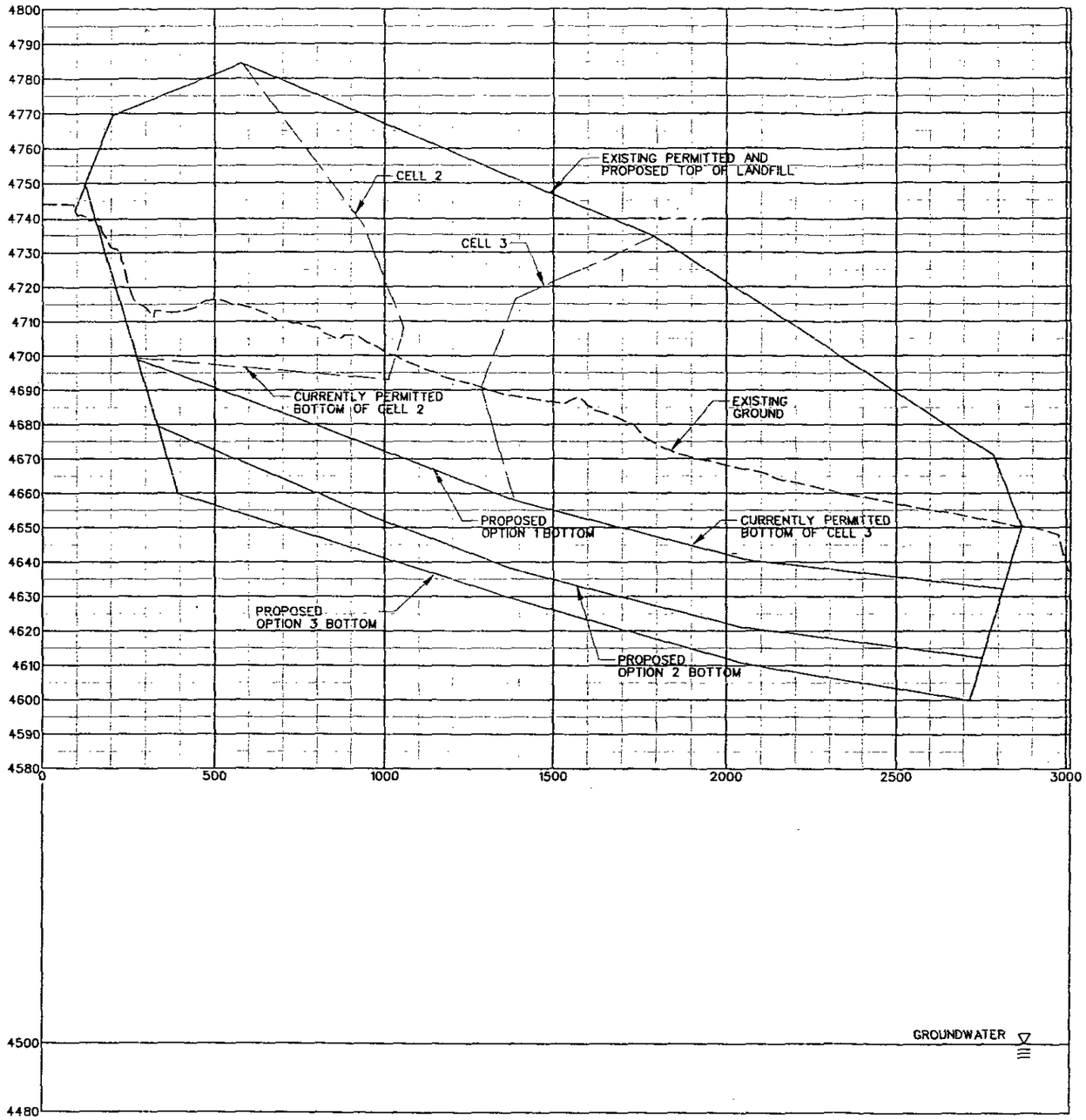

A 2&3 4 SECTION
SCALE: 1" = 400'

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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

CELL 2 & 3
CROSS SECTION A

Date	Project No.	Figure No.	Issue
DECEMBER, 2001	08325-001-044	4	0

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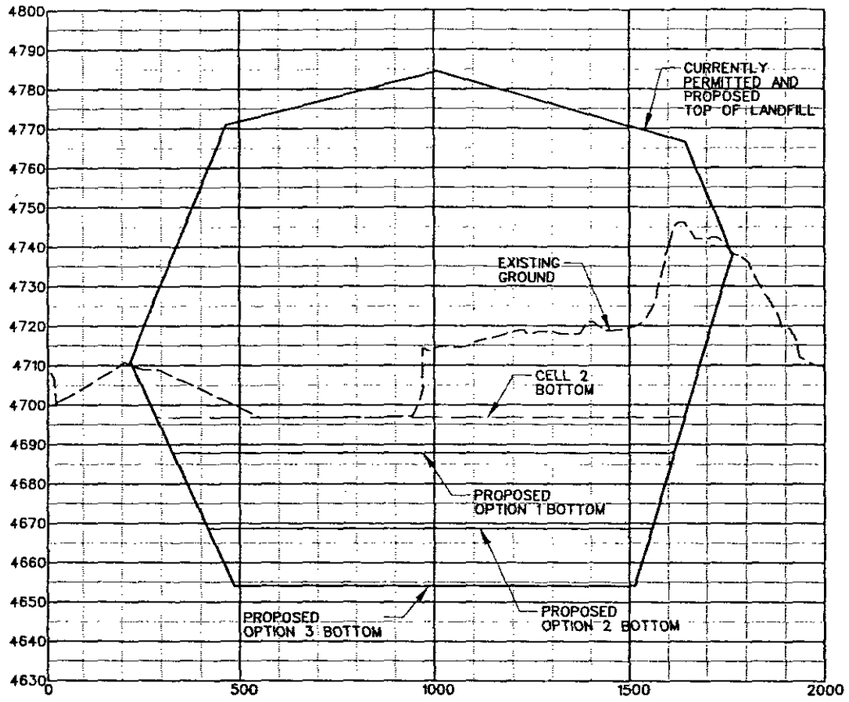

B 2&3 5 SECTION
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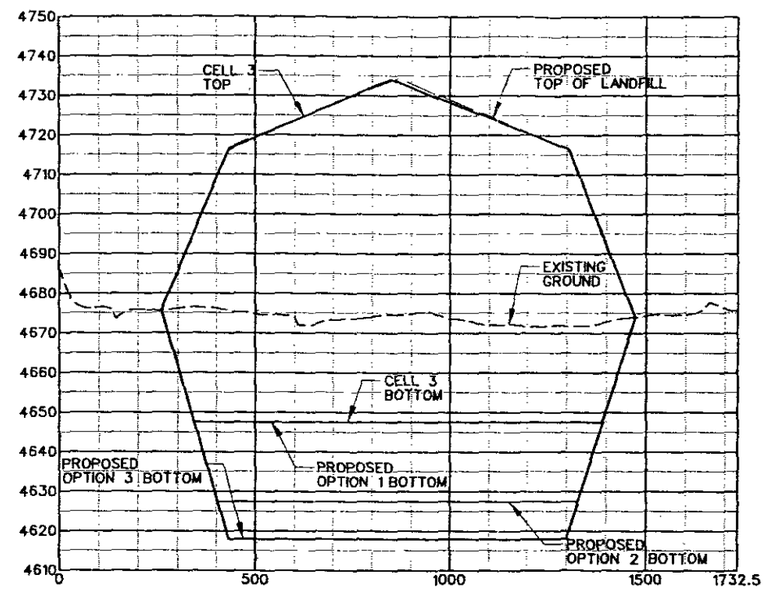

C 2&3 5 SECTION
SCALE: 1" = 400'

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Electrical | Structural
Designed: M.DAVISION | Drawn By: J.ZEPEDA

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

NOT FOR CONSTRUCTION

CELL 2 & 3
CROSS SECTION B & C

Date	Project No.	Figure No.	Issue
DECEMBER, 2001	08325-001-044	5	0

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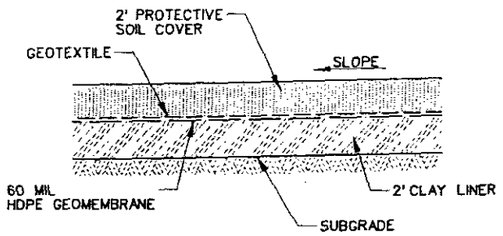

TYPICAL LANDFILL LINER DETAIL (1 / 6 | 6)
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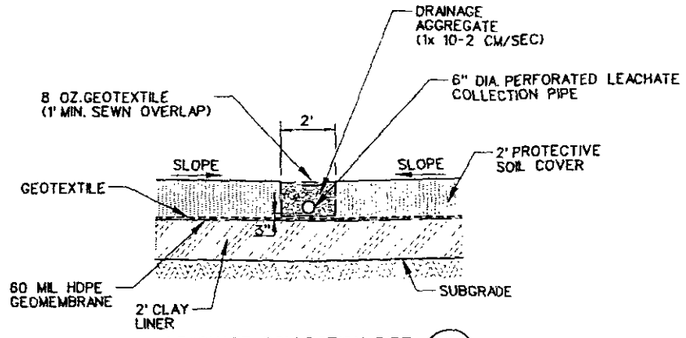

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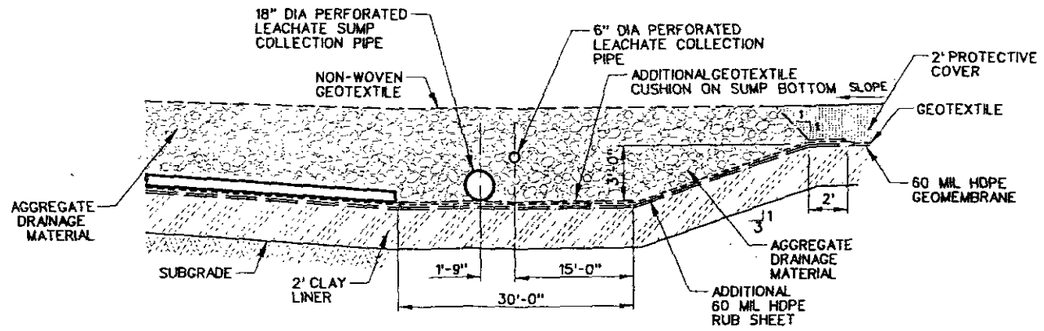

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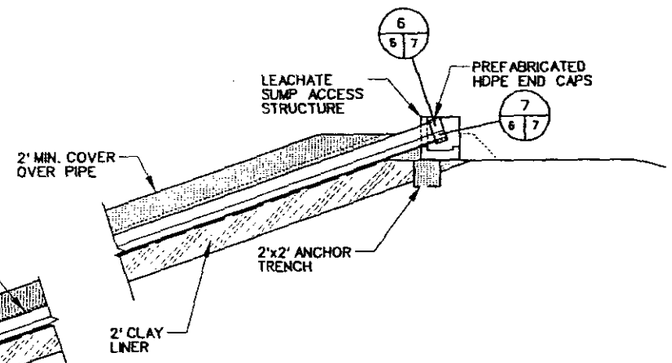

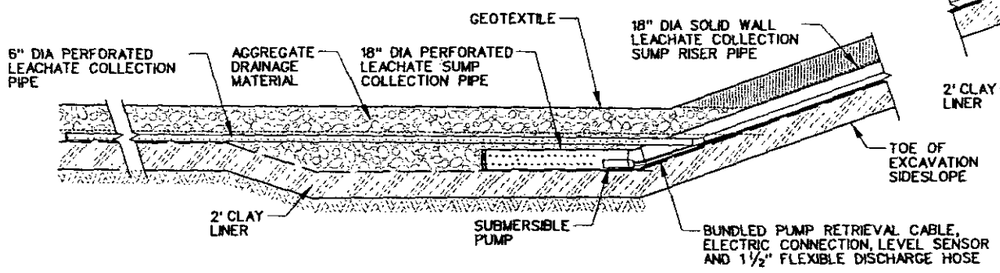

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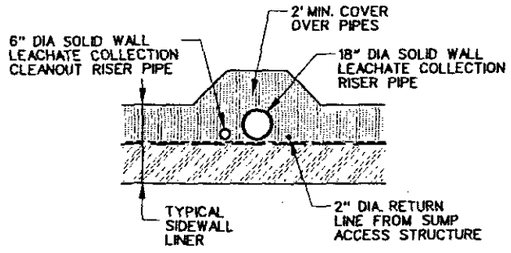

LEACHATE SUMP RISER SECTION (5 / 6 | 6)
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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

CELL 2 & 3
LEACHATE COLLECTION SYSTEM DETAILS

Date	Project No.	Figure No.	Issue
DECEMBER, 2001	08325-001-044	6	0

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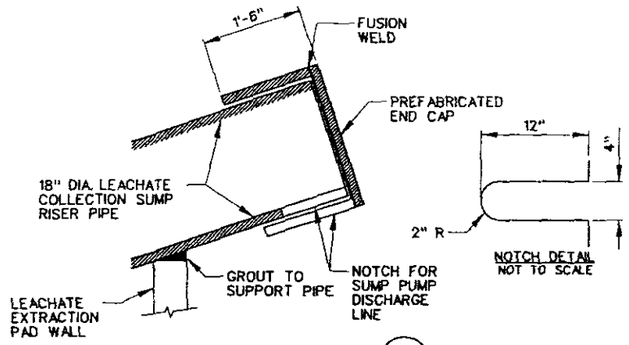

SUMP RISER END CAP (6 / 6 7)
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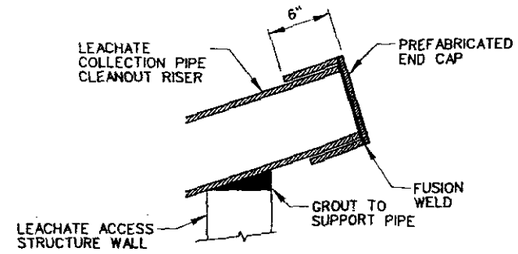

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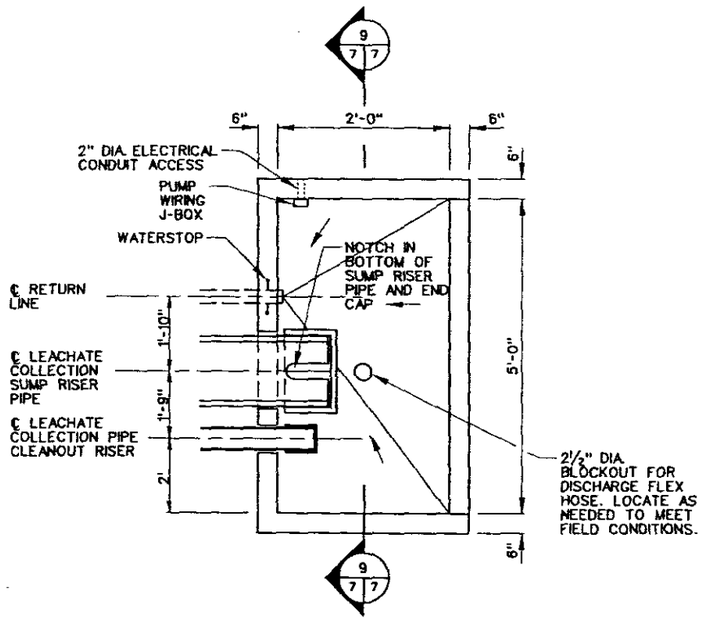

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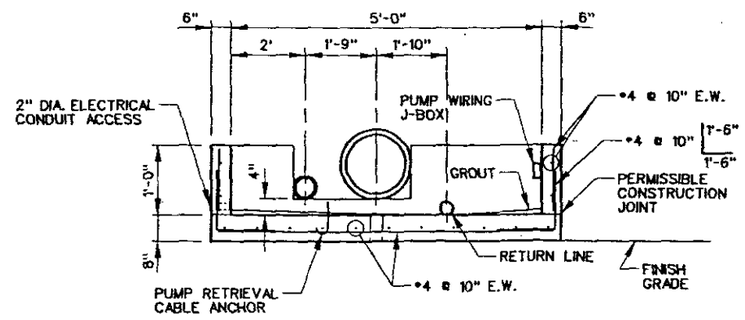

LEACHATE SUMP ACCESS - SECTION (9 / 7 7)
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SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

CELL 2 & 3
LEACHATE COLLECTION SYSTEM DETAILS

Date	Project No.	Figure No.	Issue
DECEMBER, 2001	08325-001-044	7	0

Scale: Not To Scale

Landfill Master Plan

Bayview Landfill

City of Provo, Utah

September 1988

H D R

HDR Engineering, Inc.

LANDFILL MASTER PLAN

BAYVIEW LANDFILL

FOR

THE CITY OF PROVO, UTAH

SEPTEMBER, 1988

HDR ENGINEERING, INC.

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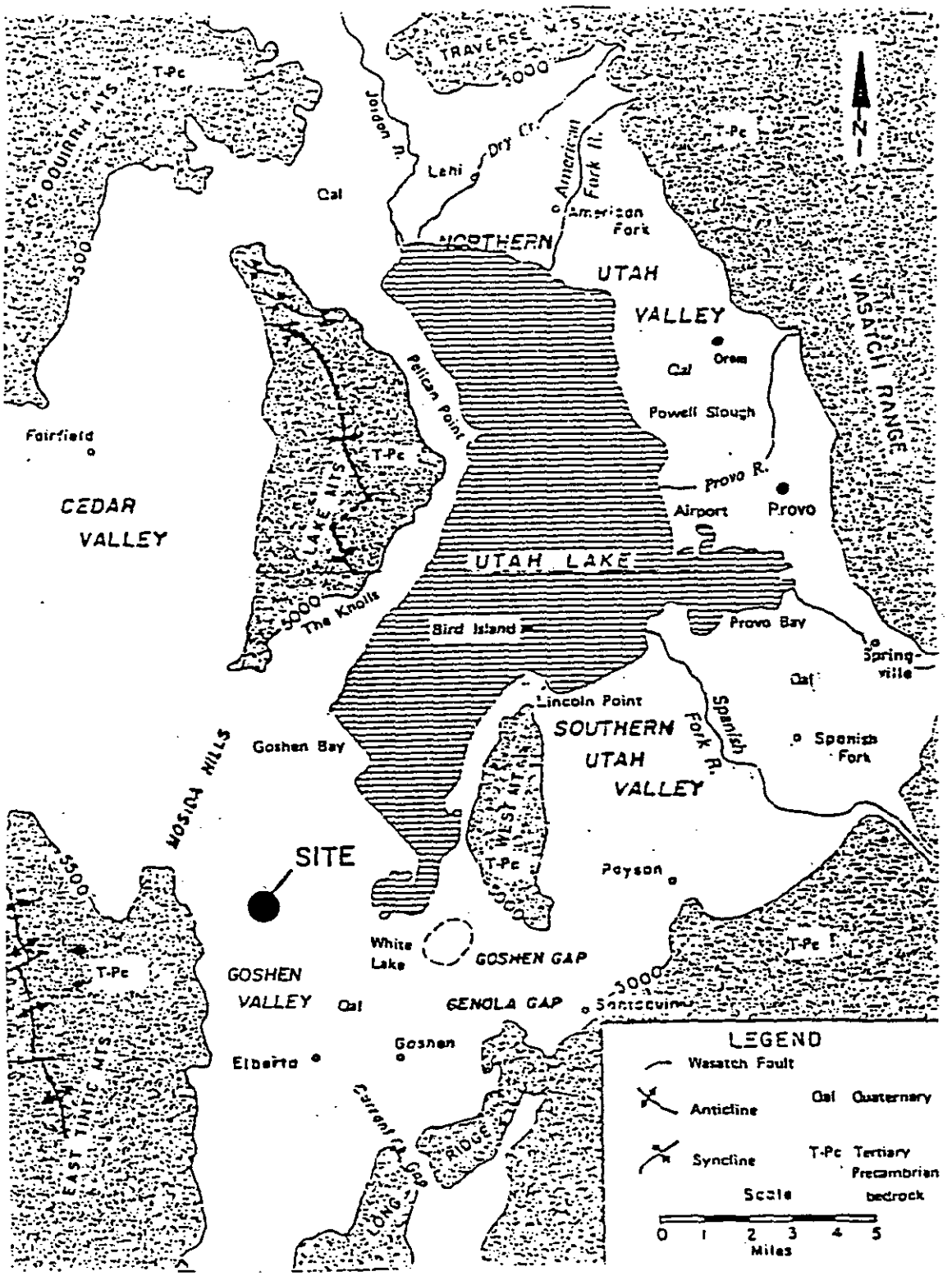
INTRODUCTION

The Bayview Landfill Site is located within the Goshen Valley in southwestern Utah County approximately 20 miles from Provo, as shown in Figures 1 and 2. The site consists of 660 acres of land along the west side of Utah Highway 68 approximately 6-1/2 miles north of the center of the agricultural community of Elberta. The region is sparsely populated and land use consists principally of grazing or operation of fruit orchards.

The City of Provo has entered into a long-term lease with the State of Utah for development of Section 17, Township 9 south, Range 1 west (SLB&M) as a sanitary landfill. The City has also leased 20 acres of land in Section 18 for location of a potable water supply well and storage tank. Approvals for use of the site as a sanitary landfill have been granted by the Utah State Department of Social Services, Division of Health, and by the Utah County Board of Adjustment.

A master plan has been prepared for the Bayview Landfill site which is intended to serve as a planning document for the sequential development of the property over many decades. It is intended to provide an overview of site use which will serve as a guide for the subsequent preparation of detailed plans and specifications for site construction and operation. This site master plan includes:

- The sizing, shape and sequential development of landfill disposal cells based on waste stream projections for the City



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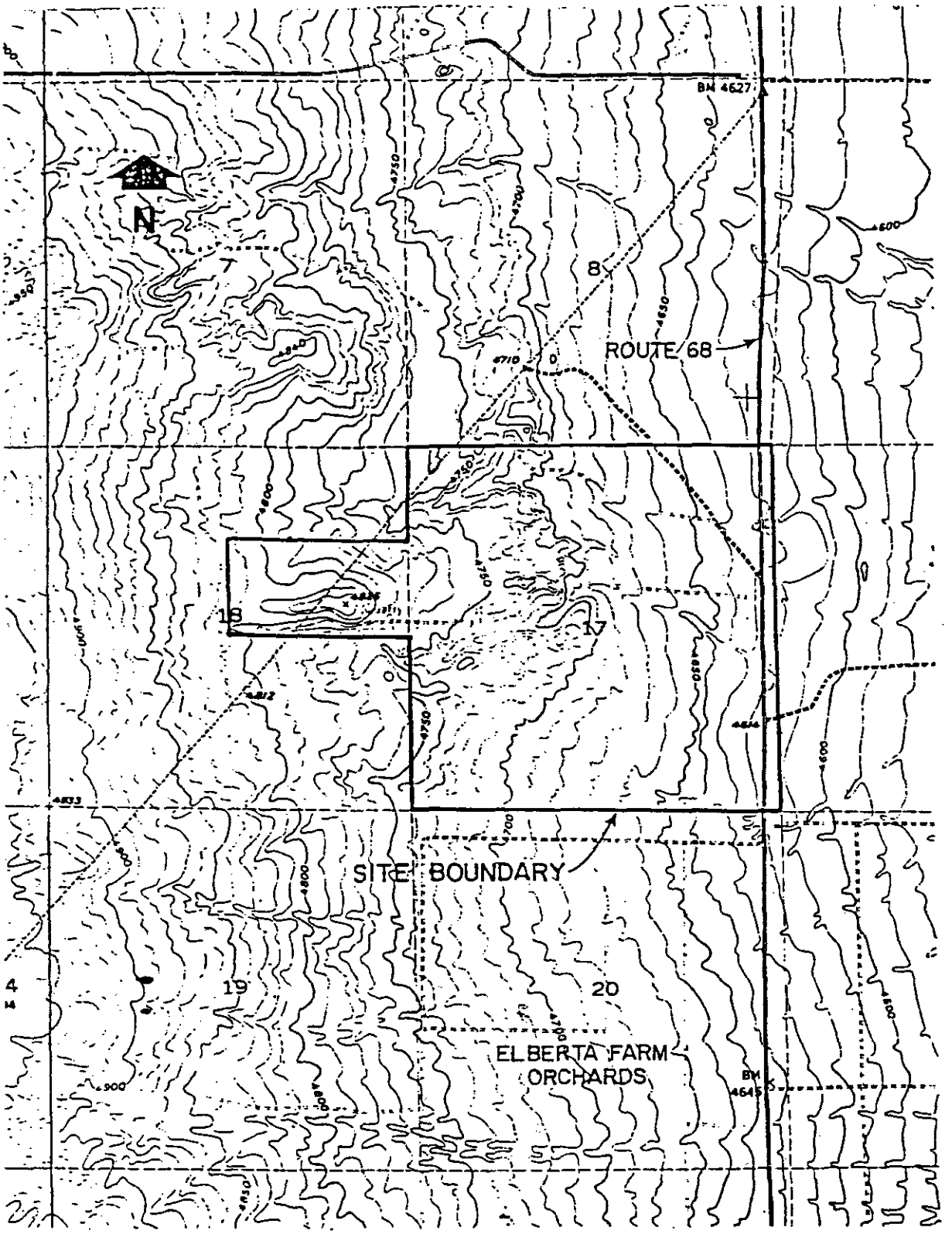
SITE LOCATION

Date

Sheet



SCALE IN MILES

0 1/2 1

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H D R

SITE VICINITY MAP
BAYVIEW LANDFILL

Date

Sheet

FIGURE 2

of Provo or incorporating wastes from other communities as a regional facility.

- The sizing and location(s) of an on-site storm water retention basin which will be utilized to drain unfilled portions of the lined disposal cells.

- An overall plan for earthwork and grading which may include the filling and diversion of some existing surface water runoff channels and the construction of screening berms.

- Recommendations for buffer area design.

- A plan for the diversion of storm water runoff around disposal cell areas.

- The planning for location of future on-site roadways providing access to cells from the main site access road off Route 68.

- Strategic location of permanent site facilities such as security fencing, vehicle maintenance building, future scale house, and scales, vehicle parking areas, and location of utilities.

- Location of facilities for leachate storage and disposal.

- Groundwater monitoring plan including location and depth of monitoring wells, frequency of sampling and parameters for testing.

- Insect monitoring plan including location of trap areas.

- Closure plan for disposal cells including landfill cap and final cover, final grades, and recommendations for reuse.

The preparation of detailed design drawings for the construction of the first disposal cell will be supplemented by an operations plan for the site. The site operations plan will provide specific directions for all daily landfill operations including procedures for placement and compaction of wastes, daily cover requirements, inclement weather operations, rodent control, dust control, litter control and fire protection.

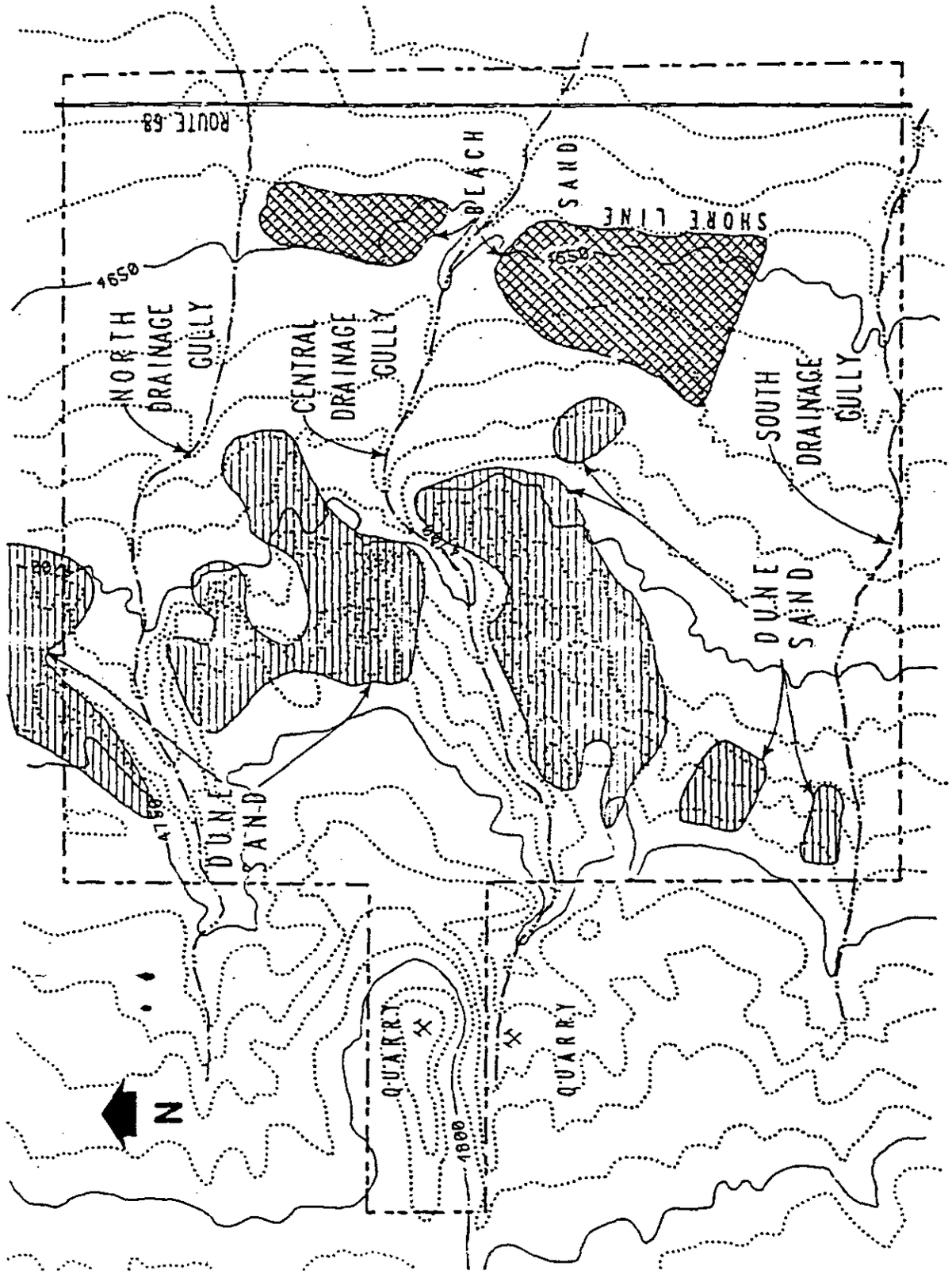
SITE CONDITIONS

Physiography

The landfill site is located over deep alluvial and colluvial soil deposits midway between the East Tintic Mountains and Utah Lake. The ground surface slopes to the east approximately 125 feet per mile across Section 17. Slopes generally increase in steepness to the west and flatten to the east.

The alluvium and colluvial deposits which consist principally of interbedded sands, silt and gravel are overlain by a thin veneer of surficial deposits whose origin is associated with the various stages of Lake Bonneville. The topography in the west-central portion of the site is influenced locally by a north-south trending band of sand dunes which are up to 25 feet high. This "blow sand" is generally located between the 4700 and 4750 elevation contours. The remnants of an old beach line are located along the 4640 elevation contour with a thin veneer of 2 to 4 feet of beach sand overlying a small topographic break at that location. Finally, a 40 foot high hill consisting primarily of gravel is located on the 20 acre portion of Section 18 which has been included in the landfill site. Gravel has been quarried periodically from two small pits dug into the hillside. The location of these surficial deposits are shown on Figure 3.

The site is dissected by three eastward draining erosion channels which serve to funnel some storm water runoff from higher elevations on the alluvial fan toward Utah Lake only during short periods of intense rainfall. The drainage basins for these gullies are small and do not extend into the East Tintic Mountains. The northern and central erosion channels have their origin in Section 14 (at about the 5400 elevation contour) two miles west of the site and each have upgradient drainage basins of less than 1000 acres. The small erosion channel along the south property boundary has its origin less than 1 mile from the site and drains less than 200 acres from above the site. The northern and central erosion channels have cut gullies about 5 feet



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SITE TOPOGRAPHY
AND PHYSIOGRAPHIC FEATURES
BAYVIEW LANDFILL

Date

Sheet

FIGURE 7

deep and 30 feet wide through the sand dune area of the site where the topographic gradient is steepest. These channels decrease in size to less than 3 feet deep and 10 feet wide by the time they reach Route 68. The southern drainage channel is only 1 to 2 feet deep. The decrease in the size of the gullies may be due to energy dissipation on the flatter slopes approaching Utah Lake, and due to the loss of surface flow in the gullies caused by direct infiltration into the underlying alluvium and colluvium.

Climate

There is no physical evidence to suggest that the on-site gullies carry water on a regular basis. Based on climatic data, they may remain dry for years at a time. Monthly precipitation records maintained at Elberta, Utah, since 1905 disclose that the site is located in one of the driest places in Utah County. The average annual precipitation is only 10.9 inches. Monthly precipitation is fairly uniform throughout the year ranging from an average of 1.09 inches in December to 0.61 inches in September. Over a period of 80 years, the total monthly precipitation has exceeded 2.00 inches only 59 times, 3.00 inches only 9 times, and 4.00 inches only once.

Most precipitation which falls in the site area is lost to evapotranspiration. Pan evaporation measured at Lehi, Utah, has averaged 56.0 inches for the seven month period between April and October of each year. However, an average of approximately 30 percent of the precipitation which falls between October and April is believed to

infiltrate into the alluvium and colluvium either directly from the ground surface or through infiltration from drainage gullies and may not be lost to evapo-transpiration. This would amount to about 1-1/2 inches per year of potential recharge to the regional groundwater system.

Hourly wind speed/direction data has been recorded at the Provo Municipal Airport since November 1986 during the times that the existing city landfill was open for operation. While this data may not be directly applicable to the Bayview site because of the proximity of the Airport to the Lake and to the Wasatch Front, it discloses that wind speeds are generally less than 5 to 10 MPH throughout most of the year. Wind speeds of 20 to 30 MPH occur occasionally during periods of frontal passage and can last several hours in duration, or intermittently over a period of several days. Frontal passage is most common between November and May and usually results in a wind direction from the west or northwest. Brief periods of high winds, 30 to 45 MPH, lasting between 30 minutes and 2 hours in duration are recorded about 10 times per year and may be associated with winter snow squalls, thunderstorms, or chinook wind conditions. The exposure of the Bayview site to winds and downdrafts off the East Tintic Mountains during frontal passage and during storms may result in a higher occurrence of days with wind speeds over 20 MPH.

The 1987 wind speed data obtained at the Provo Municipal Airport is summarized in Table 1.

TABLE 1

SUMMARY OF WIND SPEED DATA
PROVO MUNICIPAL AIRPORT

HOURLY WIND SPEED RECORDED
ON WEEKDAYS, 7 a.m. - 7 p.m.

Month	Number of Days During Which Hourly Wind Speed Exceeded 20 MPH	Number of Days During Which Hourly Wind Speed Exceeded 30 MPH
January	1	1
February	2	0
March	6	2
April	1	0
May	5	2
June	2	1
July	4	1
August	6	2
September	1	1
October	0	0
November	1	0
December	1	0
Total	30	10

Hydrogeology

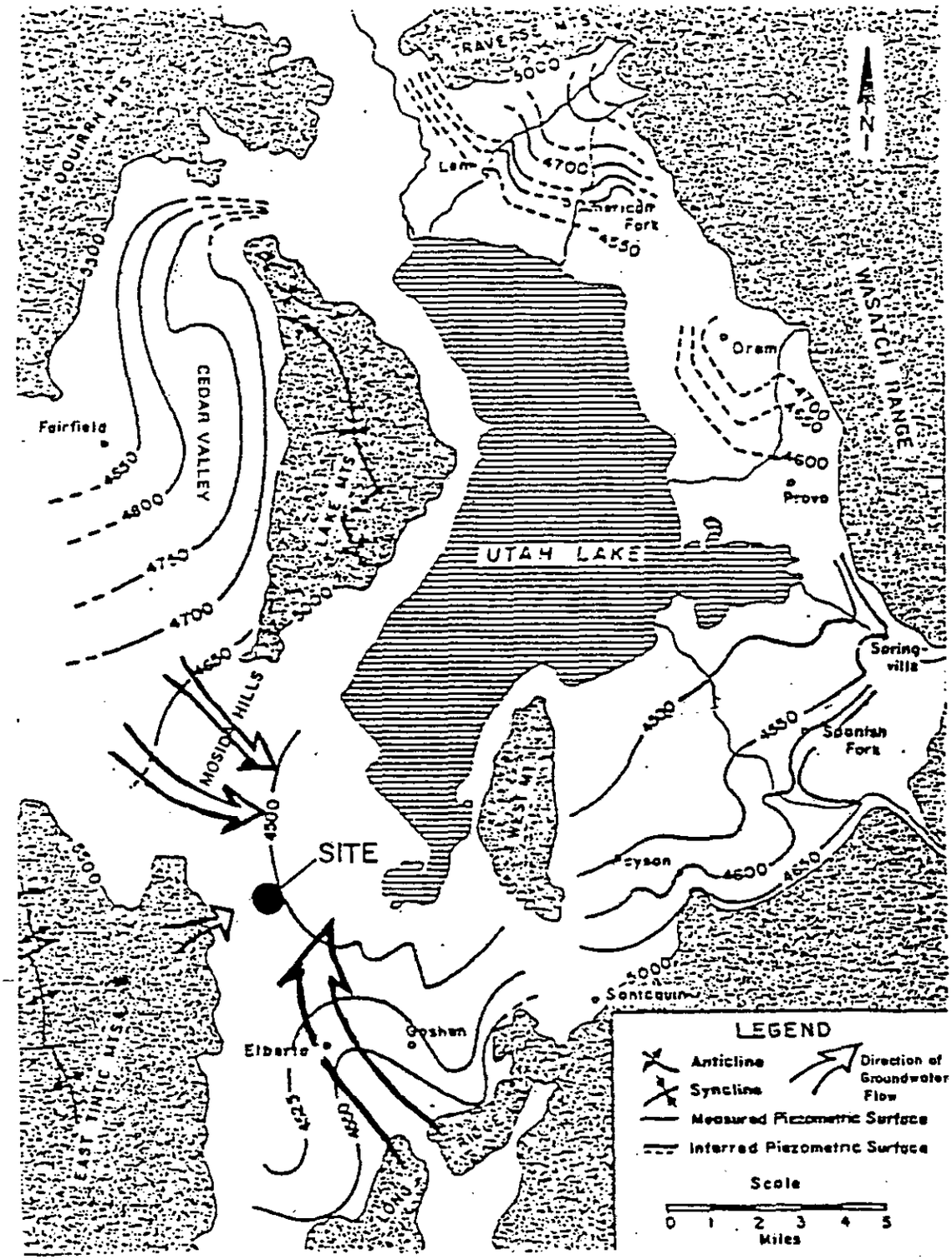
Alluvial and colluvial soil deposits below the Bayview site consist of interbedded sands, silts and gravels which are expected to be more than 800 feet in thickness. Based on previous regional studies performed by the State of Utah Department of Natural Resources, groundwater at the site is expected to be encountered in a perched water table, two Pleistocene aquifers and several deeper Tertiary aquifers. The maximum depth of test borings drilled on-site has been about 50 feet.

A perched water table may exist on an intermittent basis during some periods of the year at depths of more than 50 feet below the surface. The shallow Pleistocene aquifer is about 75 feet in thickness and may be encountered at depths of 150 to 200 feet below the surface. The deep Pleistocene aquifer may be encountered at depths of 250 to 400 feet and is believed to be partially confined by a 50 to 90 foot thick layer of calcium carbonate cemented sands and gravels between the two aquifers. The perched water table and both Pleistocene aquifers are suspected to be hydraulically interconnected at some locations and are influenced by the same sources of groundwater recharge and discharge. At other locations, the Pleistocene aquifers are known to be confined with artesian pressure exhibited in the lower aquifer. The Tertiary aquifers are confined. Most domestic and culinary water supplies are derived from the Pleistocene aquifers to a depth of 400 feet, but several of the Elberta Farm wells have been drilled to depths of 650 and 800 feet and probably derive the majority of their water from Tertiary aquifers even though the wells may be perforated through the Pleistocene aquifers.

Groundwater flow in all aquifers appears to be from the south (from Current Creek Gap) with smaller contributions derived from the west (East Tintic Mountains) and northwest (from Cedar Valley through the Mosida Hills). Groundwater is anticipated to approach the Bayview Landfill site from the south and southwest, and is expected to leave the site in a downgradient direction to the northeast. Groundwater discharge from all aquifers is into Utah Lake, less than 1-1/2 miles northeast of the site. The anticipated regional groundwater flow patterns are depicted in Figure 4.

There are approximately four water supply wells that are located northeast of the site in the downgradient direction of groundwater flow. Two of these wells are owned by Elberta Farms. The majority of the fruit orchard growing areas are located just south of the Bayview site in a direction which is expected to be upgradient from the landfill site.

Culinary wells are pumped only intermittently throughout the year with sustained periods of groundwater withdrawal only during the summer months. Peak drawdowns in pumping wells of about 35 to 80 feet have been reported for wells penetrating the Pleistocene aquifers. This would result in an effective cone of depression around the wells of no more than 500 to 1000 feet assuming all water has been removed from storage during the brief period of sustained pumping. On this basis, and the fact that some partial confinement of the Pleistocene aquifers



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GROUNDWATER FLOW DIRECTIONS
BAYVIEW LANDFILL

Date

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may occur, it is unlikely that groundwater withdrawal from existing wells, located upgradient on Elberta Farms more than 1/2 mile from the property boundary, could intercept or draw groundwater from below the site.

No information is available on the drawdown of Elberta Farm wells that penetrate deeper Tertiary aquifers. Yields on these wells are reported to be between 1200 gpm and 2400 gpm in the vicinity of the site. Due to the high yields, drawdown is expected to be minimal. Confinement of the aquifer and artesian pressure should minimize any possibility of aquifer contamination from a surficial source such as the Bayview Landfill.

WASTE STREAM PROJECTIONS

Approximately 133,000 tons of municipal solid waste are generated in Utah County each year. Based on projections of growth expected to be about 1 percent annually in Orem, and 1/2 percent annually in Provo, waste quantity projections for the region are presented in Table 2.

Over the next 50 years, the communities of Utah County will generate approximately 8.2 million tons of municipal solid waste. Assuming that future efforts to recycle solid wastes would remove about 5 to 10 percent of these wastes, the jurisdictions will have to provide future landfill disposal capacity for about 7.5 millon tons of waste. Utilizing a daily soil cover to waste ratio of 1 to 4 and a compaction density of 1000 pounds per cubic yard, the total required landfill volume over the next 50 years will be about 19 million cubic yards.

TABLE 2

SOLID WASTE PROJECTIONS
TONS/YR

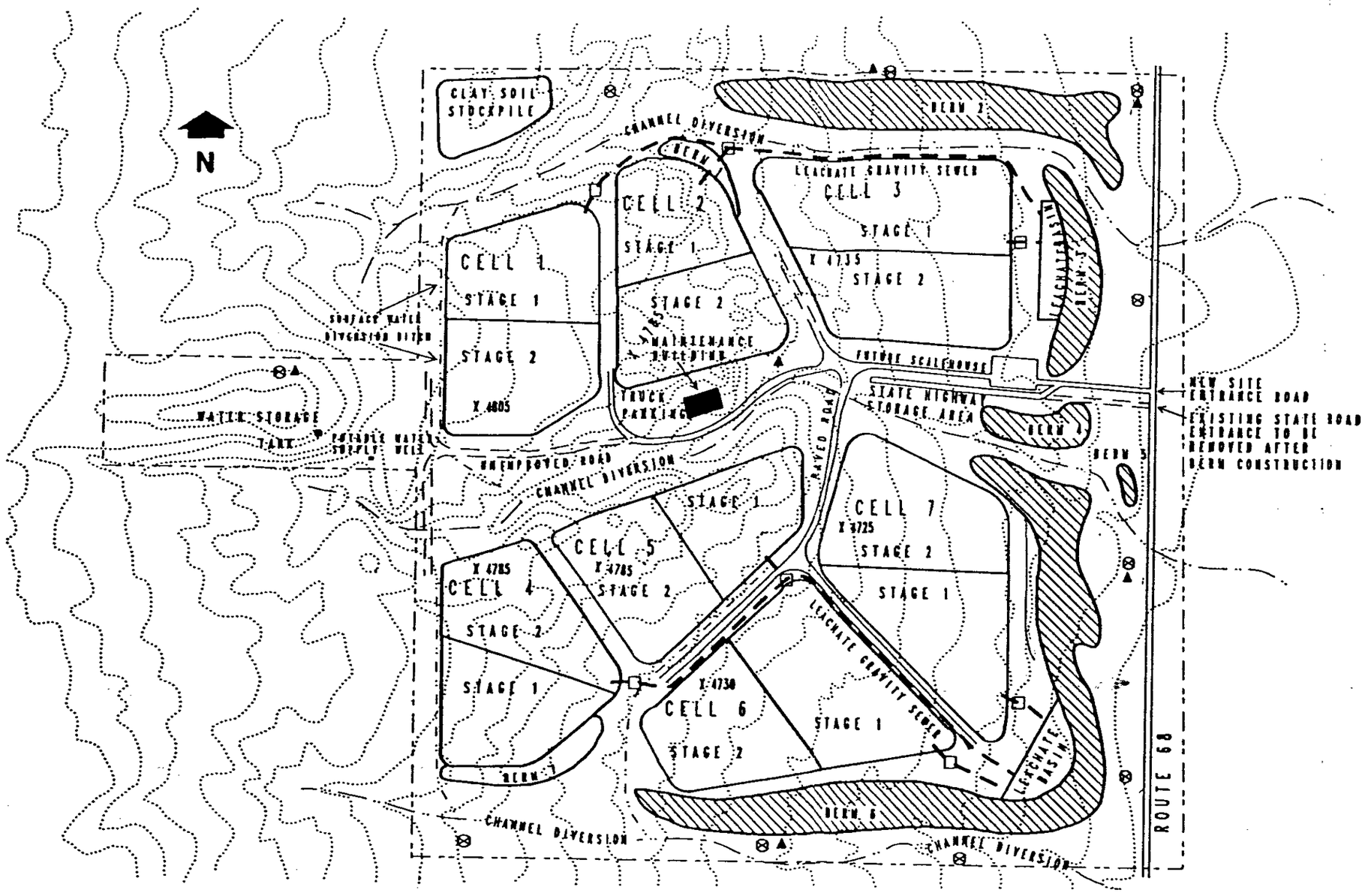
Year	Provo (BYU)	Orem	Other Communities	Total
1987	55,000	67,000	11,000	133,000
1990	56,000	69,000	11,000	136,000
2000	59,000	76,000	12,000	147,000
2010	62,000	83,000	12,000	157,000
2020	64,000	91,000	13,000	168,000
2030	68,000	100,000	14,000	182,000
2040	72,000	110,000	15,000	197,000

SITE MASTER PLAN

Disposal Cells

A master plan has been developed for the 660 acre Bayview landfill site which will provide sufficient disposal capacity to meet the needs of the jurisdictions of Utah County for the next 50 years. The site will be developed in stages consisting of seven separate disposal cells which will provide a total disposal capacity of 7.6 million tons of municipal solid wastes. The conceptual plan for site development is shown in Figure 5. Pertinent site development data is presented in Table 3.

The U.S. EPA is currently in the process of developing technical criteria that will apply to the siting, design, and performance of all future municipal solid waste landfills. These new criteria will be promulgated under the Resource Conservation and Recovery Act (RCRA) Subtitle D program and will establish minimum federal standards for these facilities. They are targeted for implementation early in 1989. These new criteria will be directed toward the protection of surface and groundwater resources and are expected to establish specific requirements for the installation of pollution control measures, facility engineering and design, and environmental monitoring programs. The State of Utah will have 18 months to revise its current solid waste regulations to comply with the minimum federal standards once they are implemented. It is expected that the State will be given additional latitude to establish the stringency of regulations for the installation of impermeable floor liners and leachate collection



KEY

- LEACHATE COLLECTION MANHOLE STRUCTURE
- LEACHATE GRAVITY SEWER
- MONITORING WELL PERCH
- MONITORING WELL SHALLOW PLEISTOCENE AQUIFER
- X 0000 SPOT ELEVATION FINAL CELL GRADES
- BERM

SCALE IN FEET

500 0 500 1000

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SITE MASTER PLAN
BAYVIEW LANDFILL

Date

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FIGURE 5

TABLE 3

SITE DEVELOPMENT DATA

BAYVIEW LANDFILL

Disposal Cell	Size Acres	Excavation yd^3	Ave Depth Below Existing Grade ft	Ave Cell Height Above Existing Grade ft	Soil Needed For Cell Operations yd^3	Surplus Soil For Berms yd^3	Capacity of Cell MSW, tons	Cell Life Based on 90% of Waste Projections From Table 2, yrs
1	32.5	1,582,000	43	30	1,047,000	535,000	920,000	7.4
2	30.8	1,430,000	36	31	1,012,000	423,000	895,000	6.7
3	44.5	1,601,000	29	36	1,382,000	210,000	1,195,000	8.7
4	31.5	1,663,000	43	31	1,070,000	593,000	960,000	6.5
5	30.7	1,547,000	38	51	1,325,000	249,000	1,290,000	8.4
6	42.1	1,729,000	29	36	1,407,000	322,000	1,256,000	7.9
7	39.4	1,504,000	29	36	1,280,000	224,000	1,128,000	6.6
	251.5	11,083,000			8,523,000	2,556,000	7,644,000	52.2
Leachate Basins			28			150,000		
						2,706,000		
Soil Required for Construction of Seven Berms, yd^3						2,228,000		
					Soil Surplus	478,000 yd^3 = 14" spread over top of all cells		

1	45,000
2	660,000
3	216,000
4	78,000
5	14,000
6	1,136,000
7	79,000
	2,228,000

Leachate Basin (A) 24 acres x 3.0" = 6.00 acre ft
1.6 acre pond, 3.8' deep

Leachate Basin (B) 22½ acres x 3.0" = 5.62 acre ft
1.62 acres pond, 3.5' deep

systems. Future state regulations could exceed the minimum federal standards.

The design of the Bayview Landfill will incorporate impermeable floor liners, leachate collection systems, an impermeable landfill cap, a landfill gas control system, and a surface and groundwater monitoring program. The master plan and design of the site has been prepared in an effort to comply with anticipated U.S. EPA RCRA Subtitle D technical criteria and future state solid waste regulations.

Landfill operations will be screened from view to local traffic on Route 68 through the progressive construction of a series of earth berms along the northern, eastern and southern perimeter of the site. The berms will vary in height from 15 feet to 45 feet and will have outside slopes of 5 horizontal to 1 vertical. Development of the site will also require diversion of portions of all three erosion gullies.

The seven disposal cells will be developed in the order shown on Figure 5 and will cover an area of 251.5 acres. The development of the site over 50 years will require the progressive excavation of over 11.2 million cubic yards of soil. Approximately 8.5 million yards of this soil will be used during site operations for liner protective cover, daily soil cover, and final cap. Construction of the screening berms will consume an additional 2.2 million cubic yards of soil, leaving a net surplus of about 480,000 cubic yards. This surplus is just under 5 percent of the total site earthwork requirements and is a reasonable

contingency to compensate for variations in application of daily cover.

Each disposal cell will be a separate facility containing its own floor liner, leachate collection system and gas control system. Each cell will be constructed and operated in two stages of about 15 to 20 acres in size as depicted in Figure 5. The floor grades of each cell will slope in a generally eastward direction at about 2.5 percent to promote drainage of leachate to a collection system located at the low end of the cell. The staged construction of each cell will be oriented parallel to the slope of the cell floor grade to facilitate drainage of any storm water from the cell excavation.

Disposal Cells 1, 4, and 5 will require the deepest excavations to reach floor grade. Excavation depths will generally vary from 30 to 55 feet for these cells and will average more than 40 feet. The side slopes of these cells will be maintained at 4 horizontal to 1 vertical. The depth of cell excavation will decrease progressively toward the east and will range from 23 to 35 feet below grade for Cells 3, 6, and 7. A generalized cross section of the Bayview site from west to east is presented on Figure 6. The alignment of the floor grades of the cells will allow gravity drainage of any storm water in the lined, unfilled excavations, and later the gravity drainage of leachate from the cells to a lined storage and evaporation basin located behind the screening berms. The leachate collection systems for Cells 1 and 2 will drain into a common gravity sewer located just north of the cells and will discharge into a 2.0 acre basin east of Cell 3. The leachate

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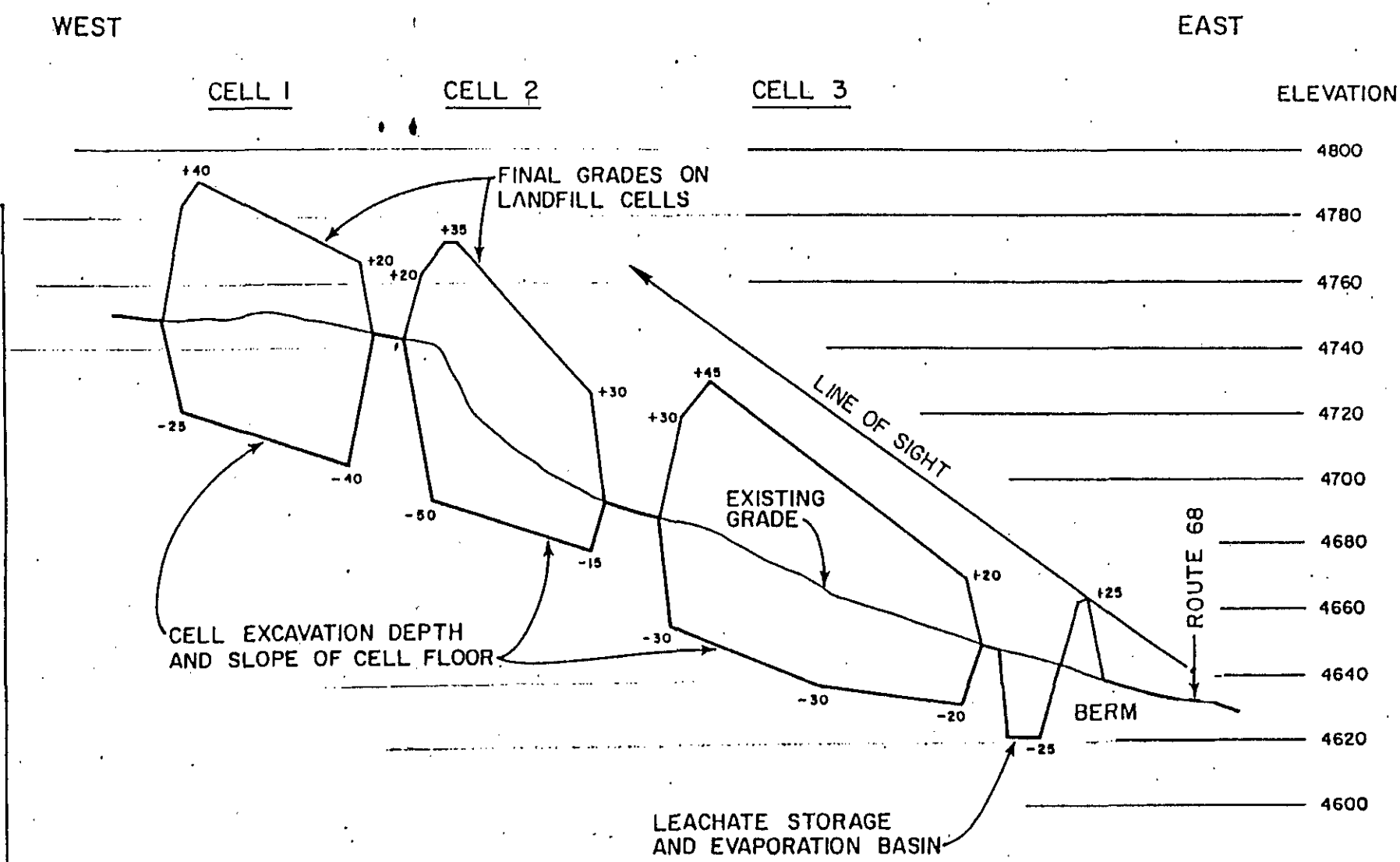
GENERALIZED CROSS SECTION



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collection systems for Cells 4 and 5 will drain into a common gravity sewer located between Cells 6 and 7 and will discharge into a 2.0 acre basin east of Cell 7. Cells 3, 6 and 7 will discharge directly to the basins via gravity sewers.

Cell 1 will be constructed utilizing a 40 mil thick high density polyethylene liner which will cover the entire cell floor and excavation side slopes below existing grade. The liner will be constructed using thermal welding procedures and all seams will be vacuum tested during quality control inspection of the construction process. The liner will be placed on a prepared surface free of sharp stones and will have a 2 foot thick layer of protective soil cover placed over it prior to the start of landfill operations. A leachate collection system consisting of a 6 inch perforated plastic pipe within a gravel trench wrapped in geotextile fabric will be placed above the synthetic floor liner within the protective cover layer. The anticipated configuration of the leachate collection system for Cell 1 is shown in Figure 7. All other cells will be similar. The need for lateral leachate collection drains across the floor of each cell does not appear necessary since the protective liner cover will consist of permeable sandy materials which will promote drainage downslope on the liner to the low end of the cell. The leachate collection header pipe will exit the cell through a liner penetration at cell floor grade using solid pipe and appropriate seals and will drain to an adjacent manhole structure.

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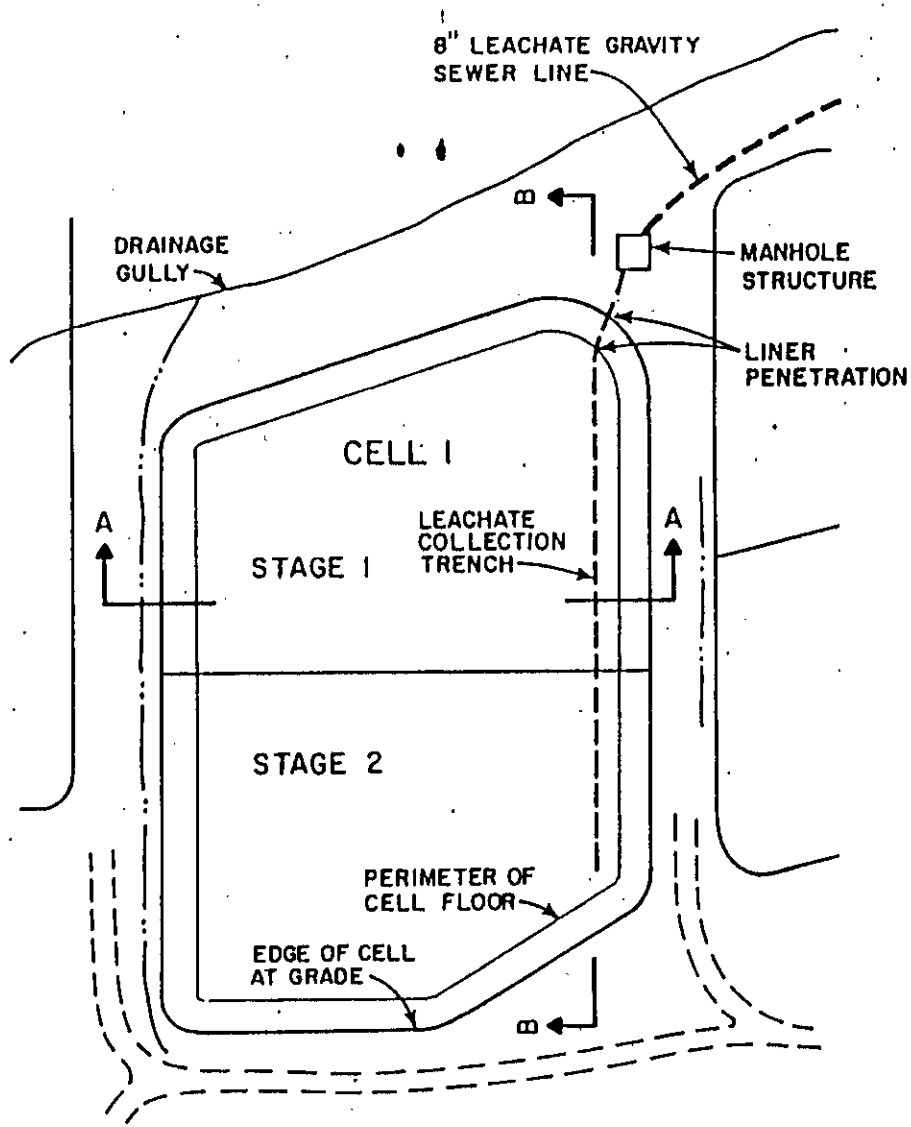
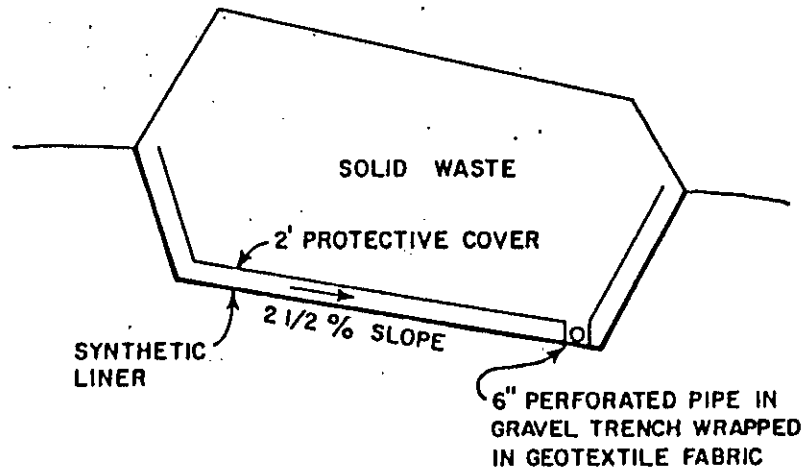
CELL I
LEACHATE COLLECTION SYSTEM





SECTION A-A

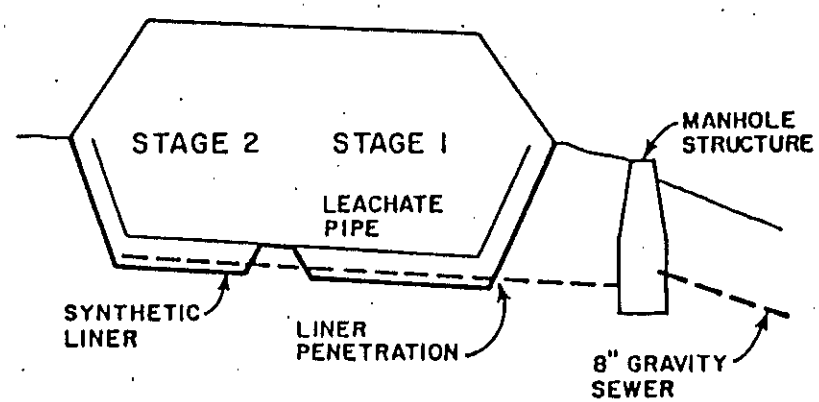


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FIGURE 7

The floor liner for disposal Cell 2 and all subsequent disposal cells will be constructed of either a synthetic geomembrane (such as high density polyethylene), compacted natural clay, or on-site soils amended with imported bentonite clay. Natural clay liners or bentonite amended soil liners will be required to have a maximum permeability of $1x10^{-7}$ cm/sec. The selection of a liner design for future landfill cells will depend upon the availability of low permeability clay soils obtained either from on-site excavations or from nearby borrow pits, and the relative costs of each type of liner being considered for installation.

The disposal cells will be filled to final grades that will vary from 25 to 65 feet above surrounding existing grades. The average height of Cell 5, which is centrally located within the Bayview site, will be just over 50 feet. The other cells will generally have final grades which average about 30 to 36 feet above grade. The maximum elevation for each cell will be located near its western edge as depicted in Figure 5. In general, each cell will have side slopes around the perimeter that will be about 20 feet high and will be constructed with grades of 4 horizontal to 1 vertical. The surface of each cell will slope in a radial, but generally eastward direction, from the high point toward the perimeter side slopes. The grades on the landfill cell surface will be maintained at between 2-1/2 and 4 percent to promote drainage. Final cell contours were also based on visibility criteria and will be maintained below a line of sight from Route 68 over the top of the screening berms. The maximum final grade for each

cell is presented in Table 4. These elevations include final cover and landfill cap.

Closure of each cell will include the construction of a landfill cap that will be 4 feet thick. The cap will consist of 18 inches of final cover over the solid waste, an impermeable layer 6 to 12 inches thick, and approximately 18 to 24 inches of natural soil over the impermeable layer. The cap will e end across the top and side slopes of the "mounded" cell and will tie into the floor liner where the two meet at existing grade. Erosion protection measures will be required on the cell side slopes. The impermeable layer within the cap will consist of either bentonite ammended on-site sandy soil (6 inches) low permeability clay or silt soils selectively graded from on-site cell excavations during site development (12 inches), or imported clay soils (6 to 12 inches depending on permeability). The landfill cell cap will be underlain by a system of shallow gravel trenches constructed within the 18 inches of final cover over the waste to promote the migration of any landfill gas to the high point of the cell where a central gas vent will be located. The venting system will allow the future controlled release of gas from within the confined cell.

TABLE 4

MAXIMUM FINAL GRADES
BAYVIEW LANDFILL DISPOSAL CELLS

Cells	Elevation, FT, MSL
1	4805
2	4785
3	4735
4	4785
5	4785
6	4730
7	4725

Sequence of Operations

Site Preparation

The Bayview site will be initially developed through a variety of site preparation activities that will be required prior to the placement of any solid waste. These activities will include:

1. Construction of a new, paved site entrance road from Route 68 to a location near the eastern side of Cell 1. This road will be constructed parallel to and about 70 feet north of the existing paved state highway department road.

2. Construction of the maintenance building, site water supply system, and electric power supply.

3. Installation of groundwater monitoring wells.

4. Site earthwork and grading to prepare the Cell 1 area, divert the northern drainage channel, construct the northern leachate storage and evaporation basin, and initiate construction of site screening berms.

5. Installation of floor liner and leachate collection system in Stage 1 of Cell 1, construction of vehicle access ramps into the cell excavation, and installation of litter screens and security fencing around the cell.

6. Installation of insect traps to monitor for apple maggot presence.

Preparation of the Cell 1 area will require the opening of an excavation for Stage 1 of the cell. Approximately 60 percent of the entire cell earthwork would be completed during this initial phase of site preparation work. Approximately 900,000 cubic yards of soil would be excavated from Stage 1. Approximately 50,000 cubic yards would be saved and used for floor liner protective cover, and the balance would be transported by scrapers to build screening berms No. 2 (660,000 cubic yards) and No. 3 (216,000 cubic yards) to the north and east of the Cell 3 area as shown on Figure 5.

Site preparation work will also include the diversion of 3300 feet of the northern drainage gully to a location north of future Cell 3, where approximately 25,000 cubic yards of excavation will be completed. Construction of the northern leachate storage and evaporation basin behind berm No. 3 will also require the excavation of about 75,000 cubic yards of soil. The basin will have an overall size of about 2 acres and will be 28 feet deep. The surplus soils from these two excavations (100,000 cubic yards) can be used to start construction of berm No. 6 in the vicinity of the landfill entrance.

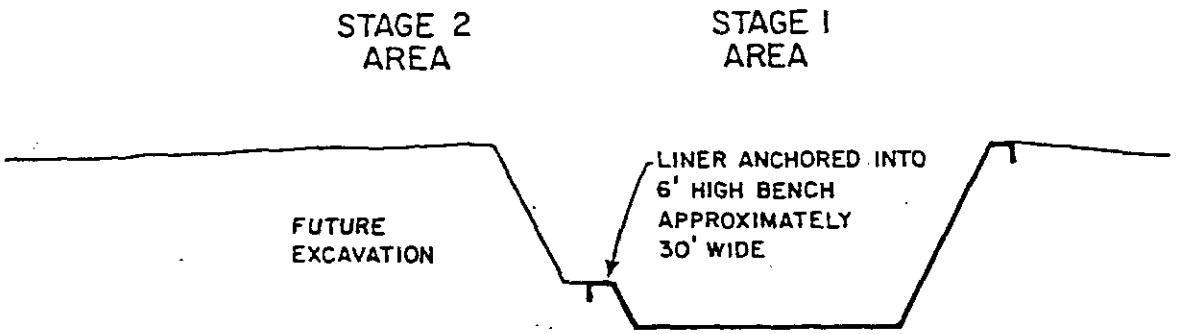
Site preparation work will also include the installation of the synthetic floor liner and leachate collection system in Stage 1, the leachate (and storm water) piping system from Cell 1 to the leachate

basin, and the installation of a liner in the basin. This liner will consist of a 40 mil High Density Polyethlene membrane. The liners for future cells could be made of low permeability clay (1×10^{-7} cm/sec) were such material to be encountered during site earthwork operations. A stockpile area for clay is designated in the northwest corner of the site.

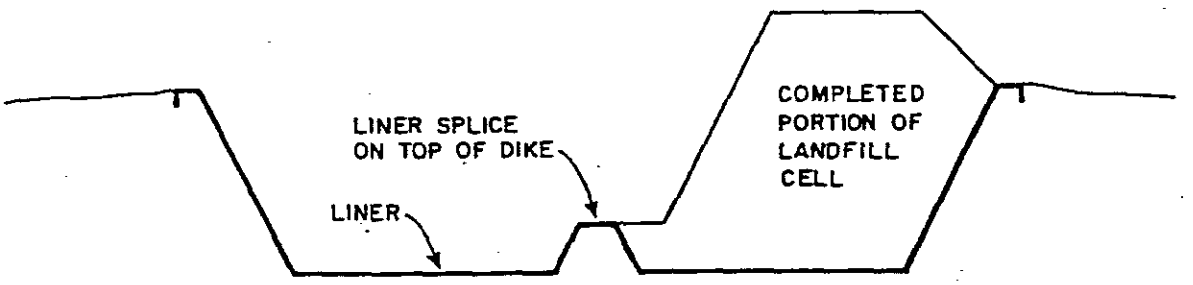
Progressive Development of Disposal Cells

Cell 1

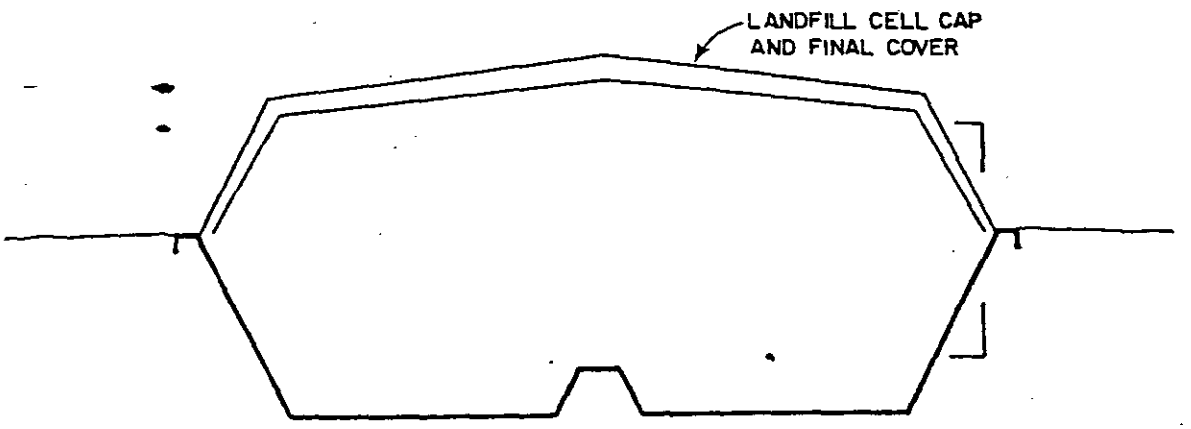
Landfill disposal operations will be initiated in Stage 1 of Cell 1 and will provide about 2-1/2 years of disposal capacity before it is necessary to expand disposal operations into the Stage 2 portion of the cell. The cross sections in Figure 8 illustrate how each cell will be constructed and operated in two stages. During the operation of Stage 1, approximately 680,000 cubic yards of soil will be excavated from the balance of the Cell 1 area. About 400,000 cubic yards of this material will have been used for daily cover in Stage 1 and for protective liner cover in Stage 2. The balance would be used to construct screening berms Nos. 4 and 5 at the landfill entrance (90,000 cubic yards) as well as portions of berm No. 6 (190,000 cubic yards). During this period of site development (within 2-1/2 years from start of operations) the existing state highway road base storage area entrance will be modified and a small section of the center drainage gully between berms Nos. 4 and 6 will be realigned.



1. STAGE I EXCAVATION AND LINER INSTALLATION



2. PREPARATION OF STAGE 2 AREA



3. COMPLETED CELL

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STAGED DEVELOPMENT OF CELLS

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The operation of Stage 2 will last about 4-1/2 to 5 years and will require about 700,000 cubic yards of soil for daily cover operations. This material would be derived from the excavation for Stage 1 of Cell 2 which would provide about 850,000 cubic yards of soil. The excavation for Stage 1 of Cell 2 should be completed one year prior to the closure of Cell 1 to provide time for liner installation. The remainder of the soil excavated from Stage 1 of Cell 2 (150,000 cubic yards) would be used to construct berm No. 1 (45,000 cubic yards) which forms the north side of the cell and a portion of berm No. 6 (100,000 cubic yards).

While Stage 2 of Cell 1 is being operated, the excavation of Stage 2 of Cell 2 should be initiated in order to complete the majority of construction of berm No. 6 along Route 68 and moving west toward Cell 4. Around 950,000 cubic yards of soil will be needed to finish the entire berm. Approximately 675,000 cubic yards of this material can be obtained partially from the excavation for the south leachate basin (75,000 cubic yards) next to berm No. 6, and from the excavation for Stage 2 of Cell 2 (600,000 cubic yards). As a result, the majority of the site screening berms will be completed during the 7-1/2 years period of time that Cell 1 is in operation.

Due to the presence of up to 25 feet of dune sand at the location of Cell 2, it may be necessary to overexcavate the side slopes of the cell excavation horizontally approximatley 50 feet around the perimeter of the cell to remove the cohesionless sand and to replace it with other

on-site soils. This would provide stability needed to hold the landfill liner on the 4 horizontal to 1 vertical side slopes. A similar procedure may be needed for Cell 5.

The closure of Cell 1 will require about 200,000 cubic yards of soil to construct the landfill cap. This material would be obtained from the Cell 3 area.

Cell 2

Operation of Stage 1 of Cell 2 will provide about 2-1/2 years of disposal capacity before the need to expand into Stage 2 of the cell. Virtually the entire excavation for Cell 2 will have been completed prior to the start of filling operations. The entire Cell 2 landfill operation will require 1,000,000 cubic yards of soil for daily cover, and an additional 100,000 cubic yards of soil for protective liner cover. This material would be derived from the total Cell 3 excavation which will yield 1,600,000 cubic yards of soil (less 200,000 cubic yards borrowed for the cap on Cell 1). The 300,000 cubic yard surplus would be used to cap Cell 2 (200,000 cubic yards), and to provide protective liner cover for Stage 1 of Cell 3.

Cells 3 through 7

The sequence of operation of cells 3 through 7 would be comparable to the operation of Cells 1 and 2. Soils needed for daily cover and for Stage 1 and 2 of Cell 3 (1,380,000 cubic yards) would be derived from the excavation of Cell 4, which will yield 1,660,000 cubic yards of

material. Approximately 280,000 cubic yards of the soil excavated from Cell 4 would be used to complete berm No. 6. The 200,000 cubic yards of soil needed for the landfill cap on Cell 3 should be obtained from the Cell 5 area, provided that the dune sands are not used for this purpose.

The excavations for Cells 5, 6, and 7 will progressively yield a surplus of soils of about 480,000 cubic yards. This material should be spread, or stockpiled on top of completed cells and would result in mounding of not more than 1 to 2 feet. This surplus soil can be used during post-closure site maintenance for regrading of cells to compensate for differential settlement.

Roads, Site Facilities

A paved entrance road will be constructed from Route 68 to the southeast corner of Cell 1 and will serve as the arterial road for landfill traffic on the site. The pavement will allow access to the disposal cells in all weather, and will serve to minimize fugitive dust problems on-site. During the period of site operation it may prove advantageous to extend paved side roads between Cell 2 and Cell 3, and between Cell 5 and Cells 6 and 7 to handle landfill traffic accessing the disposal cells in those areas. The paved roads will also provide all-weather access to the leachate manholes and to the leachate storage and basins.

Access to the state highway roadbase storage area will be provided by a short section of new pavement in front of the future gatehouse area.

Electric power serving the site will be provided by underground conduit from Route 68 running along the main site entrance road to the maintenance building and beyond to the potable water supply well and pump station for the water storage tank. Water supply and fire protection will be provided from the storage tank utilizing lines buried along the site entrance road, and placement of hydrants at strategic locations.

The maintenance building and heavy equipment parking area will be centrally located on site between Cells 2 and 5 with room for future expansion, if necessary. Space has been provided for a future scale house plaza at the landfill entrance which would be located behind berm Nos. 3 and 4.

The site will be secured by an entrance gate and a three-strand barbed wire fence around the perimeter. A six foot high chain link fence will be constructed around each disposal cell during the period of time the cell is in operation. The entrance to the cell will be secured by locked gates which will allow access only during landfill working hours. Separate gates will be used to allow access by collection trucks and transfer vehicles, and by scrapers used to transport excavation soil or daily cover. The security fence around the perimeter of the cell will be removed upon cell closure and will be re-used, if possible, for the next disposal cell.

A security fence will also be installed around each leachate storage and evaporation basin for safety purposes.

Storm Water Management

A system of shallow, unlined ditches about 1 foot deep will be constructed around the perimeter of most of the disposal cells as a precautionary measure to divert any sheet flow of surface runoff during a major storm from the top of completed cells directly to the drainage gullies which pass through the site. The surface ditch system will also be used to divert any storm water runoff around cell excavation areas. The location of some of these ditches is shown on Figure 5.

Lined disposal cells that have not been filled with solid waste will trap storm water which falls directly into the excavation. During the initial phase of cell operation, any storm water which is trapped in the low end of the excavation will be released into the leachate collection system and will drain by gravity to the lined leachate storage and evaporation basin. These basins will be designed to hold substantially more than 6 acre-feet of water, which would be the anticipated runoff from a 3.0 inch storm filling the 24 acre lined floor exposed during each stage (1 or 2) of cell construction, and will be about 2 acres in overall size. The maximum depth of water in the basin would be about 3.5 feet. Since the basins will be about 28 feet deep to allow gravity drainage from the floor of Cells 3, 6, and 7, they will have ample capacity. Any water collected in the basins will

be evaporated over the summer months. No release to surface drainage gullies is anticipated since some of the storm water could come in contact with solid waste that has been placed in a portion of the cell, and could contain dilute leachate. It is also possible that leachate generated in a closed cell tied to the same basin, could be discharged into the basin concurrent with storm water a cell under initial stages of operation.

Leachate Management

All leachate generated in the disposal cells will be collected by the floor drain system above the synthetic (or clay) liner and will drain by gravity flow into a manhole structure outside of the low end of the cell. The location of these leachate manholes are shown on Figure 5. The manholes from Cells 1 and 2 will be connected by a buried, solid plastic pipe approximately 8 inches in diameter. This gravity sewer and the sewer from the manhole for Cell 3 will discharge directly into the northern leachate basin. A similar configuration of manhole structures and gravity sewer system will connect the leachate collection systems for Cells 4, 5, 6, and 7 to the southern leachate basin. The system will be sealed and will be installed with a monitoring system to detect any leakage. Cleanout ports will be provided.

The floor and side slopes of the two leachate storage and evaporation basins will be lined with 60 mil High Density Polyethylene membrane. This membrane will be buried below two feet of protective soil cover and will be stablized using either drainage nets, geotextile fabric,

geo grids, or soil cement to prevent sloughing and erosion of the protective cover on the side slopes.

All leachate collected in the basins will be allowed to evaporate during the summer months. Should it ever prove necessary, an aeration system can be installed in the basins to control odor. Since the disposal cells will be designed to minimize the infiltration of water, it is unlikely that any significant amount of leachate will drain to the basins, once the cells are capped. Some infiltration of precipitation will occur through the cap of completed disposal cells during the winter and spring months. Due to the low permeability layer in the cap, the amount of infiltration should be substantially less than the 1-1/2 inches per year that occurs on the natural ground surface. As a result, the refuse in the cells will not reach field capacity (saturation) for several decades, and the generation rate for leachate is expected to be very low.

Gas Control

Each disposal cell will be constructed with a passive gas collection system below the landfill cap which is designed to allow migration of gas within the cell to the topographic high point where it will be vented to the atmosphere through a standpipe. The lateral escape of methane gas from the landfill will be minimized by the synthetic floor liner placed on the bottom and side slopes of the cell excavation.

Gas generation is expected to be minimal due to the lack of moisture (and biological activity) expected in the cells.

In the future, the passive gas vents can be converted to a flaring system should methane production be sufficient to sustain gas combustion.

Litter Control

High winds (greater than 20 MPH) blowing downslope off the East Tintic Mountains during periods of frontal passage or during storms may dictate the need for special litter control measures. The City of Provo will install a portable meteorological station at the Bayview site during the summer of 1988 to record hourly wind speed and direction for comparison to similar data collected at the Provo Municipal airport, and for use in design of site litter control measures.

The six foot high chain link security fence surrounding the working cell will provide a mechanism to collect paper and plastics tumbling along the ground. It may prove necessary to install screening such as fish nets supported on cable strung from wooden telephone poles to provide a downwind barrier for airborne litter. This litter screen would be 20 to 25 feet high and could be positioned to the east and southeast sides of the cell, as determined from on-site wind speed and direction data.

As the elevation of the disposal cell climbs above surrounding grade (up to 65 feet in Cell 5), it may prove necessary to use skid mounted 10 foot high, screens or snow fence barriers close to the working face to help contain blowing litter. If the litter screens and security fencing placed around each working cell proves to be inadequate to capture all the blowing litter, additional snow fences or wire screening will be placed around the inside toe of the site perimeter screening berms, or at other suitable locations downwind on the Bayview site. All litter should be removed from the screens and fences on a daily basis, and along the site entrance road on a weekly basis.

Closure

Each landfill cell will be treated as a separate disposal facility and will be closed following the completion of filling operations at that location. Closure will consist of placement of final cover, landfill cap, and gas venting system.

Following completion of Cell 7, the City will close the entire site. Two options are available:

1. Leave the screening berms in place and develop a site re-use plan that will be consistent with the seven mounded disposal cells, separated by roadway areas as shown on Figure 5.

2. Develop a more level site topography by removing the perimeter screening berms and utilizing this soil (approxi-

mately 2,000,000 cubic yards) plus any stockpiled surplus borrow soils (up to 600,000 cubic yards) to fill in some of the roadway areas between the cells. This would result in a single "mound" combining Cells 1, 2, and 3, and a single mound combining Cells 4, 5, 6, and 7. All affected leachate manholes and clean-out ports would have to be raised vertically to the new grades. The three major drainage gullies would remain, as well as the main site entrance road and the two leachate storage and evaporation basins. All ground water monitoring wells would be preserved. The alternative proposed closure plan is shown on Figure 9.

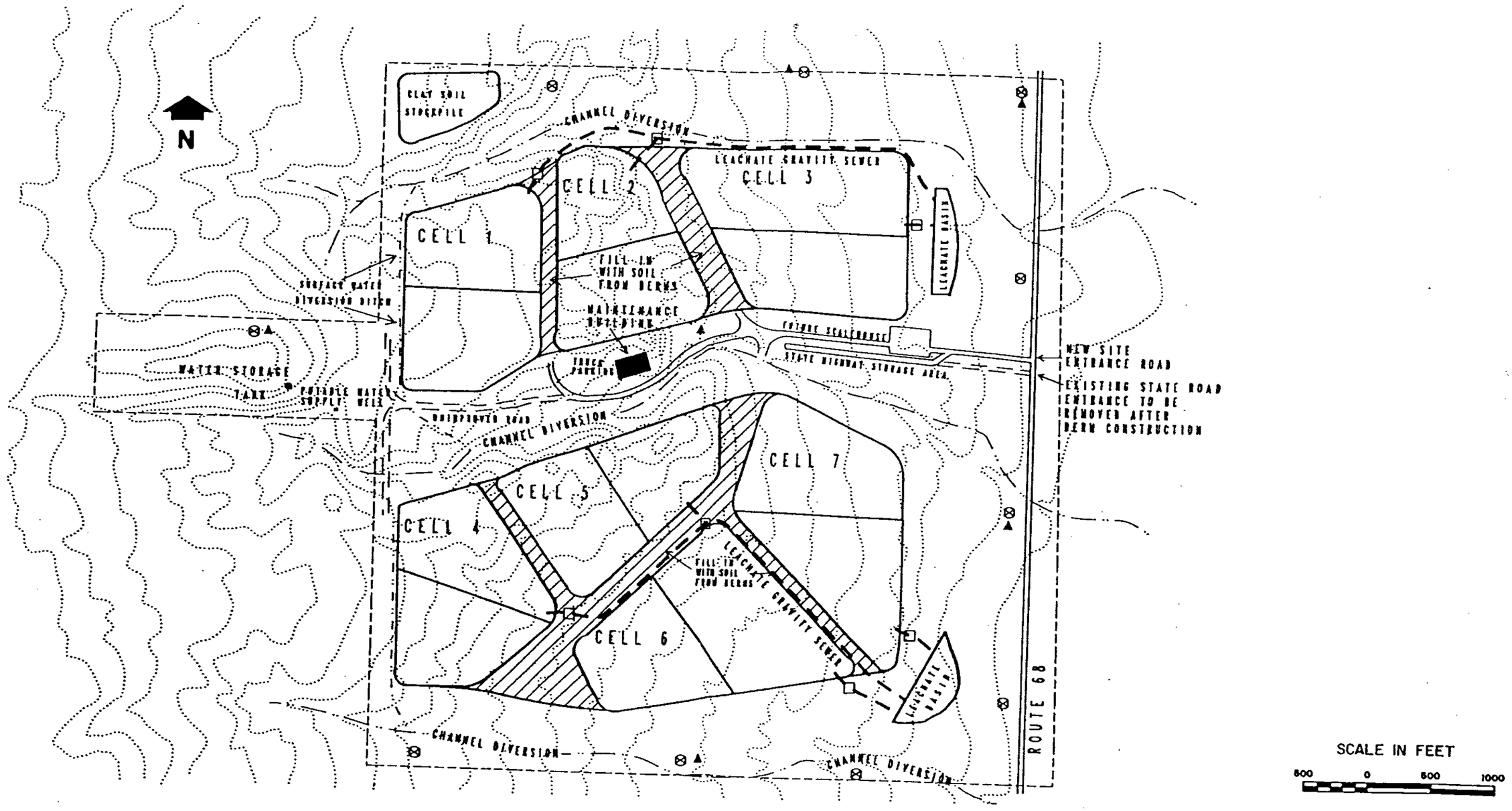
Provisions will be necessary to assure that positive surface drainage is maintained off of all closed cells.

Site re-use options consist of open area recreation or agricultural uses such as grazing of sheep.

ENVIRONMENTAL MONITORING PROGRAM

Groundwater and Surface Water

A groundwater monitoring program will be established at the Bayview site prior to the start of landfilling operations. All monitoring wells will be 4 inches in diameter and will be constructed in accordance with U.S. EPA and National Water Well Association standards for this type of installation. The location of all proposed monitoring wells is shown on Figure 5.



HDR Engineering, Inc.

HDR

ALTERNATIVE CLOSURE PLAN
BAYVIEW LANDFILL

Date

Sheet

FIGURE 9

A total of six monitoring wells will be used to monitor for perched water table conditions and will be installed to a depth of 100 feet below the ground surface. The wells will be sealed off within 30 feet of the ground surface and will be screened for the remaining depth. Up gradient monitoring wells will be located in the extreme western portion of the site and along the south property boundary. One well will be centrally located in the Bayview site near the maintenance building, and three down gradient wells will be located along the north and east sides of the site.

A total of 10 groundwater monitoring wells will be installed into the shallow pleistocene aquifer at depths of up to 250 feet below grade. The wells will be sealed off above the aquifer to prevent infiltration of any perched water, and will be screened within the aquifer.

All groundwater monitoring wells will be sampled at least four times prior to the start of landfilling operations in Cell 1. Following the start of operations, all monitoring wells will be sampled quarterly for the parameters in Table 5, and annualy for the parameters listed in Table 6.

Water level readings should be recorded for all monitoring wells prior to sampling. This data will be used to confirm the direction of groundwater flow.

TABLE 5

GROUNDWATER MONITORING PROGRAM

QUARTERLY SAMPLING

Indicator Parameters

Ph
Specific Conductance
Total Dissolved Solids
Total Organic Carbon
Chloride
Sulfate
Nitrate (NO_3)
Bicarbonate
Calcium

TABLE 6

GROUNDWATER MONITORING PROGRAM

ANNUAL SAMPLING

Metals and Other Parameters

Iron
Arsenic
Magnesium
Lead
Chromium
Cadmium
Barium
Zinc
Manganese
Sodium
Mercury
Flouride
Sulfide
Potassium
Hardness
Carbonate Hardness
BOD
COD
Ammonium (NH_4)
Nitrate (NO_3 + NO_2)

No surface water sampling program is anticipated due to the lack of flowing streams or springs on the Bayview site. Random samples of leachate collection in the storage and evaporation basins should be obtained and tested to monitor the chemicals and organic constituents present.

Insects

Insect traps will be installed around the perimeter of each operating landfill cell, and along the south property boundary. The traps will be monitored on a regular basis.

APPENDIX B

SPECIAL USE LEASE AGREEMENT

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

This document was submitted
as part of a previous Permit.

APPENDIX B

SPECIAL USE LEASE AGREEMENT

January 6, 1984

Provo City Corporation
359 West Center Street
Provo, Utah 84601

Gentlemen:

RE: SULA MAYR

Enclosed please find two copies of the above referenced special use lease. Please sign both copies, have your signature notarized and return both copies to this office, at which time we will send you the fully executed original for your file and reference.

Thank you.

Sincerely,

Richard B. Wilcox
LAND SPECIALIST

RBW:jcl

Enclosures (2)

Note: paragraph 6 has been added to the lease.

RECEIVED
JAN 10 1984
PROVO CITY MAYOR

SPECIAL USE LEASE AGREEMENT NO. 498

School Fund

The STATE OF UTAH, acting by and through the DIVISION OF STATE LANDS, LESSOR, hereby leases to Provo City Corporation, LESSEE, 359 West Center Street, Provo, Utah 84601, the following described tract of State land in Utah County, Utah , to-wit:

Parcel "A":

Township 9 South, Range 1 West, SLB&M
Section 17: SW¼NW¼

Containing 40 acres, more or less.

Parcel "B":

Township 9 South, Range 1 West, SLB&M
Section 17: That portion of the section ot described by Parcel "A".

Containing 600 acres, more or less.

TO HAVE AND TO HOLD for a term of 51 years, beginning as of January 1, 1984, subject to any and all existing valid rights in said land and subject also to the following terms and conditions. LESSOR and LESSEE enter into this Special Use Lease Agreement for the purpose that LESSEE develop the land in the manner hereinafter described and consistent with the principles and objectives of land development expressed and implicit in the Enabling Act of Utah (Act of July 16, 1894, Ch. 138, 28 Stat. 107) and Article X of the Constitution of the State of Utah.

1. The subject tract shall be used by LESSEE for the purpose of constructing and maintaining a sanitary landfill, including all improvements reasonably associated therewith. All improvements constructed on the subject tract shall comply with the applicable provisions of the Uniform Building Code, Current Edition, International Conference of Building Officials.

2. LESSEE shall pay, to the LESSOR as rental, for the subject tract, the sum of $1,000.00 per year until LESSEE commences construction of the sanitary landfill on the subject property, after which the annual rate shall be $40.00 per acre per annum for that portion of the subject property which is currently being used as the sanitary landfill proper (Parcel A). The sanitary landfill proper is that portion of the subject tract enclosed by a fence and which is used for sanitary landfill purposes. The fee for that portion of the subject property which is not currently being used as the sanitary landfill proper is $10.00 per acre per annum (Parcel B). The annual lease fee, based on th above rates is $7600.00 per annum. LESSOR acknowledges the receipt of $1,020.00 which is payment of this rental for the year January 1, 1984 through December 31, 1984 plus the $20.00

application fee. Should construction on the sanitary landfill commence during the 1984 rental year, or any other subsequent rental year, the lease rates will be prorated according to the rates as outlined above. Failure to pay the rental for a period of one month from the date such rent is due shall work a forfeiture of the lease upon expiration of thirty (30) days written notice by LESSOR to LESSEE, requiring performance, if payment shall not be made within said thirty (30) day period.

3. LESSEE agrees that LESSOR shall have the right to adjust the annual rentals as provided for in Paragraph 2 at the end of each five (5) year period as LESSOR shall deem to be reasonably necessary in the best interest of the State.

LESSEE also agrees that at the end of five (5) years from the date of this lease, and, if necessary, for each two (2) year period thereafter, LESSEE has not developed the land as proposed in Paragraph (1), LESSEE shall then be required to appear before the Board of State Lands and show that it has exercised due diligence toward development of the land. If LESSEE fails to show due diligence, then LESSEE agrees that LESSOR may at its option, terminate this lease agreement as to any or all the land leased hereunder. In the event LESSOR so terminates, LESSEE 's interest in the land shall revert to the State.

4. LESSEE, in exercising the privileges granted by this lease, shall comply with the provisions of all valid Federal, State, County, and Municipal laws, ordinances, and regulations which are applicable to the subject tract and operations covered by this lease.

5. LESSEE shall take reasonable precautions to protect, in place, all public land survey monuments and private property corners.

6. LESSEE shall be bound by all of the provisions, conditions, and prohibitions of Chapter 14 of Title 73, Utah Code Annotated (1953) as amended. No waste or by-products shall be discharged which contain any substance in concentrations which will result in substantial harm to fish and wildlife, or to human water supplies. Storage facilites for materials capable of causing water pollution, if accidentally discharged, shall be located so as to prevent any spillage into waters, or channels leading into water, that would result in substantial harm to fish and wildlife or to human water supplies.

7. LESSEE agrees to permit LESSOR free and unrestricted access to and upon the subject tract at all reasonable times for all lawful and proper purposes not inconsistent with the intent of this lease or with the reasonable exercise and enjoyment by the LESSEE of the rights and privileges granted herein.

8. It is hereby understood and agreed that all treasure-trove and all articles of antiquity in or upon the subject lands are and shall remain the property of the State of Utah. LESSEE shall report any discovery of a "site" or "Specimen" to the Division of State History in compliance with the provisions of Section 63-18-27, Utah Code Annotated (1953), as amended.

9. LESSEE may relinquish or surrender this lease at any time during the term hereof by giving LESSOR one year's advance written notice, and by paying all rentals due to the effective date of such relinquishment or surrender; provided, all accounts are in good standing and all terms and conditions have been performed by LESSEE. The relinquishment or surrender shall become effective upon written acceptance thereof by LESSOR.

10. This lease may be terminated by LESSOR upon breach of any conditions hereof. If LESSOR determines that the LESSEE, its assigns or successors in interest have breached any conditions of this lease, LESSOR shall notify the breaching party (parties) in writing by certified mail, return receipt requested, specifying the particular breach. The breaching party (parties) shall have thirty (30) days from the date of such notice, or such longer period as may reasonably be required under the circumstances, to correct such breach. If breaching party (parties) fails (fail) to correct such breach within such period, LESSOR may terminate this lease upon thirty (30) days notice; provided, however, such termination shall not release breaching party (parties) from liability for damage prior to such termination.

11. This lease is made pursuant to the provisions of all applicable laws and subject to the rules and regulations of the departments and agencies of the State of Utah presently in effect and to such laws, rules and regulations as may be hereafter promulgated by the State.

12. It is understood that the LESSEE will use the subject lands as a sanitary landfill and consistent with such a use, the LESSEE shal maintain the subject lands in a reasonable state of repair, orderliness, neatness, sanitation and safety. In no event shall the condition of the subject lands be less than that required by law and applicable regulations.

13. LESSEE shall have the right to remove any improvements and any personal property placed on the lands by LESSEE, provided that the same shall be removed within sixty (60) days after the expiration of the term of this lease, provided that the LESSEE shall properly restore any damage caused thereby to the subject tract or any improvements remaining thereon; provided further, that LESSOR shall have the option to retain without compensation to LESSEE any and all underground pipes or facilities for water and sewer now on the premises or subsequently installed thereon by LESSEE.

14. LESSEE assumes liability for and agrees to indemnify LESSOR for and against any and all liability (including attorney's fees) of any nature imposed upon, incurred by, or asserted against LESSOR which in any way relates to or arises out of the activity or presence upon the premises of LESSEE, its servants, employees, agents, sublessees, assignees or invitees.

15. LESSEE shall not assign this lease, in whole or in part, nor sublease the leased premises, nor allow unauthorized or commercial use of the premises without obtaining the prior written consent of LESSOR.

16. LESSOR expressly reserves the right to lease said lands to third parties for mineral exploration and/or development purposes together with the right to grant the mineral lessee reasonable access by ingress and egress to and from the mineral estate through the surface estate in connection with mineral exploration and/or development, but without damage to improvements made by LESSEE. Provided, however, that the rights reserved by this paragraph and any rights conveyed by the LESSOR to a mineral lessee shall in no event be inconsistent with the construction or maintenance of a sanitary landfill.

17. LESSOR claims title in fee simple, but does not warrant to LESSEE the validity of title to the leased premises. LESSEE shall have no claim from damages or refund against the LESSOR for any claimed failure or deficiency of LESSOR's title to said lands or for interference by any third party.

18. If LESSEE shall initiate or establish any water right on the leased premises, such right shall become an appurtenance of the leased premises. LESSEE agrees that any existing application to appropriate water on said State land shall be transferred to the Division of State Lands after the application has been completed, without any cost to the State. It is expressly understood and agreed that this lease does not confer any rights upon LESSEE to use any water presently developed on the subject lands.

19. LESSEE shall at all times observe reasonable precautions to prevent fire on the leased premises and shall comply with all applicable laws and regulations of any governmental agency having jurisdiction. In the event of a fire on the leased premises proximately caused by LESSEE, its servants, employees, agents, sublessees, assignees or licensees which necessitates suppression action by the State Forester, LESSEE agrees to reimburse LESSOR for the cost of such fire suppression action.

20. LESSEE shall comply with any and all valid sanitation and pollution regulations prescribed by any governmental agency having jurisdiction; and the LESSEE agrees to indemnify LESSOR for any damage which LESSOR may suffer which arises out of the improper or unlawful disposal of refuse associated with said land.

21. LESSEE may fence the leased premises at his own expense, but if there is no fence erected, LESSEE shall have no right of action against any other State grazing permittee by reason of a trespass upon the leased premises.

22. In the event of any breach of this agreement, the party at fault shall pay all costs of enforcing the same, including reasonable attorney's fees.

23. Any notice contemplated herein to be served upon LESSEE shall be in writing and shall be deemed sufficient if deposited in the United States mail, postage prepaid and certified or registered, and addressed as follows:

Provo City Corporation
359 West Center Street
Provo, Utah 84601

or at any such other address as LESSEE may from time to time designate by written notice to LESSOR.

24. The provisions hereof shall inure to and be binding upon the successors and assigns of LESSEE.

25. IN WITNESS WHEREOF, the Director of the Utah Division of State Lands has executed this instrument as of the _____ day of _____, 1983, by authority of a resolution of the Board of State Lands, dated January 20, 1982.

LESSOR: STATE OF UTAH
DIVISION OF STATE LANDS
3100 State Office Building
Salt Lake City, Utah 84114

By: _____
RALPH A. MILES, Director

ATTORNEY GENERALS OFFICE
APPROVED AS TO FORM

LESSEE:

By: _____

STATE OF UTAH)
: ss.
COUNTY OF SALT LAKE)

On the _____ day of _____, 1983, personally appeared before me Ralph A. Miles, who being by me duly sworn did say that he is the Director of the Division of State Lands of the State of Utah, and that said instrument was signed in behalf of said Board by resolution of the Board, and said Ralph A. Miles acknowledged to me that said Board executed the same in behalf of the State of Utah.

Given under my hand and seal this _____ day of _____, 1983.

_____
Notary Public, residing at:

My Commission Expires:

26.

STATE OF UTAH)
: ss.
COUNTY OF)

On the _____ day of _____, 1983, personally appeared before me _____, who being by me duly sworn did say that he is the _____ of Provo City Corporation, and said _____ acknowledged to me that said City executed the same.

Given under my hand and seal this _____ day of _____, 1983.

_____
Notary Public, residing at:

My Commission Expires:

AMENDMENT

TO

SPECIAL USE LEASE AGREEMENT NO. 498

The STATE OF UTAH, acting by and through the DIVISION OF STATE LANDS & FORESTRY, LESSOR, and Provo City Corporation, LESSEE, hereby agree to amend Special Use Lease Agreement No. 489, as follows:

The leased premises shall include, in addition to Parcel "A" and Parcel "B" as described in SULA No. 498, Parcel "C" which is a tract of State land in Utah County, Utah, to-wit:

Township 9 South, Range 1 West, SLB&M
Section 18: S2SE4NE4

Containing 20 acres

1. Parcel "C" shall be used by LESSEE for the purpose of constructing and maintaining a water well and water tank to be used in conjuction with a sanitary landfill including improvements reasonably associated . All improvements constructed on the subject tract shall comply with the applicable provisions of the Uniform Building Code, Current Edition, International Conference of Building Officials.

2. LESSEE shall pay, to the LESSOR as rental, for the subject tract the sum of $1000.00 per year until LESSEE commences construction of the sanitary landfill on the subject property, after which the annual rate shall be $40.00 per acre per annum for that portion of subject property which is currently being used as the sanitary landfill proper (Parcel A). The sanitary landfill proper is that portion of the subject tract enclosed by a fence which is used for sanitary landfill purposes. The fee for that portion of the subject property which is not currently being used as the sanitary landfill proper is $10.00 per acre per annum (Parcel B). The fee for that portion of the subject property which is used for the water well and water tank site (Parcel C) will be $600.00 per year. The annual lease fee, based on the above rates is $8,200.00 per annum.

3. IN WITNESS WHEREOF, the Director of the Utah Division of State Lands and Forestry has executed this instrument as of the 14th day of JAN., 1987, by authority of a resolution of the Board of State Lands, dated January 20, 1982.

LESSOR: STATE OF UTAH
DIVISION OF STATE LANDS AND FORESTRY
3 Triad Center, Suite 400
355 West North Temple
Salt Lake City, Utah 84180

By: Ralph A. Miles
RALPH A. MILES, Director

APPROVED AS TO FORM:
DAVID L. WILKINSON
ATTORNEY GENERAL

BY: David L. Christensen

LESSEE: Provo City Corporation
359 West Center
Provo City, UT 84601

By: Joseph Q. Jenkins

STATE OF UTAH)
: ss.
COUNTY OF SALT LAKE)

On the 14th day of JANUARY, 1987, personally appeared before me Ralph A. Miles, who being by me duly sworn did say that he is the Director of the Division of State Lands and Forestry of the State of Utah, and that said instrument was signed in behalf of said Board by resolution of the Board, and said Ralph A. Miles acknowledged to me that said Board executed the same in behalf of the State of Utah.

Given under my hand and seal this 14th day of JANUARY, 1987.

Jan C. Lucas
Notary Public, residing at: S.L.C.

My Commission Expires: 4-16-90

4.

STATE OF UTAH)
: ss.
COUNTY OF)

On the 31 day of Dec., 1986, personally appeared before me Joseph A. Jenkins, who being by me duly sworn did say that he is the Mayor of Provo City, and said Joseph A. Jenkins acknowledged to me that said company executed the same.

Given under my hand and seal this 31 day of Dec., 1986.

Jean Ellard
Notary Public, residing at:

My Commission Expires:
12-10-90

APPENDIX C

COST BREAKDOWN FOR CLOSURE/POST-CLOSURE

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

Bayview Landfill
Closure Cost Estimate
Cell 1 and Stage 1 of Cell 2

Cell #1	33	Acres
Cell #2 Stage 1	15	Acres
Total	48	Acres

	Item	Unit	Unit Cost	Quantity	Cost
1.00	**Engineering/Management**				
1.01	Topo Survey Preliminary	HR	$125	28	$3,500
1.02	Topo Survey Final	HR	$125	24	$3,000
1.03	Site Reconnaissance	HR	$125	16	$2,000
1.04	Boundary Survey	HR	$125	12	$1,500
1.05	Construction Plans/Specs	LUMP	$50,000	1	$50,000
1.06	Bidding and Award	LUMP	$5,000	1	$5,000
1.07	Quality Control Testing	LUMP	$5,000	1	$5,000
1.08	Construction Management/QC	LUMP	$50,000	1	$50,000
1.09	Closure Report/As-Builts	LUMP	$10,000	1	$10,000
1.10	Obtain UPDES and other permits	LUMP	$10,000	1	$10,000
			Subtotal		$140,000
			Contingency	10%	$14,000
			Engineering Subtotal		**$154,000**

2.00	***Construction***				
2.01	Excavation for Cover Material [5,6]	CY	$2.00	232,320	$464,640
2.02	Grading Top of Intermediate Cover	LS	$20,000.00	1	$20,000
2.03	3' Compacted Fill Placement (Cap) [2]	CY	$2.50	232,320	$580,800
2.04	Silt Fence/Erosion Control	LF	$2.25	5,000	$11,250
2.05	Dust Control and Watering	LS	$10,000.00	1	$10,000
2.06	Import Fill	CY		0	$0
2.07	Drainage Ditches	LF	$2.50	5,000	$12,500
2.08	Temporary Drainage Control	LS	$10,000.00	1	$10,000
2.09	Revegetation	SY	$0.22	232,320	$51,110
2.10	Gas Collection System [7]	ACRE	$10,000.00	33	$330,000
			Subtotal		$1,490,300
			Contingency	10%	$149,030
			Construction Subtotal		**$1,639,330**

	Summary		Engineering		$154,000
			Construction		$1,639,330
			Legal	5%	$89,667
				Total	**$1,882,997**

Assumptions/Notes:

1. Estimate assumes closure of Cell #1 (33 acres) and Cell #2 Stage 1 (15 acres).
2. Alternative final cover, consisting of 34 inches of onsite soil.
3. The existing detention pond is adequate and no additional improvements are necessary.
4. No permanent culverts or drainage piping is required.
5. Existing on-site stock pile quantity is approximately 100,000 cy.
6. Aproximately 123,000 cy of borrow material are available from Cell 2.
7. Passive gas collection wells only, with no collection or destruction.

Bayview Landfill
Post-Closure Care Cost Estimate for
Cell 1

COST ESTIMATE FOR LANDFILL POST-CLOSURE CARE

	Item	Unit	Unit Cost	Quantity	Cost
1.0	ENGINEERING				
1.1	Post Closure Plan	LUMP	$5,000	1	$5,000
1.2	Site Inspection & Recordkeeping (annual)	PER YEAR	$2,000	30	$60,000
1.3	Correctional Plans & Specs (annual)	PER YEAR	$1,000	30	$30,000
1.4	Site Monitoring (quarterly)	PER YEAR	$9,000	30	$270,000
2.0	CONSTRUCTION COSTS	PER YEAR	$5,000	30	$150,000
3.0	LEACHATE DISPOSAL	PER GALLON	$0.05	0	$0
			Subtotal		$515,000
			Contingency (10%)		$51,500
			Total		$566,500

Closure Cost Estimate	$ 1,882,997
Closure/Post-Closure Total	**$ 2,449,497**

APPENDIX D

ENGINEERING DRAWINGS/SPECIFICATIONS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

APPENDIX D – ENGINEERING DRAWINGS/SPECIFICATIONS

Engineering drawings and specifications will be inserted here upon completion.

APPENDIX E

BORING LOGS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

This document was submitted
as part of a previous Permit.

APPENDIX E-1

CULINARY WELL

Page 1 of 4

Form 113—5M—11-60

Examined _____ 19__

Recorded: B. C. _____ T. B. _____

Inspection Sheet _____

Copied _____

REPORT OF WELL DRILLER

STATE OF UTAH

Test Well Request

Application No. 86-5371-TH

Claim No. _____

Coordinate No. _____

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

S.C.

(1) WELL OWNER:

Name Provo City Water and Waste Water Dept.

Address P.O. 1849 Provo Utah

(2) LOCATION OF WELL:

County Utah Ground Water Basin _____ (leave blank)

North 2640 feet, South _____ feet, East 15 feet, West _____ feet from NW Corner of Section 17, T. 9 S., R. 1 E., SLBM (strike out words not needed)

1,130
1,447
From E ¼ Cor. Sec. 18

(3) NATURE OF WORK (check):

New Well ☑ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐

If abandonment, describe material and procedure: _____

(4) NATURE OF USE (check):

Domestic ☐ Industrial ☐ Municipal ☑ Stockwater ☐

Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):

Rotary ☐ Dug ☐ Jetted ☐

Cable ☑ Driven ☐ Bored ☐

(6) CASING SCHEDULE:

Threaded ☐ Welded ☑

18" Diam. from 0 feet to 100 feet Gage 250

12" Diam. from 0 feet to 502 feet Gage 375

_____ Diam. from _____ feet to _____ feet Gage _____

New ☑ Reject ☐ Used ☐

(7) PERFORATIONS:

Perforated? Yes ☑ No ☐

Type of perforator used Mills

Size of perforations 3/8 inches by 2 1/2 inches

= 7.56 ft.² 1160 perforations from 350 feet to 445 feet; perforations from 450 feet to 500 feet

perforations from _____ feet to _____ feet

perforations from _____ feet to _____ feet

perforations from _____ feet to _____ feet

@ 302 gpm = 0.09 cfs

(8) SCREENS:

Well screen installed? Yes ☐ No ☑

Manufacturer's Name _____

Type _____ Model No. _____

Diam. _____ Slot size _____ Set from _____ ft. to _____

Diam. _____ Slot size _____ Set from _____ ft. to _____

(9) CONSTRUCTION:

Was well gravel packed? Yes ☐ No ☑ Size of gravel: _____

Gravel placed from _____ feet to _____ feet

Was a surface seal provided? Yes ☑ No ☐

To what depth? 100 feet

Material used in seal: Grout

Did any strata contain unusable water? Yes ☐ No ☑

Type of water: _____ Depth of strata _____

Method of sealing strata off: _____

Was surface casing used? Yes ☑ No ☐

Was it cemented in place? Yes ☑ No ☐

(10) WATER LEVELS:

4505.5

Static level 264 feet below land surface Date 9/9/86

Artesian pressure _____ feet above land surface Date _____

LOG RECEIVED:

(11) FLOWING WELL:

Controlled by (check) Valve ☐ Cap ☐ Flow ☐ No Control ☐

Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS:

Drawdown is the distance in feet the water level is lowered below static level.

Was a pump test made? Yes ☑ No ☐ If so, by whom? Rodney Bro.

Yield: 153 gal./min. with 26 feet drawdown after 2 hours

" 201 " " 44 " 4 "

" 202 " " 97 " 10 "

5.9
4.6
3.1

T = 6,500 gpd/ft.

Bailer test _____ gal./min. with _____ feet drawdown after _____ hours

Artesian flow _____ g.p.m. Date _____

Temperature of water 68°F Was a chemical analysis made? No ☐ Yes ☒

(13) WELL LOG:

18" to 100' Diameter of well 12" inches

Depth drilled 510 feet. Depth of completed well 502 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Bedrock	Other	REMARKS
0	5	X		X	X					
5	10	X		X	X					
10	15	X		X	X					
15	20	X			X					
20	25	X			X					
25	30	X			X					
30	35	X			X					
35	40	X			X					Reddish Sand
40	45	X			X					" "
45	50	X			X					" "
50	55	X			X					" "
55	60	X			X					" "
60	65	X			X					" "
65	70	X			X					" "
70	75	X			X					" "
75	80	X			X					" "
80	85	X			X					" "
85	90	X			X					" "
90	95	X			X					" "
95	100	X			X					" "
100	105	X			X					" "
105	110	X			X					" "
110	115	X			X					" "
115	120	X			X					" "
120	125	X			X					" "
125	130	X			X					" "
130	135	X			X					" "
135	140	X			X					" "
140	145	X			X					" "
145	150	X			X					" "
150	155	X			X					" "
155	160	X			X					" "

Work started 7-2-86 Completed 9-9-1986

(14) PUMP:

Manufacturer's Name _____

Type: Turbine H. P. _____

Depth to pump or bowls 400 feet

Well Driller's Statement:

This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.

Name Binning Drlg. Co. (Person, firm, or corporation) (Type or print)

Address 1085 E. 150 North Fairview, Ut.

(Signed) Peter L. Binning (Well Driller)

License No. 243 Date Sept. 10, 1986

USE OTHER SIDE FOR ADDITIONAL REMARKS

Page 2 of 4

Form 113—50d—12-40

Examined _____

Recorded: B. C. _____ T. B. _____

Inspection Sheet _____

Copied _____

REPORT OF WELL DRILLER
STATE OF UTAH

Test Well Request

Application No. 86-5331-TW

Claim No. _____

Coordinate No. _____

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:

Name Provo City Water Waste Water

Address _____

(2) LOCATION OF WELL:

County _____ Ground Water Basin _____ (leave blank)

North / South _____ feet, East / West _____ feet from _____ Corner

of Section _____, T. _____ N/S, R. _____ E/W SLBM/UBM (strike out words not needed)

(3) NATURE OF WORK (check):

New Well ☐ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐

If abandonment, describe material and procedure: _____

(4) NATURE OF USE (check):

Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☐

Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):

Rotary ☐ Dug ☐ Jetted ☐

Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE:

Threaded ☐ Welded ☐

____" Diam. from ____ feet to ____ feet Gage ____

____" Diam. from ____ feet to ____ feet Gage ____

____" Diam. from ____ feet to ____ feet Gage ____

New ☐ Reject ☐ Used ☐

(7) PERFORATIONS:

Perforated? Yes ☐ No ☐

Type of perforator used _____

Size of perforations _____ inches by _____ inches

____ perforations from ____ feet to ____ feet

____ perforations from ____ feet to ____ feet

____ perforations from ____ feet to ____ feet

____ perforations from ____ feet to ____ feet

____ perforations from ____ feet to ____ feet

(8) SCREENS:

Well screen installed? Yes ☐ No ☐

Manufacturer's Name _____

Type _____ Model No. _____

Diam. _____ Slot size _____ Set from _____ ft. to _____

Diam. _____ Slot size _____ Set from _____ ft. to _____

(9) CONSTRUCTION:

Was well gravel packed? Yes ☐ No ☐ Size of gravel: _____

Gravel placed from _____ feet to _____ feet

Was a surface seal provided? Yes ☐ No ☐

To what depth? _____ feet

Material used in seal: _____

Did any strata contain unusable water? Yes ☐ No ☐

Type of water: _____ Depth of strata _____

Method of sealing strata off: _____

Was surface casing used? Yes ☐ No ☐

Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:

Static level _____ feet below land surface Date _____

Artesian pressure _____ feet above land surface Date _____

LOG RECEIVED:

(11) FLOWING WELL:

Controlled by (check) Valve ☐

Cap ☐ Plug ☐ No Control ☐

Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS:

Drawdown is the distance in feet the water level is lowered below static level.

Was a pump test made? Yes ☐ No ☐ If so, by whom? _____

Yield: _____ gal./min. with _____ feet drawdown after _____ hours

" _____ " _____ " _____ " _____

Bailer test _____ gal./min. with _____ feet drawdown after _____ hours

Artesian flow _____ g.p.m. Date _____

Temperature of water _____ Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG:

Diameter of well _____ inches

Depth drilled _____ feet. Depth of completed well _____ feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
160	165	X			X							
165	170	X			X							
170	175	X			X							
175	80	X			X							
180	85	X			X							
185	90	X			X							
190	95	X			X							
195	200	X			X							
200	205	X			X							
205	210	X			X							
210	215	X			X							
215	220	X			X							
220	225	X			X							
225	230	X			X							more Rocks!
230	235	X			X							
235	240	X			X							
240	245	X			X							
245	250	X			X							
250	255	X			X							
255	260	X			X							
260	265	X			X							A little Water!
265	270	X			X							" "
270	275	X			X							" "
275	280	X			X							" "
280	285	X			X							" "
285	290	X			X							
290	295	X			X							
295	300	X			X							
300	305	X			X							
305	310	X			X							
310	315	X			X							
315	320	X			X							

Work started _____ 19____ Completed _____ 19____

(14) PUMP:

Manufacturer's Name _____

Type: _____ H. P. _____

Depth to pump or bowles _____ feet

Well Driller's Statement:

This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.

Name BINNING Drlg. Co. (Person, firm, or corporation) (Type or print)

Address _____

(Signed) _____ (Well Driller)

License No. 243 Date _____, 19____

USE OTHER SIDE FOR ADDITIONAL REMARKS

Page 3 of 4

Test Well Request

Form 115—5M—1240

Examined _____

Recorded: R. C. _____ T. B. _____

Inspection Sheet _____

Copied _____

REPORT OF WELL DRILLER

STATE OF UTAH

Application No. 86-53-H-TW

Claim No. _____

Coordinate No. _____

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:

Name Moab City Water and Waste Water

Address _____

(2) LOCATION OF WELL:

County _____ Ground Water Basin _____ (leave blank)

North / South _____ feet, East / West _____ feet from _____ Corner

of Section _____, T. _____ N/S, R. _____ E/W SLBM (strike out words not needed)

(3) NATURE OF WORK (check):

New Well ☐ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐

If abandonment, describe material and procedure: _____

(4) NATURE OF USE (check):

Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☐

Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):

Rotary ☐ Dug ☐ Jetted ☐

Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE:

Threaded ☐ Welded ☐

_____" Diam. from _____ feet to _____ feet Gage _____

_____" Diam. from _____ feet to _____ feet Gage _____

_____" Diam. from _____ feet to _____ feet Gage _____

New ☐ Reject ☐ Used ☐

(7) PERFORATIONS:

Perforated? Yes ☐ No ☐

Type of perforator used _____

Size of perforations _____ inches by _____ inches

_____ perforations from _____ feet to _____ feet

_____ perforations from _____ feet to _____ feet

_____ perforations from _____ feet to _____ feet

_____ perforations from _____ feet to _____ feet

_____ perforations from _____ feet to _____ feet

(8) SCREENS:

Well screen installed? Yes ☐ No ☐

Manufacturer's Name _____

Type _____ Model No. _____

Diam. _____ Slot size _____ Set from _____ ft. to _____

Diam. _____ Slot size _____ Set from _____ ft. to _____

(9) CONSTRUCTION:

Was well gravel packed? Yes ☐ No ☐ Size of gravel: _____

Gravel placed from _____ feet to _____ feet

Was a surface seal provided? Yes ☐ No ☐

To what depth? _____ feet

Material used in seal: _____

Did any strata contain unusable water? Yes ☐ No ☐

Type of water: _____ Depth of strata _____

Method of sealing strata off: _____

Was surface casing used? Yes ☐ No ☐

Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:

Static level _____ feet below land surface Date _____

Artesian pressure _____ feet above land surface Date _____

LOG RECEIVED:

(11) FLOWING WELL:

Controlled by (check) Valve ☐

Cap ☐ Plug ☐ No Control ☐

Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS:

Drawdown is the distance in feet the water level is lowered below static level.

Was a pump test made? Yes ☐ No ☐ If so, by whom? _____

Yield: _____ gal./min. with _____ feet drawdown after _____ hours

" " " " " "

Bailer test _____ gal./min. with _____ feet drawdown after _____ hours

Artesian flow _____ g.p.m. Date _____

Temperature of water _____ Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG:

Diameter of well _____ inches

Depth drilled _____ feet. Depth of completed well _____ feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
320	325	X			X							
325	330	X			X							
330	335	X			X							Water (more gravel than Clay)
335	340	X			X							"
340	345	X			X							"
345	350	X			X							"
350	355	X			X							Water mostly Gravel
355	360	X			X							" " "
360	365	X			X							" " "
365	370	X			X							" " "
370	375	X			X							" " "
375	380	X			X							" " "
380	385	X			X							" " "
385	390	X			X							" " "
390	395	X			X							
395	400	X			X							
400	405	X			X							
405	410	X			X							
410	415	X			X							
415	420	X			X							
420	425	X			X							
425	430	X			X							
430	435	X			X							
435	440	X			X							
440	445	X			X							
445	450	X			X							
450	455	X			X							
455	460	X			X							
460	465	X			X							
465	470	X			X							
470	475	X			X		X					Deep Rock + Clay
475	480	X			X		X					" " "

Work started _____ 19__ Completed _____ 19__

(14) PUMP:

Manufacturer's Name _____

Type: _____ H. P. _____

Depth to pump or bowls _____ feet

Well Driller's Statement:

This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.

Name BINNING DRLG. CO. (Person, firm, or corporation) (Type or print)

Address _____

(Signed) _____ (Well Driller)

License No. 243 Date _____ 19__

USE OTHER SIDE FOR ADDITIONAL REMARKS

Page 4 of 4

Form 113—534—12-60

Examined _____
Recorded: R. C. _____ T. R. _____
Inspection Sheet _____
Copied _____

REPORT OF WELL DRILLER
STATE OF UTAH

Test Well Request
Application No. _____
Claim No. 86-53-1-TW
Coordinate No. _____

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Provo City Water and Waste Water
Address _____

(2) LOCATION OF WELL:
County _____ Ground Water Basin _____ (leave blank)
North / South _____ feet, East / West _____ feet from _____ Corner
of Section _____ T. _____ N / S, R _____ E SLBM / W USM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☐
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure: _____

(4) NATURE OF USE (check):
Domestic ☐ Industrial ☐ Municipal ☐ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☐
_____" Diam. from _____ feet to _____ feet Gage _____
_____" Diam. from _____ feet to _____ feet Gage _____
_____" Diam. from _____ feet to _____ feet Gage _____
New ☐ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☐ No ☐
Type of perforator used _____
Size of perforations _____ inches by _____ inches
_____ perforations from _____ feet to _____ feet
_____ perforations from _____ feet to _____ feet
_____ perforations from _____ feet to _____ feet
_____ perforations from _____ feet to _____ feet
_____ perforations from _____ feet to _____ feet

(8) SCREENS: Well screen installed? Yes ☐ No ☐
Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot size _____ Set from _____ ft. to _____
Diam. _____ Slot size _____ Set from _____ ft. to _____

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☐ Size of gravel: _____
Gravel placed from _____ feet to _____ feet
Was a surface seal provided? Yes ☐ No ☐
To what depth? _____ feet
Material used in seal: _____
Did any strata contain unusable water? Yes ☐ No ☐
Type of water: _____ Depth of strata _____
Method of sealing strata off: _____

Was surface casing used? Yes ☐ No ☐
Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:
Static level _____ feet below land surface Date _____
Artesian pressure _____ feet above land surface Date _____

LOG RECEIVED:

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☐ No ☐ If so, by whom? _____
Yield: _____ gal./min. with _____ feet drawdown after _____ hours
" _____ " _____ " _____ "
" _____ " _____ " _____ "
Bailer test _____ gal./min. with _____ feet drawdown after _____ hours
Artesian flow _____ g.p.m. Date _____
Temperature of water _____ Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well _____ inches
Depth drilled _____ feet. Depth of completed well _____ feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
480	485	X			X		X					Big Rocks + Clay
485	490	X			X							
490	495	X			X							
495	500	X				X						
500	505	X			X							Mostly Gravel
505	510	X			X							" "

Work started _____ 19__ Completed _____ 19__

(14) PUMP:
Manufacturer's Name _____
Type: _____ H. P. _____
Depth to pump or bowles _____ feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Binning Drlg. Co. (Person, firm, or corporation) (Type or print)
Address _____
(Signed) _____ (Well Driller)
License No. 243 Date _____, 19__

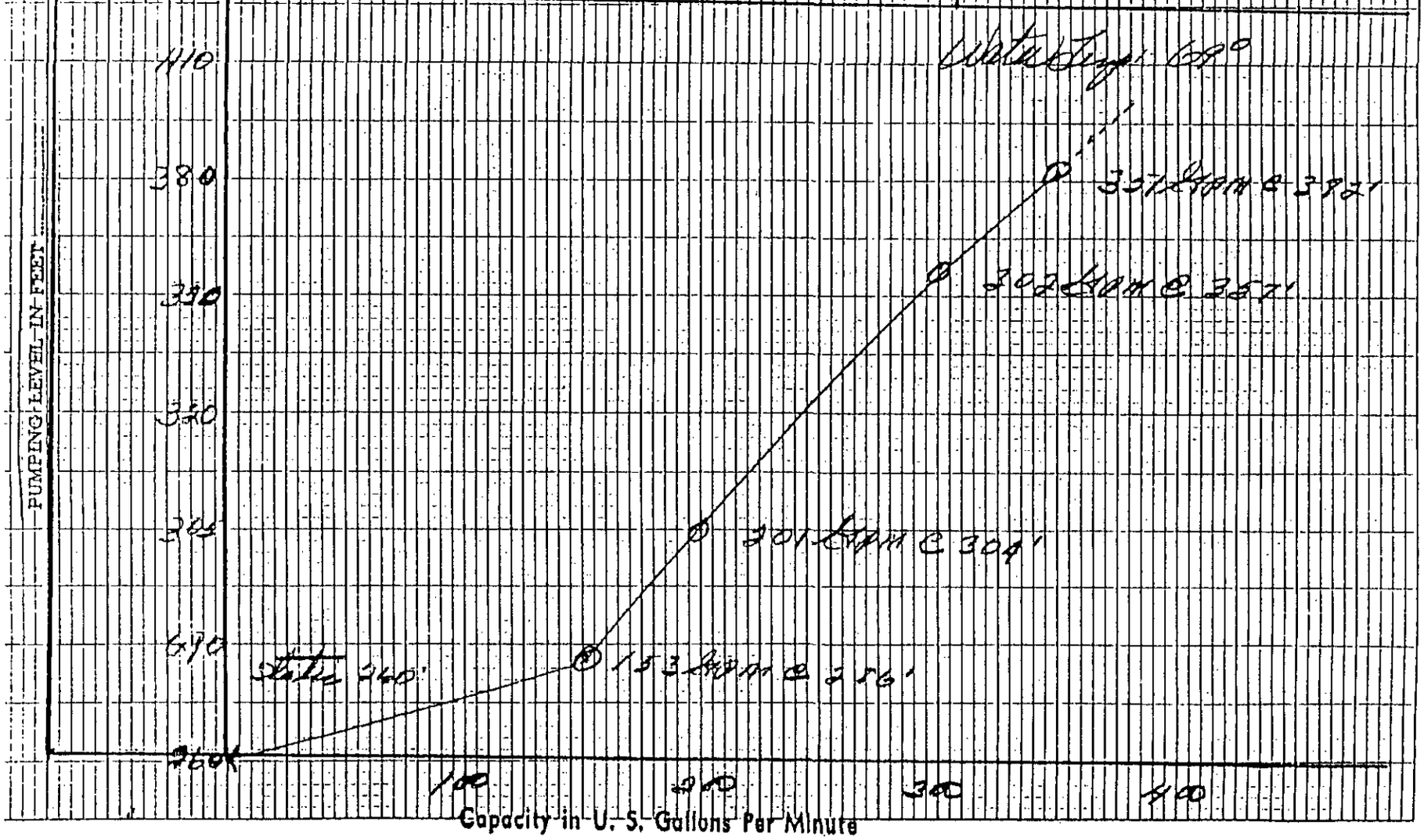
USE OTHER SIDE FOR ADDITIONAL REMARKS

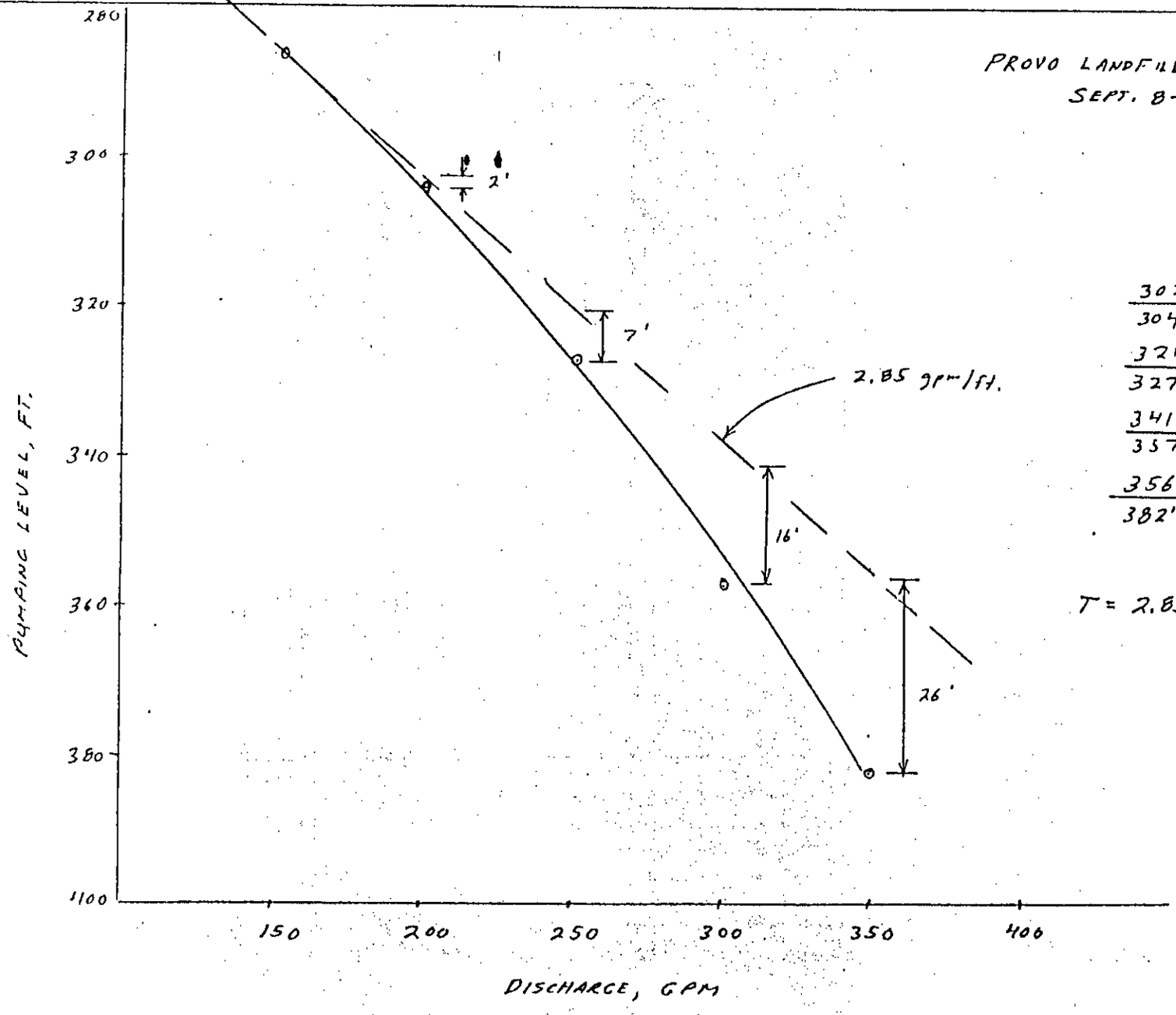
KEUFFEL & ESSER CO. MADE IN U.S.A.

Field Copy of Well Test, Application No. .....

Test Conducted by Rhodes Bros.; Fillmore, Utah — 743-6277

Job Name [illegible]	Driller [illegible]	Remarks [illegible]
Location [illegible]	Column Size [illegible] Bowl Size [illegible]	
Date of Test [illegible]	No. Hours Pumped [illegible]	
Well Size [illegible]	Feet of Drawdown from Static	
Well Depth [illegible]	Drawdown Measured with [illegible]	
Static [illegible]	Gallons Per Ft. of Drawdown	
Perforations [illegible]	Pump Setting [illegible]	





$\frac{302}{304}$ @ 200 gpm = 0.993

$\frac{321}{327}$ @ 250 gpm = 0.982

$\frac{341}{357}$ @ 300 gpm = 0.955

$\frac{356'}{382'}$ @ 350 gpm = 0.932

T = 2.85 × 2000 = 5,700 gpd/ft.

Landfill Well | Pumping Test | CHC 9/10/86

CHEMTECH

CHEMICAL AND BACTERIOLOGICAL ANALYSES

367 SOUTH COMMERCE LOOP
OREM, UTAH 84057
(801) 226-8822

2875 MAIN
SUITE #101
SALT LAKE CITY, UTAH 84115
(801) 483-1163

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Provo City Water Dept.
Provo, UT 84601

LAB NO.: U014828

DATE SAMPLED: 9-9-86

TIME SAMPLED: 0940

SAMPLED BY: CXC

LOCATION: Land Fill Site, Well Discharge Pipe (dis = 350 gpm)

COMMENTS:

PARAMETER	LEVEL
Alkalinity as $CaCO_3$, mg/l	308
Ammonia as NH_3-N, mg/l	11.1
Arsenic as As, mg/l	<.01
Barium as Ba, mg/l	0.022
Bicarbonate as HCO_3, mg/l	375
Boron as B, mg/l	0.19
Cadmium as Cd, mg/l	<.01
Calcium as Ca, mg/l	72
Carbonate as CO_3, mg/l	0

PARAMETER	LEVEL
Chloride as Cl, mg/l	57.6
Chromium as Cr (Hex.), mg/l	<.01
Chromium as Cr (Total), mg/l	<.01
Conductivity, umhos/cm	676
Copper as Cu, mg/l	0.085
Fluoride as F, mg/l	0.72
Hardness as $CaCO_3$, mg/l	138
Hydroxide as OH, mg/l	0
Iron as Fe (Dissolved), mg/l	0.082
Iron as Fe (Total), mg/l	0.32
Lead as Pb, mg/l	0.045
Magnesium as Mg, mg/l	13.3
Manganese as Mn, mg/l	<.01
Mercury as Hg, mg/l	0.0018
Nickel as Ni, mg/l	<.01
Nitrate as NO_3-N, mg/l	1.60
Nitrite as NO_2-N, mg/l	<.005
Phosphate as PO_4-P, mg/l	0.018
Potassium as K, mg/l	15.2
Selenium as Se, mg/l	<.002
Silica as SiO_2 (Dissolved), mg/l	70.2
Silver as Ag, mg/l	<.01
Sodium as Na, mg/l	82.4
Sulfate as SO_4, mg/l	60.3
Total Dissolved Solids, mg/l	614
Turbidity, NTU	0.46
Zinc as Zn, mg/l	0.082
pH Units	8.08

Positive $CaCO_3$ saturation index (Langlier)
Scale forming water. Not corrosive.

Rex Henderson

APPENDIX E-2

1989 BORING LOGS

Herm Hughes & Sons, Inc. represents that we have determined and verified all field dimensions and measurements, field construction criteria, materials, and similar data, and that we have checked and coordinated this submittal with the requirements of the Work and the Contract Documents.

1-24-90

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-12-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. SMW-1 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Decon Rig & D.P. & casing	Bitter	11	1
					move set up on #SMW-1 Drill & Drive			
		0	-		12" to 28'			
			5"	5"	sand & silt			
		5"	10		conglomarant gravel & sand cemented			
		10	15					
		15	20					
		20	25					
		25	28		Drill open hole to 75			
		28	30					
		30	45					
		45	60					
		60	75					
					Install 71' 4½ PVC and gravel			
					pack 25' of hole.			
					move rig Decon and set up on			
	6:00				SMW #2			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11

Signature of Owner or Representative _____

CASING USED: Size 12 Ft. Used 30 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON BORING NO. RV-SMW-1

PROJECT NAME BAYVIEW LANDFILL LOGGED BY TOM FELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING DATE DRILLED 12-1-90

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION NORTH OF WATER TANK

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 1 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: REDDISH-BROWN, COARSE-GRAINED MEDIUM SAND. 10% GRAVEL.
				5					
									SAND: REDDISH-BROWN MEDIUM GRAINED WELL SORTED
				10					
									GRAVELLY SAND: REDDISH-BROWN, MEDIUM SORTED 10% GRAVEL
				15					
									GRAVELLY SAND: REDDISH-BROWN MEDIUM SORTED 20% GRAVEL
				20					
									GRAVELLY SAND: FINE-GRAINED REDDISH BROWN MEDIUM SORTED 10% GRAVEL
				25					
									SANDY PEBBLY GRAVEL: REDDISH-BROWN VERY POORLY SORTED 30% PEBBLES
				30					

REMARKS FIRST 2-3 FEET GREY, WEATHERED GRAVEL. REMAINDER OF BOREHOLE IS REDDISH BROWN SANDS + GRAVELS

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. RV-SMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: REDDISH-RED, POORLY SORTED
				35					
									PEBBLY SILTY SAND: REDDISH BROWN, VERY POORLY SORTED, SOME CLAYBALLS
				40					
									PEBBLY SILTY SAND: REDDISH BROWN, VERY POORLY SORTED: CEMENTATION BY SAND.
				45					
									CEMENTED SILTY SAND: WHITE to REDDISH BROWN VERY FINE-GRAINED-CEMENTED.
				50					
				55					GRAVELLY SAND: REDDISH-BROWN, POORLY SORTED: SOME CEMENTATION BY SAND
				60					SILTY GRAVEL: REDDISH-BROWN POORLY SORTED SILT + GRAVEL CEMENTED

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BY-SMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T _____ R _____ SECT. _____ TRACT _____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SILTY SAND: REDDISH-BROWN
				65					CEMENTED VERY SOLIDLY
									GRAVELLY SAND: REDDISH-BROWN
				70					CEMENTED.
									GRAVELLY SAND: REDDISH-BROWN POORLY
			T.D.	75					SORTED, CEMENTED.

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-13-89

RIG NO. 10 RIG TYPE Failing WELL NO. SMW-1 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc, 20'			
					of 4½" screen and 49' of blank			
					4½" pvc. To 70'			
		75'			Install silica sand from 75'-			
					44'			
					Install coarse bentonite from 44'-			
					20'			
					Install neat cement from 20'-			
			0	75'	5' and concrete from 5'-0			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [signature]	Helper	Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-13-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. SMW-2 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview land Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					unload caseing + Drill pipe	Button	11	1
					move axy comp.			
					start to drill + drive 12"			
		0	10		sandy silty + Little bit of clay			
		10	20		gravel + sand. cobbles			
		20	30		gravel cemented cobbles			
		30	40		" "			
		40	50		gravel cemented cobbles			
		50	60		gravel sand cobbles			
	6:00	60	75		gravel sand cobbles			
					Move Rig to decon pad			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11

Signature of Owner or Representative _____

CASING USED: Size 12 Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Martin Petersen | Helper Mike Cindell | Helper

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON — BORING NO. BV-SMW-2

PROJECT NAME BAYVIEW LANDFILL — LOGGED BY T. BELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING — DATE DRILLED 10/12/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION EAST OF CELL #1

LOCATION: T ____ R ____ SECT. ____ TRACT ____ — PAGE 1 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				5					SANDY SILT: BROWN; 10% SAND, VERY WELL SORTED, FINE GRAINED
				10					SANDY SILT: BROWN, 20% SAND, WELL SORTED FINE GRAINED
				15					GRAVELLY SAND: BROWN, WELL SORTED (2-4 mm) ANGULAR PARTICLES
				20					SANDY GRAVEL: BROWN, MEDIUM SORTED (3-6 mm) ANGULAR & SUBANGULAR, 30% SAND
				25					SANDY GRAVEL: BROWN, MEDIUM SORTED (4-10 mm) 10% SAND, COARSE GRAVEL
				30					PEBBLY GRAVELLY SAND: BROWN, POORLY SORTED PEBBLES TO 20 mm 10% PEBBLES 30% GRAVEL

REMARKS FIRST 10' FINE-GRAINED SILT, PROBABLY WINDBLOWN. BALANCE OF BOREHOLE IS SAND + GRAVEL WITH NO FINE GRAINED MATERIAL

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-SMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 2

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				35					SANDY GRAVEL: BROWN, POORLY SORTED SOME PEBBLES, 20% SAND.
				40					GRAVELLY SAND: BROWN MEDIUM SORTED 20% GRAVEL
				45					GRAVELLY SAND: BROWN, POORLY SORTED 10% GRAVEL
				50					SANDY GRAVEL: BROWN, MEDIUM SORTED 10% SAND.
				55					PEBBLY SANDY GRAVEL: VERY POORLY SORTED 10% PEBBLE 30% SAND
				60					GRAVELLY SAND: BROWN MEDIUM SORTED 40% GRAVEL (2-6mm)

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-SMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T _____ R _____ SECT. _____ TRACT _____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SANDY GRAVEL: BROWN, POORLY SORTED 30% SAND
				65					
									SANDY GRAVEL: REDDISH BROWN, POORLY SORTED (2-5 mm)
				70					
				T.D. 73					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-14-89

RIG NO. 10 RIG TYPE Failing WELL NO. SMW-2 TYPE monitoring

JOB OWNER Provo City

LOCATION Bay view

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc, 20'			
					of 4½" screen and 49' of 4½"			
					pvc. To 70'			
		74'			Install silica sand from 74'-			
					44'			
					Install coarse bentonite from 44'-			
					20'			
					Install neat cement from 20'-5'			
			0	74'	and concrete from 5'-0			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Robert Christensen	Helper	Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-5-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. BU-5 MW-3 TYPE ~~[illegible]~~ Monitor

JOB OWNER Provo city

LOCATION Bayview Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Move from #5 to Decon. clean Rig.	Button	11	1
					D.P. & casing. move and set up			
		0			on #3 Drill & Drive 12" Casing			
			70	70				
		0	5		Gravelly Sand			
		5	10		Pebbly Gravel			
		10	20		Gravel - Sandy-silt			
		20	30		Gravel · silty-sand			
		30	40		Gravel - Sandy-silt			
		40	50		Sandy Gravel			
		50	60		Gravel clayey silt			
	6:00	60	70		Gravel sand & silt			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size 12 Ft. Used 74 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	Robert A

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON — BORING NO. GV-SMW-3

PROJECT NAME RAYVIEW LANDFILL — LOGGED BY TOM BELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING — DATE DRILLED 10/5/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION NORTH OF BERM 2

LOCATION: T ____ R ____ SECT. ____ TRACT ____ — PAGE 1 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: GREY, MEDIUM SORTED
				5					
									PEBBLY GRAVEL: GREY, MEDIUM SORTED SOME PEBBLES TO 35 mm
				10					
									GRAVELLY SANDY SILT: BROWN, POORLY SORTED SILT IS QUITE COHESIVE
				15					
									GRAVELLY SILTY SAND: BROWN, POORLY SORTED
				20					
									PEBBLY GRAVELLY SAND: BROWN-GREY POORLY SORTED, SOME PEBBLES TO 40 mm
				25					
									PEBBLY GRAVELLY SAND: BROWN, MEDIUM SORTED
				30					

REMARKS

THIS BOREHOLE ENCOUNTERED MORE GRAVEL THAN THE FIRST TWO. PENETRATION RATE WAS BETTER. THE CUTTINGS PILE WAS 1-2 FEET BECAUSE OF THE GRAVEL CONTENT

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON — BORING NO. BV-SMW-3

PROJECT NAME BAYVIEW LANDFILL — LOGGED BY TOM BELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING — DATE DRILLED 10/5/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION NORTH 2 FROM 3

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY SANDY GRAVEL: GREY BROWN, MEDIUM SORTED, PEBBLES TO 30 mm.
				35					
									PEBBLY GRAVEL: GREY, MEDIUM SORTED 10% SAND, PEBBLES to 20 mm.
				40					
									SANDY GRAVEL: BROWN MEDIUM SORTED 10% SAND
				45					
									PEBBLY SAND: BROWN, VERY POORLY SORTED 10% PEBBLES ≤ 30 mm
				50					
									CLAYEY GRAVELLY SILT: BROWN POORLY SORTED VERY COHESIVE SILT
				55					
									PEBBLY SANDY GRAVEL: BROWN, POORLY SORTED 30% SAND PEBBLES ≤ 20 mm.
				60					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON BORING NO. [illegible]

PROJECT NAME PAYVIEW LANDFILL LOGGED BY TOM BELCHAK

DRILLING METHOD DRILL, DRIVE AIR ROTARY 12" CASING DATE DRILLED 10/5/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION NORTH of Berm 2

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SANDY PEBBLY GRAVEL: MEDIUM SORTED PEBBLES TO 35 mm.
				65					
									GRAVELLY SILTY SAND: BROWN [illegible] SORTED 20% GRAVEL 30% SILT.
				70					
			T.D. 71						

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-9-89

RIG NO. 10 RIG TYPE Failing WELL NO. SMW-3 TYPE monitoring

JOB OWNER Park City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc, 20'			
					of screen and 49' of 4½" pvc.			
					To 70'.			
		75'			Install silica sand from 75'-			
					44'.			
					Install coarse bentonite from			
					44'-20'			
					Install neat cement from 20'-			
			0	75'	5' and concrete from 5'-0.			
					Install surface completion.			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [signature]	Helper	Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-11-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. SMW-4 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Load 12" casing and Drill pipe	Button	11	1
					Fill water truck.			
					set up and start to drill & drive			
					12"			
			0	5	silty and sandy			
			5	10	gravel sand			
			10	15	gravel + sand			
			15	20	gravel + sand			
			20	25	gravel cemented			
			25	30	" "			
			30	35	" "			
			35	40	" "			
			40	45	" "			
			45	60	" "			
			60	73	" "			
					pull Drill pipe move off the			
					hole.			
	6:30				work on the swivel packing.			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11 1/2

Signature of Owner or Representative _____

CASING USED: Size 12 Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Marty Petersen | Helper Mike Spindell | Helper

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON BORING NO. BV-SMW-4

PROJECT NAME BAYVIEW LANDFILL LOGGED BY Dr. EE. [illegible]

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING DATE DRILLED [illegible]

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION NEXT TO ORCHARD

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 1 OF 3

HEAD SPACE USING (FPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				5					GRAVELLY SILT: BROWN, POORLY SORTED (2-4mm) ANGULAR 10% GRAVEL
				10					SANDY GRAVEL: BROWN, MEDIUM SORTED
				15					GRAVELLY SILT: BROWN POORLY SORTED (3-8mm) ANGULAR 20% GRAVEL
				20					SANDY GRAVEL: BROWN, MEDIUM SORTED 40% SAND
				25					SANDY GRAVEL: BROWN MEDIUM SORTED 20% SAND
				30					SANDY GRAVEL: BROWN, MEDIUM SORTED 20% SAND

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-SMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILTY GRAVEL: BROWN, POORLY SORTED (2-6mm) 30% SILT
				35					
									GRAVELLY SAND: BROWN, WELL SORTED FINE GRAINED 30% GRAVEL
				40					
									SANDY GRAVEL: REDDISH POORLY SORTED (3-8mm) ANGULAR to SUB ANGULAR
				45					
									GRAVELLY SAND: REDDISH BROWN MEDIUM SORTED 20% GRAVEL
				50					
									GRAVELLY SAND: REDDISH BROWN MEDIUM SORTED 10% GRAVEL COARSE SAND
				55					
									GRAVELLY SAND: REDDISH BROWN, MEDIUM SORTED 10% GRAVEL, COARSE SAND
				60					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-SMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVELLY SAND: BROWN, MEDIUM SORTED
				65					10% PEBBLES, 30% GRAVEL, COARSE SAND, ROUNDED
									SANDY GRAVEL: GREY BROWN, MEDIUM SORTED,
				70					30% SAND.
			T.D.	73					GRAVELLY SAND: REDDISH BROWN, WELL SORTED
									20% GRAVEL

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-13-89

RIG NO. 10 RIG TYPE Failing WELL NO. SMW-4 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc, 20'			
					of 4½" screen and 49' of blank			
					4½" pvc To 70'			
		75'			Install silica sand from 75'-			
					44'			
					Install coarse bentonite from 44'-			
					20'			
					Install neat cement from 20'-5'			
			0	75'	and concrete from 5'-0			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [illegible] | Helper | Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-4-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. 5 S m w TYPE Monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					move Rig Decon Rig + D.P.	Button	11	1
		0			set up on # 5 Drill + Drive			
					12" casing.			
			74	74				
					0-5' silt + sand			
					5-10' silt + sand			
					10-15 sand + silt + gravel			
					15-20 gravel - sand silt			
					20-25 gravel - silt			
					25-30 gravel - sand			
					30-35 gravel - silt			
					35-40 gravel			
					40-45 gravel			
					45-50 gravel + clay			
					50-55 gravel + clay			
					55-60 gravel + "			
					60-65 " - "			
					65-70 " - "			
	6:00				70-73 " - "			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11

Signature of Owner or Representative _____

CASING USED: Size 12 Ft. Used 75' Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	

LOG OF EXPLORATORY BORING

PROJECT NO. DRILLER: MARTY PETERSON
BORING NO. SMW 5
PROJECT NAME BAYVIEW LANDFILL
LOGGED BY Tom PELCHAK
DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING
DATE DRILLED 10/4/89
STATE ____ COUNTY ____ DESCRIPTIVE LOCATION EAST SIDE OF STORM WATER POND
LOCATION: T ____ R ____ SECT. ____ TRACT ____
PAGE 1 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				5					CLAYEY SILT: GREYISH BROWN, FINE GRAINED WELL SORTED 10% CLAY
				10					PEBBLY SAND: YELLOW BROWN, MEDIUM GRAINED, MEDIUM SORTING, SOME PEBBLES
				15					SANDY GRAVEL: GREY, VERY POORLY SORTED, SOME PEBBLES TO 25mm
				20					GRAVEL: GREY, MEDIUM SORTING (3-6mm)
				25					PEBBLY GRAVEL: GREY BROWN, POORLY SORTED SOME PEBBLES TO 40mm
				30					SANDY GRAVEL: GREY BROWN, VERY POORLY SORTED, 10% SILT, SOME PEBBLES TO 20mm

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. SMW 5

PROJECT NAME BAYVIEW LOGGED BY TOM BELCHAK

DRILLING METHOD DRILL, DRIVE AIR ROTARY 12" CASING DATE DRILLED 10/4/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT _____ PAGE 2 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
		25							SILTY GRAVEL: BROWN. POORLY SORTED
2:00				35					SILT IS COHESIVE PEBBLES TO 20mm
2:11									
	13	3/ft							GRAVEL: GREY. MEDIUM SORTED, SOME
2:12				40					(3-6 mm) PEBBLES to 10 mm
2:21									
	44/3	[illegible]							
									SANDY GRAVEL: GREY, MEDIUM SORTED SOME
				45					(2-4 mm) PEBBLES to 10 mm
									SILTY GRAVEL: BROWN, VERY POORLY SORTED
				50					VERY COHESIVE SAMPLE 20% CLAY
									SANDY GRAVEL: BROWN, MEDIUM SORTED,
				55					SOME PEBBLES to 10 mm
									PEBBLY GRAVEL: BROWN, WELL SORTED, ROUNDED
				60					(2-3 mm) UNIFORM SIZE DISTRIBUTION

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. SMW 5

PROJECT NAME BAYVIEW LOGGED BY TOM BELCHAK

DRILLING METHOD DRILL/DAVE AIR ROTARY 12" CASING DATE DRILLED 10/4/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SANDY GRAVEL: REDDISH BROWN, POORLY SORTED, (3-6 mm) SOME PEBBLES ≥ 10mm.
				65					
									GRAVELLY SAND: BROWN, MEDIUM SORTED
				70					
			T.D. 76						

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-7-89

RIG NO. 10 RIG TYPE Failing WELL NO. SMW-5 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc, 20'			
					of 4½" screen and 49' of blank			
					4½" pvc to 70'			
		76'			Install silica sand from 76'-			
					44'.			
					Install coarse bentonite from 44'-			
					20'.			
					Install neat cement from 20'-5'			
			0	76'	and concrete from 5'-0			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [signature]	Helper	Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-3-89

RIG NO. 7 RIG TYPE C-P-7000 WELL NO. SMW-6 TYPE Monitor

JOB OWNER Provo city

LOCATION Bay view Land fill west of Utah Lake

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					move rig and set up on #6	Button	11	1
		0			Drill + Drive 12" caseing.			
			73					
					0'-15' silt + Sand			
					15'-30' silt + Sand			
					30'-45' gravel + Sand			
					45'-60' gravel + Sand			
					60'-75' gravel + Sand			
	5:30				move comp. Rig to #6			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10½

Signature of Owner or Representative _____

CASING USED: Size 12 Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

10-2-89. ready to set up but no pad

Driller Martin Peterson | Helper Robert A. | Helper Mike S

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON BORING NO. BVSMW-6

PROJECT NAME BAY VIEW LANDFILL LOGGED BY T. BELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING DATE DRILLED 10/3/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION EAST OF LEACHATE POND.

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 1 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SILTY SAND: BROWN, MEDIUM SORTED, SOME PEBBLES
				5	X				
									GRAVELLY SILTY SAND: BROWN, POORLY SORTED 10% GRAVEL
				10					
									SILTY GRAVEL: GREY, MEDIUM SORTED, ANGULAR (3 mm) TO SUBANGULAR
				15					
									PEBBLY GRAVEL: GREY, MEDIUM SORTED (3-10 mm)
				20					
									GRAVELLY SILTY SAND: BROWN MEDIUM SORTED, SILT IS COHESIVE
				25					
									SILTY GRAVEL: GREY BROWN, POORLY SORTED
				30					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-SMW-6

PROJECT NAME BAYVIEW LANDFILL LOGGED BY T. BELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 12" CASING DATE DRILLED 10/2/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVEL: GREY BROWN, MEDIUM (3-10 mm) SORTED
				35					
				40					GRAVEL: REDDISH GREY BROWN, WELL SORTED (3 mm) ROUNDED
									SANDY GRAVEL: REDDISH BROWN, VERY (<1 mm) WELL SORTED, ANGULAR
				45					
									SILTY GRAVEL: BROWN, POORLY SORTED ANGULAR, SOME PEBBLES
				50					
									SANDY CLAYEY SILT: BROWN, POORLY SORTED 30% CLAY CONTENT
				55					
									GRAVELLY CLAYEY SILT: BROWN, POORLY SORTED 40% CLAY
				60					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: WARTY PETERSON BORING NO. BV-SMW-6

PROJECT NAME _____ LOGGED BY TOM BELCHAK

DRILLING METHOD DIR/ROTARY CASING DRIVER 12" CASING DATE DRILLED 10/3/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILTY GRAVEL: BROWN, POORLY SORTED 10% CLAY
				65					
									GRAVELLY SAND: BROWN, POORLY SORTED SOME SILT + CLAY
				70					
			T.D	73					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-6-89

RIG NO. #10 RIG TYPE Failing WELL NO. SMW-6 TYPE monitoring

JOB OWNER Park City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" p.v.c, 20'			
					of 4½" screen and 49' of blank			
					4½" p.v.c. to 70'.			
		73'			Install silica sand from 73'-			
					44'.			
					Install coarse bentonite from 44'-			
					20'.			
					Install neat cement from 20'-5'			
			0	73'	and concrete from 5'-0			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [illegible]	Helper	Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-16-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. Dmw-1 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drilling & Drive 10" caseing	Button	9 3/4	1
		65	80		Gravel & sand cemented			
					fill water truck fuel up Rig's			
		80	90		cemented Rock			
					caseing stoped. pull D.P. put			
					on stableizer run back in the			
					hole, start to drill.			
		90	105		cemented Rock.			
		105	125		cemented Rock			
		125	145		mudstone with sand			
		145	165		" " "			
		165	185		" " sand & clay			
	5:30	185	205		mudstone with sand & clay			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10 1/2

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 90 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Tim Ross	Steve ~~[illegible]~~ montague

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-17-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-1 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00		205			Drilling 9¾" open	Button	9¾	1
			220		mud stone + clay + sand			
		220	240		same formation no change			
		240	260		↓			
		260	280					
		280	300					
		300	320					
		320	340					
		340	360					
		360	380		water check at 380'			
		380	400		↓			
		400	420					
		420	440		water check at 430'			
		440	460		↓			
		460	480					
		480	500		water check at 500			
	6:00	500	520					
			•		Pull Drill pipe.			
			•		put new starter on pick-up			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11-Hrs

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Martin Petersen | Helper Robert A | Helper Tim Rees

TOTAL DEPTH 520'

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON — BORING NO. BV-DMW-1

PROJECT NAME BAYVIEW LANDFILL — LOGGED BY TOM GELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 10" CASING — DATE DRILLED 10/14/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION NORTH of WATER STORAGE TANK

LOCATION: T ____ R ____ SECT. ____ TRACT ____ — PAGE 1 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILTY GRAVELLY PEBBLES: GREY/BROWN POORLY SORTED PEBBLES TO 40 mm 20% GRAVEL 10% SILT
				5					
									PEBBLY GRAVELLY SAND: GREY, POORLY SORTED PEBBLES to 30 mm, 10% PEBBLES
				10					
									PEBBLY SAND: REDDISH BROWN MEDIUM SORTED LG PEBBLE TO 20 mm MEDIUM SAND 10% FINES
				15					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED PEBBLES to 25 mm 20% GRAVEL.
				20					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED 20% GRAVEL
				25					
									PEBBLY SAND. REDDISH BROWN, MEDIUM SORTED 10% PEBBLES MEDIUM SAND.
				30					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/14/99

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				35					PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED 20% PEBBLES to 30 mm.
				40					PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED 10% PEBBLES to 20 mm. 20% GRAVEL.
				45					PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED COARSE SAND PEBBLES to 20 mm.
				50					SANDY PEBBLY GRAVEL: RED SAND, GREY GRAVEL; 20% SAND 20% PEBBLES
				55					PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED 20% GRAVEL.
				60					PEBBLY SAND: BROWN, WELL SORTED FINE SAND
				65					GRAVELLY SAND: BROWN, WELL SORTED, FINE SAND (2-6mm)

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/16/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SAND: REDDISH BROWN, WELL SORTED. FINE-MEDIUM SAND.
				70					
									PEBBLY GRAVELLY SAND: GREY, POORLY SORTED COARSE SAND
				75					
									SAND: REDDISH BROWN, WELL SORTED, FINE to MEDIUM SAND.
				80					
									GRAVELLY SAND: REDDISH BROWN, POORLY SORTED COARSE SAND. 30% GRAVEL.
				85					
									GRAVELLY SAND: REDDISH BROWN, VERY POORLY (3-6mm) SORTED. COARSE SAND 40% GRAVEL
				90					
									GRAVELLY SAND: REDDISH BROWN, POORLY SORTED (3-15mm) FINE to MEDIUM SAND.
				95					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/16/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 4 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SAND: REDDISH BROWN, POORLY SORTED COARSE GRAINED SAND.
				100					
									PEBBLY SANDY GRAVEL: REDDISH BROWN VERY POORLY SORTED
				105					
									SILT: REDDISH BROWN SILTSTONE
				110					
									GRAVELLY SILT: REDDISH BROWN, CEMENTED
				115					
									CLAY: REDDISH BROWN, FINE GRAINED.
				120					
									CLAY: REDDISH BROWN, FINE GRAINED
				125					

REMARKS LITHOLOGY CHANGES DRAMATICALLY AT 110' TO BROWN CLAY-SILTSTONE.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/16/99

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 5 OF 6

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				130					GRAVELLY SILT: REDDISH BROWN FINE-(2-3mm) GRAINED
				135					GRAVELLY SILT: SAME
				140					GRAVELLY SILT: SAME
				145					GRAVELLY SILT: SAME 20% GRAVEL
				150					GRAVELLY SILT: SAME 20% GRAVEL
				155					GRAVELLY SILTSTONE: 20% GRAVEL

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-1
PROJECT NAME _____ LOGGED BY _____
DRILLING METHOD _____ DATE DRILLED 10/16/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 6 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				160					SILTSTONE: REDDISH BROWN
				165					SILTSTONE: REDDISH BROWN
				170					SILTSTONE: SAME
				175					SILTSTONE: SAME
				180					SILTSTONE: SAME
				185					SILTSTONE: SAME

REMARKS SILTSTONE IS VERY HOMOGENEOUS FINE-GRAINED, WELL BONDED. "SHINY FLECKS" IN THE VIGHT MAY BE GYPSUM.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/16/97

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 7 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				190					CLAYSTONE: REDDISH-BROWN, VERY FINE GRAINED NONDESCRIPTIVE. CUTTINGS IN ¼ INCH CHUNKS
				195					CLAYSTONE: SAME
				200					CLAYSTONE: SAME
				205					CLAYSTONE: SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-1

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/17/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 8 OF 8

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
			205-520						CLAYSTONE: REDDISH BROWN, VERY FINE GRAINED, INDURATED, HOMOGENEOUS

REMARKS

BORING WAS TERMINATED AT 520' WITH NO SIGN OF WATER.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-18-89

RIG NO. 10 RIG TYPE Failing WELL NO. DMW-1 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install course bentonite in			
		520'	0	520'	hole from 520' – 0			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

BOREHOLE ABANDONED DUE to LACK of WATER

Driller [illegible]	Helper	Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-18-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. Dmw-1-A TYPE monitor

JOB OWNER Provo city

LOCATION Bay view land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					move Rig from Dmw-1 to Decon	Button	9 3/4	1
					clean it lube it.			
					Move to Dmw-1-2 set up start to			
		0			drill & Drive 10" casing.			
					Had trouble getting casing started			
			30		Stright ahet of Big rock's			
		0	5		gravel			
		5	10		gravel			
		10	15		gravel			
		15	20		gravel			
		20	25		Sand			
		25	30		gravel + mudstone with Sand			
	5:30							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10 1/2

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 30 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [illegible] | Helper [illegible] | Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-19-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-1-A TYPE Monitor

JOB OWNER Provo city

LOCATION Bay view Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					work on pick-up trying to get	Button	9 7/8	1
					it started. No luck			
		30			start to drill + drive 10" cseing			
		30	35		Red mudstone			
		35	40		" "			
		40	45		" "			
		45	50		" "			
		50	55		" "			
		55	60		" "			
		~~60~~						
	5:30							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10 1/2

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 30 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Called Provo city cark came out and looked at the cutting's said move hole more to the north.

Driller	Helper	Helper
Marty Pelusan	Tim Ross	Steve montague

LOG OF EXPLORATORY BORING

DRILLER: ~~PROJECT NO.~~ MARTY PETERSON

BORING NO. BV-OMW-1A

PROJECT NAME

LOGGED BY

DRILLING METHOD

DATE DRILLED

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION ____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE ____ OF ____

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SAMPLES WERE DESTROYED BY ROAD GRADER PRIOR TO LITHOLOGIC LOGGING. NO LOG AVAILABLE FOR THIS BOREHOLE. DRILLER REPORT WAS FINE-GRAINED RED-MUDSTONE THROUGHOUT DEPTH.

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-23-89

RIG NO. 10 RIG TYPE Failing WELL NO. DMW-1A TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install coarse bentonite from			
		60'	0	60'	60' — 0 ABANDON HOLE			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Robert Clinton		

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-23-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. Dmw-1-B TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					move rig from Dmw-1-A to	Button	9 3/4	1
					1-B.			
					set up start to drill & Drive			
					10" casing.			
		0	5		gravel & sand-silt			
		5	10		" " "			
		10	20		" " "			
		20	25					
		25	30		" " "			
		30	35		" " "			
		35	40		mudstone			
		40	45		mudstone 10" casing stopped at 44'			
					Drill open hole			
		45	55		mudstone			
		55	65					
		65	75					
		75	95					
	4:00	95	105					

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9 -

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 45 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [illegible] | Helper [illegible] | Helper

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-24-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-1-B TYPE monitor

JOB OWNER Provo City

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:30					Drilling 10" open hole	Button	9 3/4	1
		105	125		mudstone			
		125	145		"			
		145	165		"			
		165	185		"			
		185	205		"			
		205	225		"			
		225	245		"			
		245	255		"			
		255	265		Hit a little bit of gravel seam's			
		265	275		mudstone with gravel seam's			
		275	285		" " " "			
		285	295		" " " "			
		295	305		" " " "			
	5:30	305	308		mudstone less gravel			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size ---- Ft. Used — Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Hit the water at 260'

Driller	Helper	Helper
Monty Peterson	Mike Spindell	

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-25-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-1-B TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:30					test for water. Run Drill pipe			
					into 265' Turn on the airlines			
					Blowing water. Ream to Bottom 305'			
					pull the Drill pipe Run in 260'			
					4½ Blank pvc. 40' 4½ screen.			
					gravel pack from 300'-245' Bentonite			
					seal from 245'-215' move Rig			
					Take it to Decon. clean it move			
					to DMW-4 set up			
	5:30							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size 4½" Blank P.V.C. Ft. Used 260 Water G.P.M. _____

CASING USED: Size 4½" PVC screen Ft. Used 40 Water Static 255'

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

2-4½" P.V.C. cap's 3/4 Big Bag of Sand 10-20

Run in well sounder Hit water 253'

Driller	Helper	Helper
Monty - Dick	mike spindell	

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON
PROJECT NAME BAYVIEW LANDFILL
DRILLING METHOD AIR ROTARY DRILL DRIVE 10"

BORING NO. BV-OMW-1B
LOGGED BY TOM BELCHAK
DATE DRILLED 10/23/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION ____

LOCATION: T ____ R ____ SECT. ____ TRACT ____

PAGE 1 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILTY GRAVEL: LIGHT BROWN POORLY SORTED
				5					
									PEBBLY SILT: LIGHT BROWN, VERY POORLY SORTED LARGE PEBBLES TO 50mm.
				10					
									SILTY GRAVEL: BROWN POORLY SORTED
				15					
									SANDY GRAVEL: GREY
				20					
									SANDY GRAVEL: GREY, POORLY SORTED 2-8mm 30% SAND
				25					
									GRAVELLY SAND: GREY POORLY SORTED 2-5mm GRAVEL, 20% GRAVEL
				30					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. _____
PROJECT NAME _____ LOGGED BY _____
DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T _____ R _____ SECT. _____ TRACT _____ PAGE 2 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: GREY, POORLY SORTED. 2-5 mm GRAVEL. 20% GRAVEL
				35					
									PEBBLY GRAVELLY SAND: REDDISH BROWN. PEBBLES TO 40mm 30% GRAVEL
				40					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, PEBBLES to 20mm 30% GRAVEL
				45					
									PEBBLY GRAVELLY SAND: REDDISH BROWN. PEBBLES to 20mm. FINE SAND
				50					
				55-105					CLAYSTONE: REDDISH BROWN. VERY FINE GRAINED, COHESIVE 1/2 INCH LAYERS

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. EV-DMW-1B

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/25/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 3

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									CLAYSTONE: REDDISH BROWN, VERY FINE-GRAINED, COHESIVE ½ INCH CUTTINGS.
			105-305						

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-30-89

RIG NO. 10 RIG TYPE Failing WELL NO. DMW-1B TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc,			
					40' of 4½" screen and 260'			
					of blank 4½" pvc. To 301'			
		308'			Install silica sand from 308'-			
					255'			
					Install coarse bentonite from			
					255'-20'			
					Install neat cement from 20'-5'			
			0	308'	and concrete from 5'-0			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
[illegible]		

WELL DEVELOPMENT

Project: BAYVIEW LANDFILL Well Number: DMW-1B

Project Number: _____ Date: 11-22-89

Well inside diameter: 4½ IN

Depth of bottom: 302 FT

Length of gravel pack: 45 FT

Diameter of gravel pack: 10-20 IN

Measured by: M. PETERSON

Recorded by: Thomas A. Bekkelf

Air temperature: 58 DegF

Weather condition: Hazey

WITHDRAWAL OF WELL VOLUMES

TIMING	Well Volume	Well Volume	Well Volume
Water level before	242		
Water level after	265		
Time begin flushing	11:30 A.M.		
Time end flushing	16:30		
Time water level after	17:30		
Estimated volume flushed (GAL)	<1 gal. per min. MEASURED ¼ gal/min AT 265' LEVEL		

FIELD ANALYSIS

Water temperature (DegC)	60°F
Sample pH	7
Sample conductivity (mhos/cm)	440
Buffer before	—
Buffer after	—
Odor	None
Color	~~Tan~~ Clear
Other	

COMMENTS

THIS WELL PRODUCED VERY LITTLE WATER DURING DEVELOPMENT AND WAS THE MOST DIFFICULT TO CLARIFY FINES FROM THE WELL.

Blew until mist was coming out shut air off let well build up again. every ½ hr. shut off air.

Attach photographs of water samples in labeled jars.

END OF SECTION

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-31-89

RIG NO. 7 RIG TYPE C-P-7000 WELL NO. DMW-2 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					move Rig and set up on	Button	9 7/8	1
					DMW-2			
		0			Drill + Drive 10" casing			
			5		sand + silt			
		5	15		gravel + sand			
		15	30		gravel + sand			
	4:30	30	45					

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9 1/2

Signature of Owner or Representative _____

CASING USED: Size 10 Ft. Used 45 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Mark Petersen | Helper Tim Ross | Helper Steve Montag.

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-1-89

RIG NO. 2 RIG TYPE C-P 7000 WELL NO. DMW-2 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drill + Drive 10" casing	Button	9 3/4"	1
		45	60		gravel + sand			
		60	75		gravel + sand			
					complete #DMW-2 from 145-65			
	4:00							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9

Signature of Owner or Representative _____

CASING USED: Size 10 Ft. Used 30 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Tim Ross	Steve Montague

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-2-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. Dmw-2 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drill + Drive 10" caseing	Button	9¾	1
		75	90		gravel + cobble's			
		90	105		gravel + cobble's			
		105	120		" "			
		120	135		" "			
		135	150		" "			
		150	165		" "			
	4:30				Blew fuel line on axy comp.			
					went to Doug's and got new one.			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9½

Signature of Owner or Representative _____

CASING USED: Size 10 Ft. Used 90 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Change oil + filter on C-P-7000

Driller Marty Peters | Helper Tim Ross | Helper Steve [illegible]

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-3-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-2 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drill & Drive 10" casing	Rotary	9 7/8	1
		165	180		gravel & cobble's			
		180	195		gravel & cobble's			
		195	210		" "			
		210	225		" "			
		225	240		" "			
	5:00							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size 10 Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Tryed to drill open hole at 195' drilled to 210' had 10' of
L in the hole. couldn't add another pipe
being started to go harder at 165 cemented gravel's

Driller	Helper	Helper
Marty Peterson	Tim Ross	Steve Montague

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-6-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW 2 TYPE Monitor

JOB OWNER Provo city

LOCATION Bay view Land Fill west of utah Lake south end

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drilling 10" open hole	Button	9 7/8	1
		240	255		cemented gravel with Fractures			
		255	270		cemented gravel " "			
					water 245'			
					Run in 40' screen 230' 4½ Blank			
					gravel pack to 240' from 270'			
	5:00				Bottom of 10" casing is at 240'			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size 4" Screen Ft. Used 40 Water G.P.M. 15

CASING USED: Size 4½ PVC Ft. Used 230 Water Static 234'

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Martin Peterson	Helper Tim Ross	Helper Steve Montague

LOG OF EXPLORATORY BORING

PROJECT NO. DRILLER: MARTY PETERSON
BORING NO. BV-OMW-2
PROJECT NAME
LOGGED BY TOM BELCHAK
DRILLING METHOD
DATE DRILLED

STATE COUNTY DESCRIPTIVE LOCATION

LOCATION: T R SECT. TRACT

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILT: GREY BROWN, WELL SORTED, VERY FINE WELL SORTED
				5					
									CLAYEY SILT: YELLOWISH BROWN, WELL SORTED VERY FINE GRAINED, COHESIVE
				10					
									SILTY PEBBLES: GREY POORLY SORTED FINE-GRAINED
				15					
									PEBBLY GRAVEL: GREY POORLY SORTED PEBBLES TO 50 m.m.
				20					
									SILTY GRAVELLY PEBBLES: GREY, VERY POORLY SORTED 10% SILT 20% GRAVEL
				25					
									PEBBLY SAND: BROWN, POORLY SORTED, MEDIUM SAND
				30					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY PEBBLES: GREY, POORLY SORTED, VERY COARSE PEBBLES to 50mm.
				35					
									GRAVELLY PEBBLY SAND: BROWN, VERY POORLY SORTED, MEDIUM SAND 20% GRAVEL 30% PEBBLE
				40					
									GRAVELLY PEBBLES: VERY POORLY SORTED, COARSE PEBBLES to 50 mm. 0% GRAVEL.
				45					
									PEBBLY GRAVEL: GREY, MEDIUM SORTED, COARSE (4-8mm) GRAVEL NO FINES some PEBBLES to 30mm
				50					
									PEBBLY GRAVELLY SAND: GREY POORLY SORTED 5% PEBBLES to 20mm, 30% GRAVEL.
				55					
									PEBBLY GRAVELLY SAND: GREY POORLY SORTED 20% PEBBLES 30% GRAVEL, MEDIUM PELLISH SAND.
				60					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-Z

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVEL: GREY, MEDIUM [illegible]
				65					30% PEBBLES to [illegible] GRAVEL 2-8mm
									PEBBLY GRAVEL: GREY, MEDIUM [illegible]
				70					10% PEBBLES to 30mm GRAVEL 2-6mm
									PEBBLY GRAVEL: GREY, MEDIUM [illegible]
				75					10% PEBBLES to 50mm
				80					GRAVELLY PEBBLY SAND: GREY-BROWN POORLY SORTED
									10% GRAVEL 30% PEBBLES to 30mm
									PEBBLY SANDY GRAVEL: GREY-BROWN, PEBBLES
				85					20% to 40mm SAND 30%
									GRAVELLY, SANDY PEBBLES: [illegible] VERY POORLY
				90					SORTED, VERY COARSE

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-7

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 4 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVELLY SAND: BROWN, POORLY SORTED, 10% PEBBLES ≥ 40mm 30% GRAVEL MEDIUM SAND
				95					
									PEBBLY GRAVELLY SAND: BROWN, POORLY SORTED, 10% PEBBLES ≥ 50mm 30% GRAVEL, FINE SAND.
				100					
									PEBBLY GRAVELLY SAND: BROWN, POORLY SORTED 10% PEBBLES ≥ 30mm 30% GRAVEL MEDIUM SAND.
				105					
									PEBBLY GRAVELLY SAND: BROWN POORLY SORTED. 10% PEBBLES ≥ 40mm 30% GRAVEL MEDIUM SAND
				110					
									PEBBLY GRAVELLY SAND: BROWN [illegible] SAND [illegible] PEBBLES [illegible] GRAVEL, MEDIUM SAND.
				115					
									SAME
				120					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. RV-[illegible]-7

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT _____ PAGE 5 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				125					PEBBLY GRAVELLY SAND: BROWN POORLY SORTED 10% PEBBLES 20% GRAVEL MEDIUM SAND.
				130					PEBBLY SAND: BROWN WELL SORTED MEDIUM SAND PEBBLES 5% to 20mm
				135					PEBBLY GRAVELLY SAND: REDDISH BROWN WELL SORTED MEDIUM SAND 10% PEBBLES 30% GRAVEL.
				140					GRAVELLY SAND: GREYISH BROWN, MEDIUM SORTED VERY COARSE SAND, 20% GRAVEL (3-6mm)
				145					PEBBLY GRAVELLY SAND: REDDISH BROWN MEDIUM SORTED MEDIUM SAND [illegible] PEBBLES [illegible] 20% GRAVEL
				150					PEBBLY GRAVELLY SAND: REDDISH BROWN, WELL SORTED FINE SAND, 10% PEBBLES to 20mm, 10% GRAVEL

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-7

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 7 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVELLY SAND: BROWN, POORLY SORTED 10% PEBBLES 30% GRAVEL.
				185					
									SAME
				190					
									SAME
				195					
									SAME
				200					
									GRAVELLY SAND: REDDISH BROWN, MEDIUM SORTED FINE SAND 30% GRAVEL.
				205					
									SAND: REDDISH BROWN, VERY WELL SORTED FINE to MEDIUM SAND.
				210					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 8 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				215					GRAVELLY SAND: LIGHT BROWN WELL SORTED MEDIUM SAND 20% GRAVEL
				220					GRAVELLY SAND: REDDISH BROWN MEDIUM SORTED FINE SAND 20% GRAVEL
				225					SILTY GRAVELLY SAND: REDDISH BROWN MEDIUM SORTED FINE SAND 10% GRAVEL
				230					↓ SAME
				235					PEBBLY SAND: REDDISH BROWN, POORLY SORTED MEDIUM SAND 20% PEBBLES to 2mm.
				240					SANDY PEBBLES: REDDISH BROWN POORLY SORTED

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T _____ R _____ SECT. _____ TRACT _____ PAGE 9 OF 9

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: RECENT BEDDING MEDIUM
				245					SORTED MEDIUM SAND [illegible]
				250					SAME
				255					SAME
				260					GRAVELLY SAND: RECENT BEDDING WELL SORTED COARSE-MEDIUM SAND [illegible] GRAVEL
				265					SAME
				270					SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-6-89 thru 11-8-89

RIG NO. #10 RIG TYPE Failing WELL NO. DMW-4, 2, SMW-4 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					11-6			
					finish Completion on hole DMW-4			
					from 30'-0. Install surface			
					completion			
					On hole DMW-2, Install 1' of			
					blank 80' of screen, and 228' of			
					4½" pvc To 269'. Install sand			
	5:00				from 270'-240'.	10 hrs		
7:00					11-7			
					Set Comp. rig and Jacks on hole			
					DMW-4. Complete well from 240'-			
	5:00				50'.	10 hrs		
7:00					11-8 finish completion on hole #2			
					from 50'-0. Install surface Comp.			
					Haul casing To drill rig.			
	5:00				Develope hole SMW-4	10 hrs		

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Robert Clinton	Tim Ross	Steve Montague

WELL DEVELOPMENT

Project: BAYVIEW LANDFILL Well Number: Dmw-2

Project Number: _____ Date: 11-22-89

Well inside diameter: 4½ IN

Depth of bottom: 271 FT

Length of gravel pack: 45 FT

Diameter of gravel pack: 10-20 SAND IN

Measured by: M. PETERSON.

Recorded by: [signature]

Air temperature: 30 DegF

Weather condition: Hazey + cold

WITHDRAWAL OF WELL VOLUMES

FLUSHING	Well Volume	Well Volume	Well Volume
Water level before	236		
Water level after	236		
Time begin flushing	8:30		
Time end flushing	9:30		
Time water level after	10:30		
Estimated volume flushed (GAL)	5 gal per min.		

FIELD ANALYSIS	
Water temperature (DegC)	58
Sample pH	6
Sample conductivity (mhos/cm)	460
Buffer before	–
Buffer after	–
Odor	None
Color	Clear
Other	

COMMENTS

THIS WELL RECOVERED VERY WELL AFTER DEVELOPMENT AND PRODUCED GOOD VOLUMES OF WATER.

Attach photographs of water samples in labeled jars.

END OF SECTION

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-10-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Rayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					set up on DMW-3 change air	Button	9 7/8	1
					filters on Rig & comp.			
					Haul 10" casing			
					make another shoe joint.			
					Drill & Drive 10" casing			
		0	5		Back fill			
		5	10		Back fill			
		10	15		gravel clay & sandy silt			
		15	20		gravel sand cobbles			
		20	25		gravel sand cobbles			
		25	30		gravel sand cobbles			
		30	45		gravel sand cobbles			
		45	60		gravel sand cobbles			
		60	75		gravel " "			
	5:00	75	90		" " "			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 11-13-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00		90			Drill + Drive 10" casing	Button	9½	1
			105		gravel sand cobbles			
		105	120		gravel sand cobbles			
		120	135		gravel sand cobbles			
		135	150		gravel sand cobbles			
		150	165		gravel sand cobbles			
	5:00	165	180		open hole gravel cemented + cobbles			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marlyn Peterson	Mike Spindell	

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-14-99

RIG NO. 7 RIG TYPE C.P.-7000 WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					pickup grout plant in Elberta	Bulldog	9½	1
					took it to shop.			
					went to the geo store got			
					150' 4½" PVC			
		180	195		gravels & sand			
	5:00				unload Bentonite trailer			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	Tim Ross

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-15-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00		195			Drilling open hole	Bulls	9 1/2	1
			210		cemented Gravel's & sand			
	9:30	210	225		cemented Gravel's			
9:30	5:00				went to trojan to set pump.			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10-

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	Tim Ross

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-16-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Rayview Land Fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00		225			Drilling open hole	Button	9½	1
			240		mud stone with clay & gravel			
		240	255		mud stone with clay & gravel			
		258	270		mud stone with gravel Little water 270'			
		270	285		mud stone with gravel layer's			
		285	300		" " " "			
					Install 280' 4½ P.V.C. 20' 4½			
	5:00				screen and gravel pack to 265'			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size 4½" Blank Ft. Used 280 Water G.P.M. _____

CASING USED: Size 4½" Screen Ft. Used 20 Water Static 260'

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Marty Petersen	Helper Tim Ross	Helper Mike

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-17-89

RIG NO. 2 RIG TYPE completion Rig WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					move C-P-7000 to Laydown area.			
					set up completion Rig + Jacks			
					Bring Bentonite from 265'-165'			
					start to pull 10" casing at 165			
					still putting in Bentonite.			
					pulled casing from 165'-45'			
					work in the Laydown area loading			
	4:00				Trucks.			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Martin Peterson | Helper Mike Spindell | Helper Tim Ross

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-20-89

RIG NO. _____ RIG TYPE Hole master WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					fill water truck			
					Put Bentonite in and pull			
					10" casing to 20' grout and			
					install 8" surface pipe and make			
					cement pad.			
					move everything to lay down area			
					get ready to set well's			
	5:30				Decon C-P-7000			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10 1/2

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	

WELL COMPLETION LOG.

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 11/20/89

RIG NO. _____ RIG TYPE Hole Master WELL NO. DMW-3 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Run in 280' 4½ P.V.C. Blank			
					20' 4½ Screen.			
					Gravel pack from 300' to 265'			
					Bentonite seal from 265'-20'			
					grout from 20'-5'			
					Sackcrete from 5'-0'			
					10-20-Sand			
					Drill + Drive 10" 0'-165'			
					open Hole 165'-300'			
					Hit water at 275'			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. 8

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Master Pelusam	Helper	Helper

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON — BORING NO. BV-DMW-3

PROJECT NAME BAYVIEW LANDFILL - PROVO CITY — LOGGED BY T. BELCHAK

DRILLING METHOD DRILL/DRIVE AIR ROTARY 10" CASING — DATE DRILLED 11/10/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION ____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ — PAGE 1 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SILTY SAND: BROWN, FINE GRAINED, 30% SILT 10% GRAVEL
				5					
									GRAVELLY SILT: OLIVE BROWN, VERY FINE GRAINED 10% GRAVEL
				10					
									SANDY SILTY GRAVEL: OLIVE BROWN, VERY POORLY SORTED, 10% SAND 25% SILT.
				15					
									SILTY PEBBLY GRAVEL: GREY BROWN POORLY SORTED 10% SILT 30% PEBBLES to 20 mm.
				20					
				25					SAME
				30					SAME

REMARKS

DATE DRILLED
0-90' 11/10/89
90-180 11/13/89
180-195 11/14/89
195-225 11/15
225-300 11/16

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. AV-OMW-3

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 11/10/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVELLY SAND: REDDISH BROWN, 10% PEBBLES ≥ 20mm, 20% GRAVEL.
				35					
									SANDY PEBBLY GRAVEL: GREY, 10% SAND 30% PEBBLES ≥ 20mm.
				40					
									SAME
				45					
									PEBBLY GRAVELLY SAND: BROWN 10% PEBBLES 20% GRAVEL, WELL SORTED MEDIUM SAND.
				50					
									PEBBLY GRAVELLY SAND REDDISH BROWN 20% PEBBLES. 25% GRAVEL, RED MEDIUM SAND.
				55					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, 20% PEBBLES 30% GRAVEL, FINE SAND.
				60					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BY-CMW-3

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY SAND: REDDISH BROWN, 10% PEBBLES WELL SORTED MEDIUM SAND.
				65					
				70					SAME
				75					SAME
				80					SAME
									PEBBLY SAND: BROWN, 10% PEBBLES TO 30 mm POORLY SORTED MEDIUM TO COARSE SAND
				85					
				90					SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BY-OMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 4 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: BROWN 20% GRAVEL MEDIUM SORTED MEDIUM BROWN SAND.
				95					
									SANDY PEBBLY GRAVEL: GREY-BROWN, VERY COARSE 10% SAND 40% PEBBLES to 50mm.
				100					
									PEBBLY GRAVELLY SAND: GREY BROWN 10% PEBBLES 20% GRAVEL
				105					
									GRAVELLY SAND: RED, 20% GRAVEL, WELL SORTED, FINE RED SAND
				110					
									PEBBLY GRAVELLY SAND, GREY BROWN, 20% PEBBLES to 20mm. 30% GRAVEL.
				115					
									SAMPLE
				120					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. EV-CMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 5 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEABLY GRAVELLY SAND: GREY BROWN 20%
				125					PEBBLES to 30 mm 30% GRAVEL.
									SAME
				130					
									SAME
				135					
									SANDY GRAVEL: GREY BROWN, 20 % SAND
				140					WELL SORTED GRAVEL.
									SAME
				145					
									GRAVELLY SAND: REDDISH BROWN, 30% GRAVEL
				150					WELL SORTED. FINE RED SAND.

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BY-DMW-3

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 6 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: REDDISH BROWN 10% GRAVEL WELL SORTED MEDIUM FED SAND.
				155					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED, MEDIUM SAND
				160					
									SAME
				165					
									SAME
				170					
									SAME
				175					
									GRAVELLY SAND: REDDISH BROWN 20% GRAVEL WELL SORTED FINE & MEDIUM FED SAND.
				180					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. AV-OMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 7 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									DEBRIS GRAVELLY SAND: REDDISH BROWN
				185					20% PEBBLES, 30% GRAVEL, FINE SAND.
									SAME
				190					
									SAME
				195					
									SAME
				200					
									SAME
				205					
									SAME
				210					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. AV-MW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 8 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				215					GRAVELLY SILT: REDDISH BROWN, VERY FINE SILT TO FINE SAND 10% GRAVEL.
				220					PEBBLY GRAVELLY SAND: REDDISH BROWN 70% PEBBLES 20% GRAVEL. FINE RED SAND
									SAME
				225					
									SAME
				230					
				235					LIMESTONE: RED, PEBBLES + GRAVEL MIXED IN CUTTINGS
									SAME
				240					

REMARKS AT 235' TRANSITION BEGINS FROM GRAVELLY SANDS TO CLAYSTONE CUTTINGS ~1/4 INCH QUITE UNIFORMLY.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. AV-OMW-2

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 9 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									CLAYSTONE: RED EXTREMELY FINE GRAINED
				245					
				250					SAME
				255					SAME
				260					SAME
				265					SAME
				270					SAME

REMARKS RED CLAYSTONE CUTTINGS ~ 1/4 INCH MIXED W/ PEBBLES + GRAVEL.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-3

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 10 OF 10

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: REDDISH BROWN, 10% GRAVEL
				275					VERY FINE GRAINED REL SAND.
				280					SAME
				285					SAME
				290					SAME
				295					SAME
				300					SAME

REMARKS THE WATER BEARING ZONE APPEARS TO BE CONTROLLED BY THE CLAY-SILT ZONE. THE FINE SAND-SILTSTONE MAY NOT BE A LARGE WATER PRODUCER.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

WELL DEVELOPMENT

Project: BAYVIEW LANDFILL Well Number: DMW 3

Project Number: _____ Date: Nov 29 1989

Well inside diameter: 4.5 IN

Depth of bottom: 300 FT

Length of gravel pack: 25 FT

Diameter of gravel pack: 10 IN

Measured by: [illegible]

Recorded by: _____

Air temperature: 40 DegF

Weather condition: _____

WITHDRAWAL OF WELL VOLUMES

FLUSHING	Well Volume	Well Volume	Well Volume
Water level before	245.5		
Water level after			
Time begin flushing	12:00		
Time end flushing	15:00		
Time water level after			
Estimated volume flushed (GAL)	1000		

FIELD ANALYSIS	
Water temperature (DegC)	60 F
Sample pH	7.0
Sample conductivity (mhos/cm)	825
Buffer before	
Buffer after	
Odor	None
Color	Clear
Other	

COMMENTS

Attach photographs of water samples in labeled jars.

END OF SECTION

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-26-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. Dmw-4 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:30					Haul caseing	Button	9 3/4	1
		0	5		start to drill + Drive 10" caseing			
		5	10		gravel + cobble's sand			
		10	15		" " "			
		15	25		" " "			
		25	35		" " "			
		35	45		" " "			
		45	55		" " "			
		55	65		" " "			
	4:30	65	75		" " "			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Martin Peters | Helper [illegible] | Helper [illegible]

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-27-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-4 TYPE monitor

JOB OWNER provo city

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:30					Drill + Drive 10" casing	Button	9 3/4	1
		75	85		gravel-sand-Bolders			
		85	95		gravel sand Bolders			
		95	105		" " "			
		105	115		" " "			
		115	125		" " "			
		125	135		" " "			
		135	145		" " "			
	5:00	145	150		" " "			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9 1/2

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Tim Ross	Dick-A

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-28-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-4 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:30					not a thing would start But			
					C-P-7000.			
					finiley got thing's started			
		150			Drilled 10"			
			165		gravel - sand - Bolder's			
	2:30							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 7

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 15 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Matt D. | Helper Tim D. | Helper

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON
BORING NO. RV-DMW-4
PROJECT NAME [illegible] LANDFILL
LOGGED BY TOM [illegible]
DRILLING METHOD DRILL/DRIVE AIR ROTARY
DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT _____

PAGE 1 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY SILT: BROWN, FINE-GRAINED
				5					
									SANDY GRAVEL: GREY, MEDIUM [illegible] 20% SAND GRAVEL 2-4 mm
				10					
									PEBBLY, SANDY GRAVEL: GREY-BROWN 10% SAND PEBBLES [illegible] MEDIUM [illegible]
				15					
									PEBBLY GRAVEL: GREY MEDIUM [illegible] COARSE ANGULAR
				20					
									PEBBLY GRAVEL: GREY, MEDIUM [illegible] VERY COARSE ANGULAR PEBBLES to 40 mm (40%)
				25					
									PEBBLY, SANDY GRAVEL: GREY, MEDIUM SORTED
				30					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVEL: GREY BROWN, WELL SORTED
				35					PEBBLES TO 25 mm
									GRAVELLY SAND: GREY, WELL SORTED
				40					
									PEBBLY GRAVELLY SAND: BROWN, 30% GRAVEL
				45					
									GRAVELLY SAND: BROWN, 40% GRAVEL
				50					
									PEBBLY GRAVEL: GREY, ANGULAR, WELL SORTED,
				55					30% PEBBLES TO 30 mm
									PEBBLY GRAVEL: GREY, WELL SORTED SUB-
				60					ANGULAR PEBBLES TO 30 mm.

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVEL: GREY VERY WELL SORTED. SUB-ANGULAR, UNIFORM [illegible]
				65					
									SANDY GRAVEL: GREY, WELL SORTED 40% SAND.
				70					
									GRAVELLY SAND: BROWN, WELL SORTED, SUB-ANGULAR [illegible]
				75					
									SANDY GRAVEL: BROWN [illegible] SORTED 30% SAND.
				80					
									PEBBLY GRAVEL: BROWN, POORLY SORTED ANGULAR, VERY [illegible]
				85					
									PEBBLY SANDY GRAVEL: REDDISH BROWN, POORLY SORTED, ANGULAR, LARGE PEBBLE [illegible]
				90					

REMARKS REDDISH BROWN [illegible] AT 90' SAMPLE, [illegible] BOREHOLE [illegible]

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-CMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 4 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				95					GRAVELLY SAND: REDDISH BROWN, WELL SORTED VERY COARSE SAND.
				100					GRAVELLY SAND: REDDISH BROWN POORLY SORTED MEDIUM SAND.
				105					PEBBLY GRAVELLY SAND: REDDISH BROWN MEDIUM SORTED 30% GRAVEL PEBBLES TO 40mm
				110					GRAVELLY SAND: REDDISH BROWN POORLY SORTED 30% GRAVEL MEDIUM TO FINE SAND.
				115					SAND: REDDISH BROWN, WELL SORTED, MEDIUM SAND.
				120					GRAVELLY SAND: REDDISH BROWN, MEDIUM SORTED 10% GRAVEL, MEDIUM SAND.

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 5 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVELLY SAND: REDDISH BROWN. POORLY SORTED 20% GRAVEL MEDIUM SAND.
				125					
									SANDY GRAVEL: REDDISH BROWN, WELL SORTED, 3-6 mm PARTICLES. 20% SAND.
				130					
									GRAVELLY SAND: REDDISH BROWN WELL SORTED 10% GRAVEL MEDIUM SAND.
				135					
									GRAVEL: REDDISH BROWN, MEDIUM SORTED SUB-ROUNDED, 2-5 mm
				140					
									SANDY GRAVEL: REDDISH BROWN POORLY SORTED 10% SAND.
				145					
									PEBBLY GRAVEL: REDDISH BROWN, POORLY SORTED ANGULAR, PEBBLES to 20 mm.
				150					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 6 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVEL: REDDISH BROWN, POORLY SORTED ANGULAR PEBBLES to 20mm
				155					
									SAND: REDDISH BROWN, MEDIUM SORTED MEDIUM to COARSE SAND.
				160					
									PEBBLY GRAVEL: REDDISH BROWN, POORLY SORTED PEBBLES to 20 mm.
				165					
									SANDY PEBBLY GRAVEL: REDDISH BROWN, VERY POORLY SORTED 10% SAND PEBBLES to 20mm
				170					
									GRAVELLY SAND: REDDISH BROWN POORLY SORTED 20% GRAVEL 6-8 mm.
				175					
									GRAVELLY SAND: REDDISH BROWN, MEDIUM SORTED 10% GRAVEL
				180					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BI-CMW-4

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 7 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: REDDISH BROWN WELL SORTED 20% GRAVEL, FINE SAND.
				185					
									GRAVELLY, PEBBLY SAND: REDDISH BROWN POORLY SORTED, LARGE PEBBLES to 40mm.
				190					
									SANDY PEBBLY GRAVEL: VARIEGATED COLOR, POORLY SORTED 10% SAND PEBBLES [illegible]
				195					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-2-84 11-3-84

RIG NO. 10 RIG TYPE Failing WELL NO. DMW-4, 2 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					th 11-2			
					Haul casing to drill rig.			
					change oil on rig.			
					dtd from 75'-165'			
	4:30				Take feul line off comp.	9½ hrs		
7:00					Fri 11-3			
					Put new feul line on comp			
					dtd from 165'-240'. Haul			
	5:00				10" casing to drill rig.	10 hrs		

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [signature] | Helper | Helper

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-31-89 thru 11-1-89

RIG NO. #10 RIG TYPE Failing WELL NO. DMW-1C, 4, 2 TYPE monitoring

JOB OWNER Provo City

LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					M 10-30			
					Take tire off forklift. Move			
					drill rig off hole DMW-4. Set			
					Jacks and Comp. rig on hole #			
					DMW-1C. Complete hole from 45'-			
	5:30				0 and Install surface completion	10½ hrs		
7:00					T 10-31			
					Set Jacks and Comp. rig on hole			
					# DMW-4. Set 7000 on hole #			
	4:30				DMW-2 and drill from 0-45'.	9½ hrs		
7:00					W 11-1 On hole # DMW-4			
					Set 195' of PVC in hole and			
					Complete hole from 195'-30'			
					load casing on boom truck and			
	4:00				load with drill pipe.	9 hrs		

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
[illegible]	Tim Ross	Steve Montague

WELL DEVELOPMENT

Project: BAYVIEW LANDFILL Well Number: D MW-4

Project Number: _____ Date: 11-12-89

Well inside diameter: 4½ IN

Depth of bottom: 145 FT

Length of gravel pack: 25 FT

Diameter of gravel pack: 10-20 IN

Measured by: M. PETERSON

Recorded by: Steven R. Belcher

Air temperature: 42 DegF

Weather condition: Fair & Sunny + clear

WITHDRAWAL OF WELL VOLUMES

FLUSHING	Well Volume	Well Volume	Well Volume
Water level before	175'-6"		
Water level after	175'		
Time begin flushing	9:15		
Time end flushing	11:15		
Time water level after	11:45		
Estimated volume flushed (GAL)	8 Gal Per min.		

FIELD ANALYSIS	
Water temperature (DegC)	60
Sample pH	7
Sample conductivity (mhos/cm)	475
Buffer before	—
Buffer after	—
Odor	None
Color	clear
Other	

COMMENTS

THIS WELL PRODUCED VERY GOOD VOLUME

Attach photographs of water samples in labeled jars.

END OF SECTION

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-8-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-5 TYPE monitor

JOB OWNER Provo city

LOCATION Bayview Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drill & Drive 10" casing	Button	9½	1
		0	5		sand & silt			
		5	15		gravel & sand			
		15	30		gravel & cobble's			
		30	45		gravel - " & sand			
		45	60		gravel - " sand			
		60	75		gravel - " sand			
		75	90		gravel - " sand			
		90	105		gravel - " sand			
	5:00	105	120		gravel - " sand			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 120 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-9-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-5 TYPE monitor

JOB OWNER Provo city

LOCATION Bay view land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Drilling & Driveing 10" caseing	Button	9 1/2	1
		120	135		gravel & sand cobble's			
		135	150		gravel & sand "			
		150	165		gravel & sand "			
		165	175		gravel & sand "			
		175	180		moist sand & gravel cobble's			
		180	185		water gravel sand & fractures			
		185	195		water gravel sand & fractures			
		195	210		water gravel sand fractures			
					Drilled from 195'-210 open Hole			
					pull Drill pipe and move Rig			
	5:00				to DMW-3.			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 10

Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller [illegible] | Helper [illegible] | Helper [illegible]

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ DRILLER: MARTY PETERSON BORING NO. BV-OMW-5

PROJECT NAME BAYVIEW LANDFILL - PORT CITY LOGGED BY T. BELCHAK

DRILLING METHOD AIR ROTARY DRILL/DRIVE 10" CASING DATE DRILLED 10/8/89

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION ____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 6 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILT: OLIVE, WELL SORTED, FINE GRAINED
				5					
									PEBBLY SILTY GRAVEL: GREY, VERY POORLY SORTED 10% PEBBLES TO 30mm, 20% SILT.
				10					
									PEBBLY GRAVELLY SILT: GREY POORLY SORTED 10% PEBBLES - 20% GRAVEL VERY DENSE SILT CONCRETE-LIKE CONSISTENCY
				15					
				20					SAME
									PEBBLY GRAVELLY SAND: BROWN-GREY, VERY POORLY SORTED 10% PEBBLES, MEDIUM-COARSE SAND.
				25					
				30					PEBBLY SANDY GRAVEL: BROWN 20% PEBBLES TO 40mm 80% SAND.

REMARKS DRILLED 10/8 + 10/9/89

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-5

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 10/8/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									↓
				35					SAME
									↓
				40					SAME
									↓
				45					SAME
									PEBBLY GRAVELLY SILT: OLIVE BROWN POORLY SORTED 10% PEBBLES ≤ 30mm 20% GRAVEL 70% FINE SILT.
				50					
									PEBBLY SILTY GRAVEL: BROWN, POORLY SORTED 10% PEBBLES ≤ 30mm 30% SILT
				55					
									↓
				60					SAME SC

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-CMW-5

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									↓
									↓
				65					SAME
									PEBBLY SILTY GRAVEL: REDDISH BROWN, POORLY SORTED, 5% PEBBLES to 30mm, 20% SILT.
				70					
									SILTY GRAVELLY PEBBLES: GREY PEBBLES RELATIVELY UNIFORM SIZE 30-20mm, 5% SILT 20% GRAVEL
				75					
									↓
				80					SAME
									↓
				85					SAME
									PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED. 10% PEBBLES, 20% GRAVEL REC. MEDIUM
				90					TO COARSE SAND.

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. AV-DMW-5

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 11/8/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT _____ PAGE 4 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED 10% PEBBLES, 20% GRAVEL MEDIUM TO COARSE RED SAND
				95					
				100					SAME
				105					SAME
				110					SAME
				115					SAME
				120					SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-OMW-5

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED 11/9/89

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT _____ PAGE 5 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: BROWN, MEDIUM SORTED 20% GRAVEL, MEDIUM + COARSE RED SAND
				125					
				130					SAME
				135					SAME
				140					SAME
									PEBBLY GRAVELLY SAND: BROWN, POORLY SORTED 10% PEBBLES, 30% GRAVEL, MEDIUM + COARSE RED SAND
				145					
				150					SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. B1-CMW-5

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 6 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									↓
				155					SAME
									PEBBLY GRAVELLY SAND: MEDIUM BROWN, 50% PEBBLES, 10% GRAVEL, MEDIUM CRYSTALLINE SAND.
				160					
									PEBBLY GRAVELLY SAND: BROWN, SUBANGULAR 30% GRAVEL, MEDIUM TO COARSE SAND.
				165					
									↓
				170					SAME
									↓
				175					SAME
									↓
				180					SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. AV-DMW-5

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT _____ PAGE 7 OF 7

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
				185					SAME
				190					SAME
				195					SAME
				200					SAME
									PEBBLY GRAVELLY SAND: PEBBLE [illegible]
				205					5% PEBBLES, 10% GRAVEL WELL SORTED FINE RED SAND
				210					SAME

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-9-84 11-10-84

RIG NO. #10 RIG TYPE Failing WELL NO. SMW-1,5,6 TYPE monitoring
JOB OWNER Provo City
LOCATION Bayview

TIME		DEPTH			DRILLING INFORMATION	BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					11-9-84			
					Develope holes, SMW-1,5,6.			
					Move drill rig off hole DMW-5			
	5:00				and set Jacks on hole.	10 hrs		
7:00					11-10-84 On hole DMW-5			
					Set pvc in hole to 210'			
		210'			Install completion from 210'-			
5:00			50'	160'	50'. Haul casing to drill rig.	10 hrs		

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____
Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____
CASING USED: Size _____ Ft. Used _____ Water Static _____
DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____
MISC.

Driller [illegible] | Helper Tim Ross | Helper Steve M. [illegible]

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 11-13-89

RIG NO. #10 RIG TYPE Failing WELL NO. DMW-5 TYPE monitoring
JOB OWNER Provo City
LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Finish Completion on hole DMW-5			
					from 50'-0. Install surface			
					completion.			
					Go To Trojan and pick up 2"			
	4:30				pipe and Take back To bayview			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 9½ hrs
Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____
CASING USED: Size _____ Ft. Used _____ Water Static _____
DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____
MISC.

Driller [signature]	Helper	Helper

WELL DEVELOPMENT

Project: BAYVIEW LANDFILL Well Number: Dmw-5

Project Number: _____ Date: 11-21-89

Well inside diameter: 4 1/2 IN

Depth of bottom: 211 FT

Length of gravel pack: 25 FT

Diameter of gravel pack: 10-20 SAND IN

Measured by: M. PETERSON

Recorded by: [signature]

Air temperature: 55 DegF

Weather condition: Fair but Hazey

WITHDRAWAL OF WELL VOLUMES

FLUSHING	Well Volume	Well Volume	Well Volume
Water level before	178'-6"		
Water level after	178'		
Time begin flushing	15:45		
Time end flushing	16:25		
Time water level after	16:45		
Estimated volume flushed (GAL)	10 per min.		

FIELD ANALYSIS	
Water temperature (DegC)	58
Sample pH	7
Sample conductivity (mhos/cm)	480
Buffer before	—
Buffer after	—
Odor	None
Color	Clear
Other	

COMMENTS

THE AQUIFER IN THIS WELL CONSISTED OF VERY COARSE GRAVEL AND PRODUCED A VERY GOOD VOLUME OF WATER.

Attach photographs of water samples in labeled jars.

END OF SECTION

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-7-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. DMW-6 TYPE Monitor

JOB OWNER Provo city

LOCATION Bayview Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					put air filter in comp.	Button	10	1
					and start to drill & Drive 10"			
		0	5		Sand & silt			
		10	20		Gravel & Sand			
		20	30		Gravel Sand & silt			
		30	40		Gravel Sand			
		40	50		Gravel Sand			
		50	55		hard pan & Gravel			
		55	60		Gravel & Sand			
	3:30	60	75		Gravel & Sand			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 8 1/2

Signature of Owner or Representative _____

CASING USED: Size 10 Ft. Used 75 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller	Helper	Helper
Marty Peterson	Mike Spindell	

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-9-89

RIG NO. 7 RIG TYPE C-P-7000 WELL NO. DMW-6 TYPE monitor

JOB OWNER Provo city corp.

LOCATION Bayview Landfill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					Load Drill pipe in caseing	Button	10	1
					haul 6 joint's to the rig			
					fill water truck. work on			
					axy air comp. try to get more			
					air.			
		75	90	15	cemented gravel & sand			
		90	105	15	cemented gravel & sand			
	6:00							

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11

Signature of Owner or Representative _____

CASING USED: Size 10 Ft. Used 30 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

Driller Martin Petersen | Helper Mike Spindell | Helper Robert H ½ day

DAVE'S DRILLING

577 West 3410 South
Salt Lake City, Utah 84115
(801) 263-9099

Date 10-10-89

RIG NO. 2 RIG TYPE C-P-7000 WELL NO. nmw-6 TYPE Monitor

JOB OWNER Provo city

LOCATION Bay view Land fill

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
7:00					fuel up Equipment	Button	9 7/8	1
					Drilling + Driveing 10"			
		105	120		Cemented gravel + sand			
		120	135		mud stone + sand-Gravel			
		135	140		cemented gravel + sand			
		140	150		water fractured cemented gravel-sand			
		150	165		cemented gravel + water			
					clean hole and pull Drill pipe			
					move Rig to Decon. Load D.P. and			
					10" caseing onto water truck. take			
					it to Decon. unload. went to			
					#5-6 Load 12" caseing.			
	6:00				move rig to S mw-#21			

STAND BY TIME HRS. _____ HOURLY WORK HRS. 11

Signature of Owner or Representative _____

CASING USED: Size 10" Ft. Used 45 Water G.P.M. _____

CASING USED: Size _____ Ft. Used _____ Water Static _____

DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____

MISC.

drilled from 150' to 165' open hole

Driller	Helper	Helper
Monty Peterson	Tom carlson	

LOG OF EXPLORATORY BORING

~~PROJECT NO.~~ [illegible] BORING NO. EY-GMW-2

PROJECT NAME ENVIRON LANDFILL LOGGED BY [illegible]

DRILLING METHOD DRILL/DRIVE AIR ROTARY [illegible] DATE DRILLED [illegible]

STATE ____ COUNTY ____ DESCRIPTIVE LOCATION EAST OF BERM 3

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 1 OF [illegible]

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									SILT: BROWN, WELL SORTED, VERY COHESIVE FINE-GRAINED
				5					
									SILTY PEBBLY GRAVEL: BROWN, VERY POORLY SORTED PEBBLES TO 60 mm.
				10					
									PEBBLY GRAVELLY SILT: BROWN, POORLY SORTED PEBBLES to 20mm. SILT IS VERY COHESIVE
									PEBBLY SILTY GRAVEL: BROWN, POORLY SORTED MANY LARGE PEBBLES to 50mm. 30% SILT
				20					
									PEBBLY GRAVEL: GREY-BROWN, MEDIUM SORTED (20mm) (3-5mm) NO FINES, WELL WASHED
				25					
									SANDY SILT: BROWN, WELL SORTED, FINE GRAINED, COHESIVE WHEN WET.
				30					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. EY-DMW-6

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 2 OF 6

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY SILTY GRAVEL: BROWN, POORLY SORTED VERY FINE SILT 30% PEBBLES 10%
				35					
									PEBBLY GRAVEL: GREY, MEDIUM SORTED (2-4mm)
				40					
									PEBBLY GRAVEL: GREY MEDIUM SORTED (4-6mm)
				45					
									PEBBLY GRAVELLY SAND: BROWN-GREY, MEDIUM SORTED PEBBLES TO 30mm.
				50					
									GRAVELLY CLAYEY SILT: BROWN, VERY POORLY SORTED VERY FINE GRAINED.
				55					
									PEBBLY GRAVEL: GREY-BROWN, MEDIUM SORTED (3-8mm) ROUNDED PARTICLES
				60					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. EX-DW11-6

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 3 OF 6

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GREY SILTY PEBBLY GRAVEL: BROWN, VERY POORLY SORTED.
				65					
									PEBBLY SANDY GRAVEL: GREY BROWN, POORLY SORTED, SOME FINES
				70					
									SANDY PEBBLES: GREY, POORLY SORTED, VERY COARSE
				75					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, MEDIUM SORTED
				80					
									PEBBLY SANDY GRAVEL: REDDISH BROWN, POORLY SORTED, SUBANGULAR to ROUNDED.
				85					
									SANDY GRAVEL: REDDISH BROWN, POORLY SORTED.
				90					

REMARKS

AFTER 75' LITHOLOGY CHANGES DRAMATICALLY IN COLOR AND TEXTURE. REDDISH BROWN, SANDY MATERIAL WITH LITTLE OR NO FINES.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-CMW-6

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 4 OF 6

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY SANDY GRAVEL: REDDISH BROWN
				95					
									GRAVELLY SAND: REDDISH BROWN, MEDIUM SORTED
				100					
									PEBBLY GRAVELLY SAND: REDDISH BROWN, POORLY SORTED
				105					
									SAND: REDDISH BROWN, WELL SORTED
				110					
									SAND: REDDISH BROWN MEDIUM SORTED
				115					
									PEBBLY GRAVEL: GREYISH BROWN, POORLY SORTED PEBBLES TO 30 MM.
				120					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. RV-MW-6

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 5 OF 6

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									PEBBLY SAND: REDDISH BROWN, POORLY SORTED PEBBLES to 20 mm.
				125					
									SILTY PEBBLY GRAVEL: BROWN, POORLY SORTED PEBBLES to 20 mm
				130					
									GRAVELLY SAND: REDDISH BROWN, POORLY SORTED
				135					
									SILTY GRAVELLY SAND: REDDISH BROWN VERY POORLY SORTED SOME PEBBLES
				140					
									GRAVELLY SAND: REDDISH BROWN
				145					
									GRAVELLY SAND: REDDISH BROWN
				150					

REMARKS

Exploratory & Monitor
Well Drilling

DAVE'S DRILLING COMPANY

LOG OF EXPLORATORY BORING

PROJECT NO. _____ BORING NO. BV-DMW-6

PROJECT NAME _____ LOGGED BY _____

DRILLING METHOD _____ DATE DRILLED _____

STATE ____ COUNTY _____ DESCRIPTIVE LOCATION _____

LOCATION: T ____ R ____ SECT. ____ TRACT ____ PAGE 6 OF 6

HEAD SPACE USING (PPM)		PENETRATION BLOW COUNT	SAMPLE TYPE	DEPTH IN FEET	SAMPLES	SAMPLE SYMBOL	LITHOGRAPHIC COLUMN	WATER LEVEL	LITHOLOGIC DESCRIPTION
									GRAVELLY SAND: BROWNISH RED 10% GRAVEL
				155					
									GRAVELLY SAND: BROWNISH RED, ROUNDED, MEDIUM SORTED. 10% GRAVEL
				160					
									GRAVELLY SAND: BROWNISH RED ROUNDED MEDIUM SORTED 10% GRAVEL
				165					
									PEBBLY SANDY GRAVEL: BROWNISH RED, POORLY SORTED LARGE PEBBLES TO 50 mm.
				170					

REMARKS

COLOR CHANGE AT 155' & 170' MORE RED COLOR IN SAND SAMPLES.

Exploratory & Monitor Well Drilling

DAVE'S DRILLING COMPANY

DAVE'S DRILLING

5617 W. Wells Park Road
Salt Lake City, Utah 84088
(801) 569-2000

Date 10-12-89

RIG NO. 10 RIG TYPE Failing WELL NO. DMW - 6 TYPE monitoring
JOB OWNER Provo City
LOCATION Bayview

TIME		DEPTH		DRILLING INFORMATION		BIT		
Start	Stop	From	To	Ft.	Log or Remarks	Type	Size	No.
					Install 1' of blank 4½" pvc,			
					20' of 4½" screen and 145' of			
		166'			blank 4½" pvc To 166'			
					Install silica sand from			
					166' - 140'			
					Install coarse bentonite from			
					140' - 20'			
					Install neat cement from 20' -			
			0	166'	5' and concrete from 5' - 0.			
					Install surface completion			

STAND BY TIME HRS. _____ HOURLY WORK HRS. _____
Signature of Owner or Representative _____

CASING USED: Size _____ Ft. Used _____ Water G.P.M. _____
CASING USED: Size _____ Ft. Used _____ Water Static _____
DRILLING MUD: Type _____ Amount _____ Fuel _____ Oil _____
MISC.

Driller [illegible] | Helper | Helper

WELL DEVELOPMENT

Project: BAYVIEW LANDFILL Well Number: DMW-6

Project Number: _____ Date: 11-21-89

Well inside diameter: 4 1/2 IN

Depth of bottom: 169.2' FT

Length of gravel pack: 25 FT

Diameter of gravel pack: 10-20 SAND IN

Measured by: M. PETERSON

Recorded by: Thomas A. Belcher

Air temperature: 56 DegF

Weather condition: Sunny & clear Little Haze

WITHDRAWAL OF WELL VOLUMES

FLUSHING	Well Volume	Well Volume	Well Volume
Water level before	139'		
Water level after	139		
Time begin flushing	13:02		
Time end flushing	13:54		
Time water level after	14:20		
Estimated volume flushed (GAL)	8-Gal per min		

FIELD ANALYSIS	
Water temperature (DegC)	60°f
Sample pH	7
Sample conductivity (mhos/cm)	471
Buffer before	—
Buffer after	—
Odor	None
Color	clear
Other	

COMMENTS

THIS WELL RECOVERED MORE RAPIDLY AFTER DEVELOPMENT THAN ANY OTHER WELL DRILLED FOR THIS PROJECT.

Attach photographs of water samples in labeled jars.

END OF SECTION

APPENDIX E-3

1996 BORING LOGS

WLI

Dwm-7

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification MONITOR WELL: 96-53-002-M-01

HDR

Owner *Note any changes*

HDR Engineering Inc.
303 East 17th Ave. Ste. 300
Denver, CO 80203

REC.: DEC 16 1996
PROJ.:
FILE:
DIST:

Contact Person/Engineer:

Well Location *Note any changes*

SOUTH 2400 feet EAST 0 feet from the NW Corner of SECTION 17, TOWNSHIP 9S, RANGE 1W, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #)

Drillers Activity Start Date: 11-18-96 Completion Date: 10-6-96

Check all that apply:
☑ New ☐ Repair ☐ Deepen ☐ Abandon ☐ Replace ☐ Public Nature of Use:

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	55	7 11/32	ODEX	∅
55	200	6 5/8	DH Rotary	∅
200	255	8"	Rotary - Hole opener	∅

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	~~COLOR~~ Hole Size	DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.)
0	5							✓✓					7 11/32	gravelly-Sand-Soil
5	10												"	Med to Coarse Sand - minor gravel
10	15												"	Coarse sand - fine's & Med Sand & grave
15	20												"	Sand & Gravel
20	25												"	Coarse, fine, Med-Sand, minor gravel
25	30												"	Fine Sand - some silt - moist
30	35												"	Clay - silt - fine Sand - Moist
35	40												"	fine Sand - (Clayey silt = Bull's up)
40	45												"	Gravelly, fine - Med Sand dry gravel!
45	55												"	" " " " " "

Static Water Level

Date 11-22-96 Water Level 263 feet Flowing? ☐ Yes ☑ No

Method of Water Level Measurement Water Indicator If Flowing, Capped Pressure PSI

Point to Which Water Level Measurement was Referenced Ground

Height of Water Level reference point above ground surface feet Temperature ☐ °C ☐ °F

Well Log

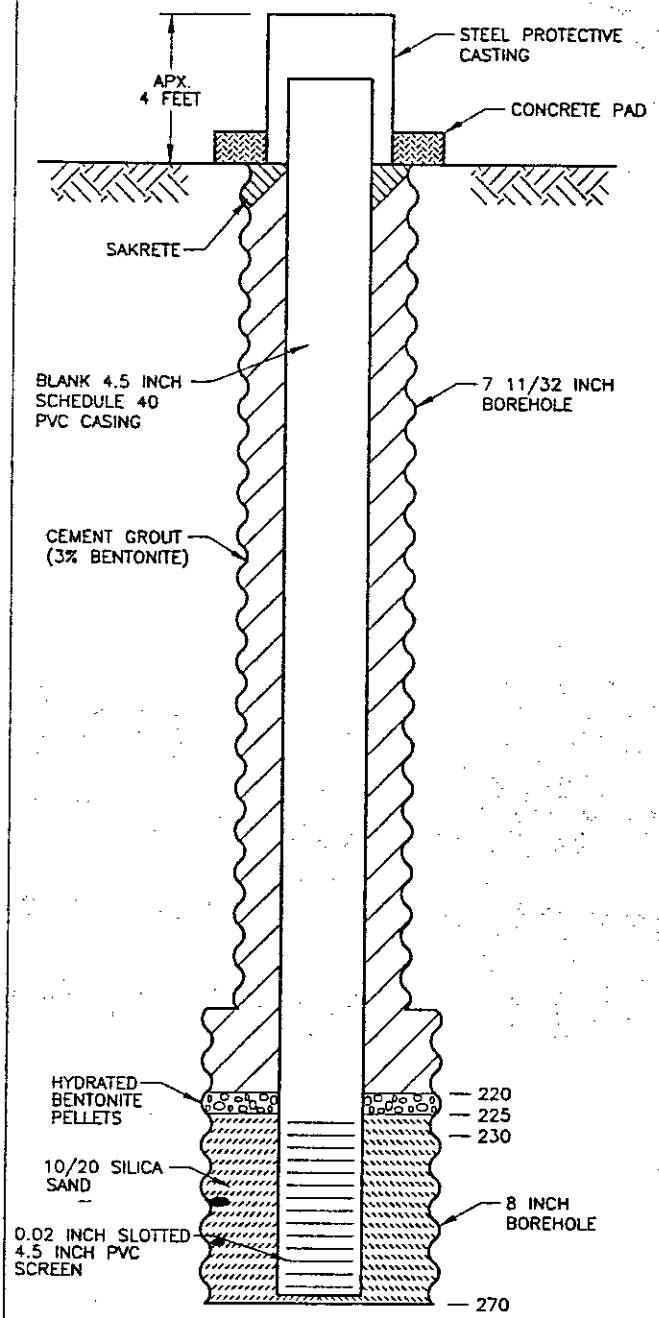
ADDITIONAL WELL DATA FORM

Water Right #_____

OWNER NAME_____

Well Log DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	~~COLOR~~ Hole Size	DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.)
55'	100'												6 5/8"	Mud/Stone - Maroon - dry
100	200												"	Mud/Stone - Silt - ~~dry~~ Some Moisture
200	255												5"	Mud/Stone - Silt - some moisture.

WELL CONSTRUCTION SCHEMATIC:



GEOLOGIC LOG:

GRAVELLY, FINE TO MEDIUM SAND
FINE TO MEDIUM SANDY GRAVEL
COARSE SANDY GRAVEL
GRAVELLY, FINE TO COARSE SAND
FINE SAND
GRAVELLY, FINE TO COARSE SAND
FINE TO COARSE SAND
FINE SAND
FINE TO COARSE SAND
FINE SAND
GRAVELLY, FINE TO COARSE SAND
GRAVELLY, COARSE SAND
FINE TO MEDIUM SAND
GRAVELLY, FINE TO COARSE SAND
FINE SAND
FINE SAND
GRAVELLY, FINE TO COARSE SAND
FINE SAND
FINE SAND
FINE SAND

UNDIFFERENTIATED MUDSTONE – MAROON, NO APPARENT BEDDING

DEPTH (FEET):

0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300

NO SCALE

HDR

WELL CONSTRUCTION SCHEMATIC AND GEOLOGIC LOG

DMW-8

Date MAR. 1997

Figure 2

FIGURE 2
P:\08325002
03/13/97

WL1

DMW-8

WELL DRILLER'S REPORT
State of Utah
Division of Water Rights

For additional space, use "Additional Well Data Form" and attach

Well Identification MONITOR WELL: 96-53-002-M-02

Owner *Note any changes*
HDR Engineering Inc.
303 East 17th Ave. Ste. 300
Denver, CO 80203

Contact Person/Engineer:

Well Location *Note any changes*
SOUTH 1900 feet EAST 1300 feet from the NW Corner of SECTION 17, TOWNSHIP 9S, RANGE 1W, SLB&M.

Location Description: (address, proximity to buildings, landmarks, ground elevation, local well #)

Drillers Activity Start Date: 11-18-96 Completion Date: 12-6-96

Check all that apply:
☒ New ☐ Repair ☐ Deepen ☐ Abandon ☐ Replace ☐ Public Nature of Use:

DEPTH (feet) FROM	TO	BOREHOLE DIAMETER (in)	DRILLING METHOD	DRILLING FLUID
0	200'	7"/32	ODEX	0
200'	270'	~~8~~ 8"	Rotary DH Bit w/ Hole opener	
~~220'~~	~~270'~~			

Well Log

DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.)
0	5'													Soil Compacted - Sandy - Gravel
5	10													Gravel - Sand - dry
10	15													Fine to med Sand - Gravel 1.5" -
15	20													Fine Sand - Minor Silt - minor Gravel - 1/2"
20	25													Fine - med Sand - Minor gravel - 1/4"
25	30													Coarse Sandy Gravel - 1 1/2" - Fine Sand
30	35													Gravely - med Coarse Sand
35	40													Fine to Coarse Sand
40	45													Fine to Coarse Sand - 1"
45	50													" " "

Static Water Level
Date 11-27-96 Water Level 245' feet Flowing? ☐ Yes ☒ No
Method of Water Level Measurement Water level indicator If Flowing, Capped Pressure _____ PSI
Point to Which Water Level Measurement was Referenced Ground
Height of Water Level reference point above ground surface _____ feet Temperature _____ ☐ °C ☐ °F

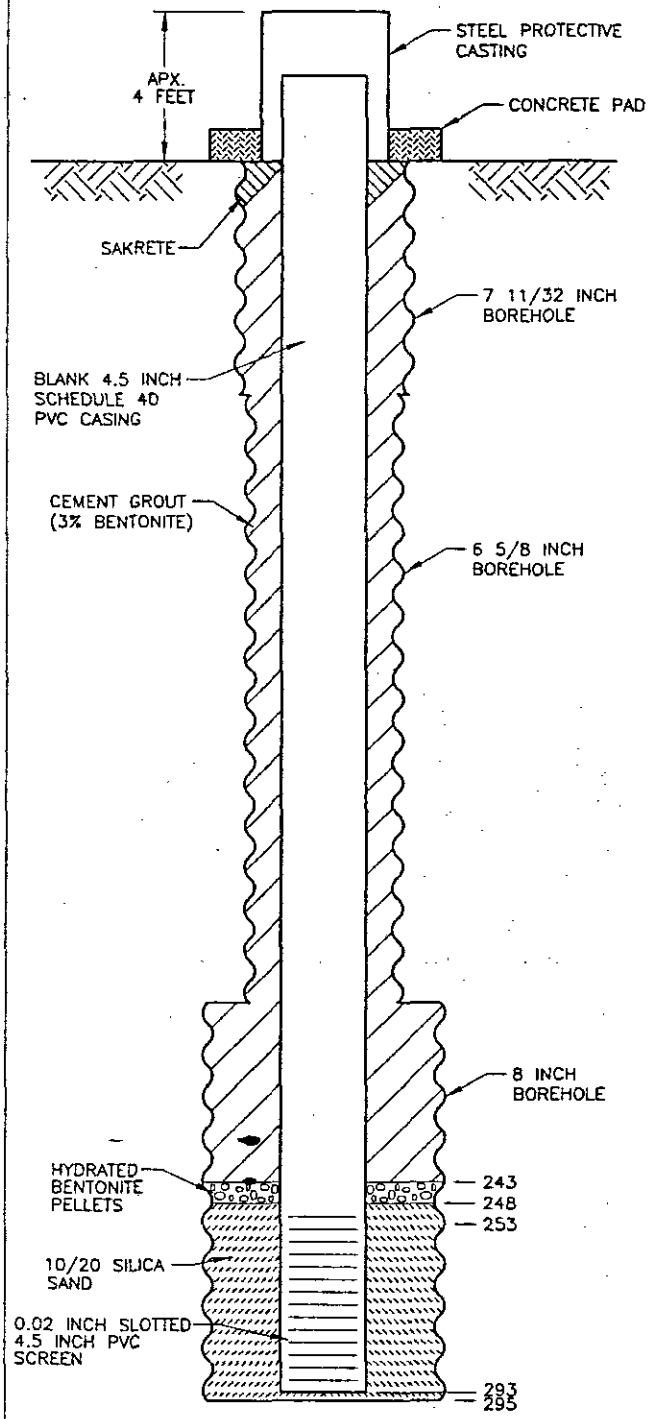
ADDITIONAL WELL DATA FORM

Water Right #_____

OWNER NAME_____

Well Log DEPTH (feet) FROM	TO	WATER	PERMEABLE high	PERMEABLE low	UNCONSOLIDATED CLAY	SILT	SAND	GRAVEL	COBBLES	BOULDER	OTHER	CONSOLIDATED ROCK TYPE	COLOR	DESCRIPTIONS AND REMARKS (include comments on *water quality* if known.)
50	100													Fine to med Coarse Sand-Gravel-1/4"
100	200													Med to fine Sand - Gravel-1/4" to 1/2"
200	270													Mudstone-

WELL CONTRUCTION SCHEMATIC:



GEOLOGIC LOG:

GEOLOGIC LOG	DEPTH (FEET)
GRAVELLY, COARSE SAND	0
MED. TO COARSE SAND	10
COARSE SAND	20
COARSE SAND	30
FINE SANDY SILT & CLAY	40
GRAVELLY, FINE TO COARSE SAND	50
BEDROCK CONTACT	60
	70
	80
	90
	100
	110
	120
	130
UNDIFFERENTIATED MUDSTONE – MAROON, DRY, NO APPARENT BEDDING	140
	150
	160
	170
	180
	190
	200
	210
	220
	230
	240
	250
	260
	270
	280
	290
	300

NO SCALE

HDR

HDR Engineering, Inc.

WELL CONSTRUCTION SCHEMATIC AND GEOLOGIC LOG

DMW-7

Date MAR. 1997

Figure 1

FIGURE_1
P:\08325002
03/10/97

REQUEST FOR PROVISIONAL/MONITOR WELL CONSTRUCTION

(for wells deeper than 30 feet)

Well Type (check one): Provisional ( ) Monitor (✓)

Applicants Name: Kenneth Nupp - HDR Engineering, Inc

Mailing Address: 303 E 17th Ave, Ste 300

Denver, CO 80203

Contact Person: Kenneth Nupp Phone: 303-764-1520

Proposed Start Date: 11/18/96 Anticipated Completion Date: 12/4/96

Well Drillers License No: 87-247278-5501-5262 Proposed No. of Wells: 2

PROPOSED LOCATION OF WELLS: County: UTAH

NO./SO. DISTANCE (feet)	EAST/WEST DISTANCE (feet)	SECTION CORNER	SECTION	TOWNSHIP	RANGE	BASE	DIAMETER (inches)	DEPTH (feet)
N1000	W1300	W4	15	2S	1W	SL	2	100
S2400	E0	NW	17	9S	1W	SL	4.5	290
S1900	E1300	NW	17	9S	1W	SL	4.5	290

Use back of form or additional paper if more room is needed

EXPLANATORY: Monitoring well screened across water table anticipated at apx 245' - Purpose is to monitor up-gradient and down-gradient of Landfill Cell

Signature of Applicant

11/15/96
Date

FOR OFFICE USE ONLY

Date of Request: _____ Approval Date: _____

Approved by: _____ Provisional/Monitor Well No. _____

Water Right Number (if available): _____

Start Card
Sent 12/26/96

APPLICANT CARD for MONITOR WELL#: 96-53-002-M

IMPORTANT: THIS CARD MUST BE COMPLETED, SIGNED AND RETURNED BY THE WELL OWNER/APPLICANT AS SOON AS THE WELL IS DRILLED BY A LICENSED UTAH WATER WELL DRILLER.

PROOF DUE/EXPIRATION DATE:

OWNER/APPLICANT NAME: HDR Engineering Inc.
MAILING ADDRESS: 303 East 17th Ave. Ste. 300, Denver, CO 80203
PHONE NUMBER: 801-764-1520
WELL LOCATION: South 1900 Feet East 1300 Feet from NW Corner Sec 17 T9S R1W

WELL ACTIVITY: NEW (X) REPAIR ( ) REPLACE ( ) ABANDON ( )

WELL COMPLETION DATE: 12/6/96

NAME OF DRILLING COMPANY/LICENSEE: PC Exploration

[signature] 12/24/96

Owner/Applicant Signature Date

***COMPLETE, SIGN AND RETURN THIS PORTION UPON FINAL WELL COMPLETION - DO NOT GIVE THIS CARD TO LICENSED WELL DRILLER - YOU MUST RETURN IT.

APPLICANT CARD for MONITOR WELL#: 96-53-002-M

IMPORTANT: THIS CARD MUST BE COMPLETED, SIGNED AND RETURNED BY THE WELL OWNER/APPLICANT AS SOON AS THE WELL IS DRILLED BY A LICENSED UTAH WATER WELL DRILLER.

PROOF DUE/EXPIRATION DATE:

OWNER/APPLICANT NAME: HDR Engineering Inc.
MAILING ADDRESS: 303 East 17th Ave. Ste. 300, Denver, CO 80203
PHONE NUMBER: 801-764-1520
WELL LOCATION: 5240 Feet East 0 Feet From NW Corner Sec 17 T9S R1W

WELL ACTIVITY: NEW (X) REPAIR ( ) REPLACE ( ) ABANDON ( )

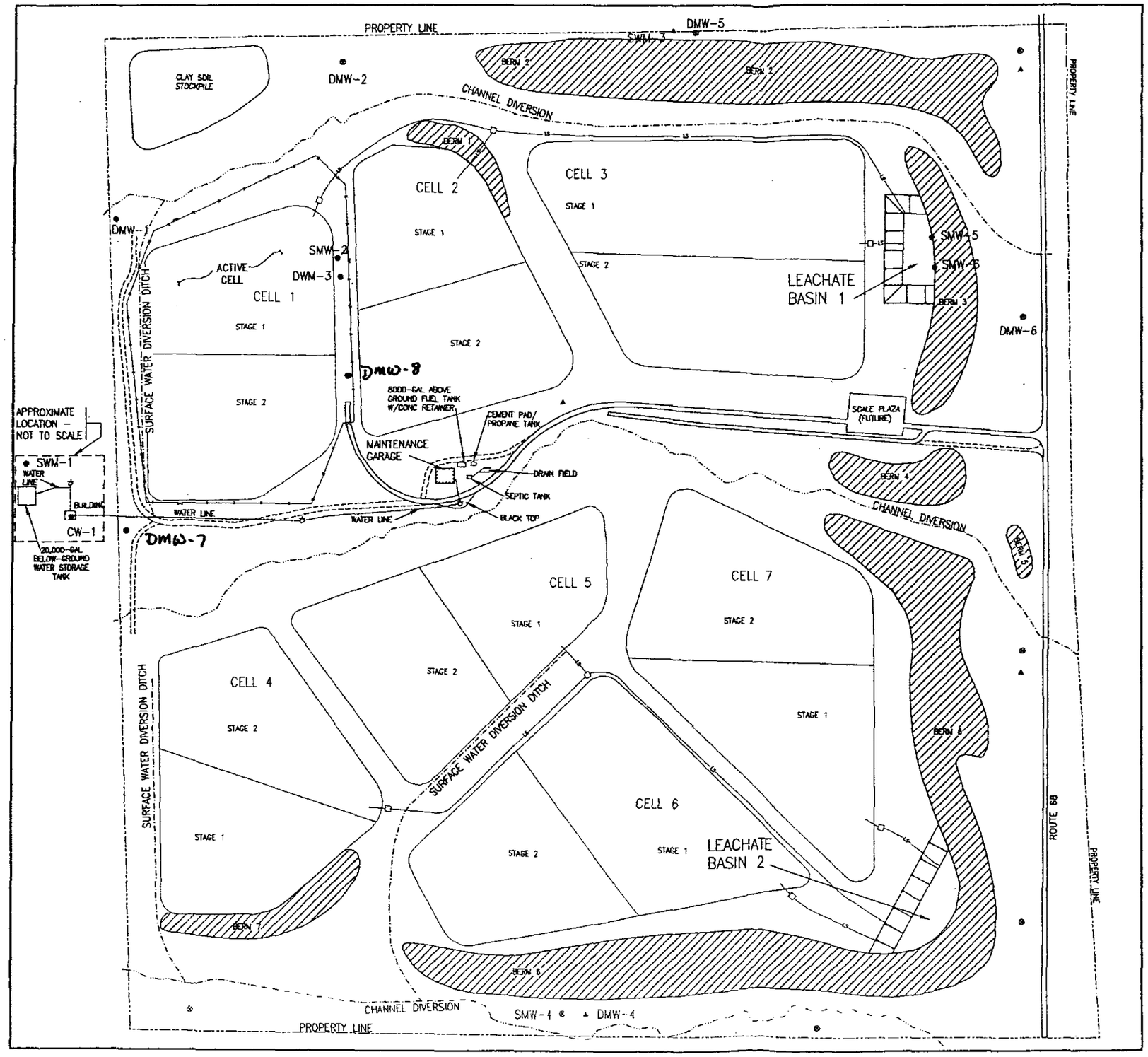
WELL COMPLETION DATE: 12/6/96

NAME OF DRILLING COMPANY/LICENSEE: PC Exploration

[signature] 12/24/96

Owner/Applicant Signature Date

***COMPLETE, SIGN AND RETURN THIS PORTION UPON FINAL WELL COMPLETION - DO NOT GIVE THIS CARD TO LICENSED WELL DRILLER - YOU MUST RETURN IT.



EXPLANATION

- PROPERTY LINE
- LEACHATE GRAVITY SEWER
- STRUCTURES
- MONITORING WELL, PERCHED WATER TABLE
- MONITORING WELL, SHALLOW PLEISTOCENE AQUIFER
- MONITORING WELL, APPROXIMATE LOCATION
- LEACHATE COLLECTION MANHOLE STRUCTURE
- BERM
- CHAIN LINK FENCE
- SLOPE INDICATOR
- UNIMPROVED ROAD
- WATER LINE (APPROXIMATE LOCATION)
- FIRE HYDRANT
- STREAM
- CHANNEL DIVERSION

-N-

0 600' 1200'

SCALE: 1" = 600'

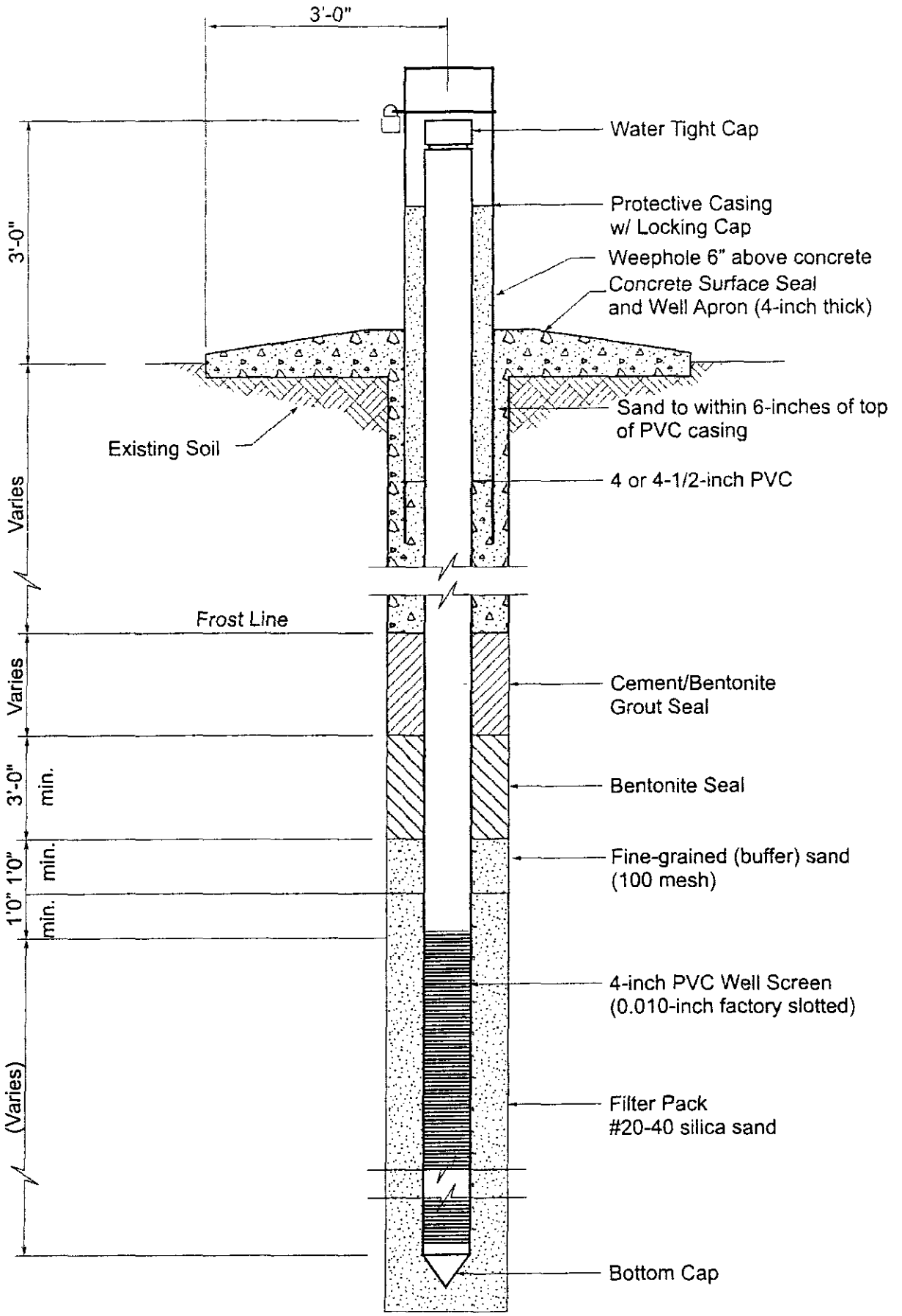
WESTON® MANAGERS DESIGNERS/CONSULTANTS
215 Union Boulevard
Suite 550
Lakewood, CO 80228
(303) 980-6800

BAYVIEW LANDFILL
SOUTH UTAH VALLEY
SOLID WASTE DISTRICT

FIGURE 5

MONITORING WELL LOCATIONS

10590007.pj-081594/600



HDR

HDR Engineering, Inc.

Typical Monitoring Well

Date
Jan. 2004

Figure
F-2

azometer.cdr
*Hatchco/Figures
/22/2001

APPENDIX F

DISTRICT'S GROUNDWATER MONITORING REPORT

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

APPENDIX F

DISTRICT'S GROUNDWATER MONITORING REPORT

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted February 2004

Prepared By:

HDR ENGINEERING, INC.

SUVSWD Bayview
Class I Landfill Permit Amendment – Appendix F

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Attachment 2 – Recording Forms
Attachment 3 – Typical Chain of Custody

Figures

Figure F-1 – Monitoring Wells
Figure F-2 – Typical Monitoring Well Design

INTRODUCTION

The Bayview Landfill is located in southwestern Utah County about 6 miles north of Elberta and 3 miles west of Goshen Bay of Utah Lake. The Bayview Landfill is underlain by unconsolidated deposits of the Provo Formation, Lake Bonneville Group, of the Pleistocene age. These deposits consist of poorly sorted, homogeneous matrix of silt, clay, sand, and gravel. Groundwater occurs under unconfined conditions in the shallow Pleistocene Aquifer and moves in a northeast direction from the East Tintic Mountains towards Utah Lake. The hydraulic gradient is very flat (0.02%) and the estimated velocity is 1.8 feet per year. The groundwater surface is at an approximate elevation of 4500 feet (Carpenter 1994).

1.0 MONITORING SYSTEM

The existing groundwater monitoring system for the site consists of eight deep monitoring wells, DMW-1 through DMW-8. Wells DMW-1 and DMW-7 serve background wells for cells 1 and 2, which are scheduled for development during the next 25 to 50 years. DMW-4 is on the southern boundary upgradient of parts of Cells 6 and 7. Wells DMW-3 and DMW-8 are compliance monitoring wells for Cell 1. Well DMW-6 is east of Leachate Basin 1. The remaining wells, DMW-2 and DMW-5, are located along the property boundary north of Cells 1 and 2, respectively. See Figure F-1 (Monitoring Wells). The locations of the monitoring wells shown in this figure are approximate; this figure is intended to present the general location relative to the landfill cells.

A new compliance monitoring well, DMW-9, will be installed north of Cell #2-Stage I. This well will serve as a compliance point and will be located within 500 feet hydraulically downgradient of the initial waste received for Cell #2. As shown in Figure F-1, two future compliance-monitoring wells will be installed along the northern boundary of Cell #2. The location of these two wells will be determined after future stages of Cell #2 are designed. Figure F-2 shows a typical design of a groundwater monitoring well.

To meet current regulations, the leachate pond will be reconstructed within the 5-year period covered by this Application. A new monitoring well could be needed for the reconstructed leachate pond. The location of the leachate pond monitoring well will be determined concurrently with the leachate pond design and the conceptual design of future stages of Cell #2, which could influence the location of the

improved leachate pond. If the leachate pond is not relocated, a new monitoring well will be installed within 500 feet of the pond's northeast corner. See Figure F-1.

The groundwater monitoring system also includes six shallow groundwater-monitoring wells, SMW-1 through SMW-6. None of the six shallow monitoring wells have contained water sufficient to either purge or sample on any sampling event, and these wells are not included in the discussion that follows.

Additional monitoring wells may be added to the system as information becomes available indicating that these wells are necessary to meet the requirements of the regulations. New wells will also be added to the system as future cells or leachate basins are designed and constructed.

2.0 GROUNDWATER SAMPLING PROGRAM

The sampling program began in March of 1991 in monitoring wells DMW-1 through DMW-6 as part of the initial landfill development process. Data from nine sampling events, from March 1991 to June 1992, was used to established background water quality in these wells. Wells DMW-7 and DMW-8 were installed late 1999 with background samples collected quarterly through 2001. For new monitoring well DMW-9, background water quality data will be collected for 2 years following installation.

In accordance with Solid Waste Regulations, groundwater samples are collected from all deep wells and submitted for laboratory analysis on a semi-annual basis. The samples collected are analyzed for the parameters listed in Utah Administrative Code Rule 315-308-4 (constituents for detection monitoring). When possible, laboratory detection limits will be set one order of magnitude below the groundwater protection standards listed in Rule 315-308-4. Attachment 1 (Groundwater Monitoring Plan For Bayview Municipal Solid Waste Landfill) provides more information on sampling procedures and monitored constituents.

The statistical analysis approach selected to analyze the ground water data uses intra-well methods consisting of control charts and prediction limits. The purpose of this analysis is to determine if there are any statistically significant changes in the compliance data relative to background. These methods use an established value based on the background water quality data collected for each well. A report summarizing the statistical analysis is prepared semi-annually and discloses any statistically significant changes in the water quality.

3.0 GROUNDWATER QUALITY

Laboratory analysis of background samples collected March 1991 to June 1992 shows no prior contamination of the groundwater by inorganic chemicals, volatile organic chemicals (VOC), or synthetic organic chemicals. (Carpenter 1994)

Laboratory analysis has never detected VOCs in groundwater samples so no statistical analysis has been needed. With the exception of zinc in DMW-2, statistical analysis of analytical results has shown no significant changes in the data from any of the compliance wells during the detection monitoring program to date.

Analytical results of samples collected on March 7, 2001, from compliance well DMW-2, showed an elevated concentration of zinc when compared to previous sampling results from the same well. However, historic samples from upgradient well DMW-1 have consistently shown zinc concentrations at the same levels. Zinc was not observed above the laboratory detection limits in all subsequent samples from compliance well DMW-2.

Historic changes in the laboratory detection limits may have resulted in the reporting of statistical significant changes for many constituents. In the event of a constituent not being detected, the statistical analysis used one-half of the laboratory detection limit as the actual concentration. The detection limit may have been greater than the projected limit value (above which would constitute a statistical change) calculated from background data. The result is a statistically significant change being reported even though a constituent was not detected by laboratory analysis. The laboratory detection limits will be set at or below the groundwater protection standards listed in R315-308-4 for all future analysis.

4.0 REFERENCES

Carpenter, Carl, CGWP No. 361. 1994. Quality of Groundwater at the Bayview Landfill Site, Elberta, Utah, April 1994.

APPENDIX F

ATTACHMENT 1: GROUNDWATER MONITORING PLAN

GROUNDWATER MONITORING PLAN

FOR

BAYVIEW MUNICIPAL SOLID WASTE LANDFILL

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

SPRINGVILLE, UTAH

Prepared by:

HDR Engineering, Inc.
3995 South 700 East, Suite 100
Salt Lake City, Utah 84107
(801) 281-8892

Submitted
January 1999

Revised
October 2003

HDR

SUVSWD Bayview
Class I Landfill Permit Amendment – Appendix F, Attachment 1

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1.0 INTRODUCTION

This groundwater monitoring plan (GMP) addresses the groundwater monitoring and sampling program at the South Utah Valley Solid Waste District's Bayview Landfill in Elberta, Utah. The GMP is required by the Utah Department of Environmental Quality (UDEQ) Municipal Solid Waste Regulations (R315-308-2) and will meet the requirements of the Federal US EPA Regulations under Subtitle D of the Resource Conservation and Recovery Act (RCRA).

The Bayview Landfill is underlain by unconsolidated deposits of the Provo Formation, Lake Bonneville Group, of the Pleistocene age. These deposits consist of poorly sorted, homogeneous matrix of silt, clay, sand, and gravel. Groundwater occurs under unconfined conditions in the shallow Pleistocene Aquifer and moves in a northeast direction from the East Tintic Mountains towards Utah Lake. The hydraulic gradient is very flat (0.02%) and the estimated velocity is 1.8 feet per year. The groundwater surface is at an approximate elevation of 4500 feet (Carpenter 1994).

1.1 Groundwater Monitoring System

The groundwater monitoring system for the site consists of eight deep monitoring wells, DMW-1 through DMW-8. Wells DMW-1 and DMW-7 serve as the upgradient or background wells for cells 1 and 2, which are scheduled for development during the next 25 to 50 years. DMW-4 is on the southern boundary upgradient of parts of Cells 6 and 7. Wells DMW-3 and DMW-8 are early warning wells for Cell 1. Well DMW-6 is east of Leachate Basin 1. The remaining wells serve as compliance wells and are located along the property boundary. Wells DMW-2 and DMW-5 are north of Cells 1 and 2, respectively. The groundwater monitoring system also includes six shallow groundwater monitoring wells, SMW-1 through SMW-6. None of the six shallow monitoring wells have contained water sufficient to either purge or sample on any sampling event, and these wells are not included in the following discussion.

Additional monitoring wells may be added to the system as information becomes available indicating the necessity to meet the requirements of the regulations. New wells may also be added to the system as new cells or leachate basins are designed and constructed.

1.2 Well Construction

Well construction records, including drilling logs, are presented in Appendix E of the Bayview Landfill Permit. Generally, wells have been constructed of 4- or 4½ -inch diameter PVC pipe with a 20-foot screened interval and a 1-foot silt sump. Table F-1 provides information on wells DMW-1 through DMW-8, including total depth and approximate depth to groundwater for each of the deep monitoring wells. Not considering minor seasonal and climatic variations, groundwater can be found at an approximate elevation of 4500 feet.

Table F-1: Monitoring well data for the Bayview Landfill.

Well	Screened Interval		Water Depth (ft.)		
Designation	Top	Bottom	Drilling	Monitoring	Variation[1]
DMW-1	280	300	265	242	1.5
DMW-2	270	278	236	232	7.5
DMW-3	245	308	245	245	2.0
DMW-4	175	195	175	174	2.5
DMW-5	189	210	178	172	20.0
DMW-6	145	166	139	137	2.0
DMW-7	243	295	NA	265	NA
DMW-8	225	270	NA	247	NA

[1]Variation is the approximate ranges of values observed during monitoring events.

2.0 GROUNDWATER ELEVATION MONITORING

2.1 Well Inspections

During each monitoring event, the wells will be inspected for damage to the well casing, protective cover, lock, well cap, and concrete pad. In addition, the ground surface around the well pads will be inspected for erosion. If any problems are discovered, they will be resolved as soon as practical.

2.2 Monitoring Procedures

Groundwater level measurements will be collected using an electric well sounder marked in 1-foot increments. A measuring tape will be used to determine the distance between 1-foot markings, with measurements recorded to the nearest ½-inch (0.04-foot) increment. For each monitoring event, the total well depth will be measured to evaluate whether the casing has silted up. Water levels in the monitor wells will be measured prior to purging or sampling. The groundwater level measurement will be recorded from a survey mark on the top of the monitor well casing. Water level measurements will always be referenced to the survey mark on the well casing. When a measurement is made, the measuring device will be raised and lowered several times to be sure the correct measurement is read off the tape measure. Water level measurements for each monitoring event will be converted to elevations (nearest 0.04 foot) and submitted with the groundwater sampling report. The survey data for each monitoring well will be referenced to the benchmark established for the landfill.

2.3 Protocol for Water-Level Measurements and Instrumentation

During each monitoring event, the current water level readings will be compared to the readings from the previous monitoring event. If a large change in water level is noted, the water level will be measured again to ensure the measurement was recorded correctly.

Prior to collecting water level measurements, the measuring device will be checked for damage, including bends or kinks in the tape. To maintain consistency and precision, the same measuring device will be used during each monitoring event, to the extent practical. Also once each year, the tape will be checked against a calibrated tape measure to verify its accuracy.

Prior to conducting the well purging activities, the pH and conductivity meters will be calibrated. Calibration of the instruments will be in accordance with the manufacturer's procedures for the particular instrument. At a minimum, the pH and conductivity meters will be calibrated using standard calibration solutions as recommended by the manufacturer. The same instrumentation will be used for each monitoring event.

3.0 DECONTAMINATION PROCEDURES

Prior to each sampling event and between wells, all non-dedicated equipment including the water level measuring device will be decontaminated thoroughly to minimize the potential for cross contamination. The decontamination procedures will consist of thoroughly flushing the equipment with potable water three times followed by a final rinse with deionized water. Decontamination of larger items, such as dedicated pumps removed for repair, will be accomplished by steam cleaning. Purge and decontamination water will be discharged into the leachate collection pond.

4.0 GROUNDWATER SAMPLE COLLECTION

4.1 Well Purging Procedures

Prior to each sampling event, the groundwater level in each well and the total well depth will be measured as described in Section 2.2. During the purging activities, disposable latex gloves will be worn by the sampling team and changed between wells. To purge a well, temperature, conductivity, and pH will be continuously measured and recorded on the forms in Attachment 2 of Appendix F. Once all these parameters stabilize, indicating stagnant water has been replaced by formation water, purging will be considered complete. If a well dewaters prior to achieving the stable water quality parameters, it will be allowed to recharge before sampling.

The method of well purging for this site consists of using a dedicated submersible pump system for each well where the discharge rate can be regulated for sampling. The pump intake will be placed within the screened section of the well casing. For wells that sustain continuous pumping without dewatering, the discharge rate on the pump will be set to allow minimal drawdown in the well. This procedure will minimize any cascading effects that may volatilize constituents in the groundwater entering the well casing and will also minimize agitating sediment collected in the bottom of the well. If the main pump system fails, temporary portable pumps will be used as backups. If portable pumps are needed, the intake will be gently lowered into the upper most portion of the water column to minimize agitating any residual sediment that has collected in the bottom of the well. If a portable pump is used for more than one well, then proper cleaning of

the pump and ancillary equipment is necessary to minimize the potential of cross contamination (refer to Section 3.0).

During the purging operations, a record of the climatic conditions, condition of the wells and surrounding ground surface, field collected water quality, color, odors, water level, depth of well and purge rate will be recorded. The information will be recorded in indelible ink, will be stored either on site at the landfill office or at the District's office in Springville, and will become part of the site operating record for the landfill.

4.2 Groundwater Collection and Handling Procedures

During groundwater collection, disposable latex gloves will be worn and changed between wells to minimize cross contamination of samples and to reduce the possibility of coming into contact with groundwater containing contaminants. Prior to collecting a groundwater sample the monitor wells will be purged of groundwater as described in Section 4.1. Purge water will be handled as discussed in Section 4.5. The monitor wells will be sampled in the same order they are purged. Samples will normally be collected immediately following purging; all samples will be collected within 24-hours following purging. If sufficient recharge does not occur within 7 days following purging, then the well will be considered dry and a sample will not be collected. The District will follow the laboratory's Quality Assurance/Quality Control (QA/QC) protocols regarding sampling containers, preservation, and holding times.

Samples will be collected from the pump discharge to maintain the slowest discharge rate possible to minimize cascading and volatilization as the sample containers are being filled. The sample containers will be held as close to the pump discharge as possible without touching to minimize the loss of volatiles. The containers for the VOCs will be tilted slightly to allow the water to gently run down the inside wall of the container. All samples will be collected in appropriate sample containers with appropriate preservatives.

Following the filling of each sample container, they will be labeled with the well number, date and time collected, preservatives used, analyses to be run, and the sampler's initials. The 40-

milliliter vials will be placed in zip-locked plastic bags. The sample containers for each well will include a minimum of two-40 milliliter VOA glass vials with Teflon® septa screw caps for volatile organic constituents (VOC), and other bottles as provided by the laboratory. Sample containers for VOCs will be completely filled and sealed carefully to prevent air bubbles. If an air bubble is present, then the sample will be discarded and the sample will be collected again. All other sample containers will be filled as completely as possible.

Once the samples have been properly sealed and labeled as described above, they will be recorded on a Chain-of-Custody (COC) form and signed and dated by the sampling technician(s). An example of a typical COC form is presented in Attachment 3 of Appendix F. The COC form will accompany the samples to the laboratory. The samples will be placed in a plastic ice chest (similar to an Igloo ice chest) with ice or a re-freezable type product to maintain a temperature as close to 40C as possible until the analyses are performed. Dry ice is not permitted due to the potential of freezing the samples and breaking the containers. Precautions will be taken to secure the samples in the ice chest to prevent them from breaking during transport. The samples will be delivered to the laboratory within 24-hours after collection.

4.2.1 Detection Monitoring Sampling Frequency

The sampling schedule for detection monitoring consists of collecting samples from each monitor well for the Detection Monitoring constituents on a semi-annual basis after background data has been established. Any changes to the frequency and/or number and type of constituents for detection monitoring must be approved by the Executive Secretary prior to implementing the change. The schedule for establishing background data will be discussed in Section 5.5.

4.3 Quality Control Samples

To provide screening of field procedures, additional samples will be collected. Trip blank samples will be prepared by the laboratory and will accompany the empty sample containers and collected samples to and from the laboratory. The trip blank will consist of filling four 40-milliliter VOA vials (two sets each) with deionized and laboratory-grade water, respectively. The purpose of the trip blank is to assess whether any of the sample containers or collected

samples has been contaminated before or during sampling, and during transport to the laboratory. At least one trip blank will be prepared for every container transported from the laboratory. The Quality Control (QC) samples will be collected and handled in a similar fashion as the other samples and will be analyzed for VOCs.

At the discretion of the District or direction of the UDEQ, blind field duplicate samples will be collected to assess the precision of the sampling and laboratory methods. The blind duplicate samples will be collected from well(s) which typically contain the highest concentrations of contaminants. When a blind sample is collected, it will be handled in a similar fashion as the other samples, but will be labeled in such a manner that the laboratory does not know it is a duplicate sample.

4.4 Weather Protocol

Sampling of the monitor wells will not be permitted during inclement weather, i.e. thunderstorms. To the extent possible, monitor wells will not be sampled during periods when the temperature drops below freezing. Caution should be taken when the temperature exceeds 100^0 F. If contamination is detected, the District will develop a health and safety plan for further ground water monitoring activities. While in the field, personnel engaged in the monitoring program shall adhere to this health and safety protocol.

4.5 Purge Water Handling Procedures

Purge and decontamination water will be collected in closable drums and disposed of in the leachate collection basin.

5.0 ANALYTICAL TESTING

5.1 Laboratory Performing the Analyses

The analytical laboratory selected to perform the required analyses will be licensed and certified by the State of Utah. At a minimum, the selected laboratory will apply quality control

procedures in accordance with EPA SW-846, Test Methods for Evaluating Solid Waste, Third Edition, November 1986 as revised December 1987.

5.2 Laboratory Procedures

The laboratory will follow appropriate QA/QC protocol developed as part of its licensing and certification. At a minimum, upon receipt of the samples by the laboratory, the sample lot will be verified with the information on the COC form (Attachment 3 in Appendix F). If there is a discrepancy with the samples, the responsible party that collected the samples will be notified and the problem will be resolved before the analyses are performed. The COC form will be signed and dated by the designated receiving personnel at the laboratory. The COC form will remain with the laboratory until the analyses are completed, then will be attached to the completed laboratory report. For samples that require overnight transport to the laboratory by a third party, the COC form will be signed including date and time received by the transporter.

5.3 Laboratory Quality Assurance and Quality Control Samples

The laboratory will adhere to its QA/QC plan developed as part of its licensing and certification. If possible, the laboratory will be required to achieve detection limits (DLs) that are at least one order of magnitude below the maximum contaminant levels (MCLs) for a constituent for which an MCL has been promulgated.

5.4 Constituents to be Analyzed and Test Methods

As specified in the UDEQ (R315-308-2) and Subtitle D (40 CFR 258.53) regulations, the groundwater monitoring program at all Municipal Solid Waste Landfills (MSWLFs) shall consist of detection monitoring that includes specific constituents. The constituents to be tested for during the detection-monitoring program are listed in Table F-2. Approved testing methods, as described in 5.1, will be used for all constituents. The laboratory DLs will be below the MCLs for each of the constituents. If a change in the analytical method is needed, then the Executive Secretary will be notified in writing. The Executive Secretary shall approve of the change prior to implementing the change. All samples will be analyzed within the required holding times for

the particular analyses. The laboratory will report the Chemical Abstracts Service (CAS) number for each constituent analyzed.

Table F-2: Background/Detection Monitoring Constituents

Inorganic Constituents

Ammonia (7664-41-7)
Carbonate/Bicarbonate
Calcium
Chemical Oxygen Demand (COD)
Chlorides
Iron (7439-89-6)
Magnesium
Manganese (7439-96-5)
Nitrate (as N)
pH
Potassium
Sodium
Sulfate
Total Dissolved Solids (TDS)
Total Organic Carbon (TOC)

Heavy Metals

Antimony (7440-36-0)
Arsenic (7440-38-2)
Barium (7440-39-3)
Beryllium (7440-41-7)
Cadmium (7440-43-9)
Chromium
Cobalt (7440-48-4)
Copper (7440-50-8)
Lead
Mercury (7439-97-6
Nickel (7440-02-0)
Selenium (7782-49-2)
Silver (7440-22-4)
Thallium
Vanadium (7440-62-2)
Zinc (7440-66-6)

VOCs

Acetone (67-64-1)
Acrylonitrile (107-13-1)
Benzene (71-43-2)
Bromochloromethane (74-97-5)
Bromodichloromethane (75-27-4)
Bromoform (75-25-2)
Carbon disulfide (75-15-0)
Carbon tetrachloride (56-23-5)
Chlorobenzene (108-90-7)
Chloroethane (75-00-3)
Chloroform (67-66-3)
Dibromochloromethane (124-48-1)
1,2-Dibromo-3-chloropropane (96-12-8)
1,2-Dibromoethane (106-93-4)
1,2-Dichlorobenzene, ortho (95-50-1)
1,4-Dichlorobenzene, para (106-46-7)
trans-1,4-Dichloro-2-butene (110-57-6)
1,1-Dichloroethane (75-34-3)
1,2-Dichloroethane (107-06-2)
1,1-Dichloroethylene (75-35-4)
cis-1,2-Dichloroethylene (156-59-2)
trans-1,2-Dichloroethylene (156-60-5)
1,2-Dichloropropane (78-87-5)
cis-1,3-Dichloropropene (100061-01-5)
trans-1,3-Dichloropropene (10061-02-6)
Ethylbenzene (100-41-4)
2-Hexanone (591-78-6)
Methyl bromide (74-83-9)
Methyl chloride (74-87-3)
Methylene bromide (74-95-3)
Methylene chloride (75-09-2)
Methyl ethyl ketone; MEK (78-93-3)
Methyl iodide (74-88-4)
4-Methyl-2-pentanone (108-10-1)
Styrene (100-42-5)
1,1,1,2-Tetrachloroethane (630-20-6)
1,1,2,2-Tetrachloroethane.(79-34-5)
Tetrachloroethylene (127-18-4)
Toluene (108-88-3)
1,1,1-Trichloroethane (71-55-6)
1,1,2-Trichloroethane (79-00-5)
Trichloroethylene (79-01-6)
Trichlorofluoromethane; CFC-11 (75-69-4)
1,2,3-Trichloropropane (96-18-4)
Vinyl acetate (108-05-4)
Vinyl chloride (75-01-4)
Xylenes (1330-20-7)

Note: The CAS Number, if appropriate, is listed in parentheses. These parameters were taken from UAC R315-308-2, and should be verified at least annually.

5.5 Establishment of Background Data

As specified in the UDEQ regulations (R315-308-2 (4)(a)) and Subtitle D (40 CFR 258.53) regulations, background data for the Detection Monitoring Constituents was established. The monitoring wells were installed, and background data was collected prior to the effective date of these regulations. The background sampling was performed from March 1991 to June 1992 from deep monitoring wells DMW-1 through DMW-6 with more than eight samples collected from each of these wells. Monitoring wells DMW-7 and DMW-8 were installed in 1996, and background sampling was conducted through quarterly sample events during 1999 and 2000.

6.0 STATISTICAL METHOD TO EVALUATE ANALYTICAL DATA

After each sampling event, the groundwater monitoring data will be evaluated to determine if statistically significant changes from background values exist for each constituent listed in Table F-2. The statistical analyses will be performed in accordance with R315-308-2 (7). To perform the statistical methods with a high degree of confidence, a minimum of eight statistically independent samples were collected from each monitor well during the background-monitoring period. Based on the available statistical methods cited in the regulations, the preferred method selected for this site is an intra-well comparison with a control chart such as a Shewert-CUSUM control chart. This procedure is the preferred method because of its relative ease to implement and because it is especially applicable to sites where no groundwater contamination exists. The analytical data may also be analyzed using Prediction Limits (PL) with the PLs determined based on background data collected.

7.0 REPORTING REQUIREMENTS

Upon completion of each Detection Monitoring sampling event, the analytical data will be summarized in a groundwater monitoring report. The semi-annual groundwater monitoring reports will be submitted with the District's annual report unless more immediate notification is required.

When a statistically significant change (SSC) has been determined, the owner/operator will, within 14 days of the completion of the statistical analysis and within 30 days from the receipt of the sample analysis results, enter this information into the operating record and notify the Executive Secretary of the finding in writing. The notification must indicate what constituents have shown SSC. In addition, all monitoring wells will be immediately resampled for the constituents listed in Table F-2. If an SSC is still present after resampling, the owner/operator must notify the Executive Secretary in writing within seven days of receipt of the sample results. However, if the SSC change from the background data is believed to be caused by a source other than the landfill, then the owner/operator can prepare a report that explains the cause of the significant change. This report must be prepared and certified by a qualified groundwater scientist and submitted to the Executive Secretary after the sampling event for approval. If the Executive Secretary approves the report, then the landfill may return to Detection Monitoring. If the Executive Secretary believes a satisfactory explanation is not given within 90 days, the Assessment Monitoring Program will be implemented at the direction of the Executive Secretary. The Assessment Monitoring Program shall be implemented in accordance with R315-308-2 (11).

APPENDIX F

ATTACHMENT 2: RECORDING FORMS

GROUNDWATER MONITORING PROGRAM
BAYVIEW MUNICIPAL SOLID WASTE LANDFILL
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

DATE:
SAMPLED BY:
RECORDED BY:
WEATHER:

Well Number	Depth of Well (feet)	Depth to Water (feet)	Temp. C_X__ F___	pH	Conductivity	Comments
DMW1	300					
DMW2	278					
DMW3	308					
DMW4	195					
DMW5	210					
DMW6	168					
DMW7	293					
DMW8	270					

APPENDIX F

ATTACHMENT 3: TYPICAL CHAIN OF CUSTODY

Chain of Custody Log Form

TO : _____
Address : _____

COC / SL # : _____

Page ____ of ____

Client : _____
Address : _____

Quote # : _____

ID : _____
PO # : _____
Contact : _____
Phone : _____

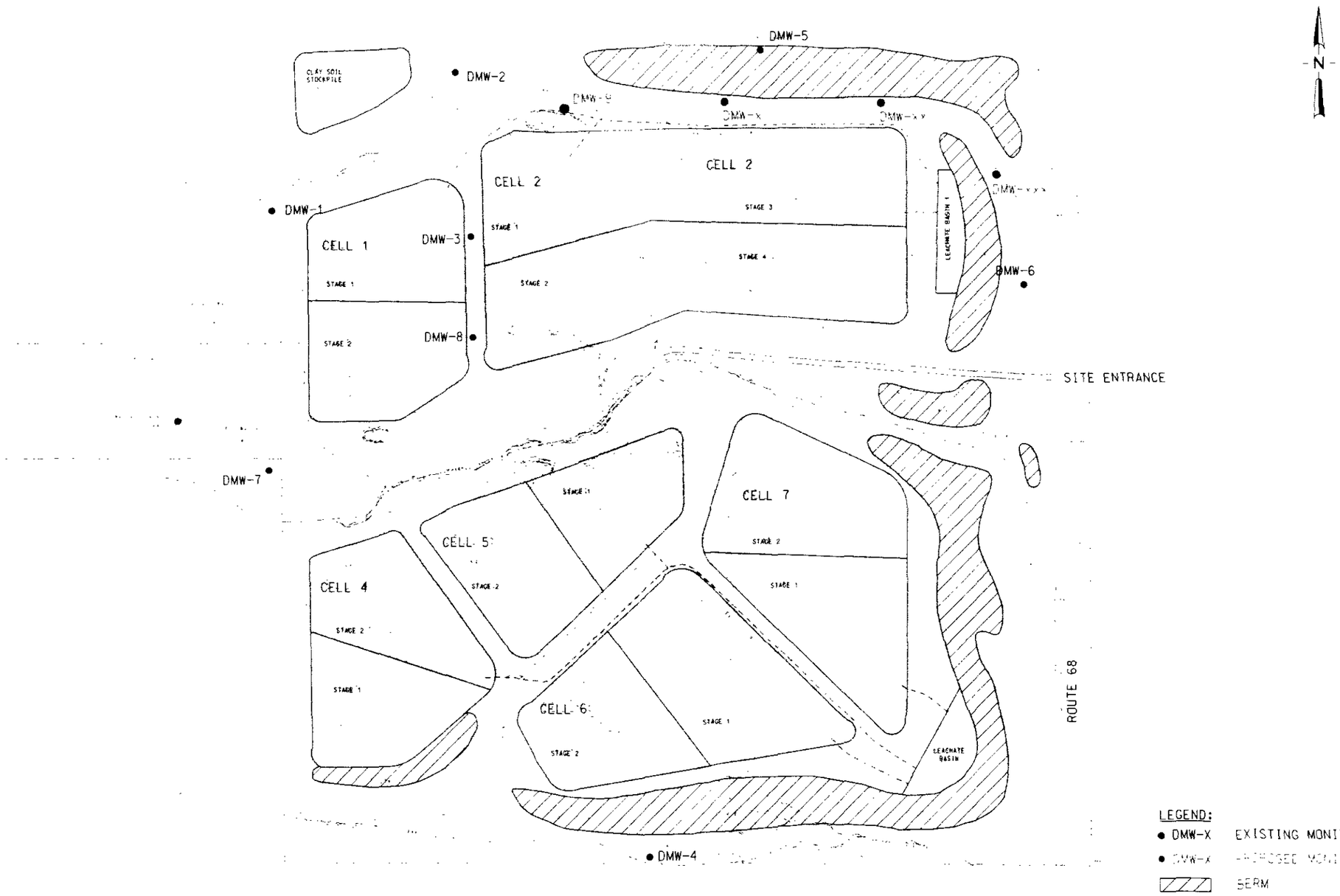
Date : _____
Turnaround : _____
Job # : _____
Sampled By : _____

Report To : _____
Address : _____

Invoice To : _____

Sample ID	Date / Time	MATRIX	Preservatives				Analyses														Comments
			Cool < 4°C																		

Relinquished By	Date	Time	Received By	Date	Time	Temperature	Airbill #



HDR ENGINEERING INC.
SALT LAKE CITY, UTAH

CHECK
CHECK
CHECK
DESIGN
DRAWN
QUANT.
APPROVAL RECOMM.
DATE
APPROVED
DATE

BAYVIEW LANDFILL
SUVSWD
Figure F1-
Monitoing Wells
SALT LAKE
COUNTY

DWG. NO.

DATE: December 2003

HDR

APPENDIX G

UTAH HYDROLOGIC DATA REPORT NO. 50

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

This document was submitted
as part of a previous Permit.

APPENDIX G

UTAH HYDROLOGIC — DATA REPORT NO. 50

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey, WRD
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

Copies of this report can be purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center
Box 25425
Denver, Colorado 80225

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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
acre	0.4047	hectare
	4,047	square meter
foot	0.3048	meter
cubic foot per second	0.02832	cubic meter per second
gallon per minute	0.06308	liter per second
inch	25.4	millimeter
	0.0254	meter
mile	1.609	kilometer
square mile	2.59	square kilometer

Water temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8\ (°C) + 32.$$

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Specific conductance and water temperature are given in metric units. Specific conductance is given in microsiemens per centimeter (µS/cm) at 25 degrees Celsius. Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (µg/L). Milligrams per liter is a unit expressing the solute per unit volume (liter) of water. For concentrations less than 7000 milligrams per liter, the numerical value is about the same as concentration in parts per million. One thousand micrograms per liter is equivalent to 1 milligram per liter.

SELECTED HYDROLOGIC DATA FOR SOUTHERN UTAH AND GOSHEN VALLEYS, UTAH, 1890–1992

By Bernard J. Stolp, Marilyn Drumiler, and Lynette E. Brooks

INTRODUCTION

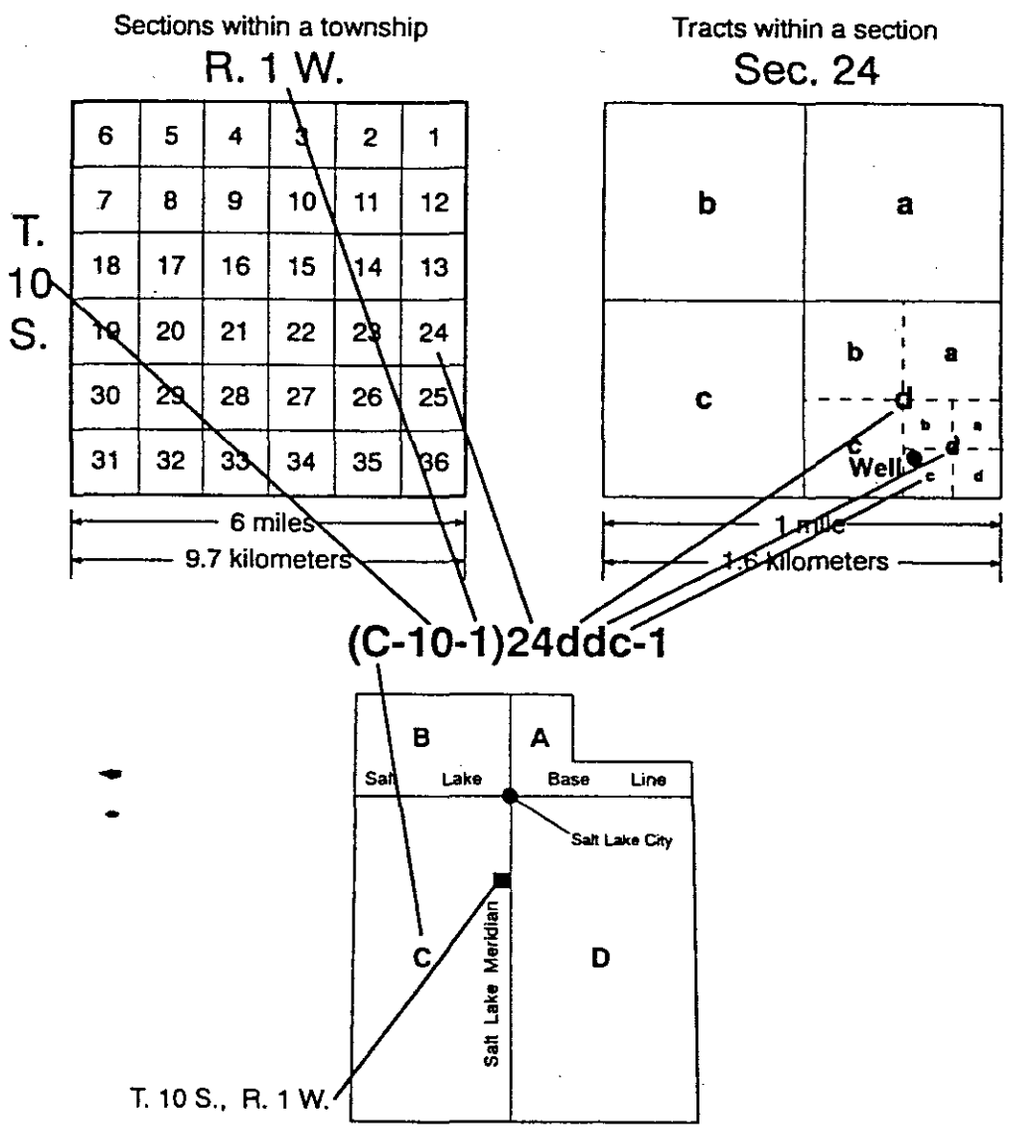
This report contains hydrologic data collected in southern Utah and Goshen Valleys from 1890 to 1992. Southern Utah and Goshen Valleys are south of Salt Lake City in Utah County, north-central Utah. The area is bounded on the east and south by the Wasatch Range, on the south by Long Ridge, on the west by the East Tintic Mountains and the Mosida Hills, and on the north by a line through about the middle of T. 7 S. Southern Utah Valley and Goshen Valley are divided by the northern tip of Long Ridge, West Mountain, and Utah Lake (Cordova, 1970). The area is in the Basin and Range physiographic province described by Fenneman (1931), and includes about 390 square miles.

Most of the data in this report were collected by the U.S. Geological Survey in cooperation with the Utah Department of Natural Resources, Division of Water Rights. Some of the earlier data were published previously by Cordova (1969 and 1970).

The purpose of this report is to provide hydrologic data for use by the general public and by officials managing the area's water resources, and to document data collected during a 4-year study of the ground-water resources in southern Utah and Goshen Valleys. Tables 1 to 8 contain selected ground- and surface-water data. Select data, including well depth and water level, is given for over 400 wells, and chemical analyses are given of samples from about 90 wells. The numbering system used in Utah for hydrologic-data sites is illustrated in figure 1. Hydrologic-data sites are shown on plate 1.

These data could not have been collected without the cooperation of local residents and officials of irrigation companies and municipalities, who permitted access to their wells and property.

The system of numbering wells and springs in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the well or spring, describes its position in the land net. The land-survey system divides the State into four quadrants separated by the Salt Lake Base Line and the Salt Lake Meridian. These quadrants are designated by the uppercase letters A, B, C, and D, indicating the northeastern, northwestern, southwestern, and southeastern quadrants, respectively. Numbers designating the township and range, in that order, follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses indicates the section, and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section—generally 10 acres[1]. The lowercase letters, a, b, c, and d indicate, respectively, the northeastern, northwestern, southwestern, and southeastern quarters of each subdivision. The number after the letters is the serial number of the well or spring within the 10-acre tract. When the serial number is not preceded by a letter, the number designates a well. When the serial number is preceded by an "S," the number designates a spring. Thus, (C-10-1)24ddc-1 designates the first well constructed or visited in the southwest 1/4, southeast 1/4, southeast 1/4, section 24, T. 10 S., R. 1 W. A location number with no serial number designates a surface-water data-collection site.



[1] Although the basic land unit, the section, is theoretically 1 square mile, many sections are irregular. Such sections are subdivided into 10-acre tracts, generally beginning at the southeastern corner, and the shortage is taken up along the northern and western sides of the section.

Figure 1. Numbering system used in Utah for hydrologic-data sites.

REFERENCES CITED

Cordova, R.M., 1969, Selected hydrologic data, southern Utah and Goshen Valleys, Utah: U.S. Geological Survey open-file report (duplicated as Utah Basic Data Release No. 16), 35 p.

—1970, Ground-water conditions in southern Utah Valley and Goshen Valley, Utah: Utah Department of Natural Resources Technical Publication No. 28, 79 p.

Fenneman, N.M., 1931, Physiography of the western United States: New York, McGraw-Hill, 534 p.

Table 1.—*Records of*

[—, no

Well number: See figure 1 for explanation of the numbering system for hydrologic-data sites.
Owner: Last known or reported owner.
Use of water: C, commercial; H, domestic or household; I, irrigation; K, mining; N, industrial; O,
Casing: Diameter: Diameter of the production string of casing; Reported from the driller's log or measured
reported, only top of perforated interval is known; R, wire wound; S, screened; X, open hole.
Elevation of land surface is given in feet above sea level. Elevations are reported to the nearest 0.01 foot
Water level is given in feet and decimal fractions. Measured except where noted R, reported.
Other data available: L, driller's log (table 2); W, water-level measurements (table 3); D, discharge

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(C-7-1)26cdd-1	Smith, Doyle	1979	S	116
(C-8-1)20cdb-2	Bateman	1967	S	345
(C-8-1)20cdb-3	Harold Howlett & Sons	1972	I	400
(C-8-1)20cdb-4	Unknown	—	I	225
(C-8-1)29dda-1	Bateman	1973	I	625
(C-8-1)34bcc-1	LDS Church	1970	H	412
(C-8-1)35dcb-1	Dixson, S.	1945	S	212
(C-8-2)25dac-1	Steadman, Bill	1972	S	600
(C-9-1)3ddb-1	LDS Church	1964	I	575
(C-9-1)4ccc-1	LDS Church	1970	I	756
(C-9-1)4ddc-1	LDS Church (No. 9)	—	I	690
(C-9-1)5ddc-1	Steadman, Bill	1970	I	776
(C-9-1)17abb-1	South Utah Valley Solid Waste District	1989	O	70
(C-9-1)17abb-2	South Utah Valley Solid Waste District	1989	O	210
(C-9-1)17ada-1	South Utah Valley Solid Waste District	1989	O	166
(C-9-1)17bba-1	South Utah Valley Solid Waste District	1989	O	269
(C-9-1)17bbc-1	South Utah Valley Solid Waste District	1989	O	301
(C-9-1)17bbd-1	South Utah Valley Solid Waste District	1989	O	70
(C-9-1)17bbd-2	South Utah Valley Solid Waste District	1989	O	300
(C-9-1)17cdd-1	South Utah Valley Solid Waste District	1989	O	195
(C-9-1)18add-1	South Utah Valley Solid Waste District	1986	P	502
[1] (C-9-1)20cdd-1	LDS Church	1964	I	532
(C-9-1)20ddd-1	LDS Church (No.7)	1963	I	788
(C-9-1)26bda-3	Burraston, B.	1915	S	56

selected wells

data available]

observation; P, public supply; Q, aquaculture; S, stock; U, unused; Z, other.
in the field. Finish: O, open end; P, perforated, where single depth is
Upper or lower limits of perforations or screen are given in feet below land surface.
when the well has been surveyed.

(table 4); C, chemical analysis (table 5).

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)	Finish	(feet)		Above (-) or below land surface		Date	
8	O		4,495	22	R	03-05-79	
16	X	227-345	4,620	120.2	R	04-04-67	C
—	O		4,620	128	R	10-10-72	C
—	—		4,620	—		—	C
12	P	100-235	4,595	89.34		03-02-87	C
	P	307-595					
6	P	402	4,535	43.94		03-04-91	
4	O		4,489	-3.0	R	06-15-64	C
8	P	300-390	4,770	276	R	05-24-72	
18	P	190-205	4,510.36	17.08		03-04-91	L,W,C
	P	225-338					
	P	365-565					
16	P	240-405	4,620	128.76		03-14-91	W,C
	P	565-750					
18	P	200-683	4,570	81.01		03-04-91	L,W,C
16	P	280-390	4,640	163	R	03-30-70	C
	P	545-740					
4.5	S	49-70	4,670	69.18		03-07-91	
4.5	S	189-210	4,665	175.19		03-07-91	
4.5	S	145-166	4,635	136		03-07-91	
4.5	S	228-269	4,730	232.72		03-07-91	
4.5	S	260-301	4,745	241.19		03-07-91	
4.5	R	49-70	4,740	69.35		03-07-91	
4.5	R	280-300	4,740	243		03-07-91	
4.5	R	175-195	4,670	171.7		03-07-91	L
12	P	350-445	4,775	264	R	09-09-86	
	P	450-500					
20	P	275-521	4,701.40	200.34		03-04-91	L,W,C
18	P	300-490	4,640	137.98		03-05-91	L,W,C
	P	490-775					
1.5	O		4,496	-7.0		05-09-90	W,C

Table 1.—*Records of*

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(C-9-1)26dcd-1	Woodard, J.E.	1956	S	37
(C-9-1)28ccb-1	LDS Church	1962	I	802
(C-9-1)29acc-1	LDS Church	1963	I	700
(C-9-1)29bcc-1	LDS Church	1963	H	800
(C-9-1)29cdc-1	Town of Elberta	1977	P	400
(C-9-1)29cdc-2	Town of Elberta	1989	P	387
(C-9-1)34ccc-1	LDS Church	1951	I	650
[2] (C-9-1)34acd-1	Miller, H.	1961	S	265
(C-9-1)34ddc-1	Miller, A.	1964	H	256
(C-10-1)2bcd-1	Green, Duane	1981	S	100
(C-10-1)3ddb-1	White, G.T.	—	H	495
(C-10-1)4bbb-1	LDS Church (No. 2)	1962	I	882
(C-10-1)4cbb-1	LDS Church	1962	I	870
(C-10-1)9ccc-1	Wright, Bill	1961	I	474
(C-10-1)10ddc-3	Green, Duane	1979	H	162
(C-10-1)11ccd-1	Burraston, Carma	1980	—	160
[3] (C-10-1)15cca-1	Morgan, H.	1951	U	168
(C-10-1)17aaa-1	Town Of Elberta	1955	U	376
(C-10-1)17bba-1	Sunshine Mining Company	—	U	860
(C-10-1)17bba-2	Sunshine Mining Company	1986	U	320
(C-10-1)18ccc-1	Levering, Dean and Betty	—	U	450
(C-10-1)24ddc-1	Lunceford, Scott	1965	U	533
[4] (C-10-1)25abd-1	Lunceford, Scott	1951	I	645

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level		Other data available
Diameter (inches)	Finish (feet)			Above (-) or below land surface	Date	
2	O		4,505	-1.33	03-07-91	
20	—		4,643	127.65	03-04-91	L,W,C
18	P	280-380	4,719	214.28	03-04-91	L,W,C
	P	380-405				
	P	426-700				
18	P	300-350	4,792	300.10	04-02-90	L,W,C
	P	350-675				
	P	700-775				
8	P	315-385	4,760	288	05-23-88	
10	P	270-340	4,760	256.55	06-29-89	
8	P	70-580	4,551	17.85	12-13-74	C
	P	587-650				
1.25	O		4,508	-6.90	03-07-91	C
2	O		4,517	-5.50	03-07-91	L,C
6	O		4,515	9.18	03-07-91	
6	—		4,555	18.86	04-24-67	C
18	P	525-880	4,672	147.04	03-05-91	L,W,C
12	S	406-550	4,664	135.86	03-04-91	L,W,C
	S	640-680				
	S	700-740				
	S	750-850				
16	P	255-346	4,681	131.68	03-08-77	C
	P	360-420				
	P	427-474				
6	O		4,555	6 R	03-07-91	C
6	P	150-157	4,550	4.37	03-05-91	
12.5	—		4,600	28.29	03-07-91	W,C
6	O		4,711	170.37	12-30-71	C
4	S	750-860	4,810	266.71	03-04-91	W
6	P	300-320	4,810.4	266.56	03-04-91	W
8	O		4,918	353.46	03-05-91	W
20	P	366-391	4,750	212.54	03-05-91	W
	P	422-428				
	P	462-482				
12	P	372-450	4,778	245.15	03-05-91	W,C
	P	461-492				
	P	507-550				
	P	568-575				
	P	585-600				

Table 1.—*Records of*

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(C-10-1)28ada-2	LDS Church	1979	H	775
(C-10-1)29cdd-1	LDS Church	1961	I	842
(C-10-1)29dcd-1	LDS Church	1954	H	460
(C-10-1)29ddd-1	LDS Church	1962	I	700
(C-10-1)30baa-1	Unknown	—	S	—
(C-10-1)31cdd-1	LDS Church	1963	I	603
(C-10-1)32ccc-1	LDS Church	1961	I	507
(C-10-1)33cbb-1	LDS Church	1961	U	567
(C-10-1)34bbb-1	Critchfield, Ross	1949	H	342
(C-10-2)13bcc-1	Bronson, Jonathan	—	—	300
(C-11-1)6abc-1	LDS Church	1963	I	679
(C-11-1)6bdd-1	LDS Church	1964	I	762
(C-11-1)6cab-1	LDS Church	1981	I	825
(D-7-2)32dad-1	Batty, Roy	1978	H	550
5 (D-7-2)33dcc-1	Banks, A.	—	S	400
(D-7-2)34dcd-1	Christofferson, B.	1959	S	194
(D-7-2)35ccd-1	Hales, G.	1900	I	300

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
8	P	746-760	4,670	135	R	04-06-79	
16	P	185-189	4,680	151.3		03-29-66	C
	P	205-275					
	P	280-574					
	P	595-685					
	P	696-762					
	P	770-815					
6	O		4,670	129.06		03-07-91	
16	P	162-195	4,660	100.50		03-04-80	C
	P	228-246					
	P	408-411					
	P	420-428					
	P	532-695					
—	—		4,778	228.67		06-05-90	W
20	P	290-603	4,760	210.69		03-14-91	L,C
16	P	210-220	4,743	204.1		03-29-66	C
	P	263-324					
	P	352-356					
	P	367-398					
	P	420-505					
16	P	155-567	4,680	115.54		03-07-91	
—	O		4,660	89.39		03-07-91	W
6	P	180-220	5,140	172.24		03-05-91	W
18	P	315-322	4,770	229.99		12-11-75	L,C
	P	330-335					
	P	390-488					
	P	495-532					
	P	545-675					
18	P	425-500	4,780.9	234.39		04-06-90	L,W,C
	P	533-541					
	P	556-577					
	P	584-659					
	P	672-745					
20	P	474-807	4,795	262	R	09-18-81	
8	P	350-353	4,493	-22.7		03-04-91	L,W,D
	P	450-453					
2.5	P	370-400	4,495	—		—	D
2	O		4,505	-6.60		03-05-91	W,C
2	O		4,507.1	-7.4		03-23-61	D

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-7-2)35ccd-2	Hales, A.	1961	H	420
(D-7-2)36bbb-1	Money, W.	1943	S	147
(D-7-2)36ccb-1	Money, W.	1961	I	504
(D-7-2)36dad-1	Huntingdon, B.	—	S	100
(D-7-2)36dcc-2	Crandall, Condie	—	U	186
(D-7-3)18dcc-1	LDS Church	1962	H	322
(D-7-3)19aac-1	John Kuhni and Sons Animal By-Product Plant	1938	N	268
(D-7-3)20adb-1	Brigham Young University	1970	U	353
(D-7-3)20bcd-1	Pacific States Cast Iron Pipe	1926	N	308
(D-7-3)20bcd-3	Pacific States Cast Iron Pipe	1927	N	635
(D-7-3)28bdb-1	Utah Division of Wildlife Resources	1963	U	338
(D-7-3)28cab-1	Park Ro-She Corp. (H.J. Robbins, Pres.)	1961	U	285
(D-7-3)28dbb-1	Utah Division of Wildlife Resources	1988	U	37
(D-7-3)29bdb-1	Fibertek	1986	N	148
6 (D-7-3)29dcc-1	Sumsion, Howard C.	1953	I	136
(D-7-3)29ddd-1	Springville City	1986	U	413
(D-7-3)30aaa-1	Perry, Robert	1977	I	277
(D-7-3)30aac-3	Condie, A.	1953	S	125
(D-7-3)31cac-2	Childs, Neil	1964	S	135
(D-7-3)32bcc-1	Wood Springs Irrigation Company	1934	I	414
(D-7-3)32bcc-2	Metcalf, Harold	1972	H	164
(D-7-3)32bcd-1	Jensen, Clarence L.	1977	S	151
(D-7-3)33baa-6	Champerlain	1900	H	138
(D-7-3)33ccc-5	Vane, J.E.	—	U	140
(D-7-3)33ccc-6	Matson Springs Irrigation Company	1966	I	533
(D-7-3)34bcb-1	Springville City	1961	P	485
(D-7-3)34cdb-1	Springville City	1960	P	445
(D-8-1)2ccd-1	Hirst, Harold	—	H	55
(D-8-1)3dda-1	Unknown	1967	U	72
(D-8-1)10bcb-1	South Shore Fruit Farms	—	U	240
(D-8-1)10bcb-2	South Shore Fruit Farms	—	U	135
(D-8-1)11bac-1	Utah County	1981	P	300
(D-8-1)13aaa-1	Schaffer, S. B.	1906	H	358
(D-8-1)13bdd-1	Atwood, G.	1950	S	119
(D-8-1)13daa-3	Mecham, Darrell F.	1949	I	345
(D-8-1)14dad-1	C. B. Turkey, Inc.	1966	I	350
(D-8-1)20abb-1	Hi-Country Fruit Farms (Phil Belnap)	—	H	205

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
4	O		4,507	-17		05-12-64	D
3	O		4,490	—		—	D
3	P	496-504	4,500	-35	R	10-01-61	D
—	—		4,500	-5.9		03-04-91	
2	O		4,503.1	-11.40		03-04-91	W,D
4	P	115-121	4,495	-18.9		03-05-91	L,W
3	O		4,493	-26.1		04-28-47	
16	P	115-350	4,520	-1	R	03-11-70	
4	O		4,495	-25.0		10-15-64	
4	O		4,494	-42.5		10-15-64	
16	P	270-330	4,520	-22.4		09-11-87	C
2	P	280-285	4,527	-14.8		03-04-91	L,W
2	O		4,550	8.43		04-18-89	
8	O		4,502	—		—	
2	O		4,515	-25	R	03-11-53	D
16	S	349-413	4,525	-28	R	01-15-87	
6	O		4,495	-40.9		03-09-82	C
2	O		4,496	-15.4		03-04-91	
4	P	130-135	4,503	-14.3		09-13-89	W,D
—	—		4,511	-5.4		03-04-91	
6	P	152-159	4,511	-14.5		03-26-81	L
6	O		4,518	-13.2		03-04-91	W
2	O		4,560	-4.7		03-04-91	W,D,C
2	O		4,567	-5.2		03-04-91	W,D
16	P	230-533	4,565	-14.3		03-08-91	W
16	P	410-475	4,580	2.0		04-22-64	
16	P	158-230	4,650	45.9		07-01-65	L,C
	P	284-395					
	P	402-442					
8	O		4,495	6.87		03-05-91	W
—	—		4,520	32.32		02-15-91	C
6	O		4,520	17.01		03-05-91	W,C
—	—		4,520	43.34		03-05-91	W
8	P	200-251	4,495	-7.7		03-04-91	C
4	O		4,499	-11.3		03-04-91	W,D
2	O		4,496	-1.5		03-05-91	W
8	P	285-328	4,499	-13.9		06-25-65	D
6	O		4,492	—		—	D
6	O		4,505	15.68		03-05-91	W

Table 1.—*Records of*

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-8-1)23bdd-1	Binning, Lester and Agnes	—	S	120
(D-8-1)25aad-1	Hansen, J.	1953	S	104
(D-8-1)25aba-1	Ludlow, W.	1944	I	173
(D-8-1)25cbb-1	Kelsey, C.	1964	S	300
(D-8-1)26bdd-1	Vannosdol, George	1977	S	126
(D-8-1)35cac-1	Hanson, Charles K.	1975	H	440
(D-8-1)35cac-2	Hanson, Charles K.	1962	I	351
(D-8-1)36bcc-1	Ercanbrack, L.	1963	S	231
(D-8-2)1baa-1	Finch, J.	1963	S	182
[7] (D-8-2)2aac-1	Banks, L.	1961	I	336
(D-8-2)2caa-1	Thomas, G.	1951	S	338
(D-8-2)2cda-1	Roach, T.	1900	H	140
(D-8-2)2daa-1	Williams, R.D.	1948	S	346
(D-8-2)3aad-1	Monk, B.	1963	I	417
(D-8-2)3ccd-1	Banks, L.	1961	S	420
(D-8-2)4abb-1	Banks, L.M.	1900	S	150
(D-8-2)4abb-2	Sorensen, James Jr.	1895	H	—
(D-8-2)4abc-1	Sorenson, W.	1950	S	230
[8] (D-8-2)4bab-1	Banks, L.	1963	H	324
(D-8-2)4cba-2	Sharp, Jeff	1909	I	330
[9] (D-8-2)4cbb-1	Lakeside Irrigation Company	1934	I	500
(D-8-2)4cdc-1	Olsen, Chet	1908	H	80
(D-8-2)4cdc-4	Olsen, Chet	1945	H	143
(D-8-2)4dad-1	Sorensen, W.	1963	I	607
(D-8-2)7cab-1	Brooks, H. L.	1947	I	263
(D-8-2)7cbd-1	Nelson, Justin R.	1962	H	355
(D-8-2)7dda-1	Hall, M.	1956	S	276
(D-8-2)7ddd-1	Hall, M.	1913	H	520
(D-8-2)9aad-1	Banks, A.	1964	H	385
(D-8-2)10adb-1	Ottesen, H.	1966	H	588
(D-8-2)10bdd-1	Sorenson, F.	1955	H	411
(D-8-2)12ddc-1	Diamond, Harold	—	S	172
(D-8-2)12ddc-2	Diamond, Harold	1961	S	372
(D-8-2)13abc-1	Johns, K.	1961	I	378
(D-8-2)13bdd-1	Pace, R.	1962	H	378
(D-8-2)14cad-1	Elson, G.	1953	S	376
(D-8-2)14dcc-1	Johns, W.	1939	H	377
(D-8-2)16caa-1	Lewis, R.C.	1895	H	570

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)	Finish	(feet)		Above (-) or below land surface		Date	
2	O		4,500	-8.0		03-05-91	W,D
2	O		4,497	-9.9		03-05-91	D
2	X	163-173	4,498	-6.5		03-05-91	W
1.5	X	205-300	4,504	-11.8		03-04-91	W
6	O		4,620	77.86		03-06-91	
6	O		4,575	52.96		03-05-91	
8	P	100-345	4,578	60.7		06-29-65	C
4	—		4,518	-10.9		03-07-91	W
6	P	167-182	4,505	-10.3		08-08-89	W,D
2	O		4,511	-22.8	R	08-06-64	D
2	O		4,518	-11.6		09-21-89	W,D
2	O		4,524.4	-4.7		03-04-91	W,D
2.5	O		4,514.9	-25.7		04-02-90	W,D,C
2.5	P	412-417	4,512	-15.8		09-15-89	W,D
2.5	O		4,512	-8	R	11-01-61	D
1.25	O		4,494.1	-14.1		03-05-91	W,D
—	O		4,498.2	-6.0		09-12-89	D
2	O		4,496	-11.3		09-12-89	W,D
3	P	316-324	4,495	-4.4		09-12-89	W,D
2	O		4,501	-17.6		03-01-91	W,D,C
8	O		4,499	-6.1		09-15-89	W,D
2	O		4,500	-12.2		03-04-91	
2	O		4,500	-13.0		03-04-91	W
3	P	593-607	4,502	-13.4		09-28-89	W,D
2	O		4,493	-7.5		08-20-64	D
4	O		4,492	—		—	D
3	O		4,498	-4.9		03-04-91	W
1.25	O		4,498	-9.3		03-01-91	W
3	O		4,511	-8.7		03-05-91	D
3	O		4,520	-19.7		03-01-91	W,D
2.5	O		4,518	-4.0		09-28-89	D
2	O		4,540	-2.6		08-13-76	D,C
3	P	364-372	4,541	-48.6		09-10-84	D,C
3	P	368-378	4,548	-18.4		09-28-89	W,D,C
3	P	368-378	4,555	-28	R	04-02-64	D
2.5	O		4,547	-3.5		03-05-91	W
2	O		4,553	-14.2		07-09-65	D
3	O		4,525	-27.2		09-05-90	W,D,C

Table 1.—*Records of*

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-8-2)16dbb-2	Huff, J.	1962	H	168
(D-8-2)17ada-1	Hansen, B.	1964	H	466
(D-8-2)17add-5	Huff, E.	1962	H	105
(D-8-2)17add-6	Huff	1950	H	80
(D-8-2)17ccc-2	Clayson, Mrs. Allen	1959	H	363
(D-8-2)17dab-2	Beckstrom, J. L.	1959	H	100
(D-8-2)17dad-1	Evans, James S.	1975	H	110
(D-8-2)17ddd-1	Simmons, Steve	1944	H	94
(D-8-2)19add-1	Beckstrom, A.	1916	H	480
(D-8-2)20cad-2	Hawkins, C.	1900	H	420
(D-8-2)21aaa-1	Anderson, Mrs. John	—	H	498
(D-8-2)21bbb-2	Lee, Eddie	1956	H	110
(D-8-2)21ddd-1	Anderson, Bernell	1936	H	347
(D-8-2)22cdc-1	Salt Lake By-Products	1935	N	620
(D-8-2)22cdc-2	Salt Lake By-Products	1957	N	385
(D-8-2)23dbd-1	Ferto Corporation	1920	N	390
(D-8-2)23dbd-2	Ferto Corporation	1916	N	390
(D-8-2)23dbd-3	Ferto Corporation	—	H	—
(D-8-2)23dca-2	Ferto Corporation	1940	I	569
(D-8-2)24bdc-2	Thomas, R.	1963	H	352
(D-8-2)25bca-1	Valley Asphalt, Inc.	1978	N	246
(D-8-2)25dac-3	Spanish Fork City	1961	U	620
(D-8-2)26aad-3	Creer, R.	1961	H	223
(D-8-2)26aad-4	Leland Milling Company	1987	N	360
(D-8-2)26abb-3	Ludlow, A.	1946	H	371
(D-8-2)26adc-1	Unknown	1971	S	—
(D-8-2)27acd-1	Thomas, I.	1948	S	180
(D-8-2)28cbd-3	Hone, Melva	1944	H	92
(D-8-2)28cca-2	Thorton, S.	1951	S	200
(D-8-2)28daa-1	Larson, D.	1939	H	120
(D-8-2)29aaa-7	Hickman, Rex L.	1957	H	390
(D-8-2)29aab-5	Steele, Alice	1956	H	176
(D-8-2)29add-1	Reynolds, Reed	1935	H	222
(D-8-2)29bcb-1	Argyle, Bert	1966	H	165
(D-8-2)29bcd-2	Zieman, Jacob	1952	H	166
(D-8-2)29cab-1	Hansen, Arthur	1947	H	168

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)	Finish	(feet)		Above (-) or below land surface		Date	
2	—		4,522	-4.2		03-04-91	W
2	X	452-466	4,514	-5.4		03-01-91	W,L
2	P	84-105	4,517	7.74		03-17-70	D
2	O		4,515	8	R	06-07-50	D
2	O		4,509	-8.5		08-17-89	W,D
2	O		4,514	9.11		09-03-64	D
4	O		4,518	9.16		03-04-91	
2	X	83-94	4,522	8	R	07-13-44	D
2	—		4,514	-12.6		03-01-91	W
2	—		4,522	-2.7		03-01-91	W
3	O		4,536	-6.85		08-28-89	W
2	O		4,522	10	R	06-26-56	D
2	O		4,541	-12.5		10-02-89	W,D
2	O		4,545	-15.4		03-04-91	W,D
4	—		4,545	-10.9		03-04-91	W,D
3	P	380-390	4,565.1	-19.6		12-17-47	
4	P	380-390	4,561	-15.6		06-23-65	
2	—		4,560	-1.1		09-15-64	D
8	P	475-500	4,562	-18.2		10-05-73	C
3	P	327-352	4,570	-1.5		08-17-89	W,D
8	O		4,610	27	R	12-30-78	
16	P	505-508	4,622	38.42		03-05-91	W
	P	512-545					
	P	547-564					
	P	600-605					
4	O		4,595	35.45		03-06-91	W
6	O		4,595	8	R	09-25-87	
2.5	O		4,579	-3.9		03-04-91	W
8	O		4,550	-4.5	R	02-16-71	
2	O		4,546	-5.2		03-05-91	W
2	O		4,525	-6.6		07-31-89	W,D,C
3	O		4,525	-4.1		03-01-91	W
2	O		4,535	-2.6	R	09-25-64	D
2.5	O		4,530	-6.9		03-05-91	W
2.5	O		4,525	-4.6		03-01-91	
3.5	O		4,526	-3.8		08-10-77	C
4	O		4,508	-10.5		08-17-89	D
2.5	O		4,512	-19.6		08-17-89	W,D
2.5	O		4,513	-26.4		03-04-91	W,D

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-8-2)30bad-1	Stewart, I.	1944	I	32
(D-8-2)31bcd-1	Tanner, Art	1890	S	60
(D-8-2)31cbb-1	Schaerrer, Grant	1945	S	96
(D-8-2)31cda-1	Schearrer, Grant	—	I	450
(D-8-2)31cdb-1	Schearrer, Grant	1920	S	90
(D-8-2)31cdb-2	Schearrer, Grant	1963	I	435
(D-8-2)32aad-1	Young, K.	1934	H	117
(D-8-2)32daa-1	Benjamin Cemetery	1949	I	247
(D-8-2)33bcc-1	Mackey, Boley	—	I	—
(D-8-2)34acd-1	Ludlow, N.	1946	S	80
(D-8-2)34dda-1	Bearnson, Gill	1946	S	130
(D-8-2)36dbd-2	Gardner, L.	1952	H	260
(D-8-2)36dbd-3	Cloward, B.	1961	H	38
(D-8-3)2dcd-1	Mapleton City	1954	P	533
(D-8-3)2dcd-2	Dawn, Richard	1977	H	200
(D-8-3)3bca-1	Springville City	1990	P	428
(D-8-3)3cca-1	Snyder, Robert	1975	H	232
(D-8-3)3dcb-1	Fullmer, Richard	1978	H	305
(D-8-3)3dcd-1	Seal, Z.	1961	I	387
(D-8-3)4caa-2	Eddington Canning Company	1945	H	117
(D-8-3)4caa-3	Eddington Canning Company	1952	I	153
(D-8-3)4caa-4	Spanish Fork City	1965	U	—
(D-8-3)4cad-1	Eddington Canning Company	1935	—	231
(D-8-3)4daa-1	Springville City	1961	P	371
(D-8-3)5bca-1	Phillips, J.L.	1890	H	150
(D-8-3)6ddd-1	Unknown	—	U	—
(D-8-3)6ddd-2	Unknown	—	I	357
(D-8-3)6ddd-3	Unknown	1934	I	149
(D-8-3)6ddd-4	Unknown	1934	I	284
(D-8-3)6ddd-5	Springville Irrigation Company	1934	I	160
(D-8-3)7aad-1	Schwartz, Glade	1948	S	148
(D-8-3)7abc-1	Leftwich, Jack	1972	C	156
(D-8-3)7aca-2	Williams, Keith	1948	I	147
(D-8-3)8abd-1	Miner, F. Lee	1959	U	300
(D-8-3)10cba-1	Hjorth Brothers	1961	I	520
(D-8-3)10dac-1	Johnson, Kelly	1977	H	62

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
2	O		4,500	-7.3		09-28-64	D
2	O		4,503.2	—		—	D
3	O		4,504	-14.8		08-28-89	W,D,C
12	P	150-450	4,510	—		—	D,C
22	O		4,510	-15.0		03-07-91	W,D,C
12	P	210-325	4,510	-30.2		03-07-91	W,D,C
	P	375-430					
2.5	O		4,520	-2.5	R	09-28-64	
5	O		4,545	11		11-10-49	C
—	—		4,525	—		—	
2	O		4,531	-7.4		03-05-91	W,D,C
2	O		4,528	-11.0		03-09-90	W,C
4	O		4,640	51.12		03-06-91	
6	—		4,640	9.13		03-06-91	W,C
10	P	238-243	4,805	221.70		03-19-65	
	P	246-533					
6	O		4,800	171.12		03-08-91	
16	P	280-420	4,640	70.23		03-05-91	L
6	P	200-232	4,702	114.17		03-05-91	L
6	P	285-305	4,725	148.69		03-05-91	
16	P	215-385	4,736	164		04-22-64	
4	O		4,560	-20	R	06-08-45	D
8	P	112	4,560	—		—	D
8	O		4,560	-25	R	07-19-65	D
4	O		4,580	-18.1		07-02-65	D
16	P	145-255	4,629	46.2		07-01-65	L
	P	280-370					
2	O		4,522.2	-9.7		03-04-91	WD
—	—		4,520	—		—	D
3	—		4,620	—		—	D
3	O		4,518	-2.7	R	11-04-64	
3	—		4,518	—		—	
3	—		4,518	—		—	
3	O		4,525	-25.1	R	03-31-64	D
8	P	132-156	4,519	-23.5		03-04-91	W,D
2.5	O		4,525	-25	R	07-14-48	D
4	O		4,560	6.14		03-04-91	L,W
8	P	395-520	4,714	127.6		06-30-65	L
6	O		4,725	34.44		03-05-91	L

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-8-3)10ddb-2	Porter, Rich D. & Lois G.	1977	H	203
(D-8-3)11abb-1	Edmonds, Paul K.	1986	I	242
(D-8-3)11caa-1	Perry, Fay L.	1983	I	215
(D-8-3)11ccc-1	Mapleton City	1961	P	500
(D-8-3)11ccc-2	Johnson, Frank	1977	H	70
(D-8-3)14acc-1	Orton, G.B.	1963	U	675
(D-8-3)14bab-1	Trojan Powder Corporation	1989	U	376
(D-8-3)14dab-1	Shurtleff, F.L.	1972	I	363
(D-8-3)14dca-1	Broadbent, J.	1965	I	395
(D-8-3)16aaa-1	Kimber and Johnson	1973	S	70
(D-8-3)16aaa-2	Rostron, Melvin	1977	H	275
(D-8-3)17ada-1	Garner, R.	1950	S	65
(D-8-3)17bad-1	Orton, G.B.	—	I	—
(D-8-3)17cdc-1	Pierce, L.	1960	H	127
(D-8-3)17cdc-2	Smith, F.	1960	H	295
(D-8-3)18aaa-3	Hanson, R.	1960	I	171
(D-8-3)18bdc-1	Spanish Fork City	1963	I	350
(D-8-3)19bbb-1	Spanish Fork City	1968	P	1,000
(D-8-3)19ccb-1	Spanish Fork City	1969	I	275
(D-8-3)19ccd-1	Christianson, H.	1890	H	25
(D-8-3)19cda-1	Spanish Fork City	1975	P	393
(D-8-3)19dca-1	Spanish Fork City	1970	P	603
(D-8-3)21bbd-1	Snyder, Paul	1977	H	358
(D-8-3)21cac-1	Storrs, Jan	1976	H	275
(D-8-3)22bab-1	Crandall, Condie	1972	H	26
[10](D-8-3)22cbd-3	Mapleton City	1961	P	541
(D-8-3)23baa-1	Dr. Orton	—	I	—
(D-8-3)23ccd-1	Biesinger, N.	1961	I	265
(D-8-3)23cdd-1	Whiting, R.W.	1973	H	381

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
6	O		4,722	141.47		03-05-91	
8	P	210-215	4,790	200	R	04-01-86	C
8	O		4,770	185.60		03-05-91	W
12	P	383-405	4,730	140		03-06-91	W
	P	409-494					
6	P	65-67	4,735	46.16		03-07-91	W
8	P	189-200	4,775	177.05		03-05-91	W
	P	372-395					
	P	507-675					
4	R	351-371	4,729.1	144.85		12-22-89	W
8	P	200-363	4,800	210	R	02-25-72	
12.5	P	210-215	4,800	195	R	07-20-65	
	P	233-252					
	P	315-378					
6	P	55-65	4,710	14.68		03-05-91	L
6	O		4,705	123.43		03-05-91	L
4	O		4,700	24.53		03-07-91	W
—	—		4,600	—		—	
4	O		4,705	9.79		03-05-91	
4	O		4,710	142.22		03-05-91	W
4	O		4,550	-2.1		03-07-91	W
6	P	330-350	4,554	-23.9		06-22-65	
16	P	780-811	4,675	—		—	
	P	820-833					
	P	890-920					
	P	948-955					
12	P	170-250	4,585	10.7	R	10-19-69	
1.5	O		4,590	-6.4		03-04-91	W
12	P	160-179	4,660	88		11-05-75	
	P	303-332					
16	P	461-50	4,690	—		—	
6	X	330-358	4,719	135.24		03-06-91	
6	P	265-275	4,735	133.12		03-06-91	
4	P	15	4,720	11.32		03-06-91	
16	P	485-535	4,760	179.88		03-06-91	L,W
—	—		4,770	—		—	
8	O		4,960	220	R	09-29-61	L
6	P	360	4,980	182.96		03-07-91	

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-8-3)26bcd-1	Trojan Powder Corporation	1989	U	236
(D-8-3)26cbd-1	Trojan Powder Corporation	1989	U	302
(D-8-3)26cbd-2	Trojan Powder Corporation	1989	U	43
(D-8-3)26cca-2	Trojan Powder Corporation	1989	U	35
(D-8-3)26ccb-1	Trojan Powder Corporation	1940	N	399
(D-8-3)27adc-1	Trojan Powder Corporation	1989	U	188
(D-8-3)27adc-2	Trojan Powder Corporation	1989	U	395
(D-8-3)27bad-1	Trojan Powder Corporation	1989	U	276
(D-8-3)27bad-2	Trojan Powder Corporation	1989	U	468
(D-8-3)27cdc-1	Spanish Fork City	1963	P	630
(D-8-3)28abc-1	Jensen, J.	1961	I	470
(D-8-3)28bcd-1	Spanish Fork City	1961	P	410
(D-8-3)28bdc-1	Anderson, G.	1961	I	395
(D-8-3)29aaa-1	Farnsworth, Richard C.	1974	H	289
(D-8-3)30dba-1	Haderlie, P.	1970	U	285
(D-8-3)31ccd-1	Hendacka, H.	1970	H	246
(D-8-3)32add-1	Southeast Irrigation Company	—	I	—
(D-8-3)32baa-1	Vincent, W.	1960	H	276
(D-8-3)33aca-1	Spanish Fork City	1971	H	328
(D-8-3)33acb-1	Strawberry Water Users' Association	1910	H	50
(D-8-3)33cac-1	Hunter, W.	1958	H	100
(D-8-3)33cac-2	Shepherd, Lee	1973	H	693
(D-8-3)34aca-1	Trojan Powder Corporation	1940	N	261
(D-8-3)34bab-1	Spanish Fork City	—	U	470
(D-8-3)34bbb-1	Hurst, Harold	1973	S	151
(D-9-1)1bac-1	Powell, Lynn, and Young, Dallas	1976	I	600
(D-9-1)1bcb-2	Powell, L.M.	1973	H	416
(D-9-1)2ada-2	Farr, L.	1948	H	610
(D-9-1)2cab-1	Hi-Country Fruit Farm	1973	H	210
(D-9-1)2ccd-1	Critchfield, Gale	1980	—	280
(D-9-1)2ddd-1	Stewart, M.	1945	H	60
(D-9-1)11acc-1	Liddle, G.	1974	H	253
(D-9-1)11acc-2	Liddle, Parley	1981	S	85
(D-9-1)11baa-1	Bezzant, Clifford	1971	I	168

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
4.5	S	216-236	4,965.6	189.04		03-08-91	W
—	—		5,012.6	231.16		03-08-91	W
—	—		4,991.1	36.13		03-08-91	W
—	—		4,983.9	21.86		03-08-91	W
8	P	365-399	5,000	266.1		03-23-65	
4	R	163-183	4,820.5	96.57		03-08-91	L,W
4.5	S	375-395	4,820.6	165.40		03-08-91	W
4	R	256-276	4,778.5	149.39		03-08-91	W
5	R	443-463	4,772.4	185.36		03-08-91	L,W
12	P	220-254	4,780	168.9		06-30-65	L
	P	377-432					
	P	515-520					
	P	541-546					
	P	583-589					
12	P	264-284	4,745	154.1		06-30-65	L
	P	425-465					
12.5	—		4,749	—		—	L
12	P	240-285	4,746	178.50		04-22-64	L
8	O		4,735	160	R	10-01-75	L
6	P	265-285	4,711	113.73		03-06-91	L,W
4	O		4,655	67.12		03-04-91	L
—	—		4,660	—		—	
5	O		4,720	164	R	03-03-65	
6	P	320	4,678	-40.6		03-04-91	
—	O		4,664	—		—	C
4	O		4,760	62.41		03-07-91	W
6	P	353-693	4,800	-13.5		03-08-91	
10	P	240-261	4,844	101.16		03-24-67	
16	—		4,797	142.75		03-06-91	W
8	P	135-146	4,720	70.87		03-06-91	W
6	—		4,520	-26.5		08-09-89	D
6	X	316-416	4,530	-6.4		03-05-91	
3	O		4,532	-3.1		03-05-91	
8	O		4,720	182.51		06-26-89	
8	O		4,730	205	R	06-22-80	
2	—		4,555	5.49		03-06-91	
6	P	175	4,610	73	R	07-01-74	
8	O		4,615	77.79		03-06-91	W
8	P	118-165	4,598	62.10		03-06-91	W

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-9-1)11bad-1	Bird, Terry	1971	H	160
(D-9-1)11ddc-1	Simpson, Leonard	1971	H	135
(D-9-1)12bbc-1	Bishop, A.	1947	H	70
(D-9-1)13bdb-1	McBeth, Clyde	1912	I	340
(D-9-1)13bdb-2	McBeth, Clyde	1920	I	340
(D-9-1)14aad-1	Wayman, Reid L.	1961	I	360
(D-9-1)14aad-2	Wayman, Craig	1971	I	300
(D-9-1)14ada-1	Stewart, D.	1945	H	55
(D-9-1)14ada-2	LDS Church	1961	I	363
(D-9-1)14ddd-1	Nay, C.	1950	H	125
(D-9-1)23acc-2	Payson Fruit Growers	1977	N	363
(D-9-1)23ada-1	Hi-Country Fruit Farm	1959	I	323
[11](D-9-1)23adb-1	Rowley Brothers	1959	H	290
(D-9-1)23daa-1	Meredity, V.	1963	H	86
(D-9-1)23dcb-1	Rowley Brothers	1970	H	201
[12](D-9-1)24acb-1	Daveport, L.	1962	H	100
(D-9-1)25aac-1	Spring Creek Irrigation Company	1934	I	34
(D-9-1)25aad-1	Holladay Field	1934	I	79
(D-9-1)25aad-2	Spring Creek Irrigation Company	1934	I	75
(D-9-1)25aca-1	Unknown	1934	I	160
(D-9-1)25ada-1	Spring Creek Irrigation Company	1934	I	124
(D-9-1)25ada-2	Unknown	—	I	—
(D-9-1)25ada-3	Holladay Field	—	I	90
(D-9-1)25ada-4	Unknown	—	—	—
(D-9-1)25ada-5	Unknown	—	I	—
(D-9-1)26aaa-1	McMullin, Dave	1973	I	380
(D-9-1)26aab-1	Rowley Brothers	1959	U	340
(D-9-1)26add-1	McMullin, Dave	1984	I	200
[13](D-9-1)26dda-1	McMullin, Dave	1961	I	307
(D-9-1)27aca-1	Keigley Quarry	—	K	310
(D-9-1)27aca-2	Keigley Quarry	1949	N	365
(D-9-1)32bbd-1	Oberg, Martin	—	U	80
[14](D-9-1)35abb-1	Strawberry Highline Canal Company	1963	I	435
(D-9-1)35bcd-1	Rowley	1957	S	190
(D-9-1)35bcd-2	Thompson, F.	1963	I	278

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
8	P	126-160	4,615	80	R	07-20-71	
8	O		4,608	64.81		03-07-91	
4	O		4,562	3.63		03-06-91	
6	O		4,605.8	—		—	
12	O		4,605.8	-7	R	11-04-64	D
12	P	90-360	4,619	57.57		03-06-91	L,W
8	P	97-100	4,605	28.70		01-23-91	L,W,C
	P	190-300					
4	O		4,620	15	R	01-27-45	C
12	P	110-360	4,620	42.10		03-25-67	C
4	O		4,649	30.60		03-06-91	W
10	P	120-170	4,770	243	R	05-15-77	
	P	220-355					
12	P	44-308	4,667	23.04		03-06-91	W,C
12	—		4,695	50.09		03-06-91	
6	—		4,687	39.71		03-06-91	W
8	P	126-198	4,760	114	R	10-22-70	
6	O		4,659	3.41		03-08-91	W
4	O		4,695	-1.6	R	10-14-64	D
4	O		4,682	-3.1	R	05-28-64	D
4	O		4,680	-5.0		03-07-91	D
3	O		4,705	-2.6		08-30-89	D
4	O		4,680	-7.6		03-07-91	W,D
—	—		4,680	-12.5		07-20-89	D
—	—		4,680	-12.8		07-20-89	W,D
—	—		4,680	-9.4		07-20-89	D
—	—		4,680	—		—	D
10	P	100-380	4,705	53	R	06-26-73	C
12	P	70-340	4,715	61.92		03-06-91	W,C
10	P	100-200	4,735	45	R	07-31-84	C
14	P	90-300	4,741	51.4		06-29-65	
8.25	O		4,765	226.96		10-25-89	W
8.5	P	220-365	4,760	224	R	01-01-50	
3	—		4,530	15.95		03-05-91	W
16	P	145-430	4,800	103	R	03-29-67	C
6	O		4,822	151.23		03-06-91	
6	P	160-210	4,822	160		10-14-64	C
	P	218-275					

Table 1.—*Records of*

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-9-1)36acb-1	Ferguson, Bill	1975	I	415
(D-9-1)36bbc-1	Strawberry Highline Canal Company	1961	I	386
(D-9-1)36cdb-1	Miller, M.	1962	H	185
(D-9-1)36cdd-1	Shaw, W.E.	1955	I	325
(D-9-2)1bcb-1	LDS Church	1966	I	733
(D-9-2)2add-1	Davis, Frank	1936	H	188
(D-9-2)2dad-1	Culmer, E.	1967	I	196
(D-9-2)2dad-2	Culmer, E.	1956	I	227
(D-9-2)3aba-4	Taylor, R.	1964	S	138
(D-9-2)4cdc-1	Island Ranch Company	1943	H	310
(D-9-2)5acc-1	Jones, H. Max	—	I	165
(D-9-2)5acc-2	Jones, H. Max	—	I	—
(D-9-2)5acc-3	Jones, H. Max	—	H	—
(D-9-2)5bcc-1	Depew, Max	1953	H	133
(D-9-2)5bcc-2	Depew, Max	1956	I	142
(D-9-2)5bcd-1	Depew, Max	1967	H	146
(D-9-2)5bcd-2	Maurin, Charles	1970	I	156
(D-9-2)5bdd-1	Jones, H. Max	1915	I	60
(D-9-2)5bdd-2	Jones, H.	1915	I	162
(D-9-2)5bdd-3	Depew, Max	—	I	—
(D-9-2)5bdd-4	Jones, H.M.	—	I	363
(D-9-2)5cbb-3	Stickney, Donna	1961	I	121
(D-9-2)5ccc-1	Wilson, Sherol	1900	I	160
(D-9-2)5ccd-2	Unknown	1990	U	32.5
(D-9-2)5dcd-3	Payson City	1934	—	166
(D-9-2)5ddb-1	Brown, Wayne L.	1974	H	40
(D-9-2)5ddc-2	Payson City	1934	U	170
(D-9-2)5ddd-1	Unknown	1990	U	32.5
(D-9-2)6add-4	Christiansen, G.	1961	H	112
(D-9-2)6add-5	Walker, James	1962	H	310
(D-9-2)6ddb-1	Wilson, Shirley	1970	I	158
[15](D-9-2)6ddb-2	Wilson, C.	1964	I	302

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
10	P	200-265	4,820	102.41		03-06-91	W,C
	P	365-415					
16	P	80-370	4,807	102.2		03-06-91	W,C
4	O		4,862	167.64		03-08-91	W
12	P	192-325	4,890	187.52		03-06-91	W,C
16	P	540-618	4,580	-7.2		03-05-91	W,D
	P	645-730					
2.5	O		4,570	-1.6		08-17-89	W,D
4	O		4,570	-.6		03-05-91	W
2	O		4,570	-9.6		03-04-91	W,D
4	O		4,528	-15.4		03-04-91	W
8.4	O		4,582	13		03-06-91	W
2	—		4,536	-32.3		03-06-91	W,D
—	—		4,542	—		—	
—	—		4,542	—		—	
4	O		4,537	-20	R	04-26-53	D
4	O		4,537	-14.2		08-09-89	W,D
6	P	136-146	4,537	-8.1		08-09-89	W,D
4	P	147-156	4,537	—		—	D
2	O		4,541.6	-13.1	R	09-23-64	
2	O		4,542	-27.9	R	09-23-64	D
—	—		4,540	—		—	
6	P	67-75	4,541	-40.0		01-02-69	D
	P	170-180					
	P	192-355					
4	O		4,541	-21.1		03-06-91	W,D
2	O		4,560.8	-8.3		12-04-64	D
1	O		4,562	3.44		07-02-90	W
3	O		4,576.8	-12.4		10-10 66	
—	O		4,565	-5.3		06-22-89	D,C
3	O		4,576.99	-15.2		03-11-74	D
1	O		4,576	5.96		03-06-91	W
6	O		4,534	-23.3		07-19-89	W,D
8	P	177	4,535	-31.2		07-19-89	W,D
8	P	85-90	4,546	-18.0		03-07-91	W,D,C
	P	100-105					
	P	121-126					
	P	146-152					
8	O		4,552	-17.9		03-07-91	W

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-9-2)7bdd-1	Peart, M.	1963	S	66
[16](D-9-2)7cda-2	Cornaby, B.	1962	S	16
(D-9-2)7dcc-1	Spencer, S.	1956	H	310
(D-9-2)8ccb-1	Unknown	1990	U	46.5
(D-9-2)9bac-1	LDS Church	1961	I	445
(D-9-2)10cad-2	Woodhouse, Ralph	1936	H	400
(D-9-2)10cad-4	Woodhouse, Mike	—	H	49
(D-9-2)10dac-1	Christensen, Don H.	1966	H	360
(D-9-2)11aaa-1	Wilson	1933	I	320
(D-9-2)11aca-3	Cole, Don	1958	H	285
(D-9-2)11adc-1	Salem City	1932	P	150
(D-9-2)13dbc-1	Johnson, Hal C.	1976	I	445
(D-9-2)13dca-1	Unknown	—	H	—
(D-9-2)14baa-1	Turpin, W.T.	1971	H	186
(D-9-2)14bdd-1	Vachea, Dan	1970	H	133
(D-9-2)15adb-1	Gasser, P.	1960	H	130
(D-9-2)15bbb-1	Payson City	1961	P	195
(D-9-2)15bcc-1	Reynaud, A.L.	1971	H	100
(D-9-2)15cda-1	Allred, Rey	1970	I	218
(D-9-2)16cbb-1	Payson City	1970	P	500
[17](D-9-2)17aaa-1	Payson City	1961	P	195
(D-9-2)17ada-1	Brimhall, Reed	—	U	165
(D-9-2)17bbb-1	Unknown	1990	U	31.5
(D-9-2)17cbc-1	Payson City	—	P	600
(D-9-2)17daa-1	Payson City	1954	P	225
(D-9-2)18aab-1	Unknown	1990	U	31.5
(D-9-2)18aca-1	Unknown	1934	H	278
(D-9-2)18dad-1	Haitt, W.	1949	H	92
(D-9-2)19aca-1	Emerald Turf Farm	1977	I	343

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
6	O		4,594	20.16		03-06-91	W
—	P	13-16	4,600	8.02		03-06-91	W
6	O		4,603	7.94		03-06-91	W
1	O		4,606	5.5		07-02-90	
16	P	50-169	4,608	37.47		03-06-91	W,C
	P	202-252					
	P	288-337					
	P	377-427					
	O		4,585	-16.1		03-04-91	
—	—		4,585	3.63		03-04-91	
6	O		4,598	-20.9		03-04-91	W,D
3	P	175-185	4,584.63	-28.8		03-04-91	W,C
	P	310-320					
4	O		4,595	-22.3		03-04-91	W,D
3	O		4,596.9	-8.4	R	12-04-64	
6	P	347-445	4,960	346	R	07-17-76	
—	—		5,020	404.96		10-25-89	
4	O		4,690	72.20		03-06-91	
6	O		4,750	128.25		03-06-91	
4	O		4,695	77.48		03-06-91	
16	—		4,611	21.41		03-06-91	
6	O		4,665	64.84		03-06-91	
8	P	25-180	4,750	104	R	05-11-70	C
12	P	250-500	4,760	156	R	04-04-71	
16	P	100-195	4,682	74.9		06-28-65	
6	O		4,720	117.42		03-06-91	W
	O		4,623	14.2		07-02-90	
16	P	235-300	4,650	40	R	04-24-89	
	P	380-415					
	P	450-518					
12	P	160-220	4,764	158.50		01-18-67	
1	O		4,613	6.16		07-02-90	
3	O		4,620	17.15		03-06-91	W
4	O		4,645	37.01		03-07-91	
16	P	160-300	4,650	40.46		03-05-91	C
	P	323-343					

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-9-2)19acb-1	Emerald Turf Farm	1976	I	311
(D-9-2)20baa-1	Hardman, H.T.	1971	I	175
(D-9-2)20bbc-2	Mount Loafer Irrigation Company	1961	I	275
(D-9-2)20bdc-1	Revel, James M.	1974	I	445
(D-9-2)20cca-1	Peay, G.	1946	H	60
(D-9-2)20ccc-1	Spring Lake Water Works Company	1962	P	145
(D-9-2)22add-1	Haskel, F.E.	1972	H	272
(D-9-2)22bad-1	Allred, Rey	1957	Z	855
(D-9-2)22cad-1	Brunson, Reed A.	1976	I	220
(D-9-2)22dac-1	Goosenest Water Company	1970	P	500
(D-9-2)23abb-1	Elk Ridge Corporation	1979	P	957
(D-9-2)24aca-1	Hanks, Ted	1971	I	450
(D-9-2)24bda-1	Hanks, Ted	—	U	300
(D-9-2)25bbb-1	Elk Ridge Corporation	1970	P	340
(D-9-2)25bbc-1	Elk Ridge Corporation	1969	P	132
(D-9-2)26add-1	Elk Ridge Corporation	—	P	500
(D-9-2)26baa-1	Elk Ridge Corporation	1971	P	530
(D-9-2)29acd-1	Judd, Steve	1950	Q	70
(D-9-2)29acd-2	Judd, Steve	—	Q	—
(D-9-2)29acd-3	Judd, Steve	—	Q	—
(D-9-2)29acd-4	Judd, Steve	—	Q	—
(D-9-2)29bba-1	Mountain View Dairy	1972	S	250
(D-9-2)29cda-1	Spring Lake Water Works Company	1961	P	116
(D-9-2)29dbd-2	Spring Lake Water Works Company	1989	P	183
(D-9-2)30bcb-2	Unknown	—	I	—
(D-9-2)30cbb-2	Helm, Andrew	1957	H	95
(D-9-2)31cda-2	Thorvaldson, A.	1962	H	167
(D-9-2)32bac-1	Ashton, C.	1953	I	367
(D-9-2)32bbb-1	Jarvis, Marvin	1970	I	505
(D-9-2)36acd-1	Loafer Water Users' Association	1980	S	340

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)		Finish (feet)		Above (-) or below land surface		Date	
12	P	157-309	4,645	35.61		03-05-91	C
—	X	175	4,740	136.81		03-05-91	
16	P	85-265	4,670	55.90		03-29-67	
8	P	190-440	4,740	120	R	09-27-74	
4	O		4,725	4.99		03-06-91	
12	P	95-110	4,716	20.40		03-05-91	L,W
	P	120-135					
8	P	262-272	4,960	248	R	09-01-72	
6	P	235	4,840	185	R	04-19-58	
8	P	160-200	5,020	140.26		03-06-91	W
12	P	185-415	5,035	190.60		04-28-89	
8	S	250-330	4,900	255	R	09-27-79	
	S	380-400					
	S	425-465					
	S	530-605					
	S	690-730					
	S	810-840					
	S	845-955					
8	P	305	5,140	266	R	11-01-71	L
4	O		5,100	286.90		03-04-91	W
6	P	150-340	5,290	158	R	04-20-70	
8	P	70-87	5,340	80.03		03-06-91	W
	P	100-130					
10	P	295-495	5,470	265	R	10-23-70	L
10	P	335-530	5,190	335	R	07-31-71	
4	O		4,780	-12.6		08-09-89	W,D
—	—		4,780	-11.8		08-09-89	
—	—		4,780	-11.1		08-09-89	
—	—		4,780	—		—	
8	X	155-250	4,730	67	R	10-01-72	
10	O		4,780	36.43		03-07-91	L
8	P	105-120	4,850	63.0		03-07-91	L
	P	140-150					
—	—		4,680	-8.6		08-03-89	D
4	O		4,705	7.74		08-03-89	W,D
6	O		4,832	140.1		06-28-65	
10	P	255-307	5,200	252.9		06-28-65	
10	P	127-500	4,800	87	R	12-01-70	
8	X	130-340	6,120	119		05-11-89	C

Table 1.—*Records of*

Well number	Owner	Year drilled	Use of water	Well depth (feet)
(D-9-3)5bbb-2	Brigham Young University	1959	H	276
(D-9-3)5bbd-1	Brigham Young University	1962	I	601
(D-9-3)5cdc-1	Koyle, J.	1946	H	105
(D-9-3)6abb-1	Cloward, R.	1904	S	14
(D-9-3)6cbc-1	Guss, P.	1965	S	280
(D-9-3)7aab-1	Tanner, Paul	1973	H	190
(D-9-3)18bbb-1	Salem City	1971	P	584
(D-9-3)19bba-1	Woodland Hills	—	P	—
(D-9-3)19bba-2	Woodland Hills	—	—	—
(D-10-1)1acd-2	East Santaquin Irrigation Company	1965	I	650
(D-10-1)1cbb-1	Santaquin City	1956	P	456
(D-10-1)2adb-1	Summit Creek Irrigation Company	1961	I	580
(D-10-1)2bba-1	Genola	1960	P	527
(D-10-1)2ddd-1	Summit Creek Irrigation Company	1969	I	694
(D-10-1)4ddc-1	Ekins, Shirl	1976	H	400
(D-10-1)10aab-1	Beardall, Norman	1974	H	333
(D-10-1)11bbd-1	Rowley, Claude	1964	H	475
(D-10-1)17cca-1	D.S. Powelson & Sons	1955	U	102
(D-10-1)19bad-1	Unknown	—	—	—
(D-10-1)19bdc-1	Ekins, Shirl	1970	I	455
(D-10-1)30bac-1	Lunceford, Scott	1983	I	600

[1] Previously reported as (C-9-1)20dcc-1 (Cordova, 1969, table 1).
[2] Previously reported as (C-9-1)34dba-1 (Cordova, 1969, table 1).
[3] Previously reported as (C-10-1)15cdd-1 (Cordova, 1969, table 1).
[4] Previously reported as (C-10-1)25aab-1 (Cordova, 1969, table 1).
[5] Previously reported as (D-8-2)4aab-1 (Cordova, 1969, table 1).
[6] Previously reported as (D-7-3)29dcb-1 (Cordova, 1969, table 1).
[7] Previously reported as (D-8-2)2abd-1 (Cordova, 1969, table 1).
[8] Previously reported as (D-8-2)4baa-1 (Cordova, 1969, table 1).
[9] Previously reported as (D-8-2)4bcb-1 (Cordova, 1969, table 1).

selected wells—**Continued**

Casing			Elevation of land surface (feet)	Water level			Other data available
Diameter (inches)	Finish (feet)			Above (-) or below land surface		Date	
8	—		4,675	94.9	R	09-01-64	
12	P	300-340	4,684	91.10		03-08-73	L,C
	P	515-586					
6	O		4,820	40.74		03-04-91	W
20	X	1-20	4,661	9.60		03-04-91	W
6	—		4,675	86.23		03-05-91	W
6	P	175	4,705	91.50		03-04-91	W
16	P	406-566	4,870	256.66		02-15-91	
—	—		5,160	—		—	
—	—		5,160	—		—	
16	P	190-643	4,920	229.85		08-09-65	C
16	P	280-454	4,973	270.14		03-07-91	W
12	P	259-548	4,938	234.90		02-15-67	C
12	P	189-520	4,880	144.70		03-14-73	
12	P	212-496	5,015	313	R	02-14-70	C
	P	506-694					
8	X	120-400	5,040	—		—	
8	P	233-245	4,960	186	R	03-22-74	
	P	273-300					
6	P	335-470	5,020	311		11-04-64	
12	—		4,563	31.22		03-05-91	W
—	—		4,580	—		—	C
16	P	200-420	4,650	125	R	08-31-70	C
	X	431-455					
12	P	300-400	4,840	257.30		03-19-90	C
	P	482-501					
	P	520-538					
	P	556-572					

[10] Previously reported as (D-8-3)22cac-1 (Cordova, 1969, table 1).
[11] Previously reported as (D-9-1)23aac-1 (Cordova, 1969, table 1).
[12] Previously reported as (D-9-1)24acc-1 (Cordova, 1969, table 1).
[13] Previously reported as (D-9-1)26daa-1 (Cordova, 1969, table 1).
[14] Previously reported as (D-9-1)35aba-1 (Cordova, 1969, table 1).
[15] Previously reported as (D-9-2)6ddc-1 (Cordova, 1969, table 1).
[16] Previously reported as (D-9-2)7dbc-1 (Cordova, 1969, table 1).
[17] Previously reported as (D-9-2)16bbb-1 (Cordova, 1969, table 1).

Table 2.—*Drillers' logs of selected wells*

Well number: See figure 1 for explanation of the numbering system for hydrologic-data sites.

Thickness: In feet.

Depth: Depth to bottom of interval, in feet below land surface. Total depth may be deeper than well depth reported in table 1.

Material	Thickness	Depth
(C-9-1)3ddb-1		
Log by Robinson Drilling Company		
Clay, sand, and gravel	98	98
Clay, yellow	17	115
Clay and gravel	30	145
Clay and sand	35	180
Clay, yellow	10	190
Sand and gravel	15	205
Clay, yellow	10	215
Sand and gravel	55	270
Clay and gravel	60	330
Clay, yellow	10	340
Clay, sand, and gravel	213	553
Clay, yellow	22	575
(C-9-1)4ddc-1		
Log by Robinson Drilling Company		
Clay and sand	80	80
Sand and gravel (water)	32	112
Clay and sand	78	190
Clay and gravel	170	360
Clay and gravel	120	480
Clay, sand, and gravel	128	608
Sand and gravel	82	690
(C-9-1)17cdd-1		
Log by Dave's Drilling Company		
Sand, gravel, and cobbles	75	75
Sand, gravel, and boulders	75	150
Sand and gravel	45	195
[1](C-9-1)20cdd-1		
Log by Robinson Drilling Company		
Silt and sand	14	14
Clay and gravel	124	138
Clay and sand	20	158
Clay and gravel (water)	52	210
Clay and sand	35	245
Sand and gravel	11	256
Clay, tan	4	260
Sand and gravel	30	290
Conglomerate	30	320
Clay, sand, and gravel	230	550
Clay, red	25	575
(C-9-1)20ddd-1		
Log by Robinson Drilling Company		
Gravel and boulders	23	23
Clay, sand, and gravel	127	150
(C-9-1)20ddd-1—Continued		
Gravel (water)	8	158
Clay and gravel	32	190
Gravel	59	249
Clay and gravel	229	478
Conglomerate	24	502
Clay and gravel	225	727
Conglomerate	2	729
Clay and gravel (red)	69	798
(C-9-1)28ccb-1		
Log by Robinson Drilling Company		
Clay and sand	16	16
Gravel and boulders	2	18
Clay, sand, and gravel	57	75
Boulders	4	79
Clay and gravel	46	125
Sand and gravel (water)	47	172
Clay, sand, and gravel	65	237
Sand and gravel	26	263
Clay, gravel, and boulders	35	298
Sand and gravel	80	378
Conglomerate	6	384
Clay and gravel	204	588
Sand and gravel	32	620
Clay and gravel	92	712
Conglomerate	18	730
Clay and gravel	72	802
(C-9-1)29acc-1		
Log by Robinson Drilling Company		
Silt	2	2
Clay and boulders	13	15
Clay, sand, and gravel	39	54
Clay, gravel, and boulders	31	85
Sand and gravel	30	115
Sand, gravel, and boulders	68	183
Clay and gravel	27	210
Sand and gravel (water)	22	232
Sand, gravel, and boulders	20	252
Sand and gravel	102	354
Clay and gravel (yellow)	62	416
Sand	8	424
Clay and gravel	208	632
Clay and sand	68	700

Table 2.—*Drillers' logs of selected wells*—Continued

Material	Thickness	Depth
(C-9-1)29bcc-1		
Log by Robinson Drilling Company		
Silt	1	1
Clay, sand, and boulders	39	40
Clay, gravel, and boulders	127	167
Sand	20	187
Clay, sand, and gravel	100	287
Gravel and cobbles	43	330
Clay, sand, and gravel	36	366
Clay and silt	8	374
Sand	13	387
Clay	59	446
Gravel	2	448
Clay, sand, and gravel	314	762
Sand and gravel	25	787
Clay and sand	13	800
(C-9-1)34ddc-1		
Log by Angus Hales		
Clay and silt	100	100
Gravel	1	101
Silt and sand	56	157
Gravel	1	158
Silt and sand	38	196
Clay	12	208
Silt and sand	57	265
(C-10-1)4bbb-1		
Log by Robinson Drilling Company		
Clay and sand	45	45
Clay, sand, and gravel	330	375
Conglomerate	20	395
Clay, gravel, and boulders	5	400
Conglomerate	23	423
Clay, sand, and gravel	50	473
Conglomerate	5	478
Clay, sand, and gravel	46	524
Clay and gravel	238	762
Clay, sand, and gravel	118	880
Unknown	2	882
(C-10-1)4cbb-1		
Log by Layne-Texas Company		
Clay, sand, and gravel	90	90
Sand and gravel	54	144
Gravel and boulders	22	166
Sand and gravel	88	254
Clay and gravel	40	294
Gravel and shale	8	302
Shale	8	310
Gravel	30	340
Sand and gravel	69	409
Gravel	120	529
(C-10-1)4cbb-1—Continued		
Shale and rybite	50	579
Clay, sand, and gravel	608	1,187
Gravel and hard rock	13	1,200
Shale	18	1,218
(C-10-1)31cdd-1		
Log by Robinson Drilling Company		
Clay and silt	10	10
Sand and gravel	20	30
Clay, sand, and gravel	180	210
Clay and volcanic ash (water)	45	255
Sand and gravel	38	293
Clay, brown	19	312
Volcanic cinders	6	318
Clay, sand, and gravel	132	450
Conglomerate	55	505
Clay and sand	5	510
Sand and gravel	18	528
Volcanic ash	8	536
Clay, conglomerate, and volcanic ash	9	545
Clay and volcanic cinders	3	548
Clay, sand, and gravel	55	603
(C-11-1)6abc-1		
Log by Eldon Corner		
Clay, sand, and gravel	21	21
Clay and cobbles	109	130
Gravel and boulders	8	138
Clay, sand, and gravel (water)	248	386
Sand, gravel, and cobbles (water)	74	460
Clay, sand, and gravel	36	496
Sand and gravel (water)	36	532
Clay, sand, and gravel	103	635
Sand and gravel (water)	42	677
Clay and gravel	11	688
(C-11-1)6bdd-1		
Log by Eldon Corner		
Clay, sand, and gravel	23	23
Gravel and boulders	19	42
Clay, tan	6	48
Clay, gravel, and boulders	17	65
Clay, sand, and gravel	213	278
Sand, gravel, and cobbles (water)	26	304
Clay, sand, and gravel	20	324
Sand, gravel, and cobbles	60	384

Table 2.—*Drillers' logs of selected wells*—Continued

Material	Thickness	Depth
(C-11-1)6bdd-1—Continued		
Clay, sand, and gravel (water)	288	672
Sand, gravel, and boulders (water)	68	740
Clay, sand, and gravel	35	775
(D-7-2)32dad-1		
Log by Jensen Construction and Drilling Company		
Clay and sand	190	190
Clay	160	350
Sand (water)	10	360
Clay, sand, and gravel (water)	190	550
(D-7-3)18dcc-1		
Log by Eldon Comer		
Sand	26	26
Clay, blue	89	115
Gravel	6	121
Clay, tan	37	158
Sand	70	228
Clay	50	278
Gravel	4	282
Clay	7	289
Sand	33	322
(D-7-3)28cab-1		
Log by Technical Services Inc.		
Silt, sand, and gravel	20	20
Clay (gray)	17	37
Sand (water)	4	41
Clay	33	74
Silt, sand, and gravel	93	167
Clay and gravel	16	183
Hardpan	4	187
Silt, sand, and gravel	21	208
Boulders	1	209
Sand and gravel	41	250
Gravel and hardpan	35	285
Boulders	5	290
(D-7-3)32bcc-2		
Log by Jensen Construction and Drilling Company		
Clay	25	25
Silt and sand	8	33
Clay	72	105
Sand	3	108
Clay	36	144
Sand, gravel, and cobbles (water)	18	162
Clay	2	164
(D-7-3)34cdb-1		
Log by J.S. Lee and Sons		
Gravel and boulders	9	9
Sand	14	23
Clay and gravel (water)	29	52
Sand and gravel	28	80
Clay and sand	60	140
Sand and gravel	115	255
Clay and gravel	190	445
(D-8-2)17ada-1		
Log by Christopherson and Simmons		
Soil	10	10
Sand	26	36
Clay	41	77
Clay (red) and sand	132	209
Clay, blue	6	215
Clay (red) and sand	23	238
Clay, blue	38	276
Clay (white) and sand	93	369
Clay, blue	9	378
Clay (red) and sand	23	401
Clay (white) and sand	33	434
Clay (blue) and sand	32	466
(D-8-3)3bca-1		
Log by Lee Drilling Inc.		
Fill	3	3
Gravel, cobbles, and boulders	15	18
Clay, sand, and gravel	5	23
Sand	45	68
Clay, gray	70	138
Gravel (water)	75	213
Sand and gravel	32	245
Clay	28	273
Sand and gravel (water)	12	285
Conglomerate	18	303
Gravel (water)	125	428
(D-8-3)3cca-1		
Log by Jensen Construction and Drilling Company		
Top soil	5	5
Sand and boulders	5	10
Hardpan	3	13
Clay and sand	186	199
Gravel (water)	33	232
(D-8-3)4daa-1		
Log by J.S. Lee and Sons		
Clay, sand, and boulders	40	40
Clay and sand	103	143

Table 2.—*Drillers' logs of selected wells*—Continued

Material	Thickness	Depth
(D-8-3)4daa-1–Continued		
Gravel	112	255
Clay, blue	19	274
Gravel	94	368
Clay and sand	3	371
(D-8-3)8abd-1		
Log by Woodhouse Drilling		
Top soil	2	2
Clay and gravel	58	60
Sand (water)	20	80
Clay, blue	40	120
Sand and gravel	93	213
Sand (water)	57	270
Clay, red	15	285
Sand and gravel	10	295
Sand	5	300
(D-8-3)10cba-1		
Log by J.S. Lee and Sons		
Sand and gravel	17	17
Sand	118	135
Clay and sand	45	180
Clay, blue	52	232
Gravel	78	310
Clay, brown	2	312
Unknown	208	520
(D-8-3)10dac-1		
Log by Basin and Range Drilling Company		
Silt and sand	4	4
Sand	7	11
Gravel and cobbles	17	28
Sand and gravel	18	46
Gravel and cobbles (water)	16	62
(D-8-3)16aaa-1		
Log by Jensen Construction and Drilling Company		
Top soil	6	6
Gravel	9	15
Clay and silt	35	50
Gravel (water)	20	70
(D-8-3)16aaa-2		
Log by Basin and Range Drilling Company		
Silt	2	2
Gravel	6	8
Sand (water)	24	32
Clay, brown	17	49
Sand and gravel	13	62
Silt, sand, and gravel	22	84
Silt and sand	53	137
Clay and sand	107	244

Material	Thickness	Depth
(D-8-3)16aaa-2–Continued		
Sand	27	271
Gravel (water)	4	275
[1](D-8-3)22cbd-3		
Log by Eldon Corner		
Clay	250	250
Clay and sand	40	290
Sand, gravel, and cobbles	21	311
Clay	134	445
Clay and sand	37	482
Gravel and cobbles	59	541
(D-8-3)23ccd-1		
Log by Woodhouse Drilling		
Top soil	3	3
Clay, brown	17	20
Clay and sand	110	130
Clay and gravel	30	160
Sand	101	261
Gravel (water)	4	265
(D-8-3)27adc-1		
Log by Dave's Drilling		
Sand and silt	40	40
Sand and gravel	15	55
Sand and silt	20	75
Sand	15	90
Sand and silt	10	100
Sand (water)	20	120
Sand and gravel (water)	15	135
Silt and sand	12	147
Shale	8	155
Sand and gravel	30	185
Sand and silt	15	200
Sand	22	222
(D-8-3)27bad-2		
Log by Engineering Science, Inc.		
Sand	10	10
Clay and sand	15	25
Gravel	5	30
Sand	20	50
Clay and sand	15	65
Silt and sand	5	70
Clay and sand	35	105
Silt and sand	30	135
Clay, silt, and sand (water)	115	250
Silt, sand, and gravel	15	265
Gravel	20	285
Sand and gravel	10	295
Clay, silt, and sand	139	434

Table 2.—*Drillers' logs of selected wells*—Continued

Material	Thickness	Depth
(D-8-3)27bad-2 —Continued		
Sand and gravel	16	450
Gravel	10	460
Sand and gravel	5	465
Gravel	10	475
(D-8-3)27cdc-1		
Log by Eldon Comer		
Gravel and cobbles	18	18
Clay and sand	151	169
Sand	25	194
Clay, sand, and gravel	17	211
Sand, gravel, and cobbles (water)	35	246
Clay, sand, and gravel	127	373
Sand, gravel, and cobbles (water)	62	435
Clay, gravel, and boulders	16	451
Clay	14	465
Clay, gravel, and cobbles	7	472
Clay	42	514
Sand and gravel	6	520
Clay	20	540
Sand and gravel (water)	6	546
Clay and sand	36	582
Sand, gravel, and cobbles	2	584
Clay and sand	56	640
(D-8-3)28abc-1		
Log by Eldon Comer		
Gravel	19	19
Clay	183	202
Sand and gravel (water)	82	284
Clay and sand	137	421
Sand and gravel (water)	49	470
(D-8-3)28bcd-1		
Log by Woodhouse Drilling		
Gravel and boulders	30	30
Clay, blue	139	169
Sand (water)	85	254
Gravel (water)	37	291
Sand and clay	49	340
Conglomerate	40	380
Sand (water)	30	410
(D-8-3)28bdc-1		
Log by Woodhouse Drilling		
Gravel	25	25
Clay	175	200
Sand	35	235
Gravel	50	285

Material	Thickness	Depth
(D-8-3)28bdc-1—Continued		
Clay	93	378
Gravel	4	382
Sand and gravel (water)	13	395
(D-8-3)29aaa-1		
Log by Burt Drilling Company		
Clay, silt, and sand	22	22
Sand and gravel	45	67
Clay	203	270
Gravel (water)	19	289
(D-8-3)30dba-1		
Log by Jensen Drilling Company		
Clay, brown	7	7
Gravel and boulders	5	12
Clay and gravel	15	27
Clay and sand (water)	91	118
Clay, blue	11	129
Clay and sand	4	133
Clay, blue	24	157
Clay and sand	58	215
Clay, sand, and hardpan	6	221
Clay and sand	42	263
Gravel (water)	22	285
(D-8-3)31ccd-1		
Log by Basin and Range Drilling		
Sand and gravel (water)	35	35
Silt and sand (water)	30	65
Clay, gray	22	87
Silt and sand	18	105
Clay and sand (water)	60	165
Sand and hardpan	7	172
Clay and sand (water)	46	218
Sand and gravel (water)	5	223
Clay, silt, and sand	22	245
Hardpan	5	250
Sand, gravel, and cobbles (water)	25	275
Silt, sand, and gravel	12	287
Clay, silt, and gravel	28	315
Silt and sand (water)	2	317
(D-8-3)32baa-1		
Log by Reda Pump Co.		
Clay	10	10
Gravel	10	20
Sand	22	42
Clay	98	140
Silt (water)	20	160
Sand	55	215

Table 2.—*Drillers' logs of selected wells*—Continued

Material	Thickness	Depth
(D-8-3)32baa-1—Continued		
Clay	25	240
Silt	20	260
Hardpan	11	271
Sand and gravel (water)	5	276
(D-9-1)14aad-1		
Log by Eldon Comer		
Clay	60	60
Clay and gravel (water)	25	85
Clay	40	125
Clay and gravel	235	360
(D-9-1)14aad-2		
Log by Binning Drilling Company		
Top soil	6	6
Clay and gravel	91	97
Gravel (water)	3	100
Clay, sand, and gravel	47	147
Clay and gravel (water)	173	320
(D-9-2)20ccc-1		
Log by Reda Pump Company		
Gravel and cobbles	55	55
Clay and sand	35	90
Gravel (water)	20	110
Clay and gravel	12	122
Gravel (water)	3	125
Clay and gravel	20	145
(D-9-2)24aca-1		
Log by Binning Drilling Company		
Top soil	8	8
Clay, gravel, and cobbles	32	40
Clay, gravel, and boulders	40	80
Clay, gravel, and cobbles	69	149
Solid rock	5	154
Clay, gravel, and cobbles	13	167
Solid rock	10	177
Clay and gravel	63	240
Clay, gravel, and boulders	20	260
Clay and gravel	13	273
Solid rock	4	277
Clay, gravel, and cobbles	23	300
Clay and boulders	5	305
Gravel (water)	10	315
Clay and gravel	34	349
Solid rock	7	356
Clay, gravel, and boulders	44	400
Clay and cobbles	37	437
Clay and gravel	5	442
Solid rock	8	450
Clay, brown	2	452
(D-9-2)26add-1		
Log by Binning Drilling Company		
Clay	10	10
Clay and gravel	90	100
Clay, gravel, and boulders	35	135
Conglomerate	13	148
Clay, gravel, and boulders	22	170
Conglomerate (water)	10	180
Clay, gravel, and boulders	50	230
Conglomerate (water)	8	238
Clay, cobbles, and boulders	27	265
Clay	20	285
Conglomerate	8	293
Clay and gravel	172	465
Conglomerate	58	523
(D-9-2)29cda-1		
Log by Woodhouse Drilling		
Boulders	20	20
Clay and gravel	20	40
Sand and gravel	38	78
Gravel (water)	38	116
(D-9-2)29dbd-2		
Log by Binning Drilling Company		
Silt and gravel	5	5
Hardpan	15	20
Clay, brown	20	40
Clay and boulders	40	80
Clay, brown	25	105
Gravel (water)	15	120
Sand	10	130
Gravel (water)	20	150
Clay	15	165
Boulders (water)	35	200
(D-9-3)5bbd-1		
Log by Eldon Comer		
Top soil	3	3
Gravel and cobbles	12	15
Sand and gravel	18	33
Clay and sand	227	260
Clay, gravel, and hardpan	30	290
Sand, gravel, and cobbles (water)	50	340
Clay, tan	8	348
Clay and gravel	4	352
Clay	81	433
Clay and sand	64	497
Clay and gravel	3	500
Sand, gravel, and cobbles	89	589
Clay, tan	31	620

[1]Actual location is different from historic records. See footnote, table 1.

Table 3.—*Water levels in selected wells*

Well number: See figure 1 for explanation of the numbering system for hydrologic-data sites.
Water level: In feet above (-) or below land surface.

Well number	Date	Water level
(C-9-1)3ddb-1	07-01-1964	19.0
	10-01-1964	16.94
	11-02-1964	18.90
	12-07-1964	18.65
	11-02-1965	19.91
	12-02-1965	18.19
	11-05-1966	18.53
	12-19-1966	20.20
	12-08-1967	19.28
	12-21-1968	19.92
	12-19-1969	21.09
	12-09-1970	22.00
	10-11-1971	22.87
	12-15-1971	20.59
	10-03-1972	21.13
	10-14-1973	21.10
	10-13-1974	21.39
	03-04-1991	17.08
(C-9-1)4ccc-1	03-03-1974	135.00
	03-11-1975	136.52
	03-09-1976	137.39
	03-10-1977	136.67
	03-10-1978	136.74
	03-12-1979	138.79
	03-03-1980	138.61
	03-04-1981	138.62
	09-17-1981	148.26
	03-01-1982	138.13
	09-20-1982	139.90
	03-02-1983	136.04
	09-21-1983	135.74
	03-10-1984	133.17
	09-11-1984	133.24
	03-04-1985	131.29
	03-11-1986	131.30
	09-08-1986	135.05
	03-02-1987	132.67
	09-15-1987	133.84
	03-01-1988	130.43
	09-14-1988	135.80
	03-01-1989	131.09
	09-15-1989	131.72
	03-08-1990	129.86
	03-14-1991	128.76
	09-10-1991	138.60
	03-11-1992	130.68
(C-9-1)4ddc-1	04-15-1964	78.96
	05-12-1964	78.04
(C-9-1)4ddc-1 Continued	09-08-1964	82.20
	10-02-1964	82.80
	11-05-1964	81.10
	12-07-1964	80.81
	02-03-1965	83.94
	03-02-1965	80.37
	03-25-1966	81.94
	04-05-1966	81.76
	12-19-1966	84.04
	03-08-1967	83.00
	04-05-1967	82.82
	03-21-1968	83.71
	03-19-1969	83.87
	03-20-1970	84.00
	03-15-1971	84.20
	03-03-1972	85.42
	03-14-1973	89.32
	03-13-1974	85.69
	03-11-1975	86.29
	03-09-1976	87.34
	03-10-1977	86.65
	03-10-1978	86.32
	03-12-1979	86.1
	03-03-1980	86.55
	03-04-1981	86.93
	03-01-1982	87.03
	03-02-1983	85.24
	03-10-1984	82.60
	03-04-1985	81.19
	03-11-1986	81.54
	03-02-1987	82.73
	03-01-1988	81.57
	12-15-1988	82.26
	01-23-1989	81.82
	02-27-1989	81.59
	03-09-1989	80.90
	06-22-1989	88.70
	07-18-1989	84.72
	08-15-1989	83.16
	09-15-1989	82.66
	10-23-1989	82.27
	11-17-1989	82.15
	12-20-1989	81.94
	02-15-1990	81.53
	03-08-1990	81.37
	04-02-1990	81.34
	05-09-1990	81.13
	07-05-1990	85.11
	08-03-1990	82.82
	09-07-1990	82.88
(C-9-1)4ddc-1 Continued	10-18-1990	81.67
	11-20-1990	81.44
	12-18-1990	81.29
	01-22-1991	81.27
	03-04-1991	81.01
	03-11-1992	80.86
[1](C-9-1)20cdd-1	03-25-1964	195.1
	04-29-1964	193.3
	05-12-1964	194.0
	06-02-1964	194.2
	07-01-1964	195.1
	09-29-1964	203.2
	10-06-1964	202.3
	11-06-1964	200.5
	12-07-1964	199.77
	03-04-1965	198.40
	05-18-1965	199.71
	06-03-1965	199.1
	03-10-1967	207.33
	04-05-1967	207.01
	04-02-1990	199.82
	03-04-1991	200.34
(C-9-1)20ddd-1	02-07-1964	135.60
	03-11-1964	134.90
	04-29-1964	134.40
	05-12-1964	134.40
	06-02-1964	134.80
	07-01-1964	135.90
	08-18-1964	138.20
	09-04-1964	138.50
	10-06-1964	139.90
	11-05-1964	139.20
	12-07-1964	139.45
	01-06-1965	139.63
	02-03-1965	138.81
	03-02-1965	138.52
	04-07-1965	138.21
	05-04-1965	140.79
	06-09-1965	140.68
	07-01-1965	141.39
	10-15-1965	143.50
	12-30-1965	145.30
	03-25-1966	141.73
	04-05-1966	141.73
	08-11-1966	147.93
	12-19-1966	146.73
	03-08-1967	145.28

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(C-9-1)20ddd-1 Continued	04-05-1967	144.76
	03-21-1968	146.92
	03-19-1969	152.32
	03-20-1970	151.30
	09-09-1970	161.48
	03-15-1971	157.20
	10-06-1971	159.19
	03-03-1972	155.29
	09-27-1972	161.55
	03-14-1973	160.22
	03-13-1974	159.05
	03-11-1975	159.48
	03-09-1976	159.45
	03-10-1977	160.45
	03-10-1978	161.23
	03-12-1979	158.70
	03-04-1980	163.25
	03-04-1981	149.10
	03-01-1982	149.72
	03-02-1983	148.18
	03-10-1984	143.80
	03-04-1985	141.72
	03-11-1986	142.71
	03-02-1987	140.96
	03-01-1988	139.75
	03-09-1989	138.66
	05-12-1989	138.39
	06-22-1989	138.74
	07-18-1989	139.21
	08-15-1989	139.50
	10-23-1989	139.76
	12-20-1989	138.90
	01-30-1990	138.20
	03-08-1990	137.94
	04-02-1990	137.80
	04-06-1990	137.73
	06-05-1990	138.32
	08-03-1990	139.25
	09-07-1990	139.70
	10-18-1990	139.64
	12-18-1990	138.74
	03-05-1991	137.98
	09-10-1991	139.42
	03-11-1992	137.57
(C-9-1)26bda-3	04-09-1964	-4.5
	05-26-1964	-5.0
	10-09-1964	-5.3
	03-17-1965	-3.9
	06-28-1965	-5.3
	12-13-1988	-7.0
	05-15-1989	-6.2
(C-9-1)26bda-3 Continued	06-22-1989	-7.0
	07-18-1989	-6.2
	08-15-1989	-5.7
	09-15-1989	-5.7
	10-23-1989	-5.7
	12-20-1989	-5.5
	04-09-1990	-9.3
	05-09-1990	-7.0
(C-9-1)28ccb-1	01-10-1963	126.60
	02-13-1963	126.50
	03-14-1963	126.50
	06-10-1963	129.00
	10-29-1963	133.00
	11-14-1963	132.40
	12-19-1963	131.80
	01-17-1964	131.10
	02-24-1964	130.10
	03-23-1964	130.60
	04-28-1964	130.20
	05-11-1964	130.20
	09-29-1964	136.40
	10-06-1964	136.20
	12-07-1964	137.29
	01-06-1965	135.59
	02-03-1965	135.34
	03-02-1965	135.05
	04-07-1965	134.42
	06-09-1965	137.55
	10-15-1965	141.50
	12-30-1965	148.20
	03-25-1966	138.13
	12-19-1966	143.13
	03-08-1967	142.05
	04-05-1967	140.60
	03-21-1968	142.53
	03-19-1969	142.69
	03-20-1970	148.32
	03-14-1973	150.56
	03-13-1974	139.50
	03-11-1975	139.25
	03-09-1976	138.25
	03-10-1977	138.30
	03-10-1978	136.30
	03-12-1979	135.91
	03-04-1980	137.13
	03-04-1981	138.67
	03-01-1982	139.30
	03-02-1983	137.22
	03-10-1984	133.94
	03-04-1985	132.09
	03-11-1986	132.91
(C-9-1)28ccb-1 Continued	03-02-1987	130.98
	03-01-1988	133.53
	03-03-1989	128.43
	03-08-1990	127.79
	03-04-1991	127.65
	03-11-1992	127.62
(C-9-1)29acc-1	04-03-1963	205.50
	05-10-1963	205.70
	06-10-1963	216.70
	09-11-1963	214.50
	10-28-1963	211.20
	11-14-1963	210.80
	12-19-1963	210.30
	01-16-1964	209.90
	02-24-1964	209.50
	03-25-1964	209.70
	04-29-1964	209.20
	05-12-1964	209.20
	06-05-1964	213.60
	09-04-1964	216.60
	11-06-1964	216.20
	12-07-1964	217.29
	03-04-1965	215.40
	03-29-1966	221.20
	03-10-1967	222.30
	04-05-1967	221.86
	03-21-1968	227.00
	03-19-1969	228.40
	03-20-1970	230.34
	03-15-1971	231.10
	03-03-1972	235.02
	03-14-1973	227.95
	03-13-1974	226.85
	03-11-1975	228.52
	03-09-1976	228.16
	03-10-1977	227.64
	03-10-1978	227.19
	03-12-1979	226.59
	03-04-1980	227.00
	03-04-1981	227.98
	03-01-1982	228.37
	03-02-1983	225.17
	03-10-1984	220.78
	03-04-1985	218.53
	03-11-1986	219.59
	03-02-1987	217.57
	03-01-1988	216.40
	03-09-1989	214.97
	03-08-1990	214.50
	04-02-1990	214.26
	03-04-1991	214.28
	03-11-1992	213.37

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(C-9-1)29bcc-1	05-10-1963	287.0
	06-10-1963	287.7
	07-11-1963	288.5
	08-12-1963	289.9
	09-11-1963	290.7
	10-29-1963	292.0
	11-14-1963	291.9
	12-19-1963	292.0
	01-16-1964	291.9
	02-24-1964	291.4
	03-25-1964	292.0
	04-29-1964	291.1
	05-12-1964	291.1
	06-02-1964	291.13
	03-04-1965	296.6
	03-10-1967	304.6
	04-06-1967	304.6
	03-20-1970	309.6
	03-21-1990	298.64
	04-02-1990	300.10
(C-10-1)4bbb-1	07-23-1962	168.30
	08-16-1962	172.50
	09-14-1962	151.00
	10-15-1962	151.50
	12-03-1962	150.30
	01-10-1963	149.90
	02-13-1963	149.80
	03-11-1963	150.20
	10-28-1963	159.70
	11-14-1963	155.60
	12-19-1963	154.30
	01-17-1964	153.60
	02-24-1964	152.90
	03-23-1964	152.70
	04-28-1964	152.30
	05-11-1964	152.40
	06-01-1964	152.90
	09-04-1964	162.20
	10-06-1964	161.20
	12-07-1964	165.51
	01-06-1965	161.75
	02-03-1965	157.72
	03-02-1965	156.01
	07-01-1965	162.95
	12-30-1965	163.59
	03-24-1966	158.51
	12-19-1966	163.85
	03-08-1967	161.00
	04-05-1967	160.46
	03-21-1968	163.02
(C-10-1)4bbb-1 Continued	03-19-1969	169.58
	03-20-1970	161.62
	03-03-1972	161.96
	03-14-1973	152.24
	03-13-1974	149.29
	03-11-1975	151.45
	03-30-1977	147.16
	03-12-1979	148.08
	03-04-1980	151.44
	03-04-1981	153.57
	03-01-1982	155.87
	03-02-1983	154.89
	03-10-1984	152.22
	03-04-1985	150.66
	03-11-1986	151.80
	03-02-1987	150.06
	03-01-1988	151.13
	12-15-1988	147.61
	02-23-1989	147.17
	03-03-1989	147.35
	05-12-1989	146.95
	06-22-1989	146.74
	07-18-1989	146.93
	08-18-1989	146.89
	09-15-1989	146.97
	11-17-1989	147.17
	01-30-1990	146.71
	03-08-1990	146.76
	05-09-1990	146.70
	07-05-1990	147.42
	09-07-1990	147.25
	11-20-1990	147.18
	01-22-1991	147.13
	03-05-1991	147.04
	03-11-1992	147.15
(C-10-1)4cbb-1	04-10-1962	143.78
	03-08-1967	149.82
	04-05-1967	151.88
	03-21-1968	150.52
	03-19-1969	157.17
	03-20-1970	154.38
	03-15-1971	153.45
	03-03-1972	143.52
	03-14-1973	140.78
	03-13-1974	142.39
	03-11-1975	140.06
	03-09-1976	135.05
	03-10-1977	134.28
	03-10-1978	131.78
	03-12-1979	134.05
(C-10-1)4cbb-1 Continued	03-04-1980	138.53
	03-04-1981	148.75
	03-01-1982	150.06
	03-02-1983	149.91
	03-10-1984	147.45
	03-04-1985	141.20
	03-11-1986	141.44
	03-02-1987	139.01
	03-01-1988	138.41
	03-03-1989	138.16
	05-12-1989	135.40
	03-08-1990	135.28
	03-04-1991	135.86
	03-11-1992	136.06
[1](C-10-1)15cca-1	10-30-1964	31.80
	02-14-1991	28.47
	03-07-1991	28.29
(C-10-1)17bba-1	04-21-1989	265.56
	05-16-1989	265.83
	06-22-1989	265.93
	07-17-1989	266.24
	08-16-1989	266.31
	09-18-1989	266.41
	10-23-1989	266.19
	12-18-1989	266.02
	01-30-1990	265.69
	03-07-1990	265.71
	05-09-1990	265.81
	07-05-1990	266.42
	08-08-1990	266.64
	09-07-1990	266.75
	10-18-1990	266.93
	11-20-1990	266.82
	12-18-1990	266.85
	01-22-1991	266.99
	03-04-1991	266.71
	09-10-1991	267.71
	03-11-1992	268.04
(C-10-1)17bba-2	02-23-1989	271.90
	05-16-1989	272.66
	06-22-1989	265.68
	07-17-1989	266.03
	08-16-1989	266.08
	09-18-1989	266.23
	10-23-1989	266.00
	12-18-1989	265.87
	01-30-1990	265.47
	03-07-1990	265.46

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(C-10-1)17bba-2 Continued	05-09-1990	265.54
	08-08-1990	266.41
	09-07-1990	266.52
	10-18-1990	266.74
	11-20-1990	266.65
	12-18-1990	266.63
	01-22-1991	266.75
	03-04-1991	266.56
	09-10-1991	267.71
	03-11-1992	267.75
(C-10-1)18ccc-1	01-20-1989	352.16
	02-23-1989	352.01
	04-21-1989	351.83
	05-16-1989	351.91
	06-22-1989	351.89
	07-17-1989	352.08
	09-18-1989	351.99
	11-17-1989	352.17
	01-24-1990	352.37
	03-07-1990	352.27
	04-05-1990	352.06
	06-05-1990	352.13
	08-08-1990	352.49
	09-07-1990	352.69
	10-18-1990	352.97
	11-19-1990	352.73
	01-22-1991	353.58
	03-05-1991	353.46
	03-11-1992	355.42
(C-10-1)24ddc-1	12-20-1966	217.8
	01-05-1967	217.28
	02-05-1967	217.06
	03-05-1967	216.54
	04-05-1967	216.29
	05-05-1967	216.61
	07-10-1967	219.59
	08-05-1967	223.15
	09-05-1967	224.55
	10-05-1967	222.73
	11-05-1967	219.22
	12-05-1967	217.57
	03-21-1968	215.90
	04-05-1968	215.3
	05-05-1968	214.92
	06-05-1968	216.47
	07-05-1968	217.31
	08-05-1968	217.88
	09-05-1968	222.59
	10-05-1968	226.26
	11-05-1968	225.29
(C-10-1)24ddc-1 Continued	12-05-1968	220.78
	03-19-1969	216.30
	03-20-1970	222.70
	03-15-1971	214.34
	03-12-1974	212.30
	03-10-1975	212.60
	03-08-1976	212.51
	03-09-1977	210.66
	08-12-1977	231.63
	03-10-1978	212.64
	08-25-1978	220.10
	03-12-1979	212.67
	09-17-1979	212.70
	03-03-1980	211.32
	09-03-1980	217.59
	03-04-1981	211.09
	09-17-1981	218.80
	03-01-1982	212.26
	09-20-1982	217.27
	03-02-1983	210.54
	09-21-1983	211.35
	03-10-1984	206.60
	09-11-1984	210.37
	03-04-1985	205.18
	09-10-1985	212.92
	03-11-1986	206.60
	09-08-1986	215.02
	03-02-1987	208.14
	09-11-1987	218.29
	03-01-1988	209.65
	09-14-1988	219.21
	12-12-1988	212.59
	01-20-1989	211.37
	03-09-1989	210.59
	04-21-1989	212.52
	05-12-1989	217.62
	06-22-1989	220.28
	07-17-1989	220.40
	08-16-1989	220.12
	09-18-1989	219.98
	10-23-1989	217.18
	11-17-1989	214.92
	12-18-1989	214.25
	01-24-1990	212.84
	02-15-1990	212.16
	03-07-1990	211.93
	05-09-1990	213.94
	06-05-1990	215.54
	07-02-1990	223.73
	08-08-1990	224.36
	09-07-1990	222.00
	10-18-1990	217.98
(C-10-1)24ddc-1 Continued	11-20-1990	214.89
	12-18-1990	214.04
	01-22-1991	213.30
	03-05-1991	212.54
	09-10-1991	222.32
	09-13-1991	223.16
[1](C-10-1)25abd-1	02-04-1964	259.8
	07-01-1964	263.4
	08-19-1964	266.8
	05-18-1965	295.8
	06-10-1965	280.8
	03-30-1966	252.5
	03-21-1990	242.82
	03-05-1991	245.15
(C-10-1)30baa-1	09-18-1989	226.10
	11-17-1989	225.96
	01-24-1990	225.93
	02-15-1990	225.71
	03-07-1990	225.58
	05-09-1990	225.74
	06-05-1990	228.67
(C-10-1)34bbb-1	03-24-1964	96.1
	05-14-1964	96.5
	06-10-1964	96.5
	07-02-1964	97.4
	08-19-1964	96.8
	09-04-1964	96.8
	10-09-1964	97.0
	12-07-1964	96.70
	01-06-1965	96.56
	02-03-1965	96.79
	03-02-1965	96.82
	04-07-1965	96.88
	05-04-1965	97.01
	06-09-1965	97.33
	07-01-1965	99.15
	10-15-1965	95.60
	03-25-1966	99.58
	08-29-1966	96.76
	12-19-1966	99.15
	03-08-1967	97.47
	12-08-1967	97.47
	12-21-1968	97.60
	12-19-1969	97.53
	12-20-1970	95.86
	03-03-1972	90.59
	12-03-1972	94.59
	03-09-1973	94.29
	12-09-1973	98.29

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(C-10-1)34bbb-1	03-12-1974	87.03
Continued	12-12-1974	91.03
	03-07-1991	89.39
(C-10-2)13bcc-1	01-20-1989	161.62
	02-24-1989	162.37
	04-21-1989	163.52
	05-15-1989	164.19
	06-22-1989	164.74
	07-17-1989	165.32
	08-16-1989	165.74
	09-18-1989	166.29
	10-23-1989	166.88
	11-17-1989	167.15
	12-18-1989	166.99
	01-24-1990	168.27
	03-07-1990	168.71
	04-05-1990	168.93
	06-05-1990	169.60
	07-05-1990	170.00
	08-08-1990	170.35
	10-18-1990	171.24
	11-20-1990	171.21
	01-22-1991	172.02
	03-05-1991	172.24
(C-11-1)6bdd-1	04-15-1964	244.68
	05-15-1964	246.50
	06-05-1964	247.10
	07-02-1964	247.60
	08-19-1964	253.00
	09-28-1964	249.70
	10-08-1964	253.60
	11-03-1964	249.40
	12-07-1964	248.63
	03-02-1965	247.68
	05-04-1965	249.73
	06-09-1965	281.53
	07-01-1965	277.10
	10-15-1965	267.00
	11-03-1965	257.48
	03-25-1966	250.71
	03-11-1967	256.20
	04-05-1967	255.77
	03-21-1968	258.00
	03-19-1969	258.42
	03-20-1970	257.10
	09-09-1970	271.64
	03-16-1971	254.60
	10-06-1971	261.44
	03-03-1972	254.34
	03-13-1974	249.74
(C-11-1)6bdd-1	03-10-1975	259.40
Continued	03-09-1976	256.60
	03-10-1977	249.31
	03-19-1990	232.96
	04-06-1990	234.39
(D-7-2)32dad-1	12-12-1980	-32.4
	02-26-1981	-32.7
	03-09-1982	-33.3
	03-04-1991	-22.7
(D-7-2)34dcd-1	09-21-1959	-9.8
	04-02-1964	-8.9
	05-13-1964	-8.0
	08-03-1964	-7.3
	10-20-1964	-6.2
	03-05-1965	-8.3
	06-23-1965	-7.6
	03-11-1969	-9.2
	03-17-1970	-9.8
	03-24-1970	-9.6
	03-17-1971	-9.7
	03-09-1972	-10.2
	03-07-1973	-9.9
	03-26-1981	-8.4
	03-12-1982	-9.4
	03-01-1983	-10.4
	03-09-1984	-11.0
	03-04-1985	-10.9
	03-10-1986	-11.3
	03-04-1987	-11.0
	03-02-1988	-8.8
	03-09-1989	-7.1
	03-05-1990	-8.7
	03-05-1991	-6.6
	03-13-1992	-9.1
(D-7-2)36dcc-2	09-07-1938	-13.0
	12-12-1938	-13.4
	01-30-1939	-14.2
	03-17-1939	-15.0
	04-13-1939	-15.3
	06-13-1939	-15.0
	08-03-1939	-11.9
	10-17-1939	-12.3
	01-04-1940	-15.0
	02-28-1940	-16.2
	04-13-1940	-16.1
	05-02-1940	-17.0
	06-17-1940	-13.6
	01-21-1941	-14.3
	03-18-1941	-15.6
(D-7-2)36dcc-2	12-11-1941	-13.8
Continued	03-27-1942	-15.4
	06-27-1942	-13.9
	12-26-1942	-15.2
	03-29-1943	-17.0
	12-29-1943	-14.7
	03-24-1944	-15.3
	12-27-1944	-14.0
	03-30-1945	-15.2
	12-17-1945	-16.4
	03-07-1946	-17.0
	12-17-1946	-18.4
	04-07-1947	-18.0
	12-17-1947	-17.2
	03-30-1948	-17.9
	12-23-1948	-15.7
	03-17-1949	-17.2
	12-16-1949	-17.1
	03-23-1950	-17.1
	12-19-1950	-16.7
	04-04-1951	-18.5
	12-26-1951	-18.3
	04-08-1952	-18.1
	12-11-1952	-18.2
	04-21-1953	-18.8
	12-08-1953	-15.1
	03-24-1954	-17.4
	12-29-1954	-14.5
	04-22-1955	-15.3
	12-22-1955	-13.8
	03-30-1956	-16.9
	12-19-1956	-14.9
	04-01-1957	-17.2
	12-06-1957	-16.5
	03-18-1958	-18.1
	12-04-1958	-15.3
	03-18-1959	-16.3
	12-24-1959	-14.5
	03-23-1960	-15.6
	12-09-1960	-14.1
	03-23-1961	-15.9
	01-05-1962	-14.2
	03-06-1962	-14.6
	12-06-1962	-15.6
	03-12-1963	-16.9
	08-27-1963	-10.4
	12-16-1963	-15.0
	03-11-1964	-15.9
	04-09-1964	-14.6
	06-01-1964	-15.1
	07-09-1964	-13.6
	08-03-1964	-12.7

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-7-2)36dcc-2 Continued	09-01-1964	-8.6
	12-03-1964	-12.1
	03-01-1965	-15.9
	10-06-1965	-14.4
	12-28-1965	-6.5
	03-24-1966	-6.2
	08-17-1966	-3.4
	12-20-1966	-3.4
	03-27-1967	-6.2
	10-02-1968	-10.9
	03-26-1981	-12.8
	03-11-1982	-13.3
	03-01-1983	-14.8
	03-09-1984	-15.9
	03-04-1985	-16.0
	03-10-1986	-16.3
	03-04-1987	-15.9
	03-03-1988	-14.2
	12-13-1988	-13.0
	01-27-1989	-11.6
	03-01-1989	-12.6
	04-19-1989	-9.8
	05-12-1989	-10.0
	06-20-1989	-10.3
	07-18-1989	-9.0
	08-15-1989	-9.2
	08-24-1989	-7.9
	09-15-1989	-9.7
	10-23-1989	-10.3
	11-14-1989	-11.0
	12-19-1989	-12.2
	01-23-1990	-13.1
	02-12-1990	-12.5
	03-05-1990	-14.1
	04-09-1990	-14.2
	05-08-1990	-13.8
	06-04-1990	-13.8
	07-03-1990	-10.1
	08-02-1990	-11.9
	09-05-1990	-11.1
	10-18-1990	-12.1
	11-19-1990	-12.3
	12-17-1990	-12.2
	01-24-1991	-12.5
	03-04-1991	-11.4
	03-13-1992	-13.5
(D-7-3)18dcc-1	12-11-1980	-35.5
	03-26-1981	-33.6
	03-09-1982	-31.9
	02-04-1991	-18.8
	03-05-1991	-18.9

Well number	Date	Water level
(D-7-3)28cab-1	03-01-1961	-15.0
	03-30-1964	-16.4
	05-12-1964	-17.0
	09-15-1964	-18.5
	06-19-1989	-17.8
	07-19-1989	-17.6
	08-24-1989	-12.4
	09-20-1989	-16.6
	10-26-1989	-16.5
	12-19-1989	-16.1
	01-23-1990	-15.5
	02-13-1990	-15.9
	03-05-1990	-15.7
	04-09-1990	-15.3
	05-10-1990	-15.3
	06-04-1990	-16.2
	07-03-1990	-14.9
	08-02-1990	-15.9
	09-05-1990	-15.5
	10-16-1990	-15.4
	11-19-1990	-15.3
	12-17-1990	-15.3
	01-24-1991	-15.2
	03-04-1991	-14.8
(D-7-3)31cac-2	11-02-1964	-11.2
	09-13-1989	-14.3
(D-7-3)32bcd-1	12-04-1980	-12.8
	03-26-1981	-11.8
	03-09-1982	-13.5
	02-06-1991	-13.1
	03-04-1991	-13.2
(D-7-3)33baa-6	08-31-1935	-6.8
	03-02-1936	-6.4
	10-03-1936	-8.7
	03-03-1937	-7.2
	09-23-1937	-9.0
	05-17-1938	-8.6
	09-14-1938	-9.6
	03-24-1939	-8.0
	09-21-1939	-8.1
	03-16-1940	-8.1
	09-24-1940	-8.2
	03-18-1941	-8.2
	12-10-1941	-10.6
	03-27-1942	-8.8
	06-27-1942	-12.4
	12-26-1942	-11.3
	03-29-1943	-9.7
	12-29-1943	-9.0

Well number	Date	Water level
(D-7-3)33baa-6 Continued	03-24-1944	-8.4
	12-27-1944	-10.7
	03-29-1945	-9.8
	12-17-1945	-11.7
	03-07-1946	-10.7
	12-17-1946	-11.5
	04-07-1947	-10.6
	12-17-1947	-11.3
	03-30-1948	-10.0
	12-23-1948	-10.9
	03-17-1949	-9.6
	12-16-1949	-11.1
	03-22-1950	-9.9
	12-19-1950	-11.3
	04-04-1951	-9.7
	12-28-1951	-11.3
	04-08-1952	-10.5
	12-11-1952	-17.3
	04-21-1953	-14.0
	12-08-1953	-12.5
	03-24-1954	-11.7
	12-29-1954	-10.0
	04-22-1955	-9.6
	12-22-1955	-9.6
	03-30-1956	-9.2
	12-19-1956	-9.5
	04-01-1957	-9.9
	12-06-1957	-11.6
	03-18-1958	-11.0
	12-04-1958	-13.8
	03-18-1959	-11.9
	12-24-1959	-8.9
	03-23-1960	-8.6
	12-09-1960	-8.7
	03-23-1961	-7.1
	01-05-1962	-6.8
	03-06-1962	-7.1
	12-06-1962	-9.7
	03-07-1963	-8.9
	08-27-1963	-5.6
	12-16-1963	-7.7
	04-09-1964	-6.2
	05-28-1964	-7.2
	07-09-1964	-7.3
	08-03-1964	-7.4
	09-01-1964	-6.4
	10-05-1964	-7.0
	11-02-1964	-7.7
	12-03-1964	-7.9
	01-05-1965	-8.0
	02-01-1965	-8.3
	03-01-1965	-7.9

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-7-3)33baa-6 Continued	04-05-1965	-7.7
	05-03-1965	-7.9
	06-07-1965	-10.1
	07-02-1965	-11.3
	10-06-1965	-12.0
	12-28-1965	-10.3
	03-24-1966	-8.8
	08-17-1966	-5.3
	10-02-1968	-11.3
	03-11-1969	-10.4
	09-03-1969	-11.4
	03-17-1970	-10.7
	09-08-1970	-9.1
	03-17-1971	-9.4
	10-06-1971	-11.7
	03-09-1972	-9.9
	09-26-1972	-7.4
	03-07-1973	-8.9
	09-05-1973	-11.5
	03-07-1974	-11.1
	03-06-1975	-9.8
	08-18-1975	-14.4
	03-04-1976	-11.6
	08-12-1976	-6.2
	03-07-1977	-8.9
	08-10-1977	-3.2
	03-08-1978	-5.5
	08-22-1978	-7.9
	03-15-1979	-8.3
	09-18-1979	-9.7
	03-06-1980	-8.3
	09-03-1980	-10.6
	03-02-1981	-9.2
	09-03-1981	-6.8
	03-02-1982	-9.0
	09-20-1982	-14.5
	03-01-1983	-12.1
	09-21-1983	-17
	03-09-1984	-15.4
	09-10-1984	-19.4
	03-04-1985	-16.5
	09-10-1985	-16.4
	03-10-1986	-14.2
	09-08-1986	-16.5
	03-04-1987	-13.9
	09-11-1987	-9.9
	03-02-1988	-7.3
	09-14-1988	-5.8
	03-10-1989	-8.6
	06-19-1989	-7.3
	07-19-1989	-5.0
	08-24-1989	-5.0
(D-7-3)33baa-6 Continued	09-19-1989	-5.5
	10-24-1989	-5.6
	11-13-1989	-5.5
	12-19-1989	-6.0
	03-05-1990	-7.0
	03-04-1991	-4.7
	09-12-1991	-4.9
	03-13-1992	-6.2
(D-7-3)33ccc-5	03-15-1938	-3.6
	09-25-1938	-8.7
	03-24-1939	-7.2
	09-21-1939	-7.3
	02-29-1940	-7.7
	10-01-1940	-7.1
	06-07-1964	-9.5
	09-01-1964	-5.5
	10-05-1964	-5.9
	03-01-1965	-8.0
	04-05-1965	-8.3
	05-03-1965	-7.9
	06-07-1965	-9.5
	07-02-1965	-10.7
	10-05-1965	-13.8
	12-28-1965	-12.0
	03-24-1966	-10.5
	08-13-1966	-4.2
	12-20-1966	-7.9
	01-21-1967	-7.6
	02-21-1967	-6.2
	03-27-1967	-7.1
	03-19-1968	-8.1
	03-11-1969	-11.3
	03-24-1970	-12.1
	03-17-1971	-10.9
	03-09-1972	-10.9
	03-12-1973	-10.5
	03-07-1974	-12.2
	03-07-1975	-11.7
	03-04-1976	-13.4
	03-07-1977	-10.2
	03-08-1978	-3.5
	03-15-1979	-9.1
	03-06-1980	-9.2
	03-02-1981	-10.6
	03-02-1982	-10.2
	03-01-1983	-14.1
	03-09-1984	-18.0
	03-04-1985	-19.0
	03-10-1986	-16.3
	03-04-1987	-15.9
	03-03-1988	-9.8
(D-7-3)33ccc-5 Continued	12-13-1988	-8.5
	01-26-1989	-9.9
	03-01-1989	-9.9
	04-18-1989	-8.2
	05-15-1989	-8.7
	06-19-1989	-6.4
	07-19-1989	-5.7
	08-24-1989	-5.3
	09-19-1989	-5.7
	10-26-1989	-6.7
	11-14-1989	-6.6
	12-19-1989	-7.6
	01-23-1990	-8.0
	02-13-1990	-8.0
	03-05-1990	-8.3
	04-09-1990	-7.8
	05-10-1990	-5.9
	06-04-1990	-6.4
	07-03-1990	-2.2
	08-02-1990	-2.5
	09-05-1990	-1.8
	10-16-1990	-3.5
	11-19-1990	-4.6
	12-17-1990	-4.7
	01-24-1991	-4.7
	03-04-1991	-5.2
	03-13-1992	-7.1
(D-7-3)33ccc-6	01-21-1967	-21.8
	03-08-1991	-14.3
(D-8-1)2ccd-1	11-01-1988	5.94
	12-12-1988	5.95
	01-23-1989	5.90
	02-24-1989	5.76
	04-19-1989	5.52
	05-12-1989	5.66
	06-20-1989	5.92
	08-15-1989	6.34
	12-20-1989	6.48
	02-12-1990	6.49
	03-06-1990	6.26
	04-02-1990	6.32
	05-08-1990	6.36
	07-05-1990	6.70
	09-06-1990	7.00
	11-18-1990	7.11
	12-17-1990	7.07
	01-24-1991	7.01
	02-15-1991	7.10
	03-05-1991	6.87
	04-05-1991	6.99

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-1)2ccd-1 Continued	05-08-1991	6.92
	06-14-1991	6.80
	08-12-1991	7.04
	09-30-1991	7.01
	01-15-1992	6.96
	03-13-1992	6.76
(D-8-1)10bcb-1	11-22-1988	14.11
	12-12-1988	14.28
	01-23-1989	14.38
	02-24-1989	14.50
	04-19-1989	14.62
	05-12-1989	14.63
	06-20-1989	14.68
	07-18-1989	14.85
	08-15-1989	14.86
	09-15-1989	14.99
	10-23-1989	15.00
	11-14-1989	15.18
	12-20-1989	15.49
	01-23-1990	15.62
	02-12-1990	15.65
	03-06-1990	15.78
	04-02-1990	15.93
	05-08-1990	16.08
	06-05-1990	16.14
	07-03-1990	16.20
	08-03-1990	16.34
	09-06-1990	16.50
	10-18-1990	16.70
	11-19-1990	16.83
	12-17-1990	17.00
	01-24-1991	17.06
	03-05-1991	17.01
	07-03-1991	17.07
	08-21-1991	17.06
	10-01-1991	17.02
	01-15-1992	17.15
(D-8-1)10bcb-2	11-22-1988	42.58
	12-12-1988	42.39
	01-23-1989	41.92
	02-24-1989	41.45
	04-19-1989	40.65
	05-12-1989	40.88
	06-20-1989	41.63
	07-18-1989	42.31
	08-18-1989	42.88
	09-15-1989	43.25
	10-23-1989	43.26
	11-14-1989	43.20
	12-20-1989	43.07
(D-8-1)10bcb-2 Continued	01-23-1990	42.78
	02-12-1990	42.60
	03-06-1990	42.30
	04-02-1990	42.10
	05-08-1990	42.27
	06-05-1990	42.80
	07-05-1990	43.02
	08-03-1990	43.33
	09-06-1990	43.34
	10-18-1990	43.24
	11-19-1990	43.30
	12-17-1990	43.31
	01-24-1991	43.17
	03-05-1991	43.34
	07-03-1991	43.47
	08-21-1991	43.53
	10-01-1991	43.42
	01-15-1992	43.35
(D-8-1)13aaa-1	05-02-1936	-13.4
	12-01-1936	-13.8
	03-03-1937	-14.7
	09-23-1937	-13.0
	04-06-1938	-18.0
	09-12-1938	-13.2
	03-24-1939	-17.3
	09-21-1939	-15.4
	03-19-1940	-17.5
	09-20-1940	-14.0
	03-18-1941	-16.7
	11-27-1941	-15.2
	03-27-1942	-16.2
	12-26-1942	-14.0
	03-29-1943	-15.0
	12-29-1943	-15.8
	03-24-1944	-16.1
	12-27-1944	-14.6
	03-30-1945	-14.6
	12-17-1945	-16.3
	03-07-1946	-16.7
	12-17-1946	-17.0
	04-07-1947	-16.7
	12-17-1947	-15.0
	03-30-1948	-16.4
	12-23-1948	-15.3
	03-17-1949	-16.3
	12-16-1949	-15.9
	03-22-1950	-14.9
	12-19-1950	-15.3
	04-04-1951	-15.8
	12-26-1951	-15.6
	12-08-1953	-15.5
(D-8-1)13aaa-1 Continued	09-01-1964	-6.6
	10-05-1964	-9.5
	11-02-1964	-10.9
	12-03-1964	-11.9
	09-20-1989	-10.8
	03-04-1991	-11.3
(D-8-1)13bdd-1	07-07-1964	-2.0
	03-05-1991	-1.5
(D-8-1)20abb-1	11-01-1988	12.64
	12-12-1988	12.92
	01-23-1989	12.88
	02-24-1989	12.83
	04-19-1989	11.50
	05-12-1989	12.65
	06-20-1989	13.19
	07-18-1989	13.71
	08-15-1989	14.10
	09-15-1989	14.50
	10-23-1989	14.68
	11-14-1989	14.67
	12-20-1989	14.68
	01-23-1990	14.51
	02-12-1990	14.41
	03-06-1990	14.22
	04-02-1990	14.15
	05-08-1990	14.17
	07-05-1990	14.80
	08-03-1990	15.20
	09-06-1990	15.67
	10-18-1990	16.02
	11-19-1990	15.98
	01-24-1991	15.75
	03-05-1991	15.68
(D-8-1)23bdd-1	06-09-1937	-7.3
	12-13-1988	-11.9
	01-26-1989	-11.9
	03-01-1989	-12.0
	04-19-1989	-10.3
	05-12-1989	-10.2
	06-20-1989	-10.6
	07-18-1989	-11.0
	08-15-1989	-10.8
	08-24-1989	-10.8
	09-15-1989	-11.1
	10-26-1989	-10.7
	11-14-1989	-10.2
	12-20-1989	-9.6
	01-23-1990	-9.4
	02-12-1990	-9.5

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-1)23bdd-1 Continued	03-06-1990	-10.1
	04-02-1990	-9.1
	05-08-1990	-9.1
	06-05-1990	-9.2
	07-03-1990	-9.3
	08-03-1990	-9.1
	09-05-1990	-7.9
	10-18-1990	-9.3
	11-19-1990	-9.3
	12-17-1990	-8.6
	01-24-1991	-9.0
	03-05-1991	-8.0
(D-8-1)25aba-1	03-24-1967	-12.9
	02-20-1991	-6.6
	03-05-1991	-6.5
(D-8-1)25cbb-1	07-21-1964	-15.2
	02-20-1991	-11.0
	03-04-1991	-11.8
(D-8-1)36bcc-1	07-21-1964	-15.9
	03-07-1991	-10.9
(D-8-2)1baa-1	04-08-1964	-11.0
	08-06-1964	-14.6
	08-08-1989	-10.3
(D-8-2)2caa-1	11-12-1951	-16
	08-06-1964	-16.7
	09-21-1989	-11.6
(D-8-2)2cda-1	08-06-1964	-6.2
	09-21-1989	-5.5
	03-04-1991	-4.7
(D-8-2)2daa-1	08-06-1964	-25.8
	04-19-1989	-26.7
	05-16-1989	-24.4
	06-22-1989	-23.6
	07-18-1989	-24.0
	08-15-1989	-22.8
	08-24-1989	-22.5
	09-15-1989	-22.9
	10-23-1989	-23.2
	11-14-1989	-24.6
	12-20-1989	-24.5
	01-23-1990	-24.8
	02-12-1990	-25.1
	03-05-1990	-25.5
	04-02-1990	-25.7
(D-8-2)3aad-1	05-01-1964	-10.0
	09-15-1989	-15.8
(D-8-2)4abb-1	08-20-1964	-8.8
	09-12-1989	-12.4
	03-05-1991	-14.1
(D-8-2)4abc-1	04-06-1964	-12.5
	05-12-1964	-12.7
	08-04-1964	-12.2
	03-05-1965	-12.5
	06-23-1965	-12.7
	09-12-1989	-11.3
[1](D-8-2)4bab-1	03-25-1963	-22.0
	08-20-1964	-15.2
	09-12-1989	-4.4
(D-8-2)4cba-2	03-03-1937	-26.1
	09-23-1937	-24.8
	03-14-1938	-28.1
	09-27-1938	-24.8
	03-24-1939	-29.4
	09-21-1939	-26.8
	04-12-1940	-29.5
	09-20-1940	-25.8
	03-18-1941	-29.8
	12-29-1941	-27.9
	03-27-1942	-27.6
	12-26-1942	-29.7
	03-29-1943	-29.9
	12-29-1943	-29.5
	03-24-1944	-30.8
	12-27-1944	-30.7
	03-30-1945	-32.1
	12-17-1945	-31.6
	03-07-1946	-32.5
	12-17-1946	-31.6
	04-07-1947	-34.1
	12-17-1947	-33.3
	03-30-1948	-35.2
	03-17-1949	-34.5
	12-16-1949	-35.1
	03-23-1950	-36.8
	12-19-1950	-35.8
	04-04-1951	-35.0
	12-26-1951	-34.4
	04-09-1952	-35.0
	12-16-1952	-38.1
	04-21-1953	-37.8
	03-24-1954	-37.4
	12-29-1954	-35.1
(D-8-2)4cba-2 Continued	04-22-1955	-34.7
	12-22-1955	-33.4
	03-30-1956	-33.4
	12-19-1956	-34.2
	04-01-1957	-35.6
	12-06-1957	-35.8
	03-18-1958	-36.7
	12-04-1958	-35.5
	03-18-1959	-36.5
	12-24-1959	-32.9
	03-23-1960	-35.1
	12-09-1960	-32.6
	03-23-1961	-35.1
	01-05-1962	-28.1
	03-06-1962	-29.9
	12-06-1962	-28.4
	03-07-1963	-26.3
	08-27-1963	-17.6
	12-16-1963	-20.2
	03-11-1964	-21.3
	04-09-1964	-20.6
	05-28-1964	-19.3
	07-09-1964	-18.9
	08-03-1964	-18.2
	09-01-1964	-17.0
	10-05-1964	-18.4
	11-02-1964	-19.6
	12-03-1964	-19.8
	01-05-1965	-20.8
	02-02-1965	-21.7
	03-01-1965	-21.7
	04-05-1965	-22.3
	05-03-1965	-19.6
	06-07-1965	-19.8
	07-02-1965	-19.9
	10-21-1965	-20.8
	12-28-1965	-22.1
	03-25-1966	-20.2
	08-23-1966	-18.0
	12-30-1966	-19.7
	01-27-1967	-20.9
	02-10-1967	-20.0
	03-01-1967	-21.0
	03-16-1967	-21.0
	04-13-1967	-21.0
	04-27-1967	-20.6
	03-19-1968	-21.8
	10-02-1968	-20.5
	03-11-1969	-23.4
	09-04-1969	-19.4
	03-24-1970	-22.4
	09-08-1970	-21.1

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-2)4cba-2 Continued	03-17-1971	-22.7
	10-06-1971	-21.2
	03-09-1972	-22.4
	09-26-1972	-20.3
	03-07-1973	-22.5
	09-05-1973	-21.5
	03-08-1974	-25.8
	03-07-1975	-24.6
	03-05-1976	-25.6
	08-13-1976	-16.4
	03-08-1977	-22.6
	08-10-1977	-21.2
	03-09-1978	-19.2
	08-28-1978	-14.6
	03-15-1979	-23.2
	09-18-1979	-18.8
	03-05-1980	-21.1
	09-04-1980	-20.9
	03-02-1981	-23.9
	09-03-1981	-19.6
	03-02-1982	-22.1
	09-20-1982	-20.5
	03-01-1983	-23.6
	09-21-1983	-21.0
	03-09-1984	-23.7
	09-10-1984	-14.2
	03-04-1985	-24.8
	09-10-1985	-20.9
	03-10-1986	-24.2
	09-08-1986	-19.1
	03-04-1987	-23.0
	09-11-1987	-19.5
	03-02-1988	-19.5
	09-14-1988	-17.9
	12-13-1988	-18.7
	01-26-1989	-20.3
	03-01-1989	-20.3
	04-19-1989	-17.9
	05-12-1989	-17.6
	06-20-1989	-16.5
	07-18-1989	-15.8
	08-15-1989	-15.9
	08-24-1989	-15.3
	09-15-1989	-15.5
	10-23-1989	-15.5
	11-14-1989	-16.1
	12-19-1989	-16.2
	01-23-1990	-16.4
	03-05-1990	-17.0
	04-02-1990	-16.7
	05-08-1990	-14.7
	06-04-1990	-14.7
(D-8-2)4cba-2 Continued	07-03-1990	-11.9
	08-03-1990	-13.3
	09-05-1990	-14.7
	10-18-1990	-14.8
	11-19-1990	-16.6
	03-01-1991	-17.6
	09-10-1991	-14.6
	03-13-1992	-16.3
[1](D-8-2)4cbb-1	04-28-1964	-39.0
	09-15-1989	-6.1
(D-8-2)4cdc-4	08-20-1964	-12.7
	03-04-1991	-13.0
(D-8-2)4dad-1	04-03-1964	-43.8
	05-19-1964	-43.7
	08-04-1964	-43.7
	10-08-1964	-42.7
	03-08-1965	-45.4
	06-23-1965	-45.2
	09-28-1989	-13.4
(D-8-2)7dda-1	03-30-1965	-7.7
	03-04-1991	-4.9
(D-8-2)7ddd-1	12-16-1963	-10.9
	03-01-1991	-9.3
(D-8-2)10adb-1	09-28-1989	-20.1
	03-01-1991	-19.7
(D-8-2)13abc-1	08-30-1961	-22.0
	04-02-1964	-28.1
	05-13-1964	-28.5
	08-25-1964	-18.7
	10-07-1964	-22.5
	03-04-1965	-29.5
	06-22-1965	-26.6
	09-28-1989	-18.4
(D-8-2)14cad-1	09-02-1964	-4.5
	02-20-1990	-3.4
	03-05-1991	-3.5
(D-8-2)16caa-1	04-13-1937	-37.3
	09-23-1937	-32.4
	04-06-1938	-41.9
	09-13-1938	-36.0
	03-24-1939	-39.2
	10-13-1939	-35.7
	04-04-1940	-40.6
(D-8-2)16caa-1 Continued	01-21-1941	-39.8
	09-02-1964	-33.5
	10-05-1964	-33.4
	11-02-1964	-34.7
	12-03-1964	-35.8
	01-05-1965	-36.0
	02-02-1965	-36.8
	03-01-1965	-37.4
	04-05-1965	-37.6
	05-03-1965	-37.6
	06-07-1965	-37.7
	07-02-1965	-36.7
	10-21-1965	-39.6
	12-29-1965	-38.8
	03-25-1966	-38.6
	08-23-1966	-35.4
	12-20-1966	-36.1
	01-20-1967	-36.4
	02-20-1967	-36.9
	03-27-1967	-37.5
	03-19-1968	-38.4
	10-02-1968	-37.5
	03-11-1969	-41.6
	09-03-1969	-39.5
	03-15-1970	-42.7
	09-08-1970	-38.7
	03-17-1971	-40.7
	10-06-1971	-38.4
	03-10-1972	-40.4
	09-26-1972	-36.6
	03-08-1973	-40.6
	09-05-1973	-37.8
	03-08-1974	-42.2
	03-07-1975	-41.4
	03-05-1976	-43.0
	08-13-1976	-36.4
	03-08-1977	-39.5
	08-10-1977	-34.2
	03-09-1978	-37.4
	08-23-1978	-33.8
	03-15-1979	-38.9
	09-17-1979	-35.1
	03-05-1980	-38.7
	09-04-1980	-36.3
	03-03-1981	-39.4
	09-03-1981	-35.9
	03-02-1982	-37.8
	09-20-1982	-39.6
	03-03-1983	-42.3
	09-21-1983	-44
	03-09-1984	-47.4
	09-10-1984	-48.4

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-2)16caa-1 Continued	03-05-1985	-50.1
	09-10-1985	-46.0
	03-10-1986	-47.0
	09-08-1986	-41.1
	03-04-1987	-44.2
	09-11-1987	-37.4
	03-02-1988	-38.0
	09-14-1988	-32.1
	12-13-1988	-31.0
	01-26-1989	-36.4
	03-01-1989	-36.3
	04-19-1989	-33.8
	05-12-1989	-32.4
	06-20-1989	-29.9
	07-18-1989	-29.0
	08-15-1989	-28.3
	09-15-1989	-28.3
	10-26-1989	-28.9
	11-14-1989	-29.3
	12-19-1989	-28.3
	01-23-1990	-32.9
	02-12-1990	-33.1
	03-05-1990	-33.7
	04-02-1990	-33.4
	06-04-1990	-32.6
	07-03-1990	-29.6
	08-03-1990	-27.7
	09-05-1990	-27.2
(D-8-2)16dbb-2	09-02-1964	-5.0
	03-04-1991	-4.2
(D-8-2)17ada-1	09-03-1964	-6.3
	03-01-1991	-5.4
(D-8-2)17ccc-2	04-03-1964	-20.6
	05-19-1964	-19.7
	07-23-1964	-17.3
	09-03-1964	-15.4
	10-08-1964	-18.9
	03-08-1965	-20.8
	06-24-1965	-17.4
	08-17-1989	-8.5
(D-8-2)19add-1	09-03-1964	-13.8
	03-01-1991	-12.6
(D-8-2)20cad-2	03-28-1967	-10.7
	03-01-1991	-2.7
(D-8-2)21aaa-1	03-03-1937	-25.6
	09-14-1964	-20.0
	08-28-1989	-6.8
(D-8-2)21ddd-1	04-02-1964	-18.4
	05-18-1964	-17.5
	09-15-1964	-14.8
	03-24-1965	-18.5
	06-24-1965	-19.2
	10-02-1989	-12.5
(D-8-2)22cdc-1	09-15-1964	-15.2
	07-19-1989	-15.1
	03-04-1991	-15.4
(D-8-2)22cdc-2	09-15-1964	-11.4
	07-19-1989	-7.8
	03-04-1991	-10.9
(D-8-2)24bdc-2	03-25-1963	-12.0
	04-08-1964	-9.7
	05-20-1964	-9.3
	09-17-1964	-3.7
	03-17-1965	-11.4
	06-24-1965	-6.6
	08-17-1989	-1.5
(D-8-2)25dac-3	08-15-1961	30.00
	03-19-1970	28.17
	03-17-1971	29.88
	10-12-1971	30.14
	03-06-1972	31.02
	03-08-1973	30.90
	03-11-1974	26.24
	03-07-1975	26.80
	03-05-1976	26.13
	03-08-1977	29.54
	03-09-1978	34.48
	03-15-1979	32.06
	03-05-1980	34.40
	03-03-1981	30.20
	03-02-1982	31.24
	03-03-1983	24.24
	03-12-1984	16.51
	03-05-1985	14.38
	03-10-1986	19.95
	03-02-1987	22.74
	03-02-1988	28.72
	11-02-1988	35.15
	12-14-1988	33.21
	01-17-1989	32.76
	02-23-1989	33.85
	03-03-1989	33.51
	04-18-1989	35.13
	05-15-1989	35.77
(D-8-2)25dac-3 Continued	06-20-1989	37.27
	07-17-1989	40.07
	08-16-1989	41.51
	09-19-1989	40.18
	10-24-1989	39.10
	11-13-1989	37.20
	12-19-1989	35.89
	01-25-1990	35.60
	02-13-1990	35.32
	03-06-1990	35.44
	04-09-1990	36.38
	05-08-1990	38.29
	06-04-1990	38.79
	07-03-1990	41.87
	08-02-1990	43.70
	09-04-1990	43.56
	10-22-1990	40.45
	11-19-1990	39.15
	12-18-1990	38.65
	01-23-1991	38.88
	03-05-1991	38.42
	09-12-1991	43.76
	03-12-1992	37.47
(D-8-2)26aad-3	03-25-1964	38.1
	05-22-1964	37.2
	09-17-1964	43.9
	10-14-1964	42.1
	03-22-1965	39.9
	07-01-1965	39.8
	01-31-1991	35.80
	03-06-1991	35.45
(D-8-2)26abb-3	09-23-1964	-2.9
	03-04-1991	-3.9
(D-8-2)27acd-1	09-23-1964	-2.5
	02-20-1991	-5.2
	03-05-1991	-5.2
(D-8-2)28cbd-3	11-04-1944	-4
	09-25-1964	-5.7
	07-31-1989	-6.6
(D-8-2)28cca-2	09-25-1964	-1.0
	03-01-1991	-4.1
(D-8-2)29aaa-7	09-27-1957	-12.0
	09-25-1964	-11.9
	11-02-1964	-12.7
	12-03-1964	-12.8

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-2)29aaa-7 Continued	01-05-1965	-13.1
	02-02-1965	-13.8
	03-01-1965	-14.2
	04-05-1965	-14.1
	05-03-1965	-13.2
	06-07-1965	-12.0
	10-21-1965	-14.8
	12-30-1965	-16.2
	03-25-1966	-14.2
	04-13-1966	-14.5
	08-23-1966	-12.1
	03-24-1967	-14.9
	03-19-1968	-16.3
	03-11-1969	-16.1
	03-24-1970	-16.4
	03-18-1971	-16.1
	03-10-1972	-16.0
	03-07-1973	-14.0
	03-11-1974	-16.0
	03-07-1975	-14.0
	03-05-1976	-12.1
	03-08-1977	-11.6
	03-09-1978	-9.4
	03-15-1979	-11.2
	03-05-1980	-7.8
	03-03-1981	-9.1
	03-02-1982	-8.7
	03-03-1983	-11.0
	03-09-1984	-10.6
	03-05-1985	-10.8
	03-10-1986	-10.6
	03-04-1987	-9.2
	03-02-1988	-7.3
	03-10-1989	-7.9
	03-06-1990	-7.5
	03-05-1991	-6.9
	03-12-1992	-6.6
(D-8-2)29bcd-2	04-06-1964	-24.0
	05-19-1964	-24.4
	09-25-1964	-22.7
	10-08-1964	-22.9
	03-08-1965	-24.4
	06-24-1965	-23.7
	08-17-1989	-19.6
(D-8-2)29cab-1	09-25-1964	-25.3
	08-17-1989	-22.0
	03-04-1991	-26.4
(D-8-2)31cbb-1	09-28-1964	-12.5
	08-01-1989	-14.4
	08-28-1989	-14.8
(D-8-2)31cdb-1	08-04-1964	-6.3
	09-01-1964	-5.8
	10-01-1964	-5.8
	11-02-1964	-6.5
	12-03-1964	-6.5
	01-05-1965	-7.2
	02-02-1965	-7.2
	03-01-1965	-7.7
	04-05-1965	-7.8
	05-03-1965	-8.0
	06-07-1965	-7.4
	07-02-1965	-7.9
	10-21-1965	-8.9
	12-29-1965	-9.5
	03-25-1966	-8.5
	08-24-1966	-6.8
	12-20-1966	-7.2
	03-24-1967	-8.8
	03-20-1968	-8.2
	03-21-1969	-8.4
	03-24-1970	-15.3
	08-18-1971	-13.3
	03-11-1972	-15.4
	03-08-1973	-14.6
	03-11-1974	-12.9
	03-10-1975	-10.9
	03-08-1976	-8.3
	08-09-1989	-5.6
	04-09-1990	-13.0
	05-08-1990	-7.2
	06-05-1990	-5.6
	07-03-1990	-5.6
	08-03-1990	-5.6
	09-05-1990	-5.0
	10-18-1990	-7.1
	11-19-1990	-14.3
	12-17-1990	-14.2
	01-24-1991	-14.3
	03-07-1991	-15.0
	09-10-1991	-5.9
	03-12-1992	-14.8
(D-8-2)31cdb-2	09-27-1968	-18
	03-12-1970	-31.7
	03-18-1971	-31.3
	03-11-1972	-29.4
	03-08-1973	-28.4
	03-11-1974	-30.2
	03-10-1975	-29.8
	03-08-1976	-30.7
	11-14-1989	-30.0
(D-8-2)31cdb-2 Continued	01-23-1990	-29.7
	03-06-1990	-29.9
	11-19-1990	-28.9
	12-17-1990	-28.9
	01-24-1991	-28.8
	03-07-1991	-30.2
	03-12-1992	-28.8
(D-8-2)34acd-1	06-20-1946	-3.0
	09-28-1964	-3.7
	07-31-1989	-4.4
	03-05-1991	-7.4
(D-8-2)34dda-1	09-29-1964	-12.4
	11-03-1964	-13.3
	12-04-1964	-13.9
	01-05-1965	-14.6
	02-02-1965	-14.5
	03-01-1965	-14.9
	04-05-1965	-14.7
	05-03-1965	-14.5
	06-07-1965	-14.2
	07-02-1965	-13.6
	10-20-1965	-15.0
	12-29-1965	-15.0
	03-25-1966	-14.3
	04-18-1966	-14.8
	08-23-1966	-10.9
	03-24-1967	-15.0
	03-20-1968	-15.8
	03-17-1969	-17.1
	03-24-1970	-18.7
	03-18-1971	-17.4
	03-10-1972	-17.3
	03-08-1973	-18.0
	03-11-1974	-18.0
	03-07-1975	-18.1
	03-05-1976	-16.8
	03-08-1977	-13.8
	03-15-1979	-14.9
	03-05-1980	-13.7
	03-03-1981	-15.5
	03-02-1982	-15.7
	03-03-1983	-16.2
	03-12-1984	-17.6
	03-05-1985	-18.9
	03-10-1986	-17.7
	03-04-1987	-15.8
	12-13-1988	-9.8
	01-26-1989	-13.2
	03-01-1989	-13.4

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-2)34dda-1 Continued	04-18-1989	-9.9
	05-15-1989	-9.0
	06-20-1989	-8.3
	07-18-1989	-6.5
	08-16-1989	-5.9
	09-19-1989	-6.5
	10-26-1989	-6.5
	11-14-1989	-8.1
	12-19-1989	-8.4
	02-13-1990	-10.5
	03-09-1990	-11.0
(D-8-2)36dbd-3	09-29-1964	6.9
	02-06-1991	9.6
	03-06-1991	9.1
((D-8-3)5bca-1	11-04-1964	-14.5
	09-14-1989	-7.0
	03-04-1991	-9.7
(D-8-3)7abc-1	08-03-1989	-16.0
	03-04-1991	-23.5
(D-8-3)8abd-1	03-26-1964	6.41
	05-13-1964	6.40
	10-14-1964	10.5
	03-05-1965	6.3
	06-30-1965	8.6
	03-19-1967	6.15
	03-19-1968	6.05
	03-08-1969	4.56
	03-19-1970	3.83
	03-07-1971	4.47
	03-08-1973	2.95
	03-11-1974	2.95
	03-10-1975	5.43
	03-05-1976	3.39
	03-09-1977	4.46
	03-09-1978	5.60
	03-15-1979	4.34
	03-06-1980	4.45
	03-02-1981	3.17
	03-02-1982	3.67
	03-03-1983	.65
	03-09-1984	flowing
	03-04-1985	flowing
	03-10-1986	flowing
	03-04-1987	flowing
	03-02-1988	2.32
	03-02-1989	3.98
	04-19-1989	4.94
(D-8-3)8abd-1 Continued	05-15-1989	7.00
	06-22-1989	12.59
	07-17-1989	10.14
	08-16-1989	12.97
	09-19-1989	12.21
	10-24-1989	11.25
	11-13-1989	7.23
	12-19-1989	5.23
	01-23-1990	4.77
	02-13-1990	4.46
	03-06-1990	4.31
	04-09-1990	5.37
	05-08-1990	8.68
	06-04-1990	10.02
	07-02-1990	13.18
	08-02-1990	14.05
	09-04-1990	14.05
	10-16-1990	8.96
	11-19-1990	7.30
	12-17-1990	6.73
	01-23-1991	6.55
	03-04-1991	6.14
	03-13-1992	5.35
(D-8-3)11caa-1	06-19-1989	180.39
	07-19-1989	182.5
	09-19-1989	184.50
	11-13-1989	182.60
	01-23-1990	181.19
	02-14-1990	181.39
	03-05-1990	181.67
	05-08-1990	182.65
	07-02-1990	185.08
	10-22-1990	187.76
	12-17-1990	185.67
	03-05-1991	185.60
(D-8-3)11ccc-1	06-08-1965	138.13
	07-02-1965	136.42
	03-27-1967	143.50
	02-04-1991	137.00
	03-06-1991	140.00
(D-8-3)11ccc-2	01-30-1991	45.05
	03-07-1991	46.16
(D-8-3)14acc-1	08-19-1963	165.30
	04-01-1964	171.0
	05-12-1964	171.4
	10-14-1964	171.1
	03-19-1965	169.7
	06-30-1965	167.0
(D-8-3)14acc-1 Continued	10-20-1965	165.1
	12-28-1965	165.62
	03-23-1966	168.00
	04-13-1966	168.82
	08-25-1966	175.52
	02-21-1967	172.56
	03-27-1967	172.34
	12-15-1988	170.76
	01-17-1989	169.82
	02-23-1989	170.53
	04-18-1989	171.48
	05-15-1989	171.47
	06-19-1989	172.27
	08-24-1989	175.46
	10-24-1989	174.41
	01-23-1990	172.18
	03-06-1990	172.39
	04-09-1990	172.86
	05-31-1990	175.23
	08-02-1990	179.75
	09-05-1990	180.70
	10-22-1990	178.84
	11-19-1990	177.49
	01-23-1991	177.36
	03-05-1991	177.05
	09-13-1991	178.60
	03-13-1992	175.37
(D-8-3)14bab-1	10-09-1989	146.45
	10-31-1989	145.93
	11-24-1989	145.02
	12-22-1989	144.85
(D-8-3)17ada-1	04-13-1965	23.60
	02-25-1991	24.11
	03-07-1991	24.43
(D-8-3)17cdc-2	03-23-1964	143.70
	03-05-1991	142.22
(D-8-3)18aaa-3	03-07-1991	-2.1
(D-8-3)19ccd-1	04-13-1965	-2.7
	02-26-1991	-6.7
	03-04-1991	-6.4
[1](D-8-3)22cbd-3	01-08-1962	180
	02-13-1962	175.5
	03-14-1962	175.4
	04-11-1962	175.4
	04-03-1964	176.1
	05-12-1964	176.1

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-3)22cbd-3 Continued	10-14-1964	176.3
	12-04-1964	175.7
	03-19-1965	173.9
	06-30-1965	172.1
	03-06-1991	179.88
(D-8-3)26bcd-1	03-30-1989	175.64
	06-28-1989	177.89
	07-31-1989	178.22
	08-30-1989	178.91
	09-29-1989	179.47
	10-31-1989	179.91
	11-24-1989	180.54
	12-22-1989	180.91
	03-08-1991	189.04
(D-8-3)26cbd-1	07-31-1989	222.45
	08-30-1989	223.02
	09-29-1989	223.68
	10-31-1989	223.88
	11-24-1989	224.29
	12-22-1989	224.77
	03-08-1991	231.16
(D-8-3)26cbd-2	03-29-1989	34.72
	06-29-1989	36.69
	07-31-1989	36.96
	08-30-1989	37.22
	09-29-1989	37.46
	10-31-1989	37.36
	11-24-1989	37.02
	12-21-1989	36.58
	03-08-1991	36.13
(D-8-3)26cca-2	03-29-1989	20.43
	06-29-1989	21.32
	07-31-1989	21.67
	08-30-1989	22.06
	09-28-1989	22.49
	10-31-1989	22.77
	11-24-1989	22.72
	12-21-1989	22.70
	03-08-1991	21.86
(D-8-3)27adc-1	10-10-1989	90.13
	10-31-1989	90.62
	11-24-1989	91.05
	12-22-1989	91.34
	03-08-1991	96.57
(D-8-3)27adc-2	03-30-1989	156.15
	06-28-1989	158.59
(D-8-3)27adc-2 Continued	07-31-1989	159.41
	08-30-1989	160.15
	09-29-1989	160.71
	10-31-1989	160.58
	11-24-1989	160.32
	12-26-1989	160.17
	03-08-1991	165.40
(D-8-3)27bad-1	10-31-1989	151.52
	11-24-1989	149.61
	12-22-1989	148.76
	03-08-1991	149.39
(D-8-3)27bad-2	01-05-1990	180.29
	03-08-1991	185.36
(D-8-3)30dba-1	05-24-1989	114.46
	03-06-1991	113.73
(D-8-3)33cac-1	10-15-1964	58.00
	03-07-1991	62.41
(D-8-3)34bab-1	11-13-1961	153.50
	12-06-1961	153.50
	01-22-1962	153.40
	02-14-1962	154.20
	03-14-1962	154.50
	04-11-1962	154.50
	03-27-1964	161.20
	04-22-1964	160.68
	05-21-1964	160.70
	07-23-1964	164.20
	10-14-1964	163.10
	12-04-1964	161.29
	01-05-1965	160.36
	02-01-1965	160.09
	03-03-1965	159.44
	04-06-1965	159.05
	05-03-1965	158.81
	06-08-1965	157.86
	07-02-1965	158.08
	10-20-1965	155.82
	12-29-1965	154.05
	01-25-1966	154.37
	02-15-1966	154.38
	03-10-1966	154.31
	04-05-1966	154.83
	05-05-1966	155.35
	06-05-1966	155.70
	07-05-1966	163.48
	08-05-1966	161.58
	09-10-1966	162.35
(D-8-3)34bab-1 Continued	10-05-1966	161.44
	11-15-1966	159.44
	12-15-1966	158.52
	01-10-1967	158.48
	02-05-1967	158.11
	03-05-1967	158.41
	04-05-1967	158.01
	05-05-1967	158.28
	07-10-1967	158.63
	08-05-1967	159.07
	09-05-1967	159.03
	10-05-1967	157.82
	11-05-1967	156.91
	12-05-1967	156.15
	01-05-1968	155.80
	02-05-1968	155.85
	03-05-1968	155.48
	04-05-1968	155.60
	05-05-1968	155.30
	06-05-1968	154.67
	07-05-1968	157.65
	08-05-1968	156.25
	09-05-1968	154.85
	10-05-1968	153.38
	11-05-1968	152.72
	12-05-1968	151.89
	01-05-1969	151.51
	02-05-1969	151.10
	03-05-1969	151.01
	04-05-1969	150.64
	05-05-1969	150.02
	06-05-1969	149.80
	07-05-1969	148.80
	08-05-1969	150.00
	09-05-1969	149.00
	10-05-1969	148.52
	11-05-1969	147.21
	12-20-1969	147.19
	01-05-1970	147.22
	02-05-1970	147.40
	03-05-1970	147.57
	04-05-1970	148.28
	05-05-1970	148.69
	06-05-1970	149.30
	07-05-1970	149.19
	08-05-1970	150.38
	09-05-1970	155.05
	10-05-1970	150.50
	11-05-1970	150.06
	12-05-1970	150.09
	01-05-1971	149.80
	02-05-1971	149.57

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-3)34bab-1 Continued	03-05-1971	149.57
	04-05-1971	150.83
	05-15-1971	150.15
	06-05-1971	150.38
	07-05-1971	152.04
	08-05-1971	153.30
	09-05-1971	152.53
	10-05-1971	150.94
	11-05-1971	149.05
	12-05-1971	148.58
	01-05-1972	148.52
	02-05-1972	148.54
	03-05-1972	149.41
	04-05-1972	148.88
	05-05-1972	149.14
	06-05-1972	151.38
	07-05-1972	153.36
	08-05-1972	154.98
	09-05-1972	153.72
	10-05-1972	153.11
	11-05-1972	151.58
	12-05-1972	150.88
	01-05-1973	150.85
	02-05-1973	150.70
	03-05-1973	150.37
	04-05-1973	150.47
	05-05-1973	150.00
	06-05-1973	150.76
	07-05-1973	151.85
	08-05-1973	150.63
	09-05-1973	150.51
	10-05-1973	148.62
	11-05-1973	147.61
	12-05-1973	147.02
	01-05-1974	146.48
	02-05-1974	146.10
	03-05-1974	146.03
	04-05-1974	146.11
	05-05-1974	146.09
	06-05-1974	146.94
	07-05-1974	147.83
	08-05-1974	149.16
	09-05-1974	148.78
	10-05-1974	147.84
	11-05-1974	146.40
	12-05-1974	145.28
	01-05-1975	144.76
	02-05-1975	144.67
	03-05-1975	144.55
	04-05-1975	145.08
	05-05-1975	145.26
	06-05-1975	144.94
(D-8-3)34bab-1 Continued	07-05-1975	144.45
	08-05-1975	144.65
	09-05-1975	145.42
	10-05-1975	143.30
	11-05-1975	142.37
	12-05-1975	141.11
	01-05-1976	141.94
	02-05-1976	141.69
	03-05-1976	142.31
	04-05-1976	142.25
	05-05-1976	142.59
	06-05-1976	145.20
	07-05-1976	146.62
	08-05-1976	148.12
	09-05-1976	149.93
	10-05-1976	148.15
	11-05-1976	146.60
	12-05-1976	145.90
	01-05-1977	145.90
	02-05-1977	145.91
	03-05-1977	146.18
	04-05-1977	145.74
	05-05-1977	147.30
	06-05-1977	148.41
	07-05-1977	154.47
	08-05-1977	152.67
	09-05-1977	152.91
	10-05-1977	153.01
	11-05-1977	151.45
	12-05-1977	151.00
	01-05-1978	150.73
	02-05-1978	150.48
	03-05-1978	150.34
	04-05-1978	150.77
	05-05-1978	150.21
	06-05-1978	150.08
	07-05-1978	152.68
	08-05-1978	152.83
	09-05-1978	152.42
	10-05-1978	149.70
	11-05-1978	148.51
	12-05-1978	147.77
	01-05-1979	147.85
	02-05-1979	147.77
	03-05-1979	148.05
	04-05-1979	147.98
	05-05-1979	147.93
	06-05-1979	149.00
	07-05-1979	150.87
	08-05-1979	151.28
	09-05-1979	149.43
	10-05-1979	149.07
(D-8-3)34bab-1 Continued	11-05-1979	147.85
	12-05-1979	147.10
	01-05-1980	146.77
	02-05-1980	146.69
	03-05-1980	146.59
	04-05-1980	146.73
	05-05-1980	146.09
	06-05-1980	146.02
	07-05-1980	146.02
	08-05-1980	146.44
	09-05-1980	145.45
	10-05-1980	144.37
	11-05-1980	143.31
	12-05-1980	143.16
	01-05-1981	143.42
	02-05-1981	143.84
	03-05-1981	144.21
	04-05-1981	144.83
	05-05-1981	145.23
	06-05-1981	145.24
	07-05-1981	146.96
	08-05-1981	149.56
	09-05-1981	148.34
	10-05-1981	147.70
	11-05-1981	146.33
	12-05-1981	146.15
	01-05-1982	146.05
	02-05-1982	146.51
	03-05-1982	146.53
	04-05-1982	146.56
	05-05-1982	146.09
	06-05-1982	144.62
	07-05-1982	144.45
	08-05-1982	143.79
	09-05-1982	143.21
	03-10-1983	139.47
	03-04-1985	124.22
	03-10-1986	130.40
	03-02-1987	126.81
	03-02-1988	135.79
	11-02-1988	143.39
	12-14-1988	141.98
	01-17-1989	142.16
	02-23-1989	143.09
	03-03-1989	142.99
	04-18-1989	144.26
	05-15-1989	144.91
	06-19-1989	145.52
	07-19-1989	149.10
	08-16-1989	148.64
	09-19-1989	148.07
	10-24-1989	147.02

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-8-3)34bab-1 Continued	11-13-1989	145.84
	12-19-1989	143.98
	01-25-1990	142.24
	02-14-1990	141.39
	03-06-1990	141.07
	04-09-1990	140.99
	07-02-1990	146.40
	08-03-1990	147.93
	09-05-1990	147.11
	10-22-1990	146.09
	11-19-1990	144.99
	12-17-1990	144.28
	01-22-1991	143.44
	03-06-1991	142.75
	09-10-1991	147.47
	03-19-1992	144.98
(D-8-3)34bbb-1	06-02-1989	72.52
	07-19-1989	75.13
	09-18-1989	74.93
	10-24-1989	74.07
	11-13-1989	73.12
	12-19-1989	71.73
	01-25-1990	70.32
	02-14-1990	69.66
	03-06-1990	69.41
	04-09-1990	69.25
	05-10-1990	69.98
	06-04-1990	70.73
	07-02-1990	72.81
	08-02-1990	74.18
	09-05-1990	74.38
	10-22-1990	73.52
	11-19-1990	72.55
	12-17-1990	72.01
	01-23-1991	71.42
	03-06-1991	70.87
	09-12-1991	74.43
	03-13-1992	72.38
(D-9-1)11acc-2	06-20-1989	69.74
	03-06-1991	77.79
(D-9-1)11baa-1	01-23-1989	59.93
	06-20-1989	58.98
	09-18-1989	57.05
	11-14-1989	58.17
	02-14-1990	60.33
	03-06-1990	60.72
	04-09-1990	61.28
	05-08-1990	61.77
	06-04-1990	61.89
(D-9-1)11baa-1 Continued	08-02-1990	59.77
	09-05-1990	58.59
	10-18-1990	58.83
	11-19-1990	59.68
	12-17-1990	60.48
	01-23-1991	61.31
	03-06-1991	62.10
(D-9-1)14aad-1	01-06-1965	60.02
	02-01-1965	59.77
	03-02-1965	59.48
	04-05-1965	59.37
	05-03-1965	59.16
	06-08-1965	65.15
	07-01-1965	66.90
	10-21-1965	57.06
	12-30-1965	56.00
	03-23-1966	55.95
	04-11-1966	56.68
	12-19-1966	57.24
	03-30-1967	57.34
	03-20-1968	56.25
	03-20-1969	55.46
	03-19-1970	55.78
	03-16-1971	55.89
	03-06-1972	55.14
	03-09-1973	57.49
	03-12-1974	56.81
	03-10-1975	58.74
	03-08-1976	57.86
	03-09-1977	63.23
	03-09-1978	61.00
	03-21-1979	59.94
	03-05-1980	59.12
	03-03-1981	57.54
	03-01-1982	58.37
	03-02-1983	55.20
	03-12-1984	53.22
	03-04-1985	53.75
	03-11-1986	54.87
	03-02-1987	55.40
	03-01-1988	57.49
	03-03-1989	58.66
	03-06-1990	57.22
	10-18-1990	57.35
	11-19-1990	56.74
	12-17-1990	57.04
	01-23-1991	57.37
	03-06-1991	57.57
	09-10-1991	65.90
	03-12-1992	57.24
(D-9-1)14aad-2	03-14-1990	26.40
	03-21-1990	26.39
	10-18-1990	29.50
	11-19-1990	28.49
	12-17-1990	28.60
	01-23-1991	28.70
(D-9-1)14ddd-1	10-15-1964	34.70
	01-31-1991	30.58
	03-06-1991	30.60
(D-9-1)23ada-1	11-14-1961	24.20
	12-21-1961	24.50
	01-18-1962	24.70
	03-05-1962	24.80
	04-03-1962	24.80
	05-15-1962	25.20
	06-05-1962	24.90
	09-10-1962	27.30
	10-18-1962	25.40
	11-15-1962	24.20
	12-28-1962	23.10
	01-30-1963	22.50
	02-26-1963	22.10
	03-22-1963	22.50
	03-26-1964	27.25
	05-15-1964	26.90
	06-01-1964	27.2
	10-12-1964	28.30
	12-04-1964	26.77
	01-06-1965	25.97
	02-01-1965	25.56
	04-05-1965	24.68
	05-03-1965	24.45
	10-21-1965	22.05
	12-30-1965	20.27
	03-23-1966	19.49
	04-11-1966	19.34
	04-12-1966	19.57
	08-24-1966	26.03
	12-19-1966	22.08
	03-25-1967	22.02
	03-20-1968	16.77
	03-18-1969	12.20
	03-19-1970	11.85
	03-16-1971	12.30
	03-06-1972	11.87
	03-09-1973	18.12
	03-12-1974	9.28
	03-10-1975	15.09
	03-08-1976	11.45
	03-09-1977	17.49

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-9-1)23ada-1 Continued	03-09-1978	24.39
	03-15-1979	17.58
	03-05-1980	16.75
	03-03-1981	10.78
	03-01-1982	15.76
	03-02-1983	5.88
	03-12-1984	2.70
	03-04-1985	3.59
	03-11-1986	7.35
	03-02-1987	6.63
	03-01-1988	11.58
	03-03-1989	15.53
	03-06-1990	19.29
	03-06-1991	23.04
	03-12-1992	21.60
(D-9-1)23daa-1	10-14-1964	44.80
	03-06-1991	39.71
[1](D-9-1)24acb-1	10-14-1964	7.20
	03-08-1991	3.41
(D-9-1)25ada-1	12-02-1937	-14.4
	12-21-1937	-13.6
	02-25-1938	-11.6
	04-06-1938	-10.9
	06-02-1938	-10.4
	08-26-1938	-13.7
	10-09-1938	-13.4
	12-23-1938	-14.3
	03-17-1939	-13.4
	04-14-1939	-12.8
	06-19-1939	-10.5
	08-25-1939	-10.5
	10-13-1939	-10.7
	01-04-1940	-10.8
	07-20-1989	-12.4
	03-07-1991	-7.6
(D-9-1)25ada-3	04-14-1964	-5.7
	05-27-1964	-5.4
	07-09-1964	-6.5
	08-03-1964	-7.4
	08-31-1964	-6.4
	10-01-1964	-5.7
	11-03-1964	-6.4
	12-04-1964	-7.0
	01-06-1965	-7.3
	02-01-1965	-8.0
	03-02-1965	-8.0
	04-05-1965	-7.9
	05-03-1965	-8.1
(D-9-1)25ada-3 Continued	06-08-1965	-9.0
	07-01-1965	-10.7
	10-21-1965	-10.8
	12-30-1965	-12.3
	03-28-1966	-10.2
	08-24-1966	-7.7
	03-28-1967	-8.0
	03-20-1968	-10.6
	03-18-1969	-13.7
	03-24-1970	-14.4
	03-18-1971	-14.8
	03-11-1972	-15.0
	07-20-1989	-12.8
(D-9-1)26aab-1	11-14-1961	63.50
	12-21-1961	63.90
	01-18-1962	63.70
	03-05-1962	64.20
	04-03-1962	64.40
	06-05-1962	65.60
	09-10-1962	67.30
	10-18-1962	65.10
	11-15-1962	64.00
	12-28-1962	62.30
	01-30-1963	61.70
	02-26-1963	61.30
	03-22-1963	61.50
	05-15-1964	66.70
	10-12-1964	68.70
	12-04-1964	66.60
	01-06-1965	65.49
	02-01-1965	65.14
	03-02-1965	64.53
	04-05-1965	63.81
	05-03-1965	63.77
	07-01-1965	65.62
	10-21-1965	61.21
	12-30-1965	58.80
	03-23-1966	57.86
	04-11-1966	57.82
	12-19-1966	61.95
	01-18-1967	61.55
	02-15-1967	61.33
	03-18-1967	61.02
	03-20-1968	54.58
	03-18-1969	49.00
	03-19-1970	48.37
	03-16-1971	48.80
	03-06-1972	47.81
	03-09-1973	56.45
	03-12-1974	44.80
	03-10-1975	52.02
(D-9-1)26aab-1 Continued	03-08-1976	47.20
	03-09-1977	54.93
	03-09-1978	63.60
	03-15-1979	55.58
	03-05-1980	54.70
	03-03-1981	46.37
	03-01-1982	53.49
	03-02-1983	40.78
	03-12-1984	33.38
	03-04-1985	33.28
	03-11-1986	40.39
	03-02-1987	38.82
	03-01-1988	47.45
	11-22-1988	51.28
	12-14-1988	51.42
	01-23-1989	52.02
	02-24-1989	52.36
	03-03-1989	52.53
	04-19-1989	52.82
	05-16-1989	53.30
	06-20-1989	54.91
	07-17-1989	56.22
	08-18-1989	57.19
	09-18-1989	58.46
	10-25-1989	56.89
	11-14-1989	56.93
	12-18-1989	56.85
	01-23-1990	57.06
	02-14-1990	57.01
	03-06-1990	57.21
	04-06-1990	57.28
	05-08-1990	58.41
	06-04-1990	58.64
	07-03-1990	59.92
	08-03-1990	60.43
	09-05-1990	61.41
	10-17-1990	62.20
	11-19-1990	61.84
	12-17-1990	61.88
	01-23-1991	61.88
	03-06-1991	61.92
	03-12-1992	60.28
(D-9-1)27aca-1	02-14-1967	230.94
	03-18-1967	231.14
	03-20-1968	230.64
	03-20-1969	229.61
	03-19-1970	229.00
	12-14-1988	228.29
	01-23-1989	226.67
	02-27-1989	230.87
	04-21-1989	227.30

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-9-1)27aca-1 Continued	05-16-1989	227.12
	06-20-1989	226.72
	07-17-1989	226.80
	08-24-1989	226.65
	10-25-1989	226.96
(D-9-1)32bbd-1	12-12-1988	13.70
	01-23-1989	14.30
	02-24-1989	14.82
	04-19-1989	15.43
	05-12-1989	15.60
	06-20-1989	15.07
	07-18-1989	14.33
	08-15-1989	13.76
	09-15-1989	13.73
	10-23-1989	12.99
	11-17-1989	13.19
	12-20-1989	13.47
	01-23-1990	13.75
	02-14-1990	13.98
	03-06-1990	14.21
	04-09-1990	14.56
	05-08-1990	14.84
	06-05-1990	15.04
	07-03-1990	15.13
	08-03-1990	15.13
	09-06-1990	15.12
	10-18-1990	15.12
	12-17-1990	15.22
	03-05-1991	15.95
	03-12-1992	14.39
(D-9-1)36acb-1	05-18-1989	97.41
	03-06-1991	102.41
(D-9-1)36bbc-1	07-09-1961	104
	10-12-1961	106.00
	11-13-1961	106.70
	12-22-1961	106.80
	01-19-1962	107.10
	03-05-1962	107.30
	04-04-1962	107.50
	05-14-1962	106.30
	06-05-1962	102.40
	07-31-1962	105.60
	10-22-1962	100.00
	11-15-1962	99.10
	12-28-1962	98.90
	01-29-1963	99.90
	02-26-1963	100.50
	05-03-1963	106.00
	06-17-1963	112.20
(D-9-1)36bbc-1 Continued	08-05-1963	112.40
	09-19-1963	113.80
	10-17-1963	110.80
	11-26-1963	108.20
	12-18-1963	107.70
	01-24-1964	107.40
	04-02-1964	106.50
	05-14-1964	107.70
	10-08-1964	111.90
	03-23-1965	102.20
	06-29-1965	125.40
	03-18-1967	103.69
	03-20-1968	96.80
	03-18-1969	93.24
	03-19-1970	92.57
	03-16-1971	90.35
	03-14-1972	91.30
	03-09-1973	97.51
	03-12-1974	87.77
	03-10-1975	92.73
	03-08-1976	90.09
	03-09-1977	95.93
	03-10-1978	104.27
	03-15-1979	96.02
	03-12-1980	96.60
	03-03-1981	89.88
	03-02-1982	96.04
	03-02-1983	84.29
	03-12-1984	76.68
	03-04-1985	76.32
	03-11-1986	84.99
	03-02-1987	82.38
	03-01-1988	91.69
	03-10-1989	95.58
	05-16-1989	96.31
	06-22-1989	95.78
	07-17-1989	97.57
	08-18-1989	99.16
	09-18-1989	100.54
	10-25-1989	98.83
	11-14-1989	98.40
	01-25-1990	98.74
	02-14-1990	98.95
	03-07-1990	99.29
	04-06-1990	99.75
	05-08-1990	100.17
	06-04-1990	103.63
	08-08-1990	111.28
	09-05-1990	106.52
	10-17-1990	103.92
	11-19-1990	102.53
	12-18-1990	102.23
(D-9-1)36bbc-1 Continued	01-23-1991	102.55
	03-06-1991	102.20
	09-12-1991	100.91
	03-12-1992	100.96
(D-9-1)36cdb-1	10-14-1964	170.10
	03-08-1991	167.64
(D-9-1)36cdd-1	03-02-1962	190.50
	04-03-1962	191.30
	05-14-1962	189.50
	06-04-1962	185.40
	07-24-1962	181.00
	10-17-1962	182.50
	11-14-1962	181.30
	12-17-1962	181.60
	01-29-1963	182.70
	02-25-1963	183.60
	03-22-1963	184.60
	05-03-1963	187.70
	06-14-1963	189.80
	08-05-1963	206.80
	09-19-1963	195.10
	10-18-1963	193.70
	11-22-1963	191.50
	12-18-1963	191.00
	01-03-1964	191.00
	01-22-1964	190.60
	03-24-1964	191.07
	05-15-1964	191.60
	10-08-1964	190.80
	12-04-1964	186.87
	01-06-1965	189.19
	02-01-1965	189.30
	03-02-1965	188.86
	04-05-1965	187.42
	05-03-1965	187.13
	06-08-1965	199.40
	10-21-1965	179.00
	12-30-1965	180.09
	03-23-1966	182.52
	12-19-1966	186.99
	03-25-1967	187.87
	03-20-1968	181.14
	03-20-1969	176.89
	03-19-1970	176.35
	03-16-1971	174.48
	03-06-1972	173.52
	03-09-1973	183.65
	03-12-1974	173.23
	03-10-1975	183.87
	03-08-1976	172.65

Table 3.—*Water levels in selected wells*—Continued

WellDate number	Water level
(D-9-1)36cdd-1	03-09-1977 178.93
Continued	03-09-1978 189.05
	03-15-1979 179.96
	03-05-1980 180.52
	03-03-1981 172.83
	03-01-1982 179.49
	03-02-1983 165.95
	03-12-1984 157.25
	03-04-1985 156.19
	03-11-1986 166.42
	03-02-1987 153.49
	03-01-1988 177.55
	11-01-1988 175.71
	12-22-1988 183.09
	01-17-1989 185.19
	02-23-1989 178.37
	03-10-1989 185.19
	05-18-1989 189.66
	03-07-1990 187.86
	03-06-1991 187.52
	03-12-1992 185.57
(D-9-2)1bcb-1	10-10-1966 -6
	04-04-1967 -9.5
	03-05-1991 -7.2
(D-9-2)2add-1	09-30-1964 -12.0
	08-17-1989 -1.6
(D-9-2)2dad-1	04-10-1967 -14.8
	03-05-1991 -.6
(D-9-2)2dad-2	11-29-1956 -16
	09-30-1964 -6.0
	03-20-1967 -15.2
	03-20-1968 -15.1
	03-17-1969 -18.4
	03-24-1970 -19.5
	03-18-1971 -19.1
	03-10-1972 -20.5
	03-08-1973 -17.4
	03-11-1974 -21.4
	03-07-1975 -21.2
	03-05-1976 -18.7
	03-08-1977 -16.2
	03-09-1978 -14.2
	03-15-1979 -14.8
	03-05-1980 -3.5
	03-03-1981 -14.3
	03-01-1982 -14.4
	03-03-1983 -19.2
	03-12-1984 -24.3

Well number	Date	Water level
(D-9-2)2dad-2	03-05-1985	-28.6
Continued	03-10-1986	-24.6
	03-02-1987	-22.9
	03-01-1988	-15.6
	03-01-1989	-14.4
	04-18-1989	-11.7
	05-15-1989	-9.8
	06-19-1989	-7.2
	07-19-1989	-3.0
	09-19-1989	-6.0
	11-13-1989	-9.2
	12-18-1989	-9.9
	01-25-1990	-10.1
	03-06-1990	-10.7
	04-09-1990	-10.6
	05-09-1990	-7.9
	06-04-1990	-6.6
	07-02-1990	-3.9
	08-02-1990	-2.9
	09-04-1990	-3.2
	10-17-1990	-6.6
	11-19-1990	-7.5
	12-17-1990	-8.5
	01-23-1991	-8.8
	03-04-1991	-9.6
	03-12-1992	-10.2
(D-9-2)3aba-4	11-03-1964	-11.30
	02-20-1991	-15.5
	03-04-1991	-15.4
(D-9-2)4cdc-1	02-10-1967	-11.70
	02-22-1991	12.90
	03-06-1991	13.00
(D-9-2)5acc-1	01-10-1967	-36.00
	08-09-1989	-26.4
	03-06-1991	-32.3
(D-9-2)5bcc-2	09-30-1964	-19.6
	08-09-1989	-14.2
(D-9-2)5bcd-1	02-25-1967	-18
	08-09-1989	-8.1
(D-9-2)5cbb-3	09-30-1964	-19.8
	08-28-1989	-17.5
	03-06-1991	-21.1
(D-9-2)5ccd-2	06-21-1990	3
	07-02-1990	3.44

Well number	Date	Water level
(D-9-2)5ddd-1	06-21-1990	5
	07-02-1990	5.27
	02-06-1991	6.35
	03-06-1991	5.96
(D-9-2)6add-4	04-01-1964	-22.9
	07-19-1989	-23.3
(D-9-2)6add-5	04-10-1963	-15.0
	07-19-1989	-31.2
(D-9-2)6ddb-1	09-30-1964	-16.8
	03-07-1991	-18.0
(D-9-2)7bdd-1	10-05-1964	15.50
	03-06-1991	20.16
(D-9-2)7cda-2	10-05-1964	7.50
	01-30-1991	8.66
	03-06-1991	8.02
(D-9-2)7dcc-1	10-05-1964	12.30
	02-22-1991	8.20
	03-06-1991	7.94
(D-9-2)9bac-1	09-18-1961	43.00
	10-12-1961	40.40
	11-14-1961	39.70
	12-27-1961	39.60
	01-19-1962	39.70
	03-06-1962	39.30
	04-04-1962	39.10
	05-15-1962	37.50
	06-11-1962	35.70
	07-02-1962	35.20
	09-11-1962	41.00
	10-22-1962	36.80
	11-19-1962	36.50
	12-28-1962	36.10
	01-30-1963	35.20
	02-27-1963	37.50
	03-26-1963	38.70
	05-03-1963	40.00
	06-17-1963	40.20
	09-20-1963	40.10
	10-17-1963	38.20
	11-26-1963	37.50
	12-20-1963	36.60
	01-15-1964	35.80
	03-19-1964	35.60
	06-25-1964	36.80
	10-01-1964	38.20

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-9-2)9bac-1 Continued	06-28-1965	34.90
	10-10-1966	36.81
	03-25-1967	38.39
	03-07-1968	35.55
	03-13-1969	34.61
	03-05-1970	33.98
	02-25-1971	33.70
	03-10-1972	34.40
	03-08-1973	35.65
	03-11-1974	32.30
	03-07-1975	31.23
	03-05-1976	32.55
	03-08-1977	33.97
	08-11-1977	63.20
	03-09-1978	35.67
	03-15-1979	35.14
	03-01-1982	33.96
	09-20-1982	32.55
	03-02-1983	30.95
	09-21-1983	27.67
	03-12-1984	27.67
	09-10-1984	26.12
	03-05-1985	27.62
	09-10-1985	28.33
	03-10-1986	28.98
	09-08-1986	28.77
	03-02-1987	30.20
	09-11-1987	29.63
	03-01-1988	35.05
	09-14-1988	32.30
	03-03-1989	34.61
	09-18-1989	33.96
	03-06-1990	36.29
	03-06-1991	37.47
	09-12-1991	36.85
	03-12-1992	37.90
(D-9-2)10dac-1	08-31-1966	-23.0
	09-20-1989	-27.5
	03-04-1991	-20.9
(D-9-2)11aaa-1	08-31-1935	-25.4
	10-08-1935	-25.6
	11-19-1935	-25.5
	12-14-1935	-25.4
	01-23-1936	-25.6
	03-05-1936	-25.3
	05-02-1936	-25.2
	06-20-1936	-26.7
	08-08-1936	-28.2
	10-03-1936	-29.2
	11-30-1936	-29.4
(D-9-2)11aaa-1 Continued	02-03-1937	-29.0
	03-03-1937	-28.5
	04-13-1937	-28.4
	06-10-1937	-27.9
	08-01-1937	-29.0
	09-23-1937	-29.1
	11-02-1937	-29.6
	12-12-1937	-29.8
	02-14-1938	-29.5
	04-06-1938	-29.2
	05-05-1938	-29.1
	06-02-1938	-29.1
	08-26-1938	-30.7
	10-29-1938	-31.8
	12-23-1938	-31.8
	03-17-1939	-32.9
	04-14-1939	-31.2
	06-19-1939	-30.8
	08-25-1939	-30.0
	10-13-1939	-30.0
	01-04-1940	-30.0
	04-12-1940	-25.2
	05-01-1940	-25.3
	06-14-1940	-28.2
	01-21-1941	-29.5
	11-14-1941	-30.0
	12-29-1941	-31.3
	01-29-1942	-31.4
	03-26-1942	-31.2
	06-27-1942	-29.8
	03-29-1943	-39.0
	12-29-1943	-38.2
	03-24-1944	-37.0
	12-27-1944	-41.4
	03-29-1945	-40.7
	12-17-1945	-43.0
	03-07-1946	-41.5
	12-17-1946	-42.3
	04-07-1947	-40.9
	12-19-1947	-39.2
	03-30-1948	-41.4
	03-17-1949	-43.7
	12-16-1949	-43.3
	03-22-1950	-42.8
	12-19-1950	-44.5
	04-04-1951	-42.7
	07-19-1951	-41.9
	12-26-1951	-41.9
	04-09-1952	-39.8
	12-16-1952	-55.3
	04-21-1953	-53.5
	12-08-1953	-50.4
(D-9-2)11aaa-1 Continued	03-24-1954	-48.0
	12-29-1954	-43.0
	04-22-1955	-40.2
	12-22-1955	-39.8
	03-30-1956	-39.4
	12-19-1956	-37.6
	04-01-1957	-36.0
	12-06-1957	-41.4
	03-18-1958	-41.7
	12-04-1958	-40.3
	03-18-1959	-46.1
	12-24-1959	-41.0
	03-23-1960	-39.8
	12-09-1960	-36.0
	01-05-1962	-34.2
	03-06-1962	-31.2
	12-06-1962	-31.3
	03-12-1963	-30.9
	08-27-1963	-27.9
	12-16-1963	-28.2
	04-09-1964	-27.1
	05-28-1964	-26.8
	07-09-1964	-26.2
	08-03-1964	-25.9
	08-31-1964	-25.8
	10-01-1964	-26.2
	11-03-1964	-26.9
	12-04-1964	-27.0
	01-05-1965	-27.5
	02-02-1965	-27.5
	03-01-1965	-28.0
	04-05-1965	-28.1
	05-03-1965	-28.2
	06-07-1965	-28.1
	07-02-1965	-28.6
	10-21-1965	-31.8
	12-29-1965	-33.2
	03-25-1966	-33.0
	08-25-1966	-33.1
	12-19-1966	-32.5
	03-25-1967	-31.4
	03-20-1968	-35.0
	10-02-1968	-36.9
	03-17-1969	-40.8
	09-03-1969	-42.1
	03-24-1970	-42.3
	09-09-1970	-40.5
	03-18-1971	-40.9
	10-06-1971	-42.6
	03-10-1972	-42.1
	09-26-1972	-40.4
	03-08-1973	-40.5

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-9-2)11aaa-1 Continued	09-06-1973	-44.5
	03-11-1974	-50.0
	03-07-1975	-50.7
	03-05-1976	-49.0
	08-16-1976	-45.5
	03-11-1977	-42.8
	08-10-1977	-37.0
	03-09-1978	-35.2
	03-15-1979	-36.7
	08-23-1979	-32.8
	03-05-1980	-36.1
	09-04-1980	-39.2
	03-03-1981	-41.0
	09-03-1981	-39.0
	03-01-1982	-39.0
	09-20-1982	-48.6
	03-03-1983	-53.8
	03-12-1984	-67.8
	09-10-1984	-74.3
	03-05-1985	-72.1
	09-10-1985	-67.3
	03-10-1986	-58.7
	09-08-1986	-59.7
	03-02-1987	-56.6
	09-11-1987	-50.9
	03-01-1988	-44.9
	09-14-1988	-39.2
	03-10-1989	-37.6
	07-19-1989	-34
	09-19-1989	-34.9
	03-06-1990	-31.6
	03-04-1991	-28.8
	09-12-1991	-26.6
	03-12-1992	-27.7
(D-9-2)11aca-3	10-06-1964	-19.3
	07-19-1989	-22.5
	03-04-1991	-22.3
(D-9-2)17ada-1	11-03-1964	112.79
	12-04-1964	113.25
	01-06-1965	113.80
	02-01-1965	114.50
	03-03-1965	114.93
	04-05-1965	115.31
	05-03-1965	115.20
	06-07-1965	112.90
	07-01-1965	113.66
	10-21-1965	108.05
	12-29-1965	109.92
	03-23-1966	111.95
	08-23-1966	115.30
(D-9-2)17ada-1 Continued	12-20-1966	112.45
	03-27-1967	113.39
	03-20-1968	110.80
	03-18-1969	109.70
	03-19-1970	110.07
	03-16-1971	110.62
	03-06-1972	115.57
	03-08-1973	111.68
	03-12-1974	109.82
	03-07-1975	110.75
	03-05-1976	111.23
	03-08-1977	112.08
	03-09-1978	114.88
	03-15-1979	112.78
	03-05-1980	112.72
	03-03-1981	110.56
	03-01-1982	110.59
	03-02-1983	106.07
	03-12-1984	105.90
	03-05-1985	106.13
	03-10-1986	108.39
	03-02-1987	108.83
	03-01-1988	113.43
	11-02-1988	112.04
	12-22-1988	111.96
	01-17-1989	112.16
	02-23-1989	112.41
	03-03-1989	112.63
	04-19-1989	113.77
	05-15-1989	116.57
	06-20-1989	116.89
	07-17-1989	117.19
	08-16-1989	116.87
	10-25-1989	113.92
	11-14-1989	113.70
	12-18-1989	113.74
	01-25-1990	114.01
	02-14-1990	114.28
	03-07-1990	114.59
	04-06-1990	115.35
	05-08-1990	117.01
	06-04-1990	117.73
	07-03-1990	119.02
	08-02-1990	118.70
	09-04-1990	119.17
	10-17-1990	117.43
	11-19-1990	116.50
	12-17-1990	116.58
	01-23-1991	117.20
	03-06-1991	117.42
	03-12-1992	118.17
(D-9-2)18aca-1	10-07-1964	17.20
	02-22-1991	17.42
	03-06-1991	17.15
(D-9-2)20ccc-1	05-09-1962	23.0
	10-17-1962	21.5
	11-15-1962	21.8
	12-17-1962	20.2
	01-29-1963	21.9
	02-26-1963	21.5
	03-22-1963	21.4
	12-24-1963	20.5
	03-01-1964	22.00
	03-24-1964	21.7
	05-21-1964	21.1
	07-24-1964	21.6
	10-09-1964	21.3
	03-23-1965	21.2
	06-28-1965	21.1
	02-15-1991	20.49
	03-05-1991	20.40
(D-9-2)22cad-1	04-20-1989	136.05
	07-10-1989	134.11
	09-18-1989	137.20
	10-25-1989	138.24
	11-13-1989	138.50
	01-25-1990	139.45
	02-14-1990	139.72
	03-06-1990	139.87
	04-06-1990	139.97
	06-04-1990	133.17
	09-05-1990	137.52
	10-17-1990	138.74
	11-19-1990	139.36
	12-18-1990	139.74
	01-23-1991	139.63
	03-06-1991	140.26
	09-12-1991	136.08
	03-12-1992	138.96
(D-9-2)24bda-1	03-02-1989	283.55
	04-20-1989	284.16
	05-15-1989	284.26
	06-19-1989	284.50
	08-18-1989	284.76
	10-25-1989	284.94
	01-25-1990	285.05
	03-07-1990	285.35
	05-09-1990	285.68
	10-22-1990	286.44
	01-23-1991	286.73
	03-04-1991	286.90

Table 3.—*Water levels in selected wells*—Continued

Well number	Date	Water level
(D-9-2)25bbc-1	05-01-1989	72.51
	03-06-1991	80.03
(D-9-2)29acd-1	06-18-1964	-12.5
	07-09-1964	-11.7
	08-03-1964	-11.6
	08-31-1964	-11.3
	10-01-1964	-11.2
	11-03-1964	-11.4
	12-04-1964	-11.8
	01-06-1965	-11.9
	02-01-1965	-12.7
	03-02-1965	-12.5
	04-05-1965	-12.6
	05-03-1965	-12.9
	06-08-1965	-12.8
	08-09-1989	-12.6
(D-9-2)30cbb-2	03-25-1967	13.25
	03-20-1968	9.00
	03-18-1969	6.46
	03-19-1970	6.04
	03-16-1971	5.05
	03-06-1972	5.02
	03-09-1973	9.44
	03-12-1974	2.52
	03-10-1975	5.90
	03-08-1976	3.93
	03-09-1977	8.02
	03-09-1978	14.10
	03-15-1979	8.04
	03-05-1980	8.11
	03-03-1981	4.08
	03-01-1982	8.00
	03-02-1983	Flowing
	03-12-1984	Flowing
	03-04-1985	Flowing
	08-03-1989	7.74
(D-9-3)5cdc-1	10-01-1964	40.98
	12-04-1964	41.17
	03-01-1965	41.23
	06-08-1965	41.29
	12-29-1965	40.12
	03-23-1966	39.56
	12-19-1966	40.19
(D-9-3)5cdc-1 Continued	02-25-1991	40.68
	03-04-1991	40.74
(D-9-3)6abb-1	03-11-1964	8.10
	02-08-1991	10.39
	03-04-1991	9.60
(D-9-3)6cbc-1	10-13-1965	80.50
	03-05-1991	86.23
(D-9-3)7aab-1	04-01-1973	80.00
	02-20-1991	91.49
	03-04-1991	91.50
(D-10-1)1cbb-1	02-13-1962	273.6
	03-02-1962	273.0
	04-03-1962	275.4
	05-14-1962	270.6
	06-04-1962	276.7
	07-03-1962	253.4
	08-06-1962	263.7
	09-10-1962	269.4
	10-17-1962	265.7
	11-14-1962	264.6
	12-17-1962	265.2
	01-29-1963	266.2
	02-25-1963	268.8
	03-22-1963	269.2
	01-07-1964	274.6
	03-24-1964	275.2
	05-15-1964	275.5
	07-27-1964	266.2
	10-09-1964	273.7
	03-23-1965	269.4
	06-28-1965	254.0
	02-21-1991	269.98
	03-07-1991	270.14
(D-10-1)17cca-1	03-19-1964	32.40
	04-15-1964	32.52
	06-01-1964	32.62
	07-09-1964	32.53
	08-03-1964	32.52
	08-31-1964	32.35
	10-01-1964	32.40
	11-03-1964	32.46
(D-10-1)17cca-1 Continued	12-02-1964	32.53
	01-06-1965	32.64
	02-02-1965	32.63
	03-02-1965	32.59
	04-07-1965	32.73
	05-04-1965	32.68
	06-09-1965	32.56
	07-01-1965	32.35
	11-02-1965	32.10
	12-30-1965	32.07
	03-25-1966	32.26
	08-22-1966	31.91
	12-19-1966	32.08
	03-08-1967	32.23
	03-21-1968	31.97
	03-20-1969	31.46
	03-20-1970	31.18
	03-15-1971	31.46
	03-03-1972	31.15
	03-09-1973	31.72
	03-12-1974	30.90
	03-10-1975	31.40
	03-08-1976	31.00
	03-09-1977	32.18
	02-14-1991	32.16
	03-05-1991	31.22

[1]Actual location is different from historic records. See footnotes, table 1.

Table 4.—*Discharge of selected wells*

Well number: See figure 1 for explanation of the numbering system for hydrologic-data sites.

Discharge: Natural flow except where noted P, pumped; flow measured except where noted e, estimated.

Well number	Date	Discharge (gallons per minute)
(C-9-1)26bda-3	11-15-39	1.0
	08-18-89	.8
	09-15-89	.8
	10-23-89	1.0
	12-20-89	1.0
(D-7-2)32dad-1	03-24-78	40
[1] (D-7-2)33dcc-1	04-03-67	33
	08-10-89	30
(D-7-2)35ccd-1	04-13-37	1.8
	06-11-37	2.0
	08-01-37	1.7
	09-23-37	1.6
	11-02-37	1.4
	12-23-37	1.9
	02-14-38	2.1
	04-06-38	2.4
	05-05-38	2.5
	06-02-38	2.5
	06-13-38	2.3
	08-25-38	1.6
	02-28-40	2.4
	04-13-40	2.0
	05-01-40	2.6
(D-7-2)35ccd-2	07-18-61	90
	07-18-61	150 P
	09-13-89	0
(D-7-2)36bbb-1	10-30-43	30
	03-17-65	60
(D-7-2)36ccb-1	10-01-61	300
	07-07-89	112
(D-7-2)36dcc-2	05-02-40	1.7
	06-01-64	.5
	07-09-64	.5
	09-01-64	2.0
	03-24-66	12
(D-7-2)36dcc-2	08-24-89	.1
	09-15-89	.1
	10-23-89	.1
	11-14-89	.1
	12-00-89	.1
	01-23-90	.1
[1] (D-7-3)29dcc-1	03-11-53	70
	08-04-64	35

Table 4.—*Discharge of selected wells*—Continued

Well number	Date	Discharge (gallons per minute)
(D-7-3)31cac-2	10-08-64	38
	11-02-64	35
	09-13-89	24
(D-7-3)33baa-6	10-07-35	12
	03-02-36	11
	05-02-36	14
	06-20-36	19
	08-08-36	19
	10-03-36	15
	12-01-36	14
	02-03-37	12
	06-11-37	19
	08-01-37	20
	09-23-37	16
	06-02-38	19
	12-23-38	15
	02-21-39	12
	03-24-39	9.6
	04-13-39	10
	04-13-40	11
	05-02-40	13
	07-09-64	7.5
	07-00-89	3.5
	11-13-89	4.4
	12-00-89	4.0
(D-7-3)33ccc-5	04-01-05	65
	07-00-89	12
	08-24-89	11
	10-26-89	11
	11-14-89	10
	12-00-89	12
	01-23-90	12
(D-8-1)13aaa-[illegible]	05-02-36	30
[illegible]	04-12-40	21
	05-01-40	25
(D-8-1)13daa-3	07-06-64	48
(D-8-1)14dad-1	05-14-66	30
	05-14-66	80 P
	01-31-67	25
(D-8-1)23bdd-1	03-00-18	3.0
	08-24-89	1.1
	09-15-89	.9
	11-14-89	.9
	12-20-89	1.0
	01-23-90	.9
(D-8-1)25aad-1	02-07-53	6.5
	07-21-64	2.0
	08-01-89	.6

Table 4.—*Discharge of selected wells*—Continued

Well number	Date	Discharge (gallons per minute)
(D-8-2)1baa-1	05-12-63	50
	08-06-64	60
[1] (D-8-2)2acc-1	06-30-61	50
	08-06-64	45
(D-8-2)2caa-1	11-12-51	40
	08-06-64	30 P
	09-21-89	.8
(D-8-2)2cda-1	08-06-64	15 P
	09-21-89	3.0
(D-8-2)2daa-1	04-12-48	80
	08-06-64	72
	08-24-89	.7
	09-15-89	.9
	10-23-89	.9
	01-23-90	1.4
(D-8-2)3aad-1	03-17-65	30
	03-17-65	30
	09-15-89	6
(D-8-2)3ccd-1	12-07-61	40
(D-8-2)4abb-1	08-20-64	35
	09-12-89	3.0
(D-8-2)4abb-2	08-20-64	.5
	09-12-89	.2
(D-8-2)4abc-1	05-23-50	35
	07-09-64	30
	09-12-89	.8
[1] (D-8-2)4bab-1	03-25-63	80
	08-20-64	75
	09-12-89	.5
(D-8-2)4cba-2	04-01-36	30
	08-24-89	4.8
	09-15-89	5
	10-23-89	5.4
	11-14-89	5.8
	12-19-89	6.0
	01-23-90	5.64
[1] (D-8-2)4cbb-1	07-06-64	36
	09-15-89	.2
(D-8-2)4dad-1	03-00-63	60
	08-00-64	70
	09-28-89	5.4
(D-8-2)7cab-1	05-07-47	35
	08-20-64	30
(D-8-2)cbd-1	04-15-62	35
	08-20-64	30
(D-8-2)9aad-1	08-24-64	35
	09-28-89	7.2
(D-8-2)10adb-1	05-31-66	80
	06-06-66	60
	09-28-89	7.5

Table 4.—*Discharge of selected wells*—Continued

Well number	Date	Discharge (gallons per minute)
(D-8-2)10bdd-1	12-00-55	40
	09-28-89	4.5
(D-8-2)12ddc-1	09-08-61	225
(D-8-2)13abc-1	08-30-61	250
	08-25-64	88
	09-28-89	2.5
(D-8-2)13bdd-1	12-20-62	175
	08-25-64	135
(D-8-2)14dcc-1	08-05-39	30
	09-02-64	10
(D-8-2)16caa-1	09-15-89	7.1
	11-14-89	7.3
	12-00-89	6.9
	01-23-90	7.6
(D-8-2)17add-5	11-04-62	12 P
(D-8-2)17add-6	06-07-50	4 P
(D-8-2)17ccc-2	10-21-59	10
	09-03-64	60
(D-8-2)17dab-2	07-02-59	5 P
(D-8-2)17ddd-1	07-13-44	6.0 P
(D-8-2)21bbb-2	06-26-56	6.0 P
(D-8-2)21ddd-1	10-15-36	45
	09-15-64	30
(D-8-2)22cdc-1	05-22-35	60 P
	07-00-89	11
(D-8-2)22cdc-2	05-17-57	100
	07-00-89	1.0
(D-8-2)23dbd-3	04-12-40	1.0
	05-01-40	1.0
	09-15-64	.5
(D-8-2)24bdc-2	03-25-63	45
	09-17-64	30
(D-8-2)28cbd-3	11-04-44	1.0
	09-25-64	1.3
	07-31-89	.2
(D-8-2)28daa-1	06-20-39	5.0
	09-25-64	1.0 P
(D-8-2)29bcb-1	12-22-66	25
	03-27-67	50
(D-8-2)29bcd-2	07-10-52	35
	09-25-64	10
(D-8-2)29cab-1	07-28-47	35
	09-25-64	63
(D-8-2)30bad-1	12-04-44	3.0
	09-28-64	1.5
(D-8-2)31bcd-1	08-04-64	38
	11-14-89	22

Table 4.—*Discharge of selected wells*—Continued

Well number	Date	Discharge (gallons per minute)
(D-8-2)31cbb-1	08-28-89	46
(D-8-2)31cda-1	07-21-89	72
(D-8-2)31cdb-1	08-04-64	6.0
	10-21-65	5.5
	12-29-65	8.0
(D-8-2)31cdb-1	03-25-66	5.8
	08-24-66	5.4
	03-24-67	5.8
	08-31-67	4.6
	08-09-89	2.6
(D-8-2)31cdb-2	09-27-68	700
	07-21-89	264
(D-8-2)34acd-1	06-20-46	2.5
	09-28-64	1.3
	07-31-89	.7
(D-8-3)4caa-2	1945	30
	06-08-45	120
	08-06-64	30
(D-8-3)4caa-3	03-31-65	140
(D-8-3)4cad-1	06-18-35	300
	03-06-36	325
	05-27-64	15
(D-8-3)5bca-1	11-04-64	40
	09-14-89	1.0
(D-8-3)6ddd-1	07-07-89	47
(D-8-3)6ddd-2	10-01-64	25
	07-07-89	105
(D-8-3)7aad-1	09-02-48	140
	03-31-65	87
(D-8-3)7abc-1	06-20-72	450
(D-8-3)7aca-2	07-14-48	120
	03-31-65	125
(D-9-1)1bac-1	11-10-76	130
(D-9-1)13bdb-2	11-04-64	30
	08-04-89	18
(D-9-1)25aac-1	06-15-34	39
	10-14-64	3.0
	06-12-90	14
(D-9-1)25aad-1	05-27-64	50
	08-03-89	69
(D-9-1)25aad-2	05-27-64	10
	08-03-89	13
(D-9-1)25aca-1	1938	14
	08-30-89	1.1
(D-9-1)25ada-1	07-05-34	70
	02-25-38	36
	06-02-38	30
	07-09-64	10
	07-20-89	12

Table 4.—*Discharge of selected wells*—Continued

Well number	Date	Discharge (gallons per minute)
(D-9-1)25ada-2	07-09-64	30
	07-20-89	12
(D-9-1)25ada-3	07-09-64	15
	10-21-65	23
	12-30-65	19
	03-28-66	15
	08-24-66	12
	03-28-67	14
	07-20-89	14
(D-9-1)25ada-4	07-09-64	30
	07-20-89	22
(D-9-1)25ada-5	07-09-64	30
	07-20-89	14
(D-9-2)1bcb-1	10-10-66	300
	10-10-66	900 P
	07-00-89	44
(D-9-2)2add-1	12-00-36	45
	09-30-64	30
	08-17-89	.5
(D-9-2)2dad-2	11-29-56	35
	09-00-89	16
	11-13-89	21
	12-18-89	16
	01-25-90	17
(D-9-2)5acc-1	08-09-89	10
(D-9-2)5bcc-1	04-26-53	38
(D-9-2)5bcc-2	11-23-56	30
	09-30-64	30
	08-09-89	8.0
(D-9-2)5bcd-1	02-25-67	70
(D-9-2)5bcd-2	04-07-70	125
	08-09-89	251
(D-9-2)5bdd-2	09-23-64	6.0
(D-9-2)5bdd-4	09-11-64	220
	03-17-67	92
	01-02-69	450
(D-9-2)5cbb-3	05-11-61	25
	09-30-64	45
	08-28-89	23
(D-9-2)5ccc-1	08-04-64	30
	08-17-89	10
(D-9-2)5ddb-1	05-11-74	15
(D-9-2)5ddc-2	08-01-34	450
	10-08-35	25
	07-09-64	15
(D-9-2)6add-4	05-20-61	130
	09-11-64	100 P
	07-00-89	100

Table 4.—*Discharge of selected wells*—Continued

Well number	Date	Discharge (gallons per minute)	
(D-9-2)6add-5	04-10-63	450	
(D-9-2)6ddb-1	10-05-70	150	
(D-9-2)10dac-1	08-31-66	41	
(D-9-2)11aca-3	12-13-58	250	
(D-9-2)29acd-1	03-21-50	7	
	06-18-64	75	
	07-09-64	75	
	08-31-64	70	
	08-09-89	100	
(D-9-2)30bcb-2	07-09-64	30	
	08-03-89	15	
(D-9-2)30cbb-2	06-29-57	40	P

[1] Actual location is different from historic records. See footnotes, table 1.

Table 5.—*Chemical analyses of*

[mg/L, milligrams per liter;

Well number: See figure 1 for explanation of the numbering system for hydrologic-data sites.
Date sampled: Except R, date received by laboratory (Cordova, 1969, table 5).
Specific conductance: µS/cm, microsiemens per centimeter at 25 degrees Celsius, measured in the
Temperature: ° C, degrees Celsius.

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-8-1)20cdb-2	07-13-81	1,300	—	26.5	—	—	—	—
	07-07-89	1,340	7.7	26.0	340	76	37	130
	06-13-90	1,310	6.3	24.0	—	—	—	—
	08-19-91	1,260	7.6	25.5	—	—	—	—
(C-8-1)20cdb-3	07-30-80	1,290	—	24.0	—	—	—	—
	07-25-83	1,260	—	25.5	—	—	—	—
	07-12-89	1,350	7.7	25.0	—	—	—	—
(C-8-1)20cdb-4	07-12-89	1,340	7.7	25.0	—	—	—	—
(C-8-1)29dda-1	07-25-83	2,870	—	18.0	—	—	—	—
	08-23-89	3,550	7.9	22.5	—	—	—	—
	07-11-90	3,480	7.7	18.5	—	—	—	—
(C-8-1)35dcb-1	07-06-60	1,700	—	—	370	88	36	170
	06-15-64	1,630	—	20.5	410	88	45	170
	04-28-66	1,590	—	14.0	490	130	43	170
	08-08-90	1,840	—	19.5	450	120	36	160
(C-9-1)3ddb-1	05-04-65	1,340	7.9	14.5	270	60	29	180
	04-28-66	1,260	7.6	14.5	230	56	22	170
	07-13-81	1,300	—	15.5	—	—	—	—
	07-12-89	1,790	7.6	14.5	—	—	—	—
	08-23-89	1,400	7.6	14.5	—	—	—	—
	07-11-90	1,300	7.8	17.5	—	—	—	—
(C-9-1)4ccc-1	08-21-75	750	6.8	14.5	160	40	15	92
	08-16-76	790	7.4	14.0	170	46	14	100
	07-12-77	800	6.6	14.0	180	44	16	98
	08-24-78	900	6.8	14.0	210	54	19	100
	07-17-79	1,000	—	16.0	—	—	—	—
	08-01-79	1,100	7.7	16.0	250	62	23	110
	07-31-80	1,210	—	15.5	—	—	—	—
	09-03-80	1,200	7.6	15.0	270	66	25	130
	07-15-81	1,220	7.9	14.5	280	70	26	120

water from selected wells

—, no data; <, less than]

field.

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	—	—	—	—	—	—	—
—	—	100	210	.60	20	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
22	—	68	390	—	—	863	—
22	—	130	400	—	—	913	—
27	—	120	400	—	—	1,010	—
20	—	65	370	<.10	71	1,020	.80
—	176	95	280	—	61	810	—
15	—	98	240	—	—	712	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
8.1	148	59	110	.30	58	477	1.30
8.1	144	62	130	.30	58	512	1.60
8.0	140	59	140	.30	56	505	—
9.2	140	64	160	.30	56	558	2.60
—	—	—	—	—	—	—	—
11	130	87	210	.30	60	658	3.80
—	—	—	—	—	—	—	—
11	140	80	240	.30	60	717	4.70
8.6	—	84	240	.20	62	703	6.00

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-9-1)4ccc-1	07-07-82	1,230	—	14.0	—	—	—	—
	08-16-85	1,460	8.0	13.0	380	93	36	150
	06-30-86	1,400	—	14.0	—	—	—	—
	07-02-87	—	7.7	14.0	350	86	34	290
	06-15-88	1,390	7.5	14.0	—	—	—	—
	08-07-90	1,050	7.7	14.0	240	61	22	99
(C-9-1)4ddc-1	05-28-64	980	8.5	16.5	200	55	16	120
	06-09-64	980	8.4	16.5	210	54	18	120
	06-17-65	1,050	8.3	16.5	230	59	21	130
	04-28-66	1,070	7.6	18.5	220	55	21	130
	07-16-79	1,750	—	17.0	—	—	—	—
	07-31-80	1,800	—	16.5	—	—	—	—
	08-07-90	1,320	7.6	20.0	310	80	26	120
(C-9-1)5ddc-1	08-29-90	790	7.7	15.0	180	45	16	81
[1](C-9-1)20cdd-1	08-19-64	720	8.2	16.0	130	34	11	—
	04-27-66	730	7.5	14.0	130	34	11	110
	06-22-81	810	—	16.5	—	—	—	—
	07-28-86	800	—	16.0	—	—	—	—
	07-05-89	1,090	7.9	18.0	220	56	19	110
	06-13-90	1,080	6.9	18.5	—	—	—	—
	07-23-90	1,060	7.8	17.0	—	—	—	—
(C-9-1)20ddd-1	06-23-65	720	—	17.0	144	32	15	91
	05-09-66	740	8.0	16.5	150	37	14	90
	07-10-73	690	7.9	17.0	130	34	12	85
	07-16-79	700	—	19.0	—	—	—	—
	07-31-80	720	—	17.0	—	—	—	—
	08-07-90	710	7.8	17.5	130	34	11	88
(C-9-1)26bda-3	01-25-61	2,130	7.8	—	370	81	41	280
	04-06-61	2,030	8.1	—	330	56	45	280
	05-26-64	2,200	7.9	11.0	450	100	46	280
	07-07-89	2,320	7.4	12.5	400	81	48	270
(C-9-1)28ccb-1	04-05-63	800	—	—	191	48	17	94
	09-11-63	830	—	—	223	62	17	101
	06-09-64	940	—	18.5	219	35	20	104
	06-17-65	980	—	18.5	235	63	19	107

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	—	—	—	—	—	—	—
9.9	—	110	320	.30	60	895	9.80
—	—	—	—	—	—	—	—
8.5	—	210	300	.30	58	1,110	9.20
—	—	—	—	—	—	—	—
9.1	—	63	170	.10	60	581	3.90
15	—	78	190	—	—	549	—
14	—	74	180	—	—	551	—
14	—	100	200	—	—	609	—
17	—	95	200	—	—	598	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
15	—	59	290	.20	77	759	2.10
9.7	—	61	110	.20	67	484	1.10
—	—	73	100	—	58	—	—
8.2	—	84	100	—	—	434	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	69	150	.30	59	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
10	—	84	98	—	—	—	—
10	—	73	94	—	—	408	—
8.9	152	53	86	—	64	434	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
8.4	—	53	87	.20	67	459	1.60
34	—	110	460	—	—	1,150	—
34	—	99	470	—	—	1,110	—
37	—	150	490	—	—	1,270	—
—	—	100	530	.40	66	—	—
11	—	80	112	—	—	—	—
11	—	102	146	—	—	—	—
13	—	98	151	—	—	—	—
13	—	115	165	—	—	—	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-9-1)28ccb-1	04-27-66	960	—	14.5	243	64	20	107
	07-31-80	1,120	—	19.5	—	—	—	—
	07-15-81	1,170	7.7	18.0	300	77	25	100
	07-07-82	1,120	—	18.5	—	—	—	—
	07-17-84	1,140	7.5	18.5	280	71	24	100
	07-03-85	2,310	8.0	17.5	310	81	26	110
	06-12-86	1,120	7.6	18.5	—	—	—	—
	08-07-90	810	7.9	19.0	180	50	14	81
(C-9-1)29acc-1	05-23-63	760	8.5	—	120	29	11	110
	05-28-64	770	8.4	—	150	37	13	110
	06-18-65	760	8.5	15.0	170	38	18	100
	04-27-66	710	7.7	15.0	150	36	14	100
	07-31-80	960	—	17.0	—	—	—	—
	06-22-81	950	—	16.5	—	—	—	—
(C-9-1)29bcc-1	06-19-65	930	8.1	17.0	290	73	26	71
	05-06-66	860	7.5	17.0	350	89	32	71
	07-02-85	740	—	15.5	—	—	—	—
(C-9-1)34ccc-1	08-21-75	1,400	6.6	17.5	520	110	59	93
	07-17-79	1,550	—	17.0	—	—	—	—
	08-01-79	1,600	7.6	19.0	—	—	—	—
	09-03-80	1,700	7.1	17.5	590	130	65	100
	07-02-86	1,510	—	17.5	—	—	—	—
[1](C-9-1)34acd-1	10-09-62	1,120	8.2	—	350	60	48	78
	04-27-66	1,050	7.8	11.5	410	82	49	80
	08-17-72	1,200	7.7	12.0	390	77	48	77
(C-9-1)34ddc-1	04-27-66	930	7.6	13.0	330	66	40	69
	10-12-71	1,050	7.5	12.5	330	63	42	69
	06-04-91	1,040	7.5	15.0	320	61	41	67
(C-10-1)3ddb-1	10-09-62	2,140	—	—	400	61	60	320
	08-05-70	2,760	—	13.0	560	91	81	—
	08-11-72	4,010	—	14.0	910	150	130	560
	09-09-74	1,560	—	19.5	530	120	57	100
(C-10-1)4bbb-1	11-01-62	690	—	—	107	30	10	98
	04-03-63	670	8.3	—	110	26	10	98
	09-11-63	800	8.1	—	150	36	14	110

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
15	—	118	166	—	—	—	—
—	—	—	—	—	—	—	—
12	—	110	210	.20	70	695	4.30
—	—	—	—	—	—	—	—
14	—	110	210	.30	65	694	5.20
12	—	110	220	.30	68	728	5.80
—	—	—	—	—	—	—	—
11	—	64	100	.40	74	474	1.60
6.3	—	78	100	—	—	426	—
7.0	—	96	100	—	—	446	—
7.0	—	110	110	—	—	462	—
8.6	—	82	110	—	—	439	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
9.0	—	150	170	—	—	533	—
9.0	—	170	170	—	—	603	—
—	—	—	—	—	—	—	—
14	199	100	300	.20	65	864	.75
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
14	190	120	360	.30	65	983	3.20
—	—	—	—	—	—	—	—
11	—	84	240	—	—	583	—
12	—	99	240	—	—	654	—
11	143	96	250	—	60	705	—
12	—	33	230	—	—	531	—
9.2	144	35	220	—	—	525	—
8.4	—	25	220	.50	65	572	—
3.5	—	200	400	—	—	1,240	—
30	351	310	550	—	35	1,680	—
6.3	405	620	830	—	51	2,590	—
17	195	100	320	.20	63	898	.73
9.3	—	42	82	—	—	—	—
9.3	—	44	83	—	—	371	—
10	—	70	130	—	—	448	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-10-1)4bbb-1	06-16-65	1,330	8.1	18.5	430	100	42	100
	04-27-66	1,340	7.4	15.5	420	100	41	110
	07-10-73	1,320	7.7	19.0	380	92	37	110
	08-03-73	1,230	—	18.5	—	—	—	—
	09-05-74	1,350	—	19.0	—	—	—	—
	08-30-76	1,160	—	19.5	—	—	—	—
	08-25-78	1,100	—	20.0	—	—	—	—
	08-01-80	1,200	—	19.5	—	—	—	—
	08-07-90	2,460	7.5	18.0	—	—	—	—
(C-10-1)4cbb-1	04-05-62	1,770	8.5	—	440	110	39	180
	08-06-62	1,440	8.2	—	370	94	34	140
	09-14-62	1,390	7.5	—	400	120	25	130
	06-07-63	1,310	8.3	—	420	130	22	120
	09-11-63	1,280	7.8	—	390	100	33	110
	06-09-64	1,300	8.2	19.0	380	100	31	120
	10-02-64	1,350	—	—	447	123	34	118
	06-16-65	1,320	8.3	19.0	670	190	49	110
	04-27-66	1,330	7.5	19.5	410	100	39	110
	09-05-69	1,230	7.7	17.0	400	93	40	—
	08-05-70	1,290	7.9	18.0	420	100	39	150
	10-07-71	1,260	7.6	16.5	370	89	35	100
	08-11-72	1,110	—	18.5	—	—	—	—
	08-03-73	1,100	7.7	19.0	330	82	30	97
	09-06-74	1,150	—	19.0	—	—	—	—
	08-16-76	1,050	7.2	19.0	320	82	27	97
	07-12-77	1,000	6.5	20.0	270	68	25	92
	07-17-79	1,100	—	19.0	—	—	—	—
	08-01-79	1,150	7.9	19.0	330	83	31	95
	08-01-80	1,510	—	19.0	—	—	—	—
	09-03-80	1,500	7.6	—	480	120	43	110
	07-13-81	1,750	7.8	19.0	530	130	49	120
	07-07-82	1,900	—	19.5	—	—	—	—
	07-18-84	1,740	7.4	17.5	610	130	69	110
	07-03-85	1,830	—	18.5	—	—	—	—
	06-30-86	2,490	7.6	19.0	900	220	84	150

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
12	—	200	240	—	—	768	—
14	—	200	240	—	—	778	—
11	135	140	230	—	—	701	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
15	—	300	310	—	—	1,020	—
14	—	220	240	—	—	831	—
13	—	240	230	—	—	839	—
13	—	240	220	—	—	825	—
11	—	200	220	—	—	755	—
13	—	230	230	—	—	777	—
13	—	338	235	—	—	—	—
13	—	260	230	—	—	906	—
15	—	210	220	—	—	788	—
—	162	160	200	—	60	767	—
—	149	300	190	—	—	896	—
10	148	180	180	—	—	683	—
—	—	—	—	—	—	—	—
9.0	153	160	160	—	64	693	—
—	—	—	—	—	—	—	—
11	158	120	160	.20	60	669	3.80
9.7	160	100	150	.20	64	602	—
—	—	—	—	—	—	—	—
11	140	99	220	.20	68	706	3.30
—	—	—	—	—	—	—	—
12	140	88	360	.20	65	898	3.60
11	—	95	420	.20	68	988	3.70
—	—	—	—	—	—	—	—
13	—	140	380	.30	62	1,040	5.20
—	—	—	—	—	—	—	—
15	—	100	710	.20	67	1,440	3.50

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-10-1)4cbb-1	08-07-90	740	7.5	20.5	200	52	18	61
(C-10-1)9ccc-1	06-13-61	2,710	7.8	—	1,200	270	120	86
	09-06-62	2,670	7.7	—	1,100	250	110	99
	06-06-63	2,540	7.8	—	1,100	260	110	100
	09-24-63	2,320	7.5	—	930	210	99	94
	05-28-64	2,530	8.1	16.5	1,100	250	110	100
	08-07-64	2,280	8.0	16.5	1,000	230	110	100
	04-28-66	2,200	7.4	18.5	920	210	94	110
	08-11-72	1,920	7.3	17.0	740	170	77	100
	09-09-74	1,940	—	18.0	740	170	77	100
	07-17-79	2,000	—	18.0	—	—	—	—
	08-04-80	2,100	—	17.0	—	—	—	—
	07-25-83	2,020	—	18.0	—	—	—	—
	07-28-86	1,670	—	18.0	—	—	—	—
	07-12-89	1,980	7.3	17.5	—	—	—	—
	08-18-89	1,960	7.4	18.0	690	160	70	120
(C-10-1)10ddc-3	06-04-91	2,800	—	14.5	960	170	130	220
[1](C-10-1)15cca-1	06-04-91	3,000	7.2	15.0	710	140	88	380
(C-10-1)17aaa-1	04-27-65	770	7.5	19.5	320	84	26	30
	10-12-71	1,390	7.3	18.0	560	140	50	45
	08-17-72	1,550	7.6	20.0	630	160	57	47
	07-10-73	1,620	7.5	20.0	730	190	63	54
	09-09-74	1,780	—	20.0	730	180	69	53
	08-21-75	1,800	6.8	18.5	830	210	73	55
	08-16-76	2,120	6.9	19.5	980	250	86	58
	07-12-77	2,180	6.8	19.5	1,100	290	95	61
[1](C-10-1)25abd-1	06-06-61	1,560	8.0	—	480	110	52	130
	07-07-61	1,570	8.3	—	490	110	50	140
	08-09-61	1,540	7.9	—	490	110	50	140
	08-31-62	1,460	7.8	—	380	75	47	150
	06-01-64	1,700	8.1	17.0	410	64	61	190
	08-04-80	2,150	—	17.5	—	—	—	—
	07-15-81	2,300	—	18.5	—	—	—	—
	07-02-86	2,100	—	17.5	—	—	—	—
	07-11-90	2,090	7.2	18.5	520	110	60	230

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
11	—	38	73	.20	78	455	2.70
16	—	580	480	—	—	1,610	—
17	—	560	490	—	—	1,560	—
15	—	610	460	—	—	1,600	—
17	—	490	410	—	—	1,360	—
17	—	630	430	—	—	1,580	—
16	—	580	380	—	—	1,480	—
18	—	510	370	—	—	1,390	—
12	134	310	330	—	60	1,140	—
14	136	290	300	.20	62	1,210	25.0
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	370	310	.10	61	—	—
14	—	190	790	.30	59	1,710	—
8.7	—	370	650	.40	41	1,860	—
—	145	67	99	—	59	484	—
12	126	140	200	—	—	663	—
12	117	170	230	—	59	805	—
14	113	200	250	—	58	897	—
16	112	230	260	.10	58	1,120	43.0
14	107	330	260	.10	56	1,250	42.0
15	109	420	300	.10	57	1,460	46.0
16	98	530	310	.10	55	1,420	—
11	—	110	250	—	—	861	—
11	—	130	250	—	—	875	—
11	—	130	260	—	—	884	—
12	—	120	260	—	—	813	—
18	—	160	360	—	—	962	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
14	—	120	340	.60	51	1,120	<.10

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-10-1)25abd-1	07-31-90	2,130	7.2	18.5	—	—	—	—
(C-10-1)29cdd-1	04-14-61	1,430	7.6	—	630	110	87	71
	07-10-61	570	8.1	—	210	54	19	28
	04-04-63	480	8.4	—	150	29	20	30
	08-07-64	590	8.0	23.0	220	62	16	26
	04-28-66	580	7.6	21.0	220	58	18	26
	07-16-79	600	—	20.0	—	—	—	—
	07-10-90	780	7.5	23.0	300	78	26	27
	07-31-90	770	7.4	22.5	—	—	—	—
	08-20-91	690	6.9	22.5	—	—	—	—
(C-10-1)29ddd-1	04-04-63	3,180	7.9	—	1,000	210	130	110
	09-10-63	1,710	8.0	—	1,000	250	100	100
	07-24-64	2,710	8.0	20.0	1,100	240	110	110
	08-07-64	3,340	8.0	18.0	1,400	330	140	120
	04-28-66	3,650	7.1	17.0	1,700	410	170	130
	08-20-91	3,460	6.9	21.5	—	—	—	—
(C-10-1)31cdd-1	06-21-63	450	8.4	—	150	28	19	26
	09-26-63	600	7.9	—	180	41	19	38
	06-03-64	470	8.3	—	180	40	19	24
	10-08-64	470	8.3	19.0	180	38	20	25
	04-28-66	580	8.0	18.5	230	59	21	26
	07-16-79	750	—	18.5	—	—	—	—
	07-13-81	800	—	21.0	—	—	—	—
	07-31-90	880	7.4	18.5	—	—	—	—
(C-10-1)32ccc-1	06-06-61	690	8.1	—	260	66	22	36
	07-10-61	650	7.8	—	240	63	20	36
	09-06-62	680	7.7	—	250	67	20	37
	04-03-63	630	8.3	—	220	54	21	37
	09-10-63	580	8.1	—	190	45	19	37
	06-16-64	560	8.3	20.0	190	47	17	36
	08-07-64	700	8.0	20.0	260	65	23	38
	06-15-66	740	8.0	20.0	280	73	24	36
	07-17-79	1,150	—	19.5	—	—	—	—
	08-04-80	1,150	—	19.5	—	—	—	—
(C-11-1)6abc-1	07-10-63	510	8.2	—	170	43	16	30

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	—	—	—	—	—	—	—
19	—	44	370	.30	46	811	—
9.8	—	36	63	—	—	306	—
5.9	—	41	69	—	—	249	—
9.8	—	46	58	—	—	315	—
9.4	—	40	62	—	—	308	—
—	—	—	—	—	—	—	—
9.4	—	31	100	.30	70	511	17.0
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
22	—	670	570	—	—	1,740	—
23	—	420	560	—	—	1,490	—
24	—	480	560	—	—	1,560	—
24	—	790	590	—	—	2,020	—
27	—	950	660	—	—	2,400	—
—	—	—	—	—	—	—	—
6.3	—	26	56	—	—	224	—
10	—	57	83	—	—	309	—
6.3	—	40	54	—	—	255	—
6.3	—	47	63	—	—	260	—
5.9	—	44	67	—	—	317	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
9.4	—	83	83	—	—	385	—
10	—	62	75	—	—	362	—
10	—	64	79	—	—	375	—
9.4	—	71	78	—	—	347	—
10	—	74	83	—	—	322	—
9.8	—	64	77	—	—	310	—
10	—	83	87	—	—	393	—
9.9	—	55	86	.50	62	440	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
7.0	—	67	58	—	—	279	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(C-11-1)6abc-1	07-24-64	520	8.3	18.0	180	42	18	33
	06-10-65	470	8.3	18.5	160	36	16	29
	08-21-75	580	7.0	18.0	230	62	18	28
	07-12-77	620	7.0	19.0	240	68	18	28
	07-13-81	610	—	20.5	—	—	—	—
	07-11-89	590	7.7	19.0	—	—	—	—
	07-18-90	610	7.6	19.5	—	—	—	—
(C-11-1)6bdd-1	08-31-64	520	7.6	18.5	210	57	16	32
	06-11-65	460	8.2	19.0	170	43	15	25
	07-13-81	560	—	20.5	—	—	—	—
	07-18-90	550	7.6	19.5	220	57	18	25
	07-31-90	560	7.7	19.5	—	—	—	—
(D-7-2)34dcd-1	05-13-64	710	8.5	13.5	240	46	30	73
	06-22-65	570	8.6	14.0	160	16	29	75
	03-26-81	640	—	13.5	—	—	—	—
(D-7-3)28bdb-1	06-21-63	1,490	7.5	—	730	190	63	—
	06-24-63	1,340	8.0	—	590	130	63	60
	05-11-64	1,470	8.0	18.0	760	190	68	60
	10-14-68	1,120	7.8	—	470	73	69	—
	09-03-69	1,170	7.9	—	530	81	80	—
	10-08-71	1,000	—	—	—	—	—	—
	06-18-72	1,120	8.0	—	450	73	64	63
	06-18-73	1,120	8.0	—	450	73	64	63
	09-09-74	1,160	—	—	460	77	64	60
	08-18-75	1,050	—	—	—	—	—	—
	08-12-76	1,150	—	—	—	—	—	—
	07-12-77	1,150	—	—	—	—	—	—
	08-22-78	1,150	—	—	—	—	—	—
	07-30-79	1,200	7.9	—	480	82	66	60
	09-03-80	1,120	8.4	—	—	—	—	—
	07-30-81	1,180	—	—	—	—	—	—
(D-7-3)30aaa-1	08-28-81	490	—	14.0	170	44	15	33
(D-7-3)33baa-6	02-11-59	540	7.8	12.0	270	71	22	—
	04-21-60	540	8.1	12.0	260	69	22	—
	09-15-60	500	8.3	12.0	250	69	20	15

water from selected wells—**Continued**

Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
7.4	—	50	65	—	—	285	—
7.0	—	51	58	—	—	253	—
7.2	159	35	60	—	57	363	—
7.3	160	43	66	.20	57	386	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	27	58	—	57	—	—
6.6	—	29	55	—	—	248	—
—	—	—	—	—	—	—	—
7.1	—	26	58	.30	62	374	1.00
—	—	—	—	—	—	—	—
5.9	—	5.3	43	—	—	404	—
5.5	—	11	44	—	—	334	—
—	—	—	—	—	—	—	—
—	212	540	78	—	14	1,080	—
7.0	—	520	86	—	—	910	—
5.1	—	560	82	—	—	1,080	—
—	52	440	87	—	1.4	786	—
—	70	410	80	—	—	733	—
—	—	—	—	—	—	—	—
5.7	30	430	84	—	.70	738	—
5.7	30	430	84	—	.70	738	—
7.2	—	430	86	—	1.0	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
6.8	34	450	85	.30	1.0	772	<.10
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
2.5	—	<5.0	28	.30	5.8	248	.11
—	235	43	13	—	11	318	—
—	230	45	14	—	10	314	—
1.1	222	46	14	.20	9.8	311	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(D-7-3)33baa-6	05-26-61	530	7.7	12.0	270	74	21	—
	08-12-76	560	—	12.5	—	—	—	—
	08-10-77	540	—	13.0	—	—	—	—
	08-22-78	540	—	13.5	—	—	—	—
	09-03-80	580	—	13.0	—	—	—	—
	09-03-81	580	—	12.5	—	—	—	—
	09-20-82	580	—	13.0	—	—	—	—
	07-29-83	560	7.2	13.5	260	68	22	14
	07-17-84	530	7.4	12.5	260	68	22	14
	08-02-85	880	7.5	13.5	—	—	—	—
	07-03-86	580	7.2	13.0	270	68	24	20
	07-29-87	—	—	13.0	260	68	22	14
	06-15-88	550	—	13.0	—	—	—	—
	06-09-89	560	7.2	13.0	270	70	22	13
	07-19-90	540	7.4	12.5	—	—	—	—
	07-22-91	540	7.4	—	—	—	—	—
(D-7-3)34cdb-1	10-14-60R	—	—	—	270	72	23	17
	09-09-74	460	8.2	18.5	220	56	20	8.8
	08-18-75	350	6.7	16.5	190	47	18	3.6
	08-12-76	590	6.8	15.5	300	72	28	16
	07-12-77	600	6.7	17.0	290	70	29	17
	08-25-78	590	6.8	19.0	300	74	27	18
	07-30-79	500	7.8	18.5	250	61	24	11
	09-02-80	540	—	17.0	—	—	—	—
	07-30-81	630	8.2	14.0	290	69	28	17
	09-20-82	600	—	12.5	—	—	—	—
	06-15-88	580	7.7	13.0	290	69	29	17
	07-20-89	580	—	26.5	—	—	—	—
	07-19-90	590	7.5	17.5	—	—	—	—
	07-22-91	600	6.2	13.0	290	70	27	16
(D-8-1)3dda-1	05-06-91	7,960	—	25.0	1,300	360	97	1,200
(D-8-1)10bcb-1	07-03-91	9,400	6.3	36.0	1,600	440	110	1,500
(D-8-1)11bac-1	06-14-91	740	7.7	16.0	210	50	20	50
(D-8-1)35cac-2	09-04-80	850	—	15.5	—	—	—	—
(D-8-2)2daa-1	08-06-64	450	7.7	16.0	210	51	21	—

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	228	45	14	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.6	—	47	14	.20	11	314	.76
1.7	—	45	10	.20	11	313	1.00
—	—	—	—	—	—	—	—
2.1	—	64	19	.20	12	348	.80
1.9	—	43	12	.20	11	310	.91
—	—	—	—	—	—	—	—
—	—	41	11	.10	11	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
5.2	224	55	26	.10	11	345	—
1.8	202	31	11	.20	9.3	263	.92
.50	179	14	3.3	—	6.8	200	—
2.3	236	59	19	.20	12	356	1.30
2.2	240	58	15	.20	12	346	—
2.4	220	57	20	.10	12	350	1.40
1.8	210	46	12	.20	10	296	1.00
—	—	—	—	—	—	—	—
2.1	—	57	14	.20	13	349	1.10
—	—	—	—	—	—	—	—
3.2	—	54	15	.30	13	354	1.40
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
2.1	—	55	15	.20	12	344	—
140	—	820	2,200	2.9	20	5,190	—
190	—	1,000	2,700	3.0	24	6,340	—
14	—	20	140	.90	52	424	—
—	—	—	—	—	—	—	—
—	—	17	12	—	25	—	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(D-8-2)2daa-1	06-09-89	480	7.8	15.0	220	52	21	15
(D-8-2)4cba-2	08-13-76	440	—	15.0	—	—	—	—
	09-20-82	440	—	15.5	—	—	—	—
(D-8-2)12ddc-1	05-03-65	630	7.7	12.0	190	30	27	75
	10-14-68	790	8.1	14.0	280	56	35	—
	09-03-69	740	7.8	12.0	260	30	44	—
	08-05-70	770	8.7	13.0	280	—	—	—
	10-14-71	780	—	14.0	—	—	—	—
	08-11-72	720	—	13.0	—	—	—	—
	06-18-73	800	8.0	—	270	62	29	71
	09-12-74	870	—	14.0	—	—	—	—
	08-13-76	750	—	12.5	—	—	—	—
(D-8-2)12ddc-2	05-27-64	440	—	16.5	200	46	20	25
	08-25-64	460	8.4	15.0	230	53	24	—
	09-03-69	480	8.0	14.0	240	49	28	—
	08-05-70	490	8.2	12.5	240	—	—	—
	10-14-71	490	—	15.5	—	—	—	—
	08-11-72	460	—	14.5	—	—	—	—
	06-18-73	470	—	14.0	—	—	—	—
	09-12-74	520	—	16.0	—	—	—	—
	08-13-76	500	—	15.5	—	—	—	—
	08-01-79	500	7.9	14.0	250	57	25	12
	09-04-80	530	—	15.0	—	—	—	—
	07-29-81	520	7.8	16.0	240	54	25	13
	09-20-82	520	—	16.0	—	—	—	—
	07-26-83	510	—	15.5	—	—	—	—
	07-17-84	510	7.6	16.0	240	55	26	13
(D-8-2)13abc-1	05-13-64	450	8.3	14.0	230	49	25	12
	08-17-90	520	7.9	15.5	250	59	25	11
(D-8-2)16caa-1	08-13-76	390	—	15.5	—	—	—	—
	09-17-79	360	—	15.0	—	—	—	—
	09-20-82	400	—	16.5	—	—	—	—
(D-8-2)23dca-2	05-27-64	440	—	16.5	200	46	20	25
	10-14-68	410	8.0	15.0	170	38	18	—
	07-30-70	390	8.6	14.0	170	—	—	—

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	—	17	9.1	.20	26	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	262	7.0	54	—	12	366	—
—	338	26	58	—	24	477	—
—	312	26	53	—	—	412	—
—	332	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
7.9	338	25	52	—	26	475	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
27	—	36	9.9	—	38	—	—
—	—	22	10	—	25	—	—
—	232	21	15	—	—	270	—
—	237	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
3.3	220	30	16	.20	28	304	.04
—	—	—	—	—	—	—	—
3.0	—	25	17	.20	29	298	0
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
3.1	—	25	15	.20	27	300	<.10
2.3	—	40	17	—	—	257	—
2.4	—	30	11	1.1	27	308	<.10
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	16	14	—	25	—	—
—	200	6.5	10	—	24	239	—
—	203	—	—	—	—	—	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(D-8-2)28cbd-3	08-30-89	980	—	22.0	—	—	—	—
(D-8-2)29add-1	05-03-65	510	—	14.0	240	54	25	17
	08-13-76	540	—	15.5	—	—	—	—
(D-8-2)31cbb-1	08-30-89	650	—	13.5	—	—	—	—
(D-8-2)31cda-1	06-06-89	500	7.5	20.0	—	—	—	—
(D-8-2)31cdb-1	08-30-89	1,270	—	19.0	—	—	—	—
(D-8-2)31cdb-2	08-04-64	430	7.7	19.0	150	34	17	—
	07-21-65	360	8.7	—	120	19	18	30
	06-06-89	3,050	6.9	28.0	—	—	—	—
(D-8-2)32daa-1	09-05-80	850	—	16.5	—	—	—	—
(D-8-2)34acd-1	07-21-65	660	8.8	13.5	280	43	41	40
	08-30-89	710	—	14.0	—	—	—	—
(D-8-2)34dda-1	05-03-65	610	7.9	13.5	270	55	31	36
	07-12-89	660	7.6	19.0	260	53	31	35
(D-8-2)36dbd-3	08-23-89	1,190	—	17.0	—	—	—	—
(D-8-3)11abb-1	06-27-89	500	7.6	—	—	—	—	—
(D-8-3)33acb-1	06-03-64	750	—	9.0	280	49	38	56
	08-22-89	900	—	13.0	—	—	—	—
	07-27-90	900	—	18.0	360	85	37	48
(D-9-1)14aad-2	07-25-83	470	—	14.0	—	—	—	—
(D-9-1)14ada-1	07-27-90	870	—	12.0	370	86	37	34
(D-9-1)14ada-2	06-03-64	600	8.3	13.5	250	46	33	30
	09-04-80	760	—	13.0	—	—	—	—
	07-25-83	760	—	13.0	—	—	—	—
	08-09-85	780	—	12.0	—	—	—	—
	07-23-90	840	7.7	12.0	—	—	—	—
(D-9-1)23ada-1	07-05-62	380	7.7	—	170	40	17	5.5
	08-07-62	410	7.8	—	210	48	21	6.4
	06-11-63	380	8.8	—	150	20	25	16
	08-28-63	420	8.1	—	170	27	26	16
	07-27-79	650	—	12.5	—	—	—	—
(D-9-1)26aaa-1	07-05-89	660	7.4	11.5	300	74	27	18
	08-22-89	650	—	11.0	—	—	—	—
(D-9-1)26aab-1	06-03-64	500	8.4	14.5	220	37	30	24
	09-04-80	750	—	15.5	—	—	—	—

water from selected wells—**Continued**

Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	—	—	—	—	—	—	—
—	225	33	12	—	49	325	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	29	15	—	63	—	—
10	—	41	12	—	—	215	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
24	—	1.9	19	—	—	388	—
—	—	—	—	—	—	—	—
—	307	3.9	19	—	26	362	—
—	—	3.0	19	.40	30	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
3.5	—	160	54	—	—	456	—
—	—	—	—	—	—	—	—
4.0	—	98	51	.30	17	531	.60
—	—	—	—	—	—	—	—
2.6	—	94	37	.20	25	522	7.80
2.3	—	100	46	—	—	349	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.2	—	8.6	7.1	—	—	178	—
1.2	—	16	8.2	—	—	216	—
2.0	—	43	20	—	—	196	—
1.6	—	44	21	—	—	218	—
—	—	—	—	—	—	—	—
—	—	29	19	.20	19	—	—
—	—	—	—	—	—	—	—
2.3	—	75	26	—	—	286	—
—	—	—	—	—	—	—	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(D-9-1)26aab-1	07-11-89	580	7.5	13.0	—	—	—	—
(D-9-1)26add-1	08-09-85	680	—	13.5	—	—	—	—
	07-31-90	620	7.4	11.0	—	—	—	—
[1](D-9-1)35abb-1	06-03-63	460	8.4	—	230	58	21	6.4
	08-29-63	330	7.9	—	150	26	21	6.7
	07-02-65	290	8.5	—	140	19	23	7.1
	07-15-81	530	—	11.5	—	—	—	—
	07-23-90	530	7.5	11.0	270	66	26	6.7
(D-9-1)35bcd-2	07-16-81	700	—	14.0	—	—	—	—
	07-02-87	520	—	13.0	—	—	—	—
	08-01-90	660	7.8	18.0	—	—	—	—
(D-9-1)36acb-1	05-18-89	500	7.8	19.5	—	—	—	—
	07-10-89	470	7.7	12.0	—	—	—	—
(D-9-1)36bbc-1	07-05-62	470	7.5	—	220	56	20	6.2
	08-07-62	480	7.7	—	250	52	28	6.4
	07-01-63	330	8.5	—	160	30	21	6.2
	08-29-63	480	7.4	—	240	60	22	6.2
	07-13-64	480	7.5	10.0	250	63	23	6.4
	07-02-65	290	7.7	9.5	140	21	22	5.5
	07-29-65	300	8.3	9.5	150	24	22	6.4
	09-03-69	500	7.9	9.0	260	61	26	—
	08-11-72	520	—	10.0	—	—	—	—
	09-12-74	520	—	10.5	—	—	—	—
	08-16-76	520	7.3	10.0	280	75	23	5.9
	07-12-77	480	6.5	10.0	270	70	23	6.1
	07-15-81	530	7.6	11.0	270	69	23	6.7
	08-25-89	500	—	10.0	250	62	22	5.9
	07-23-90	490	7.4	10.0	260	63	24	6.0
(D-9-1)36cdd-1	07-13-64	560	7.5	9.5	300	78	26	7.1
	07-31-81	590	—	11.5	—	—	—	—
	07-11-89	520	7.7	12.0	—	—	—	—
	08-16-89	690	7.7	12.0	—	—	—	—
	07-27-90	500	7.5	10.0	260	68	21	6.4
(D-9-2)5ddb-1	05-24-89	1,000	7.0	14.0	—	—	—	—
(D-9-2)6ddb-1	05-24-89	800	7.4	14.0	—	—	—	—

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.2	—	14	12	—	—	240	—
1.2	—	24	8.9	—	—	168	—
1.2	—	31	9.9	—	—	159	—
—	—	—	—	—	—	—	—
1.6	—	18	26	.30	19	293	2.20
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.2	—	18	11	—	—	289	—
1.2	—	26	9.2	—	—	255	—
1.6	—	24	7.8	—	—	173	—
1.2	—	24	8.2	—	—	252	—
1.2	—	31	8.2	—	—	267	—
.80	—	24	11	—	—	153	—
.80	—	31	8.9	—	—	164	—
—	239	14	12	—	15	288	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.4	230	21	14	.20	15	303	2.20
1.5	220	22	13	.20	16	285	—
1.5	—	22	28	.20	17	309	2.20
1.3	—	15	25	.30	16	276	1.50
1.3	—	13	25	.30	17	298	1.70
1.2	—	41	9.6	—	—	321	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.2	—	20	13	.30	14	297	1.50
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(D-9-2)9bac-1	07-05-62	490	8.3	—	140	21	21	40
	08-07-62	570	8.0	—	210	42	25	34
	07-02-63	550	8.1	—	210	41	25	34
	08-01-63	690	7.7	—	290	73	26	33
	08-22-63	680	7.4	—	250	59	26	31
	07-14-64	520	8.3	14.5	190	31	27	34
	07-27-65	550	8.2	14.0	200	34	27	35
	07-30-70	680	8.1	12.5	290	67	29	—
	08-11-72	660	—	14.5	—	—	—	—
	07-30-73	730	—	14.5	—	—	—	—
	09-12-74	560	—	17.0	—	—	—	—
	08-13-76	700	7.3	14.0	310	78	27	30
	07-12-77	650	6.5	14.5	300	73	28	30
	08-23-78	650	6.8	14.0	290	71	27	29
	07-27-79	670	—	14.5	—	—	—	—
	08-01-79	670	—	14.5	—	—	—	—
	07-30-81	690	7.4	14.5	280	66	27	30
	09-20-82	650	—	14.5	—	—	—	—
	08-09-84	640	7.4	14.0	290	69	28	32
	07-02-87	580	7.3	14.0	270	67	26	180
	08-23-89	640	—	15.0	—	—	—	—
	09-04-90	610	7.5	14.5	230	56	21	36
	08-19-91	630	7.5	14.5	—	—	—	—
(D-9-2)11aaa-1	05-17-64	520	7.8	14.0	240	61	22	—
	08-16-76	570	—	14.0	—	—	—	—
	09-20-82	550	—	—	—	—	—	—
	07-19-90	550	7.5	14.5	270	66	26	15
(D-9-2)15cda-1	07-30-81	600	—	14.5	—	—	—	—
	07-10-89	540	7.6	14.0	—	—	—	—
(D-9-2)19aca-1	07-02-87	420	—	13.0	—	—	—	—
	07-10-89	690	8.0	14.0	—	—	—	—
(D-9-2)19acb-1	09-05-80	490	—	14.5	—	—	—	—
	07-26-83	510	—	14.5	—	—	—	—
	07-02-86	570	—	16.0	—	—	—	—
(D-9-2)36acd-1	05-11-89	540	6.9	12.0	—	—	—	—

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
12	—	50	37	—	—	265	—
9.4	—	49	37	—	—	309	—
9.0	—	61	37	—	—	314	—
9.0	—	52	42	—	—	386	—
8.6	—	33	41	—	—	344	—
9.8	—	83	36	—	—	294	—
9.4	—	66	35	—	—	307	—
—	268	41	33	—	51	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
9.0	261	48	32	.30	49	448	4.00
8.3	250	51	31	.20	49	423	—
8.2	250	45	29	.20	45	417	3.40
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
8.1	—	44	25	.20	53	423	3.00
—	—	—	—	—	—	—	—
9.1	—	47	30	.30	51	440	3.40
8.5	—	110	25	.30	50	644	3.40
—	—	—	—	—	—	—	—
10	—	34	33	.20	56	402	2.90
—	—	—	—	—	—	—	—
—	—	27	24	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.2	—	28	19	.20	13	307	1.10
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—

Table 5.—*Chemical analyses of*

Well number	Date sampled	Specific conductance (µS/cm)	pH, field (standard units)	Temperature (°C)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dis-solved (mg/L as Ca)	Magnesium, dis-solved (mg/L as Mg)	Sodium, dis-solved (mg/L as Na)
(D-9-3)5bbd-1	07-14-64	380	8.5	12.0	170	27	26	14
	09-03-69	560	7.9	11.0	270	65	27	—
	10-14-71	530	—	12.5	—	—	—	—
	08-11-72	650	7.5	12.5	320	73	33	18
	07-31-73	550	—	12.0	—	—	—	—
	08-17-76	670	7.2	12.5	300	75	28	16
	07-12-77	620	6.5	12.5	310	75	31	19
	08-23-78	590	6.8	12.5	300	72	29	18
	08-01-79	650	—	12.5	—	—	—	—
	09-04-80	600	—	15.5	—	—	—	—
(D-10-1)1acd-2	07-14-89	730	7.2	15.0	—	—	—	—
(D-10-1)2adb-1	07-29-65	—	—	—	170	—	—	—
	07-05-66	530	7.8	9.5	280	75	22	5.3
	07-30-80	530	—	11.0	—	—	—	—
	07-14-89	500	7.6	12.0	—	—	—	—
	08-17-90	540	7.9	10.5	270	71	22	6.4
(D-10-1)2ddd-1	08-22-89	570	7.3	10.0	—	—	—	—
(D-10-1)19bad-1	07-15-81	2,100	—	23.0	—	—	—	—
	06-30-86	2,060	—	21.0	—	—	—	—
(D-10-1)19bdc-1	09-04-80	2,000	—	21.5	—	—	—	—
	07-02-86	2,130	—	21.5	—	—	—	—
(D-10-1)30bac-1	08-09-85	3,800	—	22.0	—	—	—	—
	07-12-89	3,550	7.1	23.5	—	—	—	—
	08-29-90	3,410	7.4	24.0	500	110	54	460

[1] Actual location is different than historic record. See footnote, table 1.

water from selected wells—**Continued**

Potassium, dis-solved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dis-solved (mg/L as SO_4)	Chloride, dis-solved (mg/L as Cl)	Fluoride, dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen NO_2+NO_3, dissolved (mg/L as N)
1.2	—	44	16	—	—	212	—
—	248	35	19	—	13	327	—
—	—	—	—	—	—	—	—
1.6	261	55	22	—	15	374	—
—	—	—	—	—	—	—	—
1.3	253	53	19	.20	12	360	.90
1.5	250	56	21	.10	13	369	—
1.6	200	54	28	.20	13	338	.94
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
.80	—	30	17	—	—	291	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
1.3	—	21	21	1.1	13	296	2.10
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—
38	—	120	860	.30	36	1,860	.50

Table 6.—*Measurements of discharge, temperature, and specific conductance of water from selected springs*

[—, no data]

Location of spring or measurement site: See figure 1 for explanation of the numbering system for hydrologic-data sites.
Discharge: ft^3/s, cubic feet per second.
Temperature: °C, degrees Celsius.
Specific conductance: µS/cm, microsiemens per centimeter at 25 degrees Celsius.

Location of spring	Location of measurement site	Name of spring	Date of measurement	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
(D-7-3)28d-S1	(D-7-3)28bcd	Spring Creek	07-02-90	15	15.5	—
			10-16-90	16	14.0	—
			04-02-91	15	—	—
(D-7-3)30a-S1	(D-7-3)30abb	Unnamed springs	11-14-90	.12	11.0	840
(D-7-3)32dba-S1	(D-7-3)31add	Wood Springs	05-31-90	[1]3.8	15.5	—
			10-16-90	[1]3.9	15.0	—
			04-02-91	[2]2.9	—	—
(D-8-3)3a-S1	(D-8-3)3abc	Wheeler Springs	05-31-90	1.1	14.0	—
			10-16-90	.89	14.0	—
			04-02-91	[3]1	—	—
(D-8-3)3dbb-S1	(D-8-3)3dbb	Clyde Springs	05-31-90	.55	13.0	—
			10-16-90	.72	13.0	—
			04-02-91	.02	—	—
(D-8-3)9d-S1	(D-8-3)9bac	Holley Springs	05-25-90	3.4	18.5	—
			10-22-90	4.1	9.0	—
			04-02-91	2.4	—	—
(D-9-2)11abd-S1	(D-9-2)11abd	Salem Lake Springs	06-01-90	5.0	16.0	—
			10-22-90	6.1	10.0	—
(D-9-2)29ac-S1	(D-9-2)29acc	Unnamed springs	08-22-89	[4]1.0	—	—
(D-9-2)29cbb-S1	(D-9-2)29cbb	Spring Lake Springs	06-01-90	[4]3.3	14.0	—
			10-17-90	[4]2.4	13.0	—
(D-9-1)25aac-S1	(D-9-1)24ddc	North Holladay Springs	06-12-90	1.1	13.5	—
			10-17-90	.78	8.0	—
(D-9-1)25adb-S1	(D-9-1)25ada	South Holladay Springs	06-12-90	.67	16.0	—
			10-17-90	.46	8.5	—

[1] Includes about 0.5 ft^3/s from Matson Springs.
[2] Includes 0.14 ft^3/s from Matson Springs.
[3] Estimated.
[4] Includes about 0.4 ft^3/s from flowing wells.

Table 7.—*Measurements of discharge, temperature, and specific conductance of water from selected springs, drains, and sloughs during seepage studies*

[—, no data]

Location of measurement site: See figure 1 for explanation of the numbering system for hydrologic-data sites. Listed in downstream order.

Inflow and outflow: Measured inflow to or outflow from the spring channel.

Discharge: ft^3/s, cubic feet per second. Used to determine ground-water discharge to springs and drains. Upstream measurement plus inflow minus outflow may not equal downstream measurement because of stream leakage, ground water discharge, or measurement error.

Temperature: °C, degrees Celsius.

Specific conductance: µS/cm, microsiemens per centimeter at 25 degrees Celsius.

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Spring Creek north channel, November 14, 1990			
(D-7-3)28bca		15	13.0	890
(D-7-3)20bda		15	12.5	1,070
(D-7-3)20bbd	Inflow from industrial effluent	.43	38.0	880
(D-7-3)19bda		15	15.0	1,180
	Spring Creek south channel, November 14, 1990			
(D-7-3)28bcb		2.1	12.0	1,050
(D-7-3)20cdb	Inflow from flowing well	.22	—	—
(D-7-3)20cdb	Inflow from waste-water treatment plant	5.1	—	—
(D-7-3)20cdb		9.4	12.5	780
	Wood Springs channel, November 14, 1990			
(D-7-3)31add		[1]3.9	13.5	620
(D-7-3)30cdd		6.4	8.0	760
	Matson Springs channel, November 14, 1990			
(D-7-3)32ddd	Inflow from flowing well	1.1	16.0	560
(D-7-3)32cda		2.6	14.0	470
(D-7-3)32cda	Outflow to Wood Springs area	1.5	—	—
(D-7-3)31cdb		1.6	14.0	610

Table 7.—*Measurements of discharge, temperature, and specific conductance of water from selected springs, drains, and sloughs during seepage studies*—**Continued**

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Dry Creek, November 15, 1990			
(D-8-3)5cdc		1.9	9.0	840
(D-8-3)5cdc	Inflow from Holley Springs	4.5	8.0	900
(D-8-3)5ccc	Inflow from unnamed springs	4.8	8.0	940
(D-8-3)6ddd	Inflow from flowing wells	.20	—	—
(D-8-3)6ccd	Inflow from waste-water treatment plant	3.7	—	—
(D-8-2)1dda	Inflow from unnamed drains	.38	10.5	580
(D-7-2)36dcc		16	9.5	1,070
	Holley Springs channel, November 15, 1990			
(D-8-3)9bac		5.0	10.0	910
(D-8-3)5cdc		4.5	8.0	900
	Unnamed channel, November 15, 1990			
(D-8-3)18add		1.2	7.0	1,070
(D-8-3)8cbd		1.4	8.0	1,130
(D-8-3)5ccc		4.8	8.0	940
	Spring Creek (near Payson), March 28, 1991			
(D-9-2)29cbb		[2]2.8	8.5	470
(D-9-2)30dad	Inflow from unnamed field drain	.06	9.0	1,020
(D-9-2)30daa	Outflow to West Ditch area	.18	10.5	485
(D-9-2)19bba		4.1	—	—
(D-9-2)18ccd	Inflow from West Ditch	1.0	—	—
(D-9-1)13ddd	Inflow from South Holladay Springs	.61	—	—
(D-9-1)13ddc	Inflow from North Holladay Springs	1.4	—	—
(D-9-2)7bba		6.8	8.0	710
(D-8-1)36dba		7.9	9.0	760

Table 7.—*Measurements of discharge, temperature, and specific conductance of water from selected springs, drains, and sloughs during seepage studies*—**Continued**

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Beer Creek and Benjamin Slough, March 28, 1991			
(D-8-1)36aad	Beer Creek	22	12.5	1,040
(D-8-1)36dba	Inflow from Spring Creek	7.9	9.0	760
(D-8-1)36dba	Inflow from Dry Hollow	1.2	11.5	1,400
(D-8-1)23aba	Benjamin Slough	33	12.0	1,060
	North Holladay Springs channel, March 28, 1991			
(D-9-1)24ddc		.82	15.0	700
(D-9-1)13ddc		1.4	—	—
	South Holladay Springs channel, March 28, 1991			
(D-9-1)25ada		[3].59	12.0	750
(D-9-1)25ada	Inflow from flowing wells	14	—	—
(D-9-1)13ddd		.61	—	—
	Dry Hollow, March 28, 1991			
(D-9-1)12bdd		.36	—	—
(D-8-1)36dba		1.2	11.5	1,400
	Beer Creek, March 29, 1991			
(D-8-2)35cdd		1.9	4.5	1,350
(D-8-2)35cdc	Inflow from waste-water treatment plant	.62	7.5	1,110
(D-9-2)3abc	Inflow from Salem Lake	6.4	10.5	770
(D-9-2)3bca		10	7.0	940
(D-8-2)33bbc		14	9.0	990
(D-8-2)32aac	Inflow from waste-water treatment plant	1.3	—	—
(D-8-2)31bb	Inflow from flowing wells	1.2	[4]14.0	[4]880
(D-8-1)36aad		20	—	—

[1] Includes 1.5 ft^3/s from Matson Springs.
[2] Includes about 0.4 ft^3/s from flowing wells.
[3] Includes 0.11 ft^3/s from flowing wells.
[4] Average of two flowing wells.

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*

[—, no data]

Location of measurement site: See figure 1 for explanation of the numbering system for hydrologic-data sites. Listed in downstream order. Unknown, exact location not known, is between known listed locations.

Inflow and outflow: Measured inflow to and outflow from the stream. Calculated inflow or outflow was determined by measuring the stream above and below the inflow or outflow. Diversion number refers to system used by the Strawberry Highline Canal Company.

Discharge: ft^3/s, cubic feet per second. Used to determine interaction between streams and ground-water system. Upstream measurement plus inflow minus outflow may not equal downstream measurement because of stream leakage, ground-water discharge, or measurement error.

Temperature: °C, degrees Celsius.

Specific conductance: µS/cm, microsiemens per centimeter at 25 degrees Celsius.

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Spanish Fork River, August 30, 1965			
(D-8-3)33acc		11	—	—
(D-8-3)32daa	Inflow from Mill Race Canal	1.0	—	—
(D-8-3)32cac		9.7	—	—
	Spanish Fork River, September 3, 1965			
(D-8-3)34cda		3.8	—	—
(D-8-3)34bbc	Inflow from springs	1.1	—	—
(D-8-3)34bbb		7.4	—	—
	Spanish Fork River, September 13, 1965			
(D-8-3)34bbb		8.9	11.5	—
(D-8-3)28ddc	Inflow from industrial effluent	.48	—	—
(D-8-3)33acb		7.4	—	—
	Spanish Fork River, October 5, 1965			
(D-8-2)25ada		18	11.5	—
(D-8-2)25bab	Inflow from ditch	.48	—	—
(D-8-2)23dca		23	13.5	—
	Spanish Fork River, October 8, 1965			
(D-8-2)23dca		32	—	—
(D-8-2)22dad	Inflow from South Field Canal	4.0	—	—
(D-8-2)22da	Inflow from ditch	.06	—	—
(D-8-2)22add		33	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Spanish Fork River, October 12, 1965			
(D-8-2)15dcd		25	—	—
(D-8-2)15d	Inflow from ditch	.28	—	—
(D-8-2)15cab		22	—	—
	Spanish Fork River, October 13, 1965			
(D-8-2)15cab		38	—	—
Unknown	Inflow from drains	.22	—	—
(D-8-2)9aad		31	—	—
	Spanish Fork River, June 1, 1966			
(D-9-3)2cab		107	—	—
(D-8-3)35ccc	Outflow to East Bench Canal	103	—	—
(D-8-3)34cdd		18	—	—
(D-8-3)34bbb		20	—	—
(D-8-3)28ddc	Inflow from industrial effluent	.03	—	—
(D-8-3)33acb		21	—	—
	Spanish Fork River, June 2, 1966			
(D-8-3)33acc		31	—	—
(D-8-3)31acd	Inflow from drain	1.1	—	—
(D-8-3)30ccc	Inflow from ditch	.60	—	—
(D-8-2)25add		31	—	—
	Spanish Fork River, June 3, 1966			
(D-8-2)25ada		18	—	—
(D-8-2)25ada	Inflow from drains	.03	—	—
(D-8-2)23dca		21	—	—
(D-8-2)22dad	Inflow from South Field Canal	.39	—	—
(D-8-2)22da	Inflow from ditch	.31	—	—
(D-8-2)22da	Inflow from ditch	.05	—	—
(D-8-2)22add		21	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—**Continued**

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Spanish Fork River, September 29, 1966			
(D-8-3)34cda		3.9	—	—
(D-8-3)34bbb		7.2	15.5	—
(D-8-3)33acb		6.7	—	—
	Spanish Fork River, September 30, 1966			
(D-8-3)33acc		20	—	—
(D-8-3)32cac		22	—	—
(D-8-3)31baa		21	—	—
(D-8-3)30c	Inflow	1.1	—	—
(D-8-2)25add		23	15.5	—
	Spanish Fork River, October 3, 1966			
(D-8-2)25ada		77	11.0	500
(D-8-2)23dca		78	12.0	520
Unknown	Inflow from ditches	.33	—	—
(D-8-2)22aba	Outflow to South Ditch	27	—	—
(D-8-2)15dca		49	13.0	520
Unknown	Inflow from ditches and well	.60	—	—
(D-7-2)32ddd		39	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Mapleton Lateral, May 26, 1966			
(D-8-3)34cda		43	11.0	—
(D-8-3)34acc		40	—	—
(D-8-3)34aba		41	—	—
(D-8-3)27acc		39	13.0	—
(D-8-3)23bdd		40	—	—
(D-8-3)23bdd	Outflow to ditch	6.8	—	—
(D-8-3)14aac		34	15.0	—
(D-8-3)14aac	Outflow to pump	.97	—	—
(D-8-3)11ddb		33	—	—
(D-8-3)11ddb	Calculated inflow from Maple Creek	7.5	—	—
(D-8-3)11ddb	Outflow to ditch	11	—	—
(D-8-3)11adb		30	—	—
(D-8-3)11aac	Outflow to ditch	11	—	—
(D-8-3)11aac		17	—	—
(D-8-3)11aba		17	16.0	—
(D-8-3)11aba	Calculated outflow to Fullmer Ditch	8.6	—	—
(D-8-3)2dcd		7.9	—	—
(D-8-3)2dca		7.7	—	—
	Mapleton Lateral, September 29, 1966			
(D-8-3)34acc		18	11.0	—
(D-8-3)34aba		17	—	—
(D-8-3)27acc		18	—	—
(D-8-3)23bdd		18	—	—
(D-8-3)14aac		19	—	—
(D-8-3)11ddb	Outflow to ditch	.14	—	—
(D-8-3)11ddb		18	—	—
(D-8-3)11aac	Outflow to ditch	.88	—	—
(D-8-3)2dcd		18	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Strawberry Highline Canal, September 28, 1965			
(D-8-3)33dbb		44	—	—
Unknown	Inflow	.17	—	—
Unknown	Outflow	3.3	—	—
(D-9-2)16adc		37	—	—
	Strawberry Highline Canal, May 31, 1966			
(D-9-2)31acc		79	—	—
(D-9-2)31cbd	Outflow to diversion #24A	2.4	—	—
(D-9-1)36dad	Outflow to diversion #25	2.1	—	—
(D-9-1)36dad		70	—	—
(D-9-1)36acb	Outflow to diversion #26	3.7	—	—
(D-9-1)36bbc		66	—	—
(D-9-1)36bbc	Inflow from well	4.4	—	—
(D-9-1)35aaa	Outflow to diversion #27	3.6	—	—
(D-9-1)35aaa		70	—	—
(D-9-1)35abb	Inflow from well	8.7	—	—
(D-9-1)26cbb		78	15.5	—
	Strawberry Highline Canal, June 1, 1966			
(D-8-3)33dbb		139	14.0	—
(D-9-3)5aaa	Outflow to diversion #3	13	—	—
(D-9-3)5adb		124	—	—
(D-9-3)7dbc		121	—	—
(D-9-3)7dbc	Calculated outflow to diversion #7	5.1	—	—
(D-9-3)7cdb	Outflow to diversion #8	.01	—	—
(D-9-2)13abc		111	—	—
(D-9-2)13bad	Calculated outflow to diversion #10	3.1	—	—
(D-9-2)13bd	Outflow to diversion #10-1	4.4	—	—
(D-9-2)14daa	Outflow to diversion #11	2.8	—	—
(D-9-2)14ccc		100	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—**Continued**

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Strawberry Highline Canal, June 2, 1966			
(D-9-2)14ccc		85	12.0	—
(D-9-2)22bba	Outflow to diversion #14.5	.65	—	—
(D-9-2)22bbb		77	13.0	—
(D-9-2)21bab	Outflow to diversion #18	1.4	—	—
(D-9-2)21bba	Outflow to diversion #19	5.2	—	—
(D-9-2)21bb	Outflow to diversion #19.5	1.1	—	—
(D-9-2)21bcb	Outflow to diversion #20	27	—	—
(D-9-2)21bcb	Outflow to diversion #20B	3.2	—	—
(D-9-2)31acc		41	16.0	—
	Strawberry Highline Canal, September 26, 1966			
(D-8-3)33dbb		73	—	—
(D-9-3)5aaa	Outflow to diversion #3	.19	—	—
(D-9-3)5adb		73	—	—
(D-9-3)7dbc		72	14.0	—
(D-9-2)13abc		71	14.5	—
(D-9-2)14cda	Outflow to diversion #12	2.8	—	—
(D-9-2)14ccc		68	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Strawberry Highline Canal, September 27, 1966			
(D-9-2)14ccc		64	—	—
(D-9-2)22bba		64	13.0	—
(D-9-2)21bab	Outflow to diversion #18	7.0	—	—
(D-9-2)21bcb	Outflow to diversion #20A	6.0	—	—
(D-9-2)20ddb	Outflow to diversion #21	.20	—	—
(D-9-2)31acc		48	14.0	—
(D-9-2)31cbd	Outflow to diversion #24A	.01	—	—
(D-9-1)36dad	Outflow to diversion #25	1.5	—	—
(D-9-1)36bbc		45	14.5	—
(D-9-1)35aaa	Outflow to diversion #27	4.0	—	—
(D-9-1)35a	Outflow to diversion #27.5	2.4	—	—
(D-9-1)26cbb		44	15.5	—
	South Field Canal, September 13, 1965			
(D-8-3)32dda		10	—	—
(D-8-2)25dbc		10	15.5	—
	South Field Canal, June 8, 1966			
(D-8-3)32dda		33	12.0	—
(D-8-3)31cdd		32	—	—
(D-8-2)36acd		35	15.0	—
(D-8-2)36acb	Outflow	4.9	—	—
(D-8-2)25dbc		30	—	—
	South Field Canal, October 3, 1966			
(D-8-3)32dda		17	—	—
(D-8-3)32c	Outflow	4.3	—	—
(D-8-3)31cdd		13	11.5	—
(D-8-3)36acd		14	—	—
(D-8-3)25dbc		13	11.5	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
		South Field Canal, October 5, 1966		
(D-8-2)25dbc		4.9	—	—
(D-8-2)23ccc		4.6	12.0	—
		Mill Race Canal, August 30, 1965		
(D-8-3)33acc		56	14.5	—
(D-8-3)33cab	Outflow	8.9	—	—
(D-8-3)32add	Outflow to Spanish Fork River	1.0	—	—
(D-8-3)19cdc		45	16.5	—
		Mill Race Canal, June 9, 1966		
(D-8-3)33acc		51	—	—
(D-8-3)32bab		57	13.0	—
(D-8-3)30ddd		55	15.0	—
(D-8-3)30dbb		59	—	—
(D-8-3)30b	Outflow	.61	—	—
(D-8-3)19cdc		55	15.0	—
(D-8-3)19cca	Outflow	3.0	—	—
(D-8-2)24dca		50	—	—
		Mill Race Canal, September 30, 1966		
(D-8-3)33acc		39	—	—
(D-8-3)32bab		38	—	—
(D-8-3)32bb	Outflow	5.7	—	—
(D-8-3)30dbb		34	—	—
(D-8-3)19cdc		34	—	—
(D-8-3)19cca	Outflow	2.5	—	—
(D-8-2)24dca		34	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
		East Bench Canal, August 25, 1965		
(D-8-3)34ddd		14	—	—
(D-8-3)27ccb		12	—	—
		East Bench Canal, June 15, 1966		
(D-8-3)34ddd		78	—	—
(D-8-3)27ccb		75	18	—
(D-8-3)27cbc	Outflow	9.0	—	—
(D-8-3)28dac	Outflow	16	—	—
(D-8-3)28dac	Outflow	2.6	—	—
(D-8-3)28dbb	Outflow	8.6	—	—
(D-8-3)28bbd	Outflow	8.3	—	—
(D-8-3)29aaa		32	—	—
		East Bench Canal, October 6, 1966		
(D-8-3)34ddd		17	—	—
(D-8-3)27ccb		15	9.0	—
(D-8-3)28dac	Outflow	9.3	—	—
(D-8-3)29aaa		5.7	9.5	—
		South Ditch, June 17, 1966		
(D-8-2)22aba		52	15.0	—
(D-8-2)15caa	Outflow	18	15.5	—
(D-8-2)16dad	Outflow	15	16.0	—
(D-8-2)16dcc		17	16.5	—
(D-8-2)21bbd	Outflow	1.9	—	—
(D-8-2)20caa		14	16.5	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
		Hobble Creek, August 17, 1965		
(D-8-3)1dbc		.77	—	—
(D-8-3)1cac		5.4	—	—
(D-8-3)1cca		5.2	—	—
(D-8-3)1ccb	Inflow from canal	1.7	—	—
(D-8-3)2ddb		6.7	—	—
(D-8-3)2dca	Inflow from Mapleton Lateral	11	—	—
(D-8-3)2dca	Outflow to canal	7.7	—	—
(D-8-3)2dca		5.3	—	—
(D-8-3)2ccb	Outflow to irrigation ditch	5.0	—	—
(D-8-3)3dda	Calculated inflow from pipe	.48	—	—
(D-8-3)3dda		2.8	—	—
		Hobble Creek, August 18, 1965		
(D-8-3)3dda		2.8	—	—
(D-8-3)3acc	Inflow from springs	.20	—	—
(D-8-3)3bbd	Inflow from drains	.87	—	—
(D-8-3)4aaa		13	—	—
		Hobble Creek, August 19, 1965		
(D-8-3)3dda		4.7	—	—
(D-8-3)4aaa		18	—	—
		Hobble Creek, August 23, 1965		
(D-8-3)3dda		1.5	—	—
(D-8-3)4aaa		9.9	—	—
		Hobble Creek, September 22, 1965		
(D-8-3)4aaa		26	11.5	—
(D-7-3)29dcc		29	12.0	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
		Hobble Creek, May 24, 1966		
(D-8-3)1cac		18	8.5	—
(D-8-3)2ddb		20	9.5	—
(D-8-3)2dca	Outflow	8.4	—	—
(D-8-3)2	Outflow	7.6	—	—
(D-8-3)3d	Calculated inflow from pipe	2.6	—	—
(D-8-3)3b	Inflow from springs	1.6	—	—
(D-8-3)4aaa		19	—	—
		Hobble Creek, September 23, 1966		
(D-8-3)1cac		3.8	10.5	—
(D-8-3)2ddb		2.8	11.5	—
		Hobble Creek, September 27, 1966		
(D-8-3)2dca		1.2	—	—
(D-8-3)2ccb	Outflow to irrigation ditch	1.9	—	—
(D-8-3)3dda		1.0	13.0	410
(D-8-3)3dbb		4.8	13.0	600
(D-8-3)3b	Inflow from Wheeler Springs	.64	—	—
(D-8-3)4aaa		7.5	13.5	560
		Hobble Creek, October 4, 1966		
(D-8-3)4aaa		5.2	11.5	540
(D-7-3)29dcc		5.4	12.0	540
		Hobble Creek, May 23, 1990		
(D-8-4)6abb		17	14.5	—
		Hobble Creek, November 14, 1990		
(D-7-3)29dcc		19	8.5	520
(D-7-3)30acc	Outflow	.04	—	—
(D-7-3)30bda		21	9.0	540

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—Continued

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
		Springville Highline Canal, June 3, 1965		
(D-8-3)1acc		8.3	—	—
(D-8-3)2adb		7.5	—	—
		Springville Highline Canal, July 23, 1965		
(D-8-3)1acc		8.0	—	—
Unknown	Outflow	.09	—	—
(D-8-3)2adb		6.1	—	—
		Springville Highline Canal, May 23, 1966		
(D-8-4)6bab		6.7	—	—
(D-8-3)1acc		6.4	—	—
		Springville Highline Canal, September 28, 1966		
(D-8-4)6bab		11	11.0	420
(D-8-3)1acc		8.8	10.5	430
		Swenson Ditch, September 29, 1966		
(D-8-3)4aaa		7.9	—	—
(D-8-3)4bbd		7.1	—	—
		Fullmer Ditch, May 25, 1966		
(D-8-3)12bbb		9.4	—	—
(D-8-3)11aba	Inflow from Mapleton Lateral	10	—	—
(D-8-3)11baa		18	—	—
		Fullmer Ditch, October 5, 1966		
(D-8-3)1cdc		13	9.0	440
Unknown	Outflow	1.3	—	—
(D-8-3)3cdc		7.5	—	—

Table 8.—*Measurements of discharge, temperature, and specific conductance of water from selected streams and canals*—**Continued**

Location of measurement site	Inflow and outflow	Discharge (ft^3/s)	Temperature (°C)	Specific conductance (µS/cm)
	Area of West Fields Irrigation Company, November 15, 1990			
(Measurements given below include all known surface inflow and outflow from the West Fields Irrigation Company area)				
(D-8-2)24acc	Inflow from Mill Race Canal	9.6	7.5	930
(D-8-2)23dba	Unnamed inflow	[1].05	—	—
(D-8-2)9aad	Unnamed outflow	.08	11.5	485
(D-8-2)4aab	Unnamed outflow	.42	9.0	[2]2,460
(D-7-2)34ddc	Unnamed outflow	2.8	8.0	895
(D-7-2)35ccc	Unnamed outflow	1.4	9.0	925
(D-7-2)35ccd	Unnamed outflow	1.8	8.5	930
(D-8-2)2abb	Unnamed outflow	.03	12.0	410
(D-8-2)1bbb	Unnamed outflow	.8	9.5	990
	Peteetneet Creek West Ditch, March 28, 1991			
(D-9-2)21bbc		3.4	—	—
(D-9-2)20bc	Inflow	.18	—	—
(D-9-2)18ccd		.96	—	—
	Summit Creek, May 23, 1990			
(D-10-1)13d		17	12.0	—
	Kimball Creek, May 25, 1990			
(C-11-2)13cdc		.15	17.5	—

[1] Estimated.
[2] Specific conductance is higher than other values because the flow at this site is composed mainly of ground-water discharge.

★ U.S. GOVERNMENT PRINTING OFFICE: 1993 - 786 - 348

APPENDIX H

LINEAMENT STUDY

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

This document was submitted
as part of a previous Permit.

EVALUATION OF LINEAMENTS AT THE PROPOSED PROVO CITY LANDFILL, GOSHEN VALLEY, UTAH

by

ROBERT M. ROBISON

UTAH COUNTY GEOLOGIST

APRIL 20, 1987

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INTRODUCTION

The proposed Provo City landfill is located in Goshen Valley, Utah, in Sec. 17, T. 9 S., R. 1 W., SLB&M (Fig. 1). The site is about 2 miles west of the southern end of Utah Lake and approximately 2 miles east of the Tintic Mountains. Elberta City is approximately 5.5 miles to the south.

The purpose of this investigation was to evaluate lineaments in Section 17 to determine if they were formed by surface fault rupture. Several lineaments were identified by the Utah County Geologist (Robison, 1986a) and Environmental Science and Engineering (ESE, Whiting, 1986) which may have been produced by faulting. The Utah County Board of Adjustments (minutes dated January 13, 1987) authorized an investigation of all lineaments. The Utah County Geologist had the responsibility to locate exploratory trenches and make the interpretation as to the presence/location of any faults found.

The scope of this investigation included a review of pertinent literature and aerial photographs, field reconnaissance, and the excavation, logging, photographing, and interpretation of eight trenches (Fig. 2). Trench locations were selected during a field reconnaissance on March 6, 1987, by the Utah County Geologist. Duane Whiting of ESE, Steve Sevier of Elberta Farms, and Dale Stephenson and Carl Carpenter of Provo City were present when the trenches were sited.

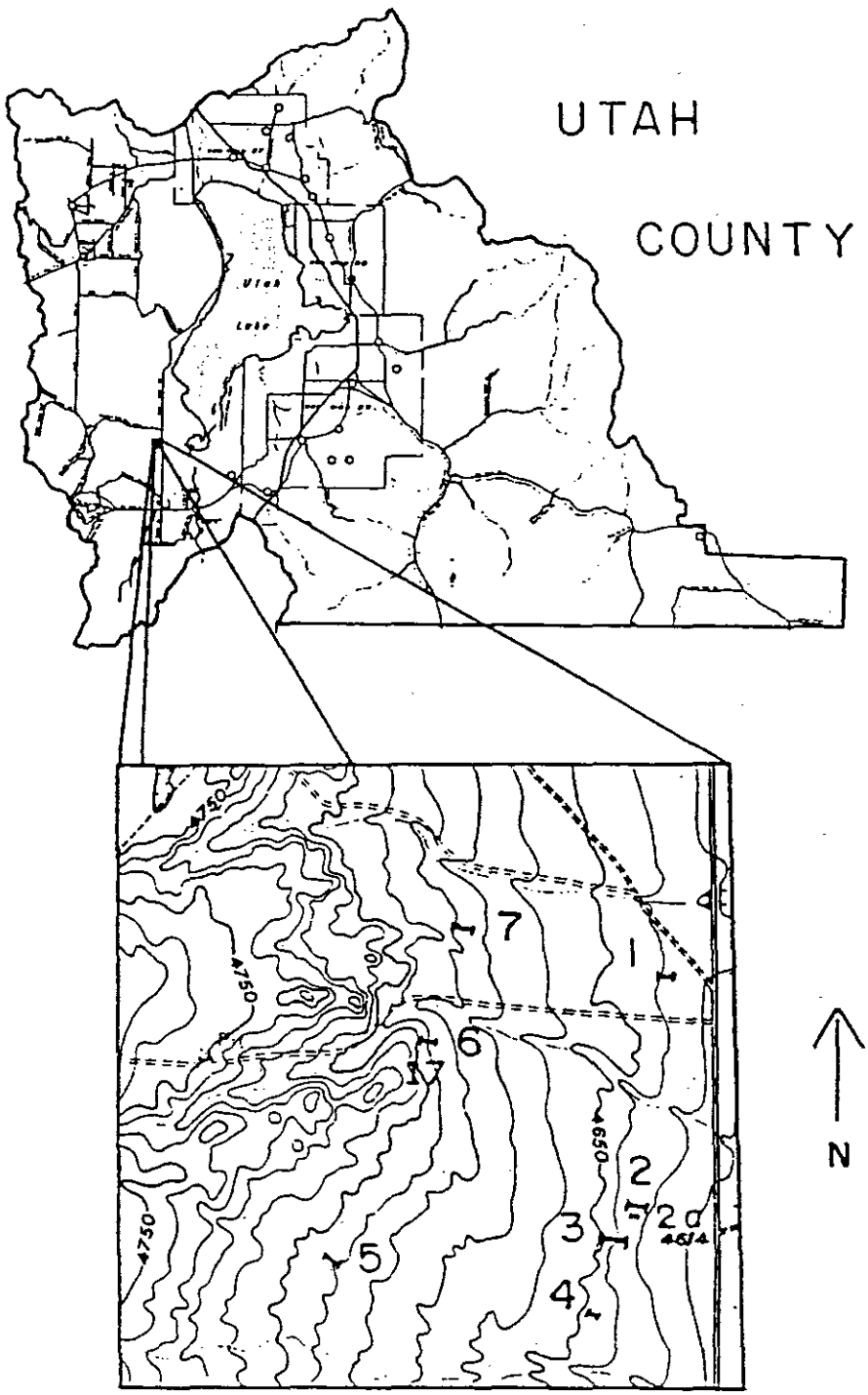

Figure 1. Map showing the location of the study area, Section 17, T. 9 S., R. 1 W., SLB&M, Goshen Valley, Utah. Single digit numbers refer to trenches. See text for logs and descriptions of trenches.

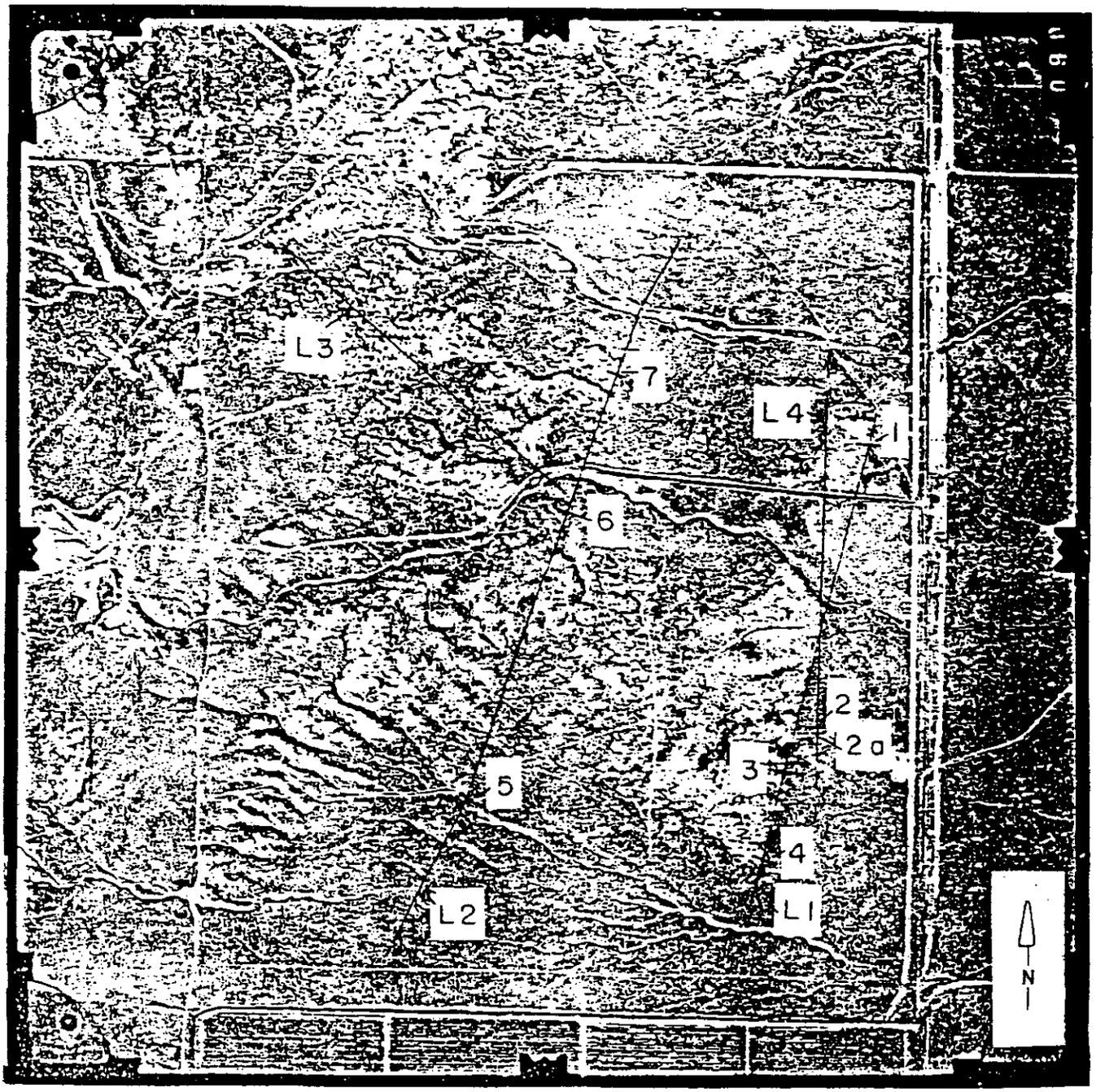

Figure 2. December, 1986, aerial photograph of the study area. Lineaments are labeled L1 to L4. Trench locations are labeled 1 to 7. Scale is approximately 1:11,500.

Eight trenches were excavated on March 24, 25, and 26, 1987 (Fig. 2) across lineaments L1, L2, and L4. Lineament L3 had no surface expression or traceable linear features, and hence was not trenched. Kimm Harty and Suzanne Hecker of the Utah Geological and Mineral Survey logged trench # 1 (Fig. 2). Robert M. Robison (Utah County Geologist) and John D. Garr (EarthFax Consultants) logged the other trenches. EarthFax Consultants were hired by Environmental Science and Engineering to participate in the investigation.

TRENCH LOCATIONS AND DESCRIPTIONS

Trenches were numbered from north-to-south on the eastern lineament (L1, trenches numbered 1 to 4, Fig.2) and from south-to-north on the western lineament (L2, trenches numbered 5 to 7, Fig. 2). The eighth trench (number 2a, Fig. 2) was parallel to trench number 2 to verify continuity of the sediments through a disturbed area. Horizontal level lines were used for elevation control and reference to bedding and features in logging trenches. The original scale of the trench logs was 1:50.

Five units were recognized in trench number 1 and were correlated in all of the trenches. A detailed explanation of each unit giving the type of deposit, thickness, color, texture and features, and genesis, is included in the appendix. A summary of the location and principal features in each trench is given below:

Trench Number 1. This trench was across the north end of lineament L1 (Fig. 2, Appendix A). Five stratigraphic units were delineated in this trench. The continuity of the beds can be seen in trench log #1 (Appendix A). Stringers of sand can be traced through the deposits. The fractures in the clayey sediments may be the result of shrinking from desiccation, or from liquefaction.

Trench Number 2. This trench was along lineament L4 (Fig.2). A total of 4 sedimentary units were logged in the trench. A large burrow(?) in the central portion of the trench made linear continuity of deposits unclear. A second trench (2a, Fig. 2) was excavated parallel to trench 2 which had continuous bedding in the region of the burrow. No logs were made of trench 2a, but photos (not included in this report) were taken.

Trench Number 3. A 5+ m high scarp was present at the site of trench number 3. A 36 m long trench was excavated across this scarp to ensure that any faults would be discovered (trench #3, Appendix A). Five stratigraphic units were logged in this trench.

Trench Number 4. This trench was located at the south end of lineament L1 (Fig. 2). Three continuous stratigraphic units were found.

Trench Number 5. Trench 5 was located at the south end of lineament L2 (Fig. 2). Three sedimentary units were identified. Unit 1 was subdivided into units 1 and 1a because of the presence

of lacustrine(?) gastropods in unit 1a (Appendix A). Sand filled fissures were common.

Trench Number 6. Trench number 6 was located in the central portion of lineament L2 (Fig. 2). Three sedimentary units were found (Appendix A). Fissures were common and most were filled with sand. Several small (< 2 cm) fissures were open within unit 3.

Trench Number 7. Trench 7 (Fig. 2) was located on the north end of lineament L2. A 3 m (9 foot) scarp was trenched approximately 11 feet deep, which revealed only eolian sand. The scarp was apparently a dune slip face (lee slope). The trench walls were very unstable and no logs were made of the trench. Photographs were taken of the trench but were not included in this report.

DISCUSSION

Sediments and features of Pleistocene Lake Bonneville dominate the study area. The western margin of the site is approximately at the Provo shoreline of the lake occupied 14,000 - 15,000 years ago. Shoreline deposits are chiefly gravel which grades eastward to offshore facies of sand, silt, and clay. Most of the lake sediments are beneath a thin covering of sandy Holocene alluvium and eolian material. In addition to these surficial deposits, trenches exposed sand and gravel. Deposits representing the transgression of Lake Bonneville about 25 thousand years ago (unit 5, Appendix); deep lake clays of the

highstand about 15 to 16 thousand years ago (units 3 and 4) and the drop to the Provo Shoreline 15 thousand years ago, and the regression of the lake out of the study area about 13 to 14 thousand years ago (unit 1a and 2). For a more complete discussion of the history of Lake Bonneville see Currey and Oviatt (1985).

The lineaments identified for study varied in surficial expression and probable origin. The aerial photographs used by Robison (1986) to identify lineaments were taken in 1959, and the photos used by ESE were taken in 1986 photos. Lineament number 1 (Fig. 2) was less visible on the 1986 photo as compared to the 1959 photo, and was at a slightly different orientation. Lineament number 2 (Fig. 2) was more evident on the 1986 photos. In addition to surface faulting, possible origins of the lineaments include grazing patterns, animal trails, fence lines, abandoned canals or ditches, differential erosion of surficial material, or natural drainage lines. The change in the character of the lineaments in the 27 years between the photos may be the result of stabilization after previous land uses, continued erosion of natural features. Also, several sand dunes are present roughly parallel to the lineaments.

No existing geologic or surficial maps indicate surface fault ruptures in this area, and none were found in the investigation. Faulting at depth has been inferred by Cordova (1970), but no faults were extended to the ground surface. Several trenches exhibited layers of sediments with sand-filled fissures with little or no offset. These fissures trended roughly parallel to lineaments, but none were found which reached the

ground surface and are not the cause of the lineaments. The sand-filled fractures may be the result of either liquefaction or desiccation. If they resulted from earthquake-induced liquefaction, the earthquake causing the liquefaction would not necessarily have had an epicenter at the location of the liquefaction. A large earthquake on the Wasatch Fault, about 12 miles east, would shake the study area sufficiently hard to induce liquefaction when ground-water conditions were favorable. The earthquake would have had to occur after deposition of the clayey sediments (unit 3, Appendix A) about 13,000 to 12,000 years ago, but before the water table had dropped, possibly about 10,000 years ago.

If the sand-filled features are the result of desiccation, then a triggering earthquake is not necessary. The fissures could have formed any time following the retreat of Lake Bonneville from this level about 12 ka. Surface water or wind could have carried the sand into the fissures. Locally, some of the fissures were open (+/-1 cm) within unit 3.

CONCLUSIONS AND RECOMMENDATIONS

The trenches revealed no features which could be interpreted as tectonic faults. The trenches were sufficiently deep to encounter well-bedded late Pleistocene (Lake Bonneville age) and Holocene sediments in which offsets due to faulting would have been readily apparent. The lineaments must be the result of past land uses, meandering drainages, and/or wind erosion and deposition.

Small sand filled fractures in trenches may be result of liquefaction during times of higher ground-water or from desiccation as sediments dried. Under present conditions, the liquefaction potential for this area is very low (Anderson and others, 1986). There appears to be no surface fault rupture hazard at the site, however, trenches or other excavations produced from the construction of the landfill should be periodically inspected by the Utah County Geologist to check for possible faults in areas not covered by this investigation.

SELECTED REFERENCES

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Cordova, R.M., 1970, Ground water conditions in Southern Utah Valley and Goshen Valley, Utah: Utah Department of Natural Resources Technical Publication No. 28, 79 p.

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Robison,R.M., 1986a, Elberta landfill site: Unpublished Utah County Planning Commission Letter, 2 p.

_____, 1986b, Elberta landfill site (Provo, Utah): Unpublished Utah County Planning Commission Letter, Dec., 1986, 4 p.

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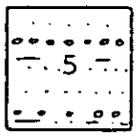
APPENDIX

EXPLANATION FOR TRENCH LOGS

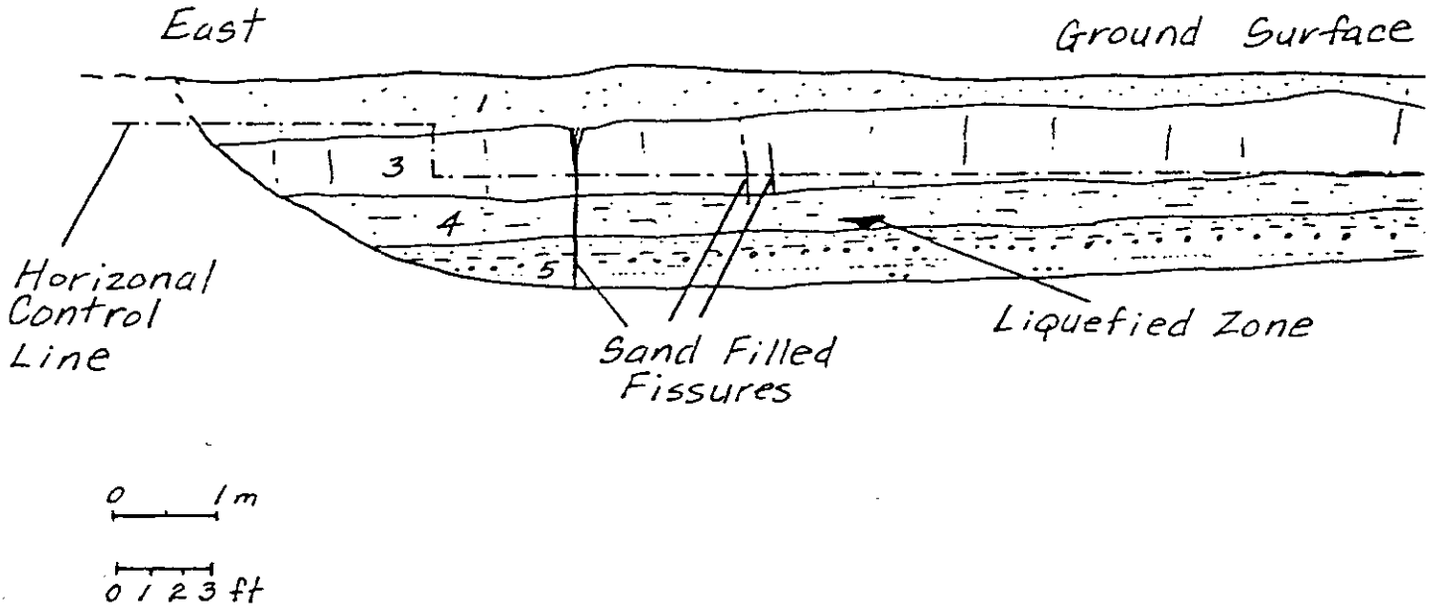
UNIT	DESCRIPTION
1 1a	Sand, silt (SP, SM, ML): some organic material, gravel present locally; unit may be >1 m thick; light brown to tan, Munsell color is 2.5Y 7/2 (dry) to 2.5Y 6/4 (damp); if sand is predominant, color may be 10YR 5/3 . Material is eolian sand, loess and/or alluvium, roots are present and burrows are abundant. This unit is the present ground surface and is probably still being deposited. Unit 1a has sand with features and color similar to unit 1. This unit is bedded with pockets of gastropods, indicating that it may be lacustrine in origin and older than unit 1, possibly 13,000 to 14,000 years ago.
2	Interbedded clay, silty clay and clayey silt, fine sand, (CL, CL-ML, SM): clay content increases toward bottom of unit, sand increases toward top of unit; unit thickness may be 2.6 m; color is green to gray, lower unit is 5Y 5.5 to 6.1 with laminations of 2.5Y 8/2 , unit grades upward to 5Y 7/2; laminated, may have sand filled fractures locally; probably represents the regressive deposits of Lake Bonneville, about 15,000 - 14,000 years ago.
3	Blocky clay (CH): homogeneous, maximum thickness about 1 m; brown to reddish brown 10YR 5/2-3; some laminations or mottling present; may locally have sand filled fissures. $CaCO_3$ horizon may be present at the top of unit; these deposits may represent the deep water cycle of Lake Bonneville, about 18,000 years ago.

Interbedded clay, silty clay and clayey silt, some fine sand (CL, CL-ML, SM): clay content decreases at the base of unit; resembles unit 2; thickness is about .9 m maximum; laminated, color is green to gray, 5Y 6/1 with streaks of 5Y 8/1 to 7/2; some sand filled fissures present; this unit was probably deposited in the deepening waters of the transgression of Lake Bonneville, about 19,000 to 20,000 years ago.



Interbedded gravel, sand, (GM, SM): bedded gravel, moderately to well sorted in places, maximum clast size 10 cm; unit thickness exceeds 1.2 m; light brown, 10YR 5/4 , a layer of red sand (oxidized iron stain) may be present at the contact between unit 4; liquefaction features (small diapirs) may be present at the upper contact; this unit may represent the transgressive gravels of Lake Bonneville, about 20,000 years ago.

TRENCH #1



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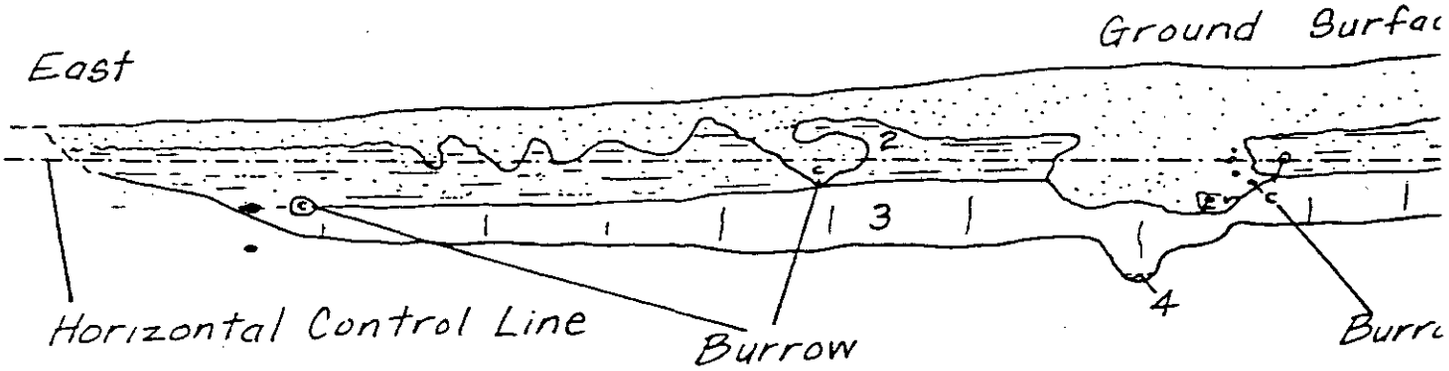
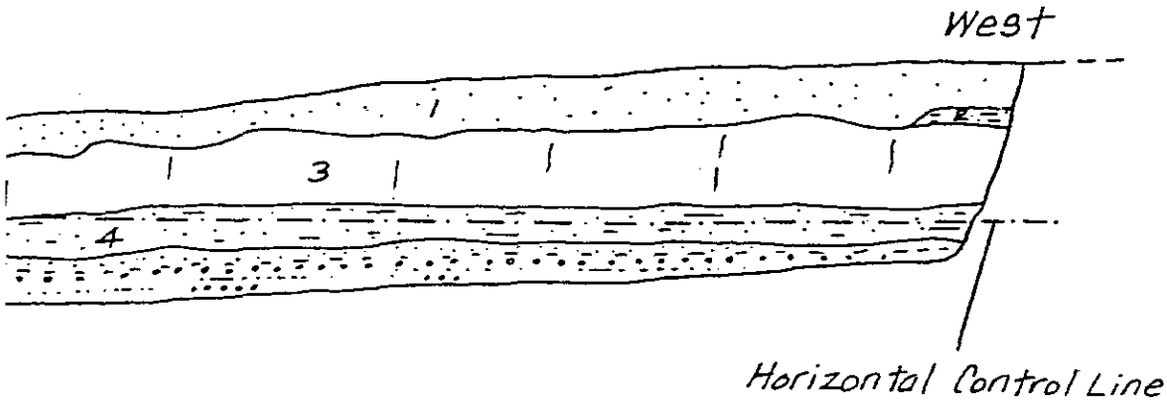
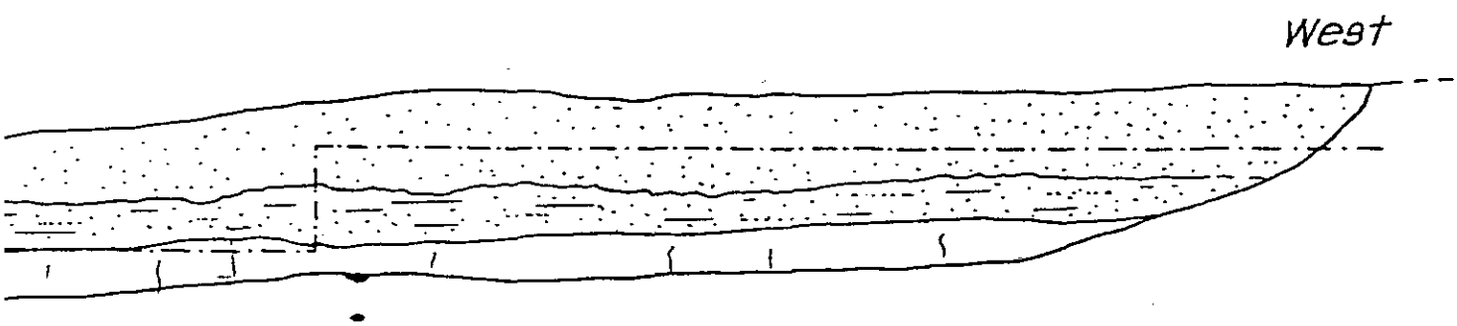



West
3
4
Horizontal Control Line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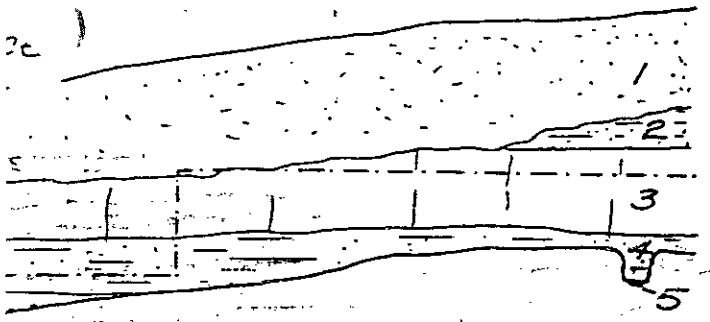

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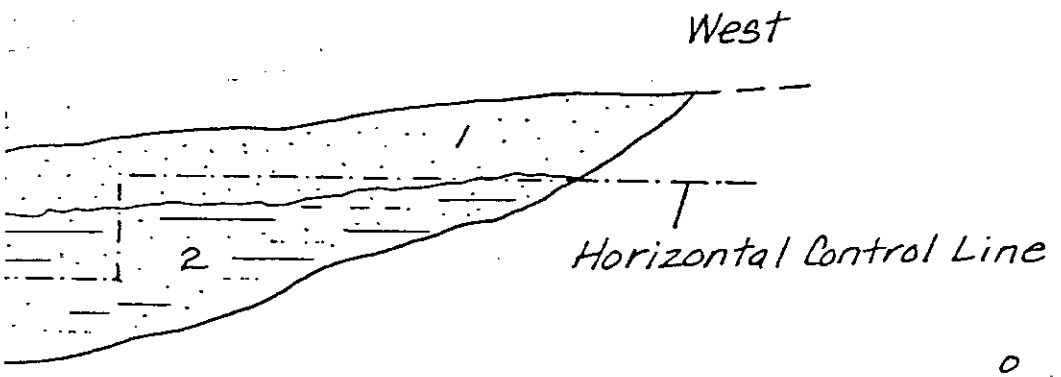

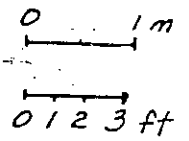

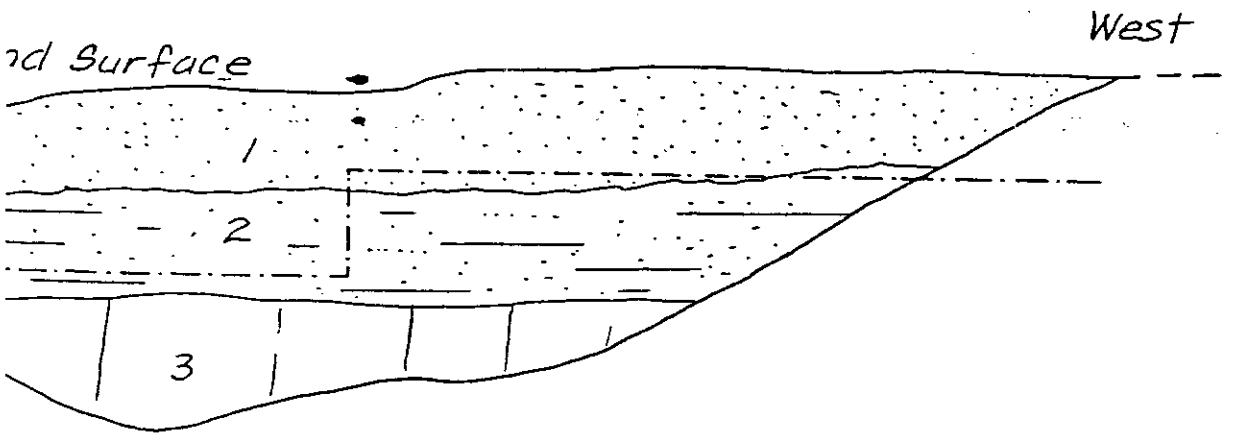

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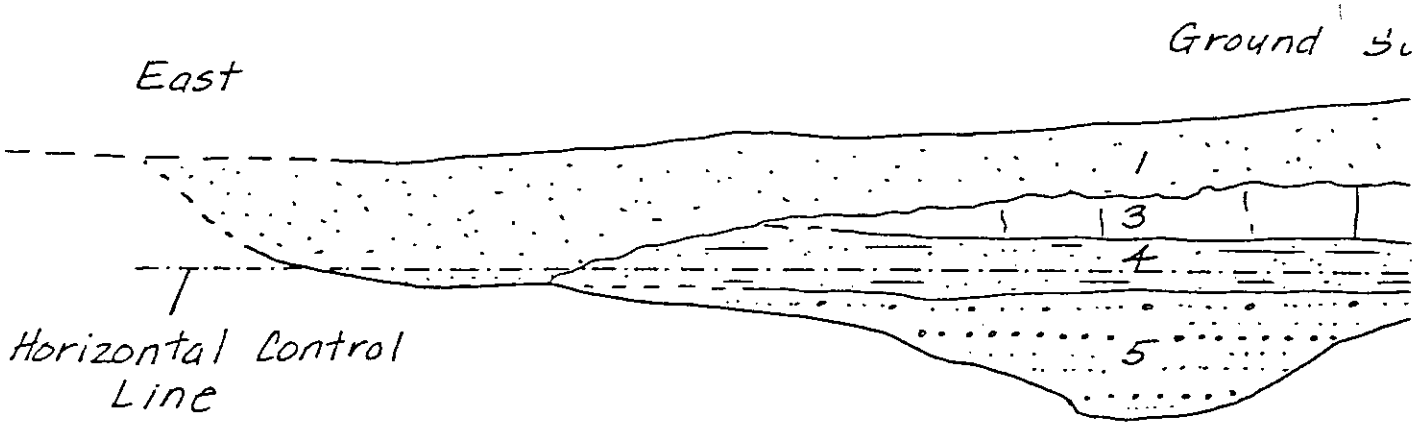

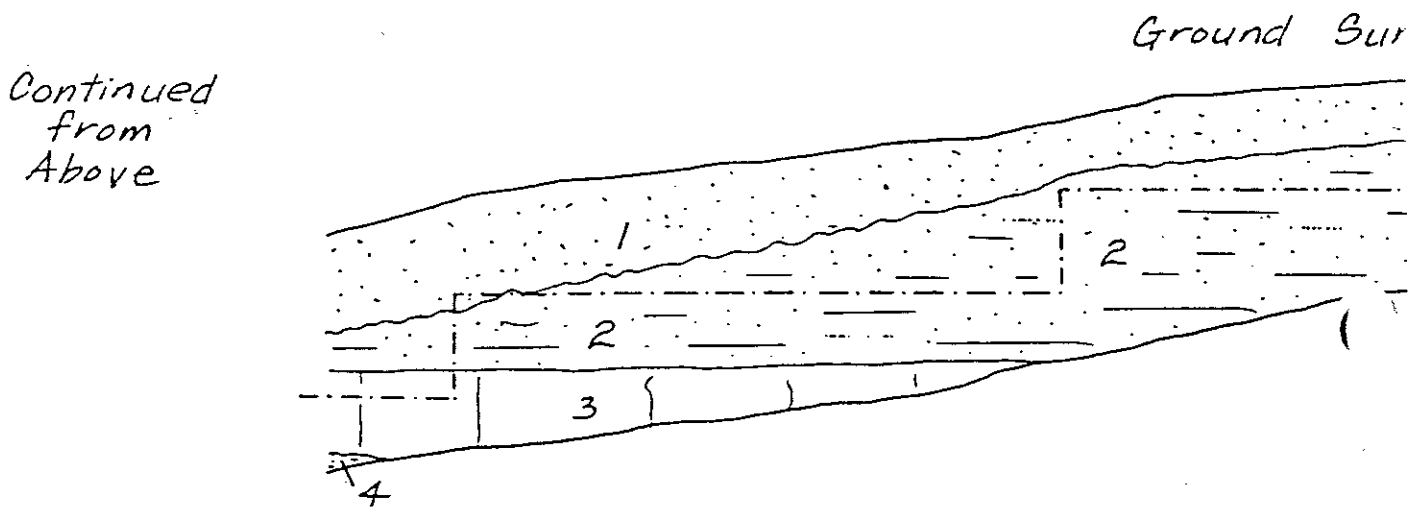

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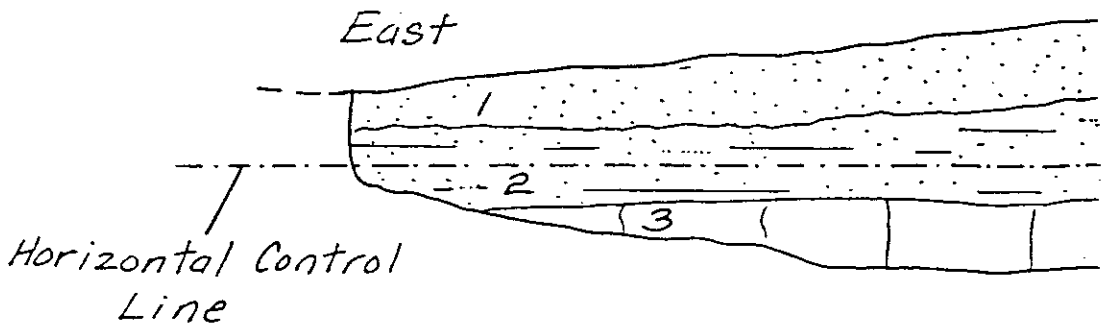

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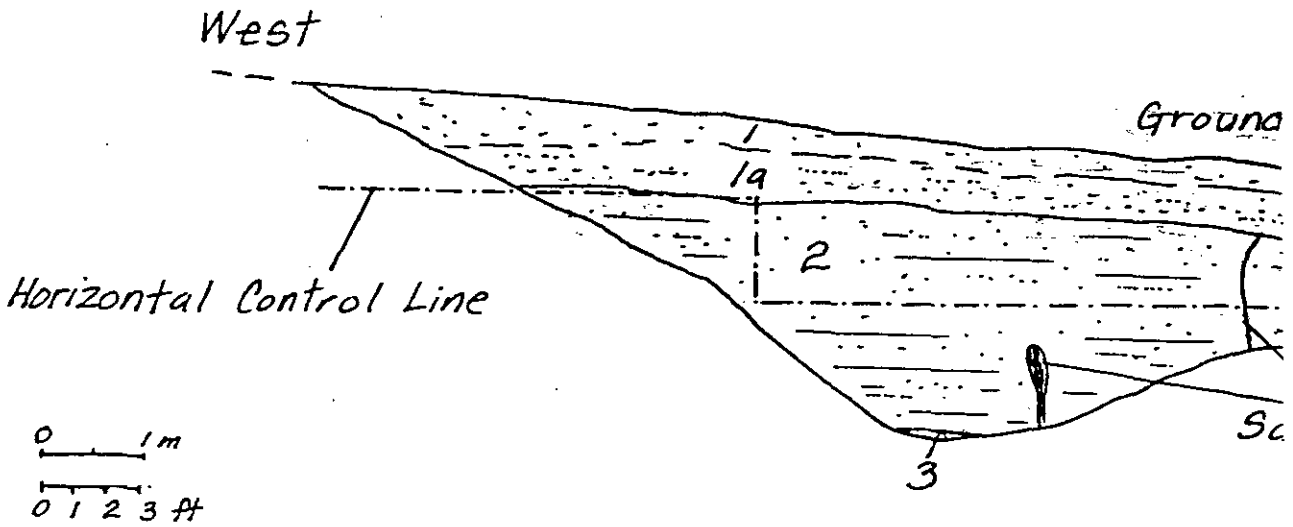

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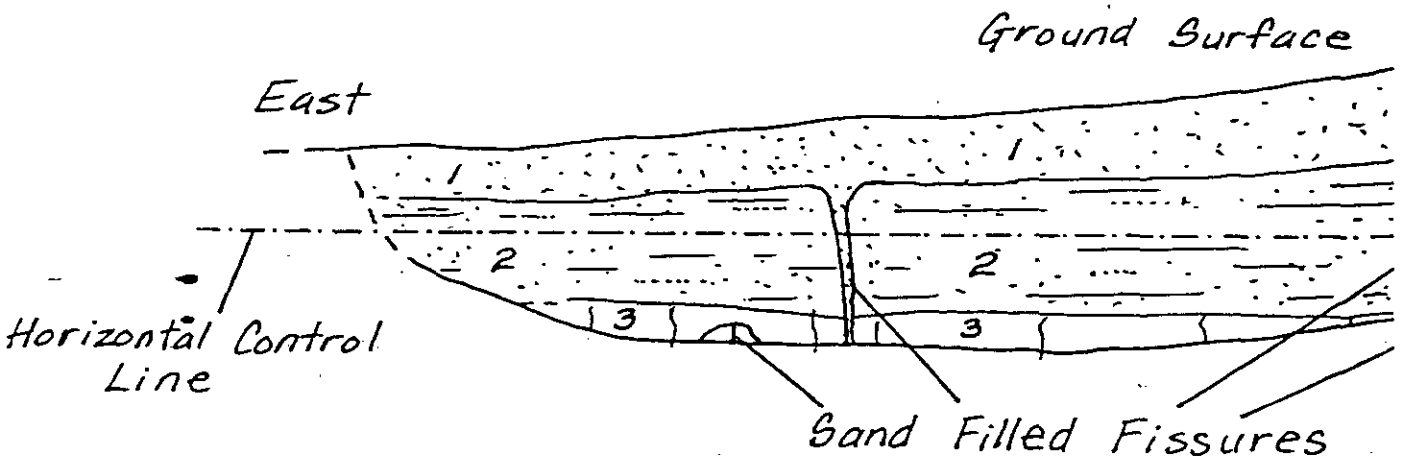
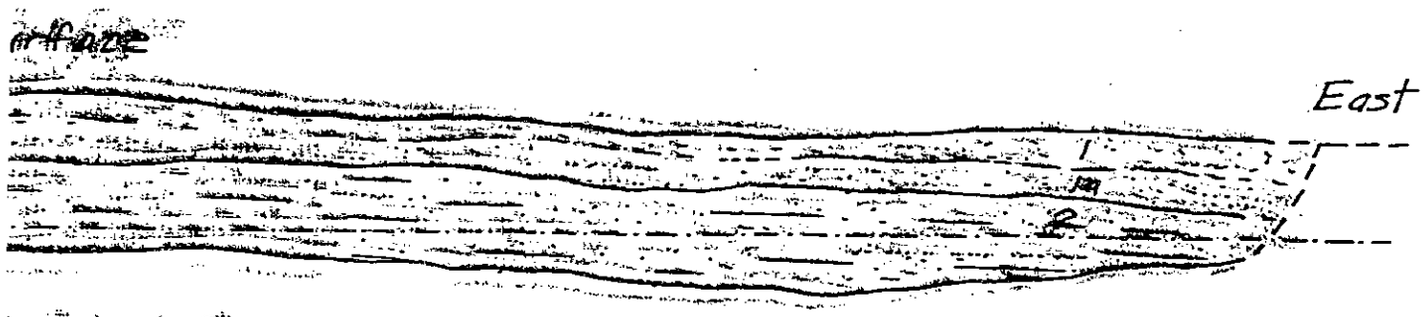
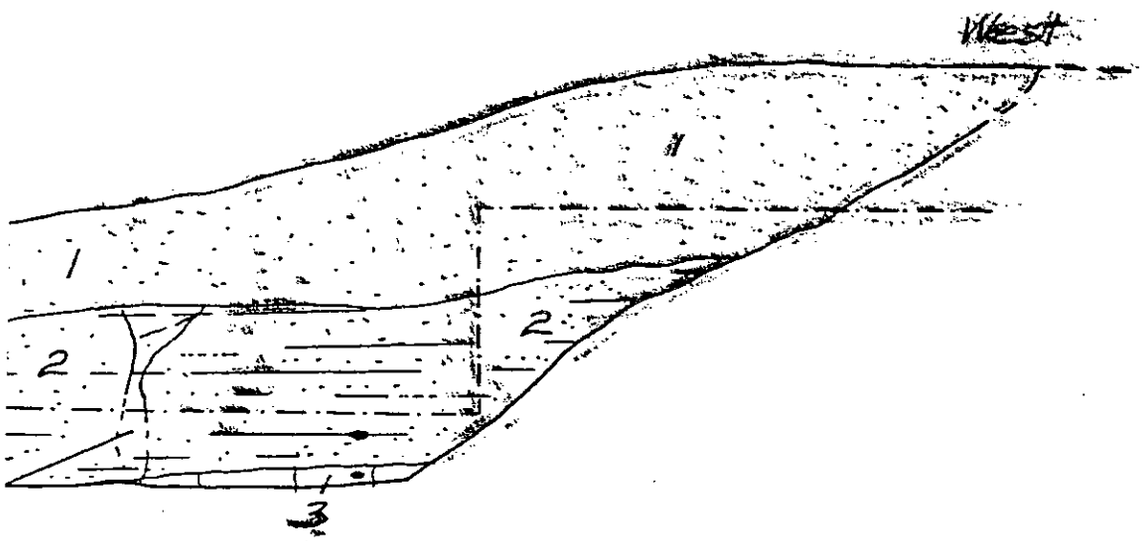




Filled Fissures



APPENDIX I

INSPECTION FORMS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

Bayview Landfill Inspection Report

South Utah Valley Solid Waste District

Type of Inspection: Daily/Weekly/Monthly/Quarterly/Semiannually (circle one)

Performed by:_____ **Date:** _____

	Overall Condition	
	Satisfactory	**Needs Work***
1. Structures & Roads		
Fences & Gates		
Access Roads		
Ditches		
Screening Berm		
2. Landfill Operations		
Fence & Gates		
Litter Control		
Protective Cover		
Daily Cover		
Intermediate Cover		
Final Cover		
Equipment		
Stormwater Ditches		
3. Leachate Pond		
Fence & Gates		
Depth Gage		
Liner System		
Influent Pipe		
Gravity Sewer		
4. Monitoring Facilities		
Weed Control		
Groundwater Wells		
Gas "Wells"		

*Specify the work needed and the timeframe.

Other Comments:

_____

_____

_____

_____

APPENDIX J

SEISMIC ANALYSIS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

APPENDIX J

SEISMIC ANALYSIS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted September 2003

Prepared By:

HDR ENGINEERING, INC.

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Attachment A - Design Earthquake Motions
Attachment B - Static and Pseudo-Static Stability Analyses
Attachment C - Site Seismic Response Analyses
Attachment D - Seismic Deformation Analyses
Attachment E - Source Material Investigation - Kleinfelder

SECTION 1.0
INTRODUCTION

1.1 Purpose

The Bayview Landfill is located in a Seismic Impact Zone, as defined by the Sate of Utah Administrative Rules (Utah Department of Environmental Quality, 1996).

This report provides analyses demonstrating that, "...all containment structures ... and surface water control systems are designed to resist the maximum horizontal acceleration in lithified earth material for the site."

These analyses have been conducted in accordance with the State of Utah Administrative Rules and EPA guidance presented in RCRA Subtitle D (258) Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, (EPA, 1995).

1.2 Scope

The scope of this report includes a literature review of regional and local seismicity, demonstration analyses of the seismic performance of the site features and a report of findings and conclusions. This report is divided into the following sections:

- **Section 2** – Site Conditions – presents soils, geology and seismicity data for the site.
- **Section 3** – Static and Pseudo-Static Stability Analyses – presents stability analyses for Cell 2 components.
- **Section 4** – Site Specific Ground Motions – presents site specific seismic response of the site soils and landfill features.
- **Section 5** – Deformation Analyses – presents estimates of deformations of the site soils and landfill features.
- **Section 6** – Findings and Conclusions – discusses the impact of the estimated deformations on the function of the landfill features.

SECTION 2.0
SITE CONDITIONS

2.1 Location

The site is located in Sections 17 and 18, T9S, R1W, of Utah County. The site is approximately 5.5 miles north of Elberta, Utah and directly west of state Highway 68. The approximate latitude and longitude of the site are 40°02'N by 111°58'W.

2.2 Soils

Information on the site soils has been obtained from regional references, on-site soil borings and on-site monitoring well logs. The locations of the on-site borings and monitoring wells are shown on the Boring Location Plan, Figure 2-1.

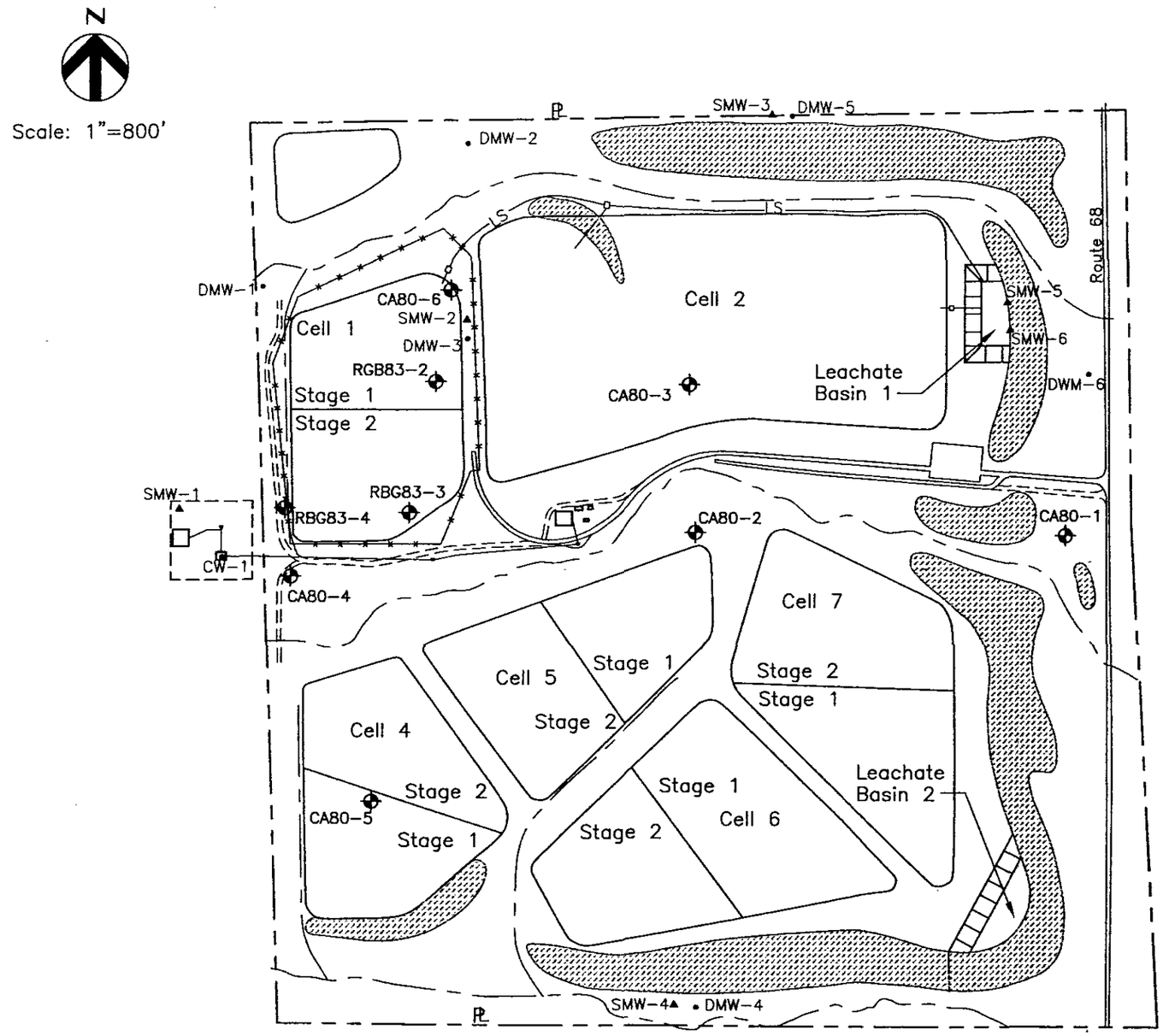
The surficial soils consist of mostly Lake Bonneville Group, Provo Formation gravel, sand, silt and clay that were deposited in Lake Bonneville during Pleistocene time (Bissell, 1963). These soils were derived from erosion of the East Tintic Mountains and carried by streams into the ancient lake where they were deposited as beach, bar, and spit deposits along the fluctuating shoreline (Hintze and Fuhriman, 1983). This fluctuating lakeshore environment created cycles of saturation and dessication, resulting in well-consolidated deposits, commonly cemented with calcium carbonate (Chen and Associates, Inc., 1980).

Nine 50-foot deep soil borings were made on the site during site selection (Chen and Associates, Inc.) and site development (Rollins, Brown, and Gunnell, Inc., 1983). The site-specific soil borings in the vicinity of Cell 2 indicate the soils consist of interbedded layers of dense to very dense sand (SW, SP, SC); medium dense to very dense gravel (GM, GW); and firm to very hard, low plasticity silt (ML) and clay (CL). Standard Penetration blow counts range from 13 to refusal in the silts and clays; 30 to 110 in the sands; and 85 to 125 in the gravels. No stratigraphic continuity was noted among the borings (Hintze and Fuhriman, 1983).

The six shallow monitoring wells shown on Figure 2-1 were advanced to nominal depths of 75 feet (Roy F. Weston, Inc., 1994). The soil types and discontinuous stratigraphy were similar to those observed in the soil borings.

The six deep monitoring wells shown on Figure 2-1 were advanced to depths ranging from 165 to 520 feet deep to encounter the "Shallow Pleistocene Aquifer." None of the borings encountered bedrock. These deeper borings indicated a trend to a more cemented soil structure and coarser gravel sizes at depths below 100 feet. The boring logs and gradation data (Bissell, 1963) indicate that cobble and boulder size materials are present.

In July 2003, Kleinfelder undertook a series of borings to investigate existing stock piles and the Cell 2 excavation area for source materials. The information from these borings corresponds to the previous information on site soils and soil profile and results are presented in Attachment E of this report.



Legend

- PL — Property Line
- LS — Leachate Gravity Sewer
- Structures
- ▲ Monitoring Well, Perched Water Tabel
- • Monitoring Well, Shallow Pleistocene Aquifer
- Leachate Collection Manhole Structure
- Berm
- Chain Link Fence
- Unimproved Road
- Water Line (Approximate Location)
- Fire Hydrant
- Channel Diversion
- Boring Location
  CA80–Chen & Associates, 1980
  RBG83–Rollins, Brown and Gumell, 1983

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Boring Location Plan

South Utah Valley Solid Waste District
Bayview Landfill

Date
July 2003

Figure
2–1

2.3 Geology

Review of well logs summarized by the United Sates Geologic Survey (USGS, 1993) indicates that wells in nearby sections have been drilled to a depth of 800 feet without encountering bedrock.

Perched water table aquifers have been encountered within the Lake Bonneville Group deposits (Dustin and Merritt, 1980). However, water production wells are advanced hundreds of feet deep to obtain adequate yield (USGS, 1993).

The site is located in northwestern Goshen Valley, in the Great Basin portion of the Basin and Range Physiographic Province (Figure 2-2, after Dustin and Merritt, 1980). The eastern boundary of the Basin and Range Province is formed by the Wasatch Range, approximately 25 km east of the site (Hecker, 1993).

This Province is characterized by block faulting that has produced roughly parallel fault-block mountains that are separated by flat valley bottoms filled with alluvial and lake deposits.

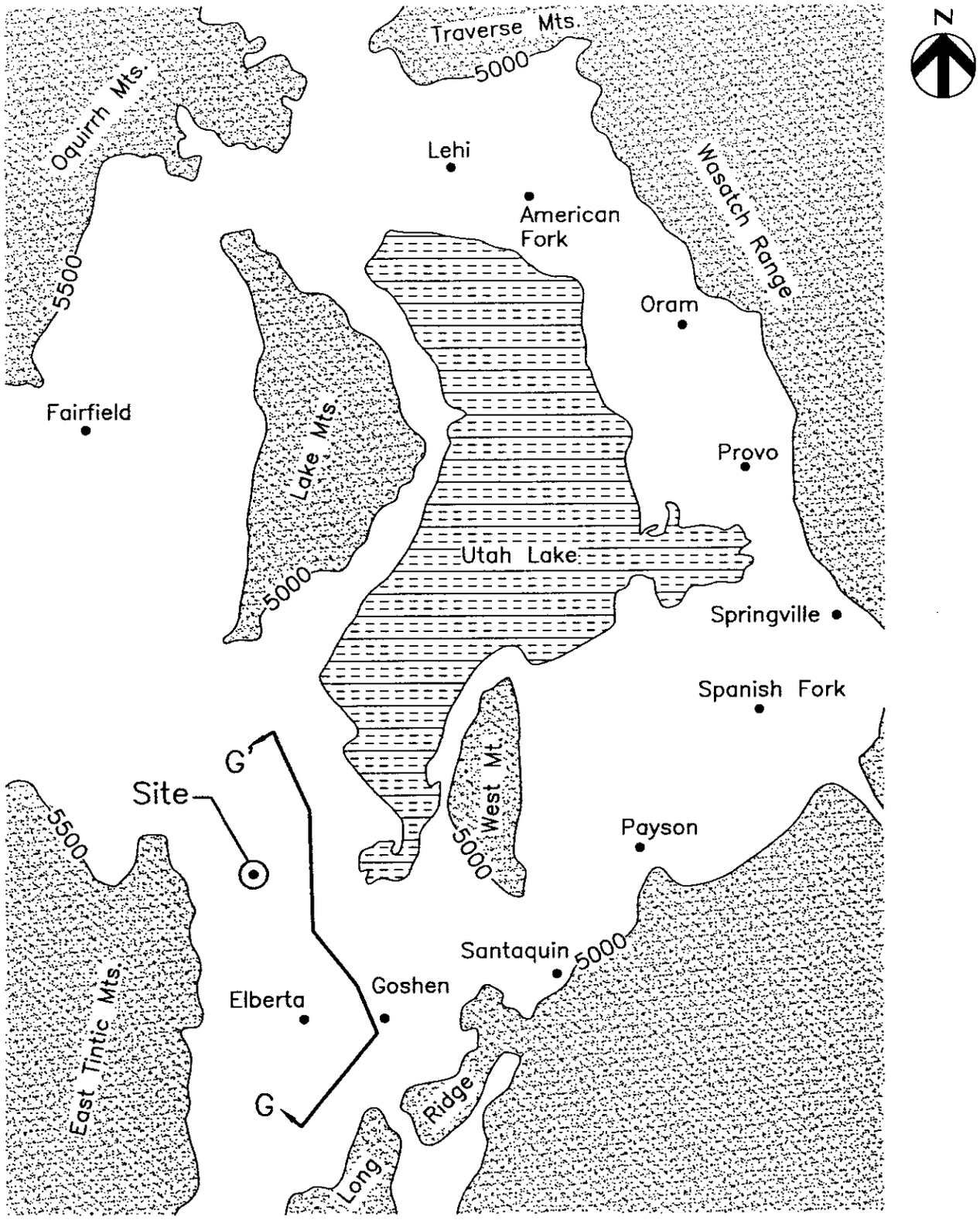
The Goshen Valley is bounded by the East Tintic Mountains on the west, Utah Lake on the north, West Mountain on the east, and Long Ridge on the south.

A cross-section of Goshen Valley, cut as shown on Figure 2-2, is presented on Figure 2-3 (Dustin and Merritt, 1980). The bedrock at the site is interpreted to consist of Miocene Epoch conglomerates, overlying Ogliocene Epoch volcanic flow materials and conglomerates, overlying Paleozoic Era limestones and dolomites.

2.4 Seismicity

The probabilistic bedrock acceleration at the Bayview site is 0.5g (490 cm/sec^2) as determined from the U.S. Geological Survey Map MF-2120 (Figure 2-4, after Algermissen et.al., 1990). The associated probabilistic maximum earthquake magnitude is 7.3 (Algermissen et.al., 1982). An overview of state-wide seismicity is presented on Figure 2-5 (after Hecker, 1993). Earthquake magnitudes (M) greater than 2, as recorded during the time period 1962-1989, are also shown on this figure.

The maximum credible earthquake (MCE) for the Bayview site cannot be determined from the probabilistic maps. These map accelerations have been established on a probability basis and often eliminate peak accelerations that are judged as having the smallest chance of occurrence.



G Profile Axis (based on well logs)

Scale
0 1 2 3 4 5
Miles

After Dustin and Merritt, 1980

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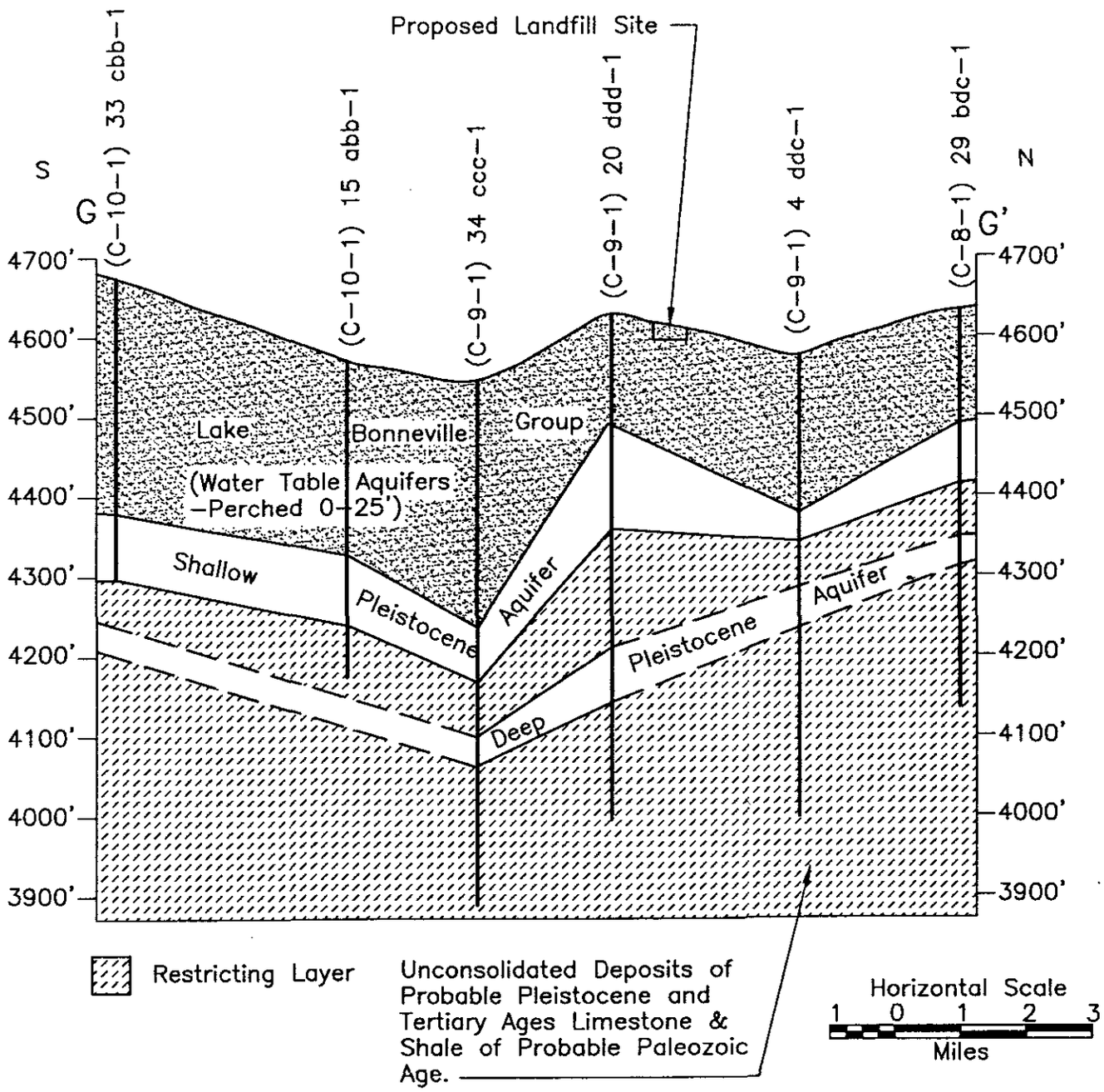
Geographic Location

South Utah Valley Solid Waste District
Bayview Landfill

Date
July 2003

Figure
2-2

\\Cd2549b3\ \AD\BAYVIEW\FIG2-2.DWG, Model, 07/10/2003 03:14:54 PM, meriksen



Atfer Dustin and Merritt, 1980

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Aquifer Cross Section G-G
Goshen Valley, Utah

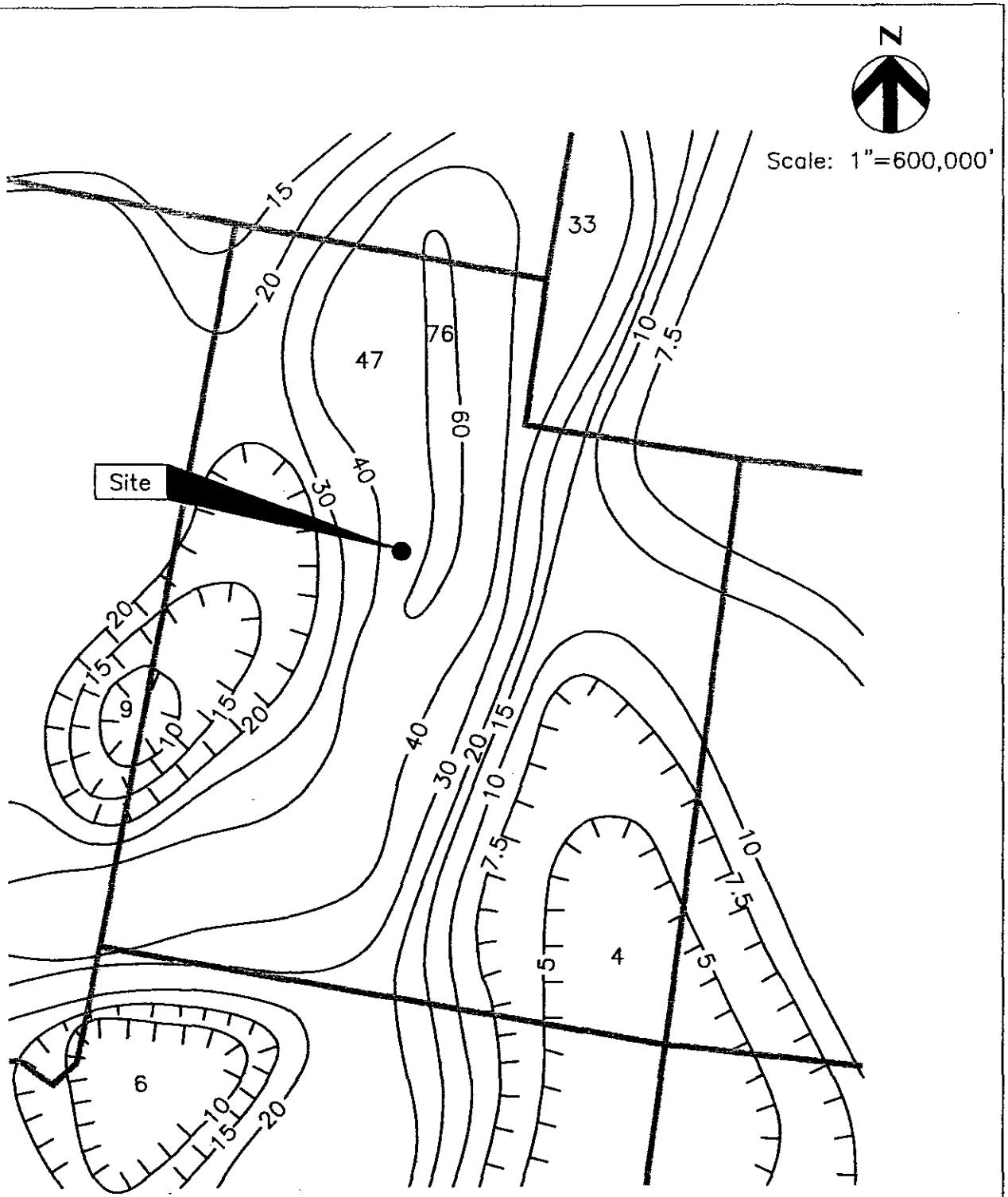
South Utah Valley Solid Waste District
Bayview Landfill

Date
July 2003

Figure
2-3

5/6/96

\\Cd254963\E_CAD\BAYVIEW\FIG2-3.DWG, Model, 08/06/2003 10:29:44 AM, meriksen



After Algermissen, et.al., 1990

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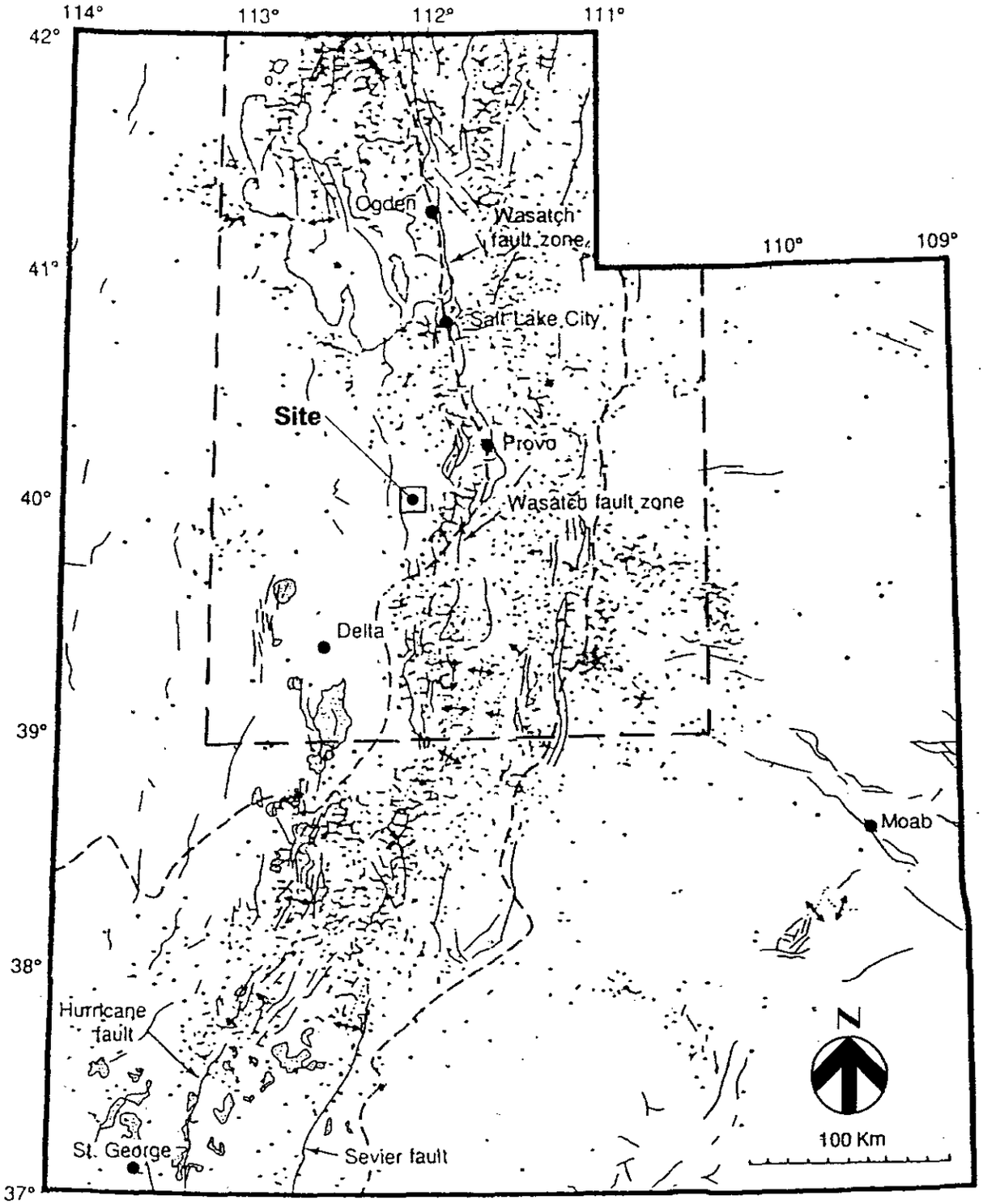
Probabalistic Earthquake Acceleration

South Utah Valley Solid Waste District
Bayview Landfill

Date
July 2003

Figure
2-4

\\Cd2549631F CAD\BAYVIEW\FIG2-4.DWG, Model, 07/10/2003 03:16:20 PM, meriksen



Notes:
1. After Hecker, 1993
2. Dots Represent M>2 Earthquakes
3. Dashed Area Represents Wasatch Fault Region

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Quaternary Tectonic Features and Seismicity of Utah

South Utah Valley Solid Waste District
Bayview Landfill

Date: July 2003

Figure: 2-5

TECTFAULT
BAYVIEW
5/6/96

Krinitsky (1989) has proposed a deterministic method, which considers the capability of a fault to produce an earthquake, independent of the probability of occurrence or return period. This method is based on the following premises:

- All earthquakes are caused by movement on faults.
- Whether or not a fault will produce earthquakes can be judged by the recency and extent of the previous fault movement.
- The size of the potential earthquake is in proportion to the size of the fault.
- Faults tend to produce earthquakes that are characteristic of each fault.

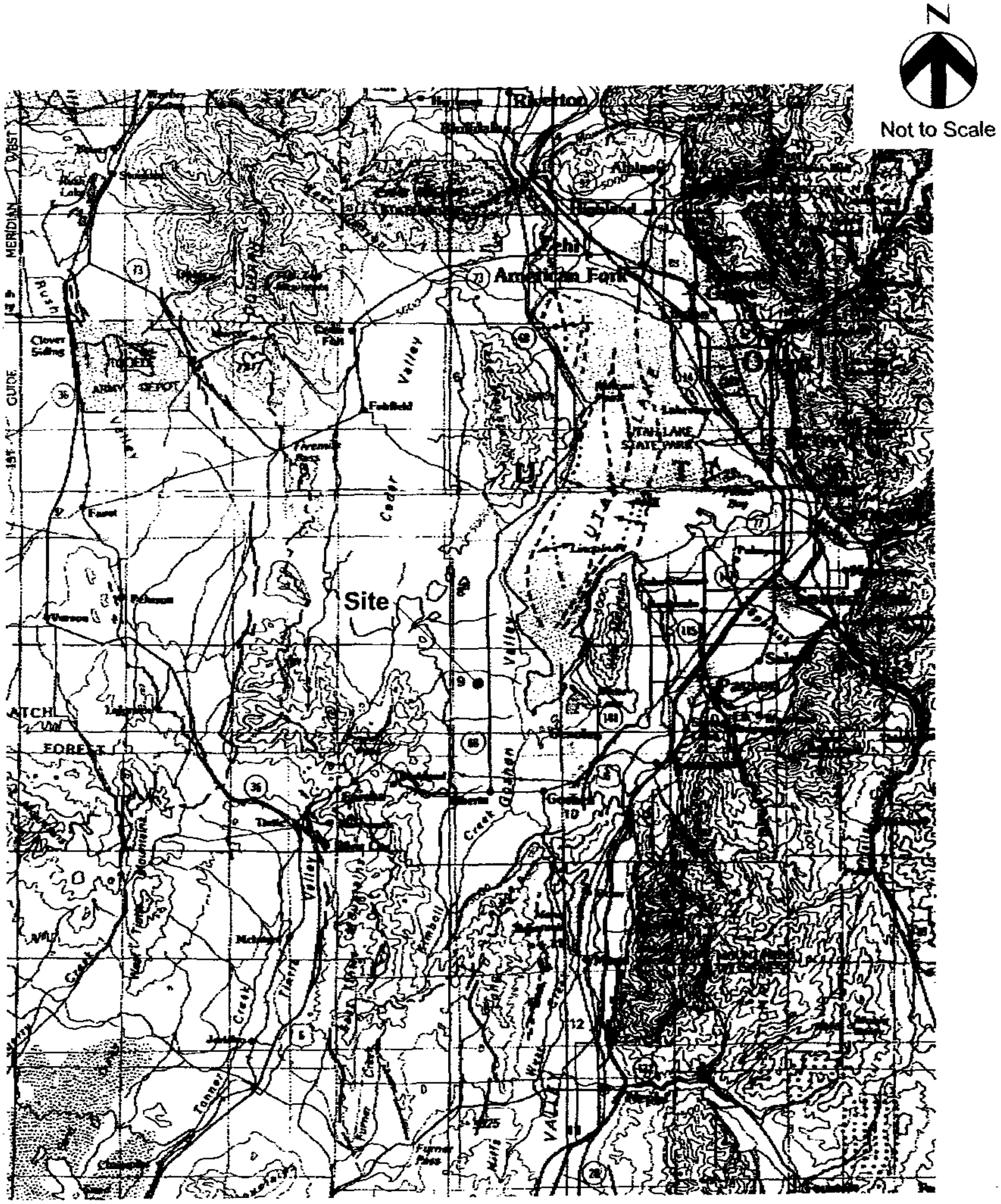
The MCE for a fault can be determined from measurements of fault length and surface displacement. The intensity and acceleration at the site can then be determined from source-to-site distance-attenuation relationships.

The site is located in the "Wasatch Front region," defined as the geographical area from latitude 38°55'N to 42°30'N, and from longitude 110°25'W to 113°10'W (Hecker, 1993). The average regional recurrence interval for surface-faulting earthquakes (M > 6 to 6.5) within the Wasatch Front region is 125 to 300 years. However, earthquakes below this M = 6.5 threshold for surface faulting may be capable of producing damaging ground motions. Faults in the vicinity of the site are shown on Figure 2-6 (after Hecker, 1993).

The design earthquakes for the Bayview site were determined using the following steps, after Krinitsky (1989):

- Determine capable faults in the site vicinity. Capable faults are active faults judged capable of generating felt earthquakes. The criteria established by the Nuclear Regulatory Commission (Krinitsky, 1989) and the historic tectonic data (Hecker, 1993) were used to screen the potential faults.
- Determine the Maximum Credible Earthquake (MCE) for each capable fault. As discussed previously, the size of the potential earthquake is in proportion to the size of the fault. Relationships presented in Krinitsky (1989) were used to determine the source magnitude (M0) from fault rupture length and displacement.

Determine the Modified Mercali Intensity (MMI) and maximum horizontal acceleration (MHA) of the MCE at the Bayview site. Source-to-site attenuation, intensity, and acceleration at the Bayview site were determined in accordance with Krinitsky (1989).



After Hecker, 1993

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Quaternary Faults and Folds, Utah

South Utah Valley Solid Waste District
Bayview Landfill

Date
July 2003

Figure
2-6

QUATFALT
BAYVIEW
5/6/96

Details of these analyses are presented in Attachment A. The results of these analyses are presented on Table 2.1.

Table 2.1
Summary of Regional and Site Seismicity

FAULT DATA			SITE DATA	
Fault Name	Distance to Site (km)	MCE (M)	MMI	MHA
Topliff Hill	22	6.8	VIII	0.30g
Mecur	24	7.0	IX	0.30g
East Tintic Mountains	18	6.7	VIII	0.38g
Wasatch – Provo segment	24-36	7.2	IX	0.40g
Long Ridge	14	6.8	VIII	0.47g
Wasatch – Nephi segment	18-21	7.2	IX	0.50g

2.5 Adopted Design Values

The regional soil stratigraphy and site-specific boring logs were reviewed to establish a design profile for use in subsequent stability analyses. Soil shear strengths were based on the laboratory soil testing program and, correlations with the Standard Penetration Test results (Department of the Navy, 1982). Waste shear strengths were based on EPA data (EPA, 1995). The adopted stratigraphy and corresponding physical properties are summarized on Table 2.2.

Table 2.2
Soil Stratigraphy and Physical Properties

DEPTH (ft)	UNIT WEIGHT (pcf)	COHESION (c) (psf)	FRICTION ANGLE (ϕ)
Waste	50	150	22°
0-100	110	0	40°
100-800	120	0	45°
800+	120	0	45°

The adopted design earthquake for the Bayview landfill site is a MMI = IX, with a corresponding MHA of 0.50g. This deterministic value is consistent with the probabilistic values of $M_o = 7.3$ and MHA = 0.50g presented by Algermissen (1982, 1990).

SECTION 3.0
STATIC AND PSEUDO-STATIC STABILITY ANALYSES

3.1 Cases Considered

Stability analyses were conducted to determine the factor of safety against slope failures under static and pseudo-static seismic loading conditions. The following stages of landfill construction and operation, shown on Figure 2-1, were considered:

3.1.1 Cell 2, Excavation

Cell 2 is proposed for development as shown in Figure 2-1. The proposed side slopes will consist of 1V:4H (25%) slopes, to a maximum depth of nominally 70 feet along the western portion of the cell. These slopes are consistent with Utah Administrative Code R315-303-4 (3), (UDEQ, 1996)

3.1.2 Cell 2, Liner and Leachate Collection System

The proposed system will consist of a 60-mil textured HDPE geomembrane over a geosynthetic clay liner (GCL) and a cushion geotextile or a sand cushion layer.

The leachate collection/protective cover layer will consist of 2 feet of native dune sand. (See Attachment E) The side slope portions of the leachate collection/protective cover layer will be reinforced with a high strength geotextile to provide cushioning and increased side slope stability under both static and seismic loading.

3.1.3 Cell 2, Operational Filling

It is anticipated that the Cell 2 waste fills will be placed in 10-foot thick lifts, similar to the current operations for Cell 1. Fill slopes typically vary, with steeper slopes occurring at the working face. Two fill heights will be considered: 1) Elev. 4740±, representing a waste backfill to the initial ground surface, and 2) Elev. 4780, representing approximately 40 feet of waste above the initial ground surface.

3.1.4 Cell 2, Filled

The proposed waste fill slopes average 5 percent from the crest at Elev. 4780± to the slope break. The side slopes are 1V:4H (25%) from the slope break to original grade. Maximum waste fill heights in Cell 2 are 114 feet above the cell bottom and 40 feet above original grade. These slopes are consistent with Utah Administrative Code 8315-303-4 (4) (UDEQ, 1996).

3.1.5 Cell 2, Closure Cap

The proposed Cell 2 final cover will consist of a minimum of 34 inches of native olive brown silty sand overlying the waste. (See Attachment E)

3.1.6 Adopted Design Cases

These features were consolidated into the following cases for analysis:

- Cell 2, excavation slopes, considering global soil stability.
- Cell 2, liner and leachate collection system (LCRS), considering side slope stability.
- Cell 2, operational filling, considering sliding on cell floor liner and LCRS.
- Cell 2, final waste fill slopes, considering waste fill stability.
- Cell 2, closure cap, considering side slope stability.

3.2 Methodology

Both static and pseudo-static conditions were evaluated. The generalized factor of safety against a slope failure is defined as: F.S. = s/τ, where s is the available shear strength of the slope and τ is the shear strength required for just-stable equilibrium.

The Simplified Bishop circular arc method was used to evaluate the global stability of the excavated and filled slopes. The computer program PCSTABL (Purdue et. al., 1978) was used to conduct these analyses. This program searches for the potential failure surface which produces the lowest factor of safety. The location of this failure surface is a function of the site geometry (slope angle and height); material stratigraphy and physical properties; and loadings (weight of soil and/or waste above the failure surface).

The sliding block (wedge) method (USACE, 1970) was used to evaluate the sliding stability along the bottom liner and the LCRS system. The computer program PCSTABL was used to conduct these analyses. The failure surface is defined by the bottom of the cell.

The infinite slope method (USACE, 1970) was used to evaluate the stability of the cell liner and LCRS system and the closure cap system. Generally, the failure surfaces for these features are defined by planar interfaces with the geosynthetic components.

For a given slope geometry, the interface friction angle, δ, between adjacent materials normally control slope stability, with the lowest interface friction angle controlling overall slope stability. Adopted friction values for the geosynthetic interfaces are presented on Table 3.1.

A minimum static safety factor of 1.5 was adopted (EPA, 1998). The pseudo-static seismic coefficient φ was iterated for both the circular arc and the infinite slope analyses to determine the yield acceleration (k_y) corresponding to a factor of safety of 1.0. this yield acceleration is used to estimate the cell liner, cell leachate collection system and closure cap deformations (Section 5).

Table 3.1
Adopted Interface Friction Values

INTERFACE		INTERFACE FRICTION (δ)
LOWER	UPPER	
LINER & LCRS		
Soil Subgrade	Cushion Geotextile (GT) -or- Sand Cushion	27° 27°+
Cushion GT -or- Sand Cushion	Geosynthetic Clay Liner (GCL)	18° 18°+
GCL	Textured 60 mil HDPE	18°
Textured 60 mil HDPE	Granular LCRS & Reinforced GT	27°
CLOSURE CAP		
Waste Subgrade	Olive Brown Silty Sand	22°

The adopted values of interface friction were derived from numerous publications and from project experience. The specifications for the project will include a requirement that the contractor will perform laboratory tests to determine the actual interface friction for each of the geosynthetic and soil materials proposed for use.

The results of the static and pseudo-static stability analyses for the excavations and waste fills are presented in Attachment B and summarized on Table 3.2. The results indicate that the static factor of safety is adequate for the proposed cut and fill slope geometry. The yield accelerations at a safety factor of 1.0 are near the adopted peak bedrock acceleration, suggesting minimal permanent deformation (EPA, 1995). The estimated magnitude of this deformation is quantified in Section 5.

Table 3.2
Global Stability of Cut and Fill Slopes

FEATURE	STATIC FACTOR OF SAFETY	YIELD ACCELERATION
Cell 2, 1V:4H Excavation Cut Slopes	2.5+	0.52g
Cell 2, 1V:4H Finished Waste Fill Slopes	2.5+	0.50g

The results of the static and pseudo-static stability analyses for the cell liner and LCRS and the closure cap are presented in Attachment B and summarized on Table 3.3.

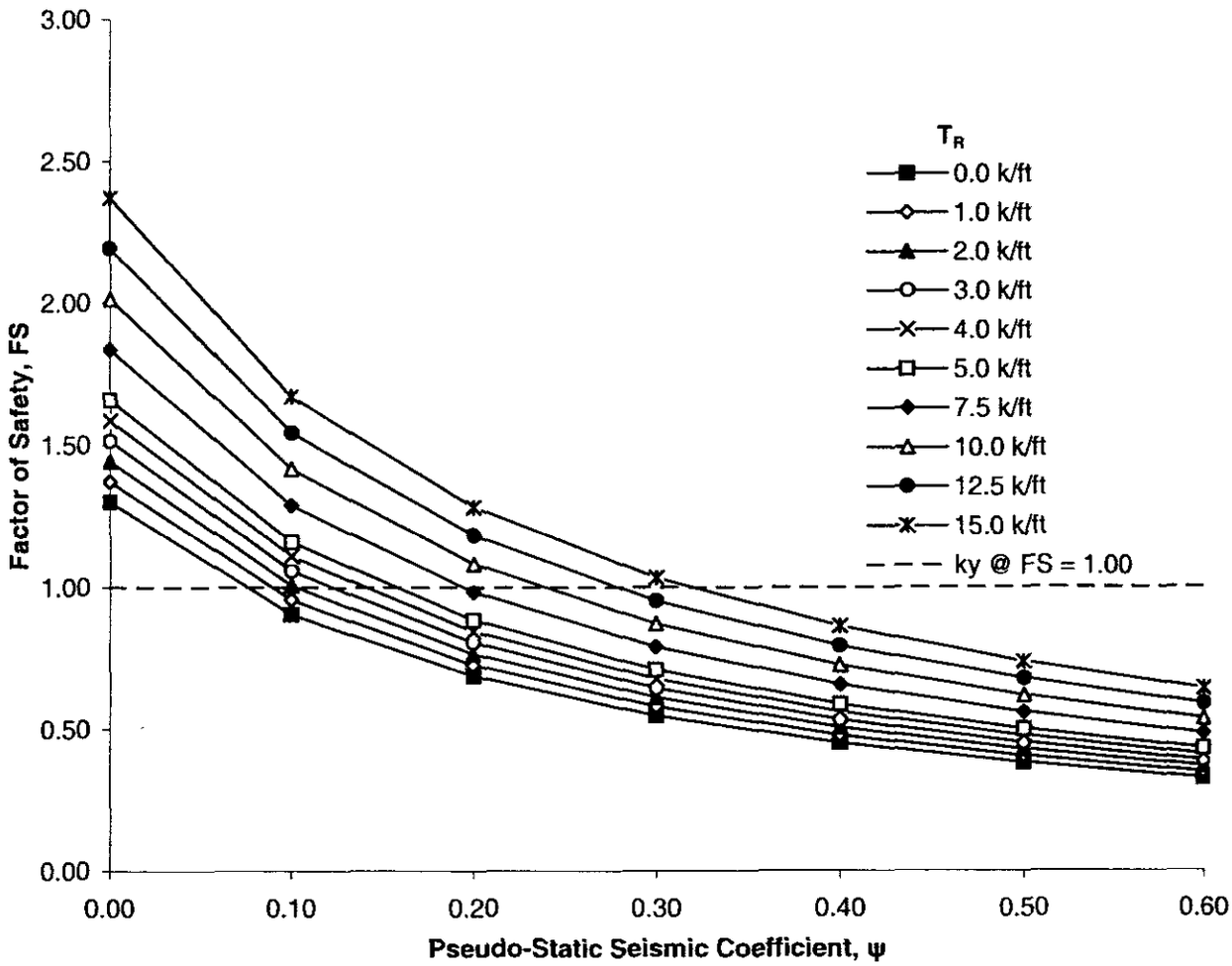
Table 3.3
Stability of Cell 2 liner and Closure Cap Slopes

FEATURE	δ	F.S.	k_y	$T_{req'd}$
Side Slope Liner and LCRS	18°	Fig 3-1	Fig 3-1	Fig 3-1
Bottom Liner and LCRS	18°	2.5+	0.22g	None
Closure Cap	22°	1.62	0.15g	None

Where $T_{req'd}$ is the required design strength of the reinforced geotextile.

Tensile reinforcement, similar to that used in the Cell 1 construction, is required to provide additional resistance against seismic forces. Higher reinforcement levels will increase both the static safety factor and the yield acceleration at which permanent displacements begin. The relationship among the interface friction angle (δ), static factor of safety (FS), yield acceleration (k_y) and the required reinforcement strength ($T_{req'd}$) is shown on Figure 3-1.

Figure 3-1
70' High 1V:4H Slope
Interface Friction = 18°



HDR | ONE COMPANY *Many Solutions*℠

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Cell 2 Liner and LCRS Stability

South Utah Valley Solid Waste District
Bayview Landfill

Date
August 2003

Figure
3-1

SECTION 4.0
SITE SPECIFIC GROUND MOTIONS

4.1 Approach

The MHA selected in Section 2 is the maximum horizontal acceleration in the site bedrock and does not reflect the effect of the overlying soils on the horizontal acceleration developed at the ground surface or at the top of the closed Cell 2.

These ground motions were determined using the "Simplified Analysis" presented in EPA, 1995. This Simplified Analysis is considered appropriate for the site, based on considerations of the soil stratigraphy and geology. The Simplified Analysis consists of the following steps:

- Classify the site, based on shear wave velocity in the upper 100 feet of the soil column.
- Estimate the free field peak ground surface acceleration (PGA), based on the site classification and the MHA in the bedrock.
- Estimate the peak acceleration at the top of the landfill, based on the PGA and the seismic response of the waste.

Details of this Simplified Analysis are presented in Attachment C.

4.2 Site Classification

The shear wave velocity was based on Utah Geologic Survey (USG) experience in the area (Christensen, 1996) and the site-specific soil borings.

The UGS has classified this area of Utah County as a "hard site," generally considered as having a shear wave velocity greater than 400 meters per second (m/s).

Site-specific shear wave velocities were computed from the Standard Penetration Test data (N values) reported in the geotechnical investigations (Department of the Navy, 1982). The computed average shear wave velocity in the upper 100 feet was 386 m/s.

Based on this range in shear wave velocity, the site was classified as a medium stiff (200 to 375 m/s) to stiff (375 to 700 m/s) site (EPA, 1995). Both classifications were carried forward for further analysis.

4.3 Free Field Acceleration

The PGA was determined from the site classification and the MHA (Section 2). Both the medium stiff and stiff classification ranges were considered. The results are presented on Table 4.1.

Table 4.1
Free Field Acceleration (PGA)

SITE CLASSIFICATION	MHA	PGA
Medium Stiff	0.50g	0.50g
Stiff	0.50g	0.50g

The results of this analysis indicate the site soils provide little attenuation or amplification to the MHA. This is a function of both the site soils and the high MHA (EPA, 1995).

4.4 Peak Acceleration at Top of Landfill

The peak acceleration at the top of the landfill was determined from the PGA and the seismic response of the waste mass, using a recommended "soft-soil site" amplification curve of Idriss (EPA, 1995).

The results of this analysis indicate a peak acceleration of 0.42g at the top of the landfill, suggesting a slight attenuation through the waste mass.

SECTION 5.0
DEFORMATION ANALYSIS

5.1 Approach

Permanent deformations resulting from the adopted design seismic event were estimated for each of the landfill features identified in Section 3. Chart solutions, based on the "Newmark sliding block" method, were used to quantify these deformations.

The Newmark method is based on the premise that permanent deformations (U) accumulate along a failure surface when the acceleration of the failure mass (a_{max}) exceeds the yield acceleration (k_y) along the failure surface. The yield acceleration and the mass acceleration for each feature are presented in Sections 3 and 4, respectively.

The results of these analyses are presented in Attachment D and discussed in the following.

5.2 Allowable Deformation

An upper limit of 30 cm (1 ft) was established as the maximum tolerable deformation for the geosynthetic components (EPA, 1995). For a 70-foot high 1V:4H slope with a slope length of 289 feet, the elongation from this maximum 1 foot of deformation would be 0.35 percent (1 ft/289 ft, as a percent). The yield elongation for 60 mil textured HDPE is nominally 12 percent (NSF, 1991), indicating adequate reserve elongation capacity.

5.3 Excavations and Fills

The permanent deformations for the Cell 2 excavations and the Cell 2 waste fill were estimated from the Makdisi and Seed chart version of the Newmark method (EPA, 1995). These estimates are presented in Table 5.1.

Table 5.1
Estimated Permanent Deformations

FEATURE	k_y	a_{max}	U
Cell 2 Excavation Slope	0.52g	0.50g	<1 cm
Cell 2 Finished Waste Fill	0.50g	0.50g	<1 cm

The estimated deformations are minor and reflect the high yield strength along the failure surface relative to the mass acceleration from the design earthquake event.

5.4 Liner and LCRS Systems

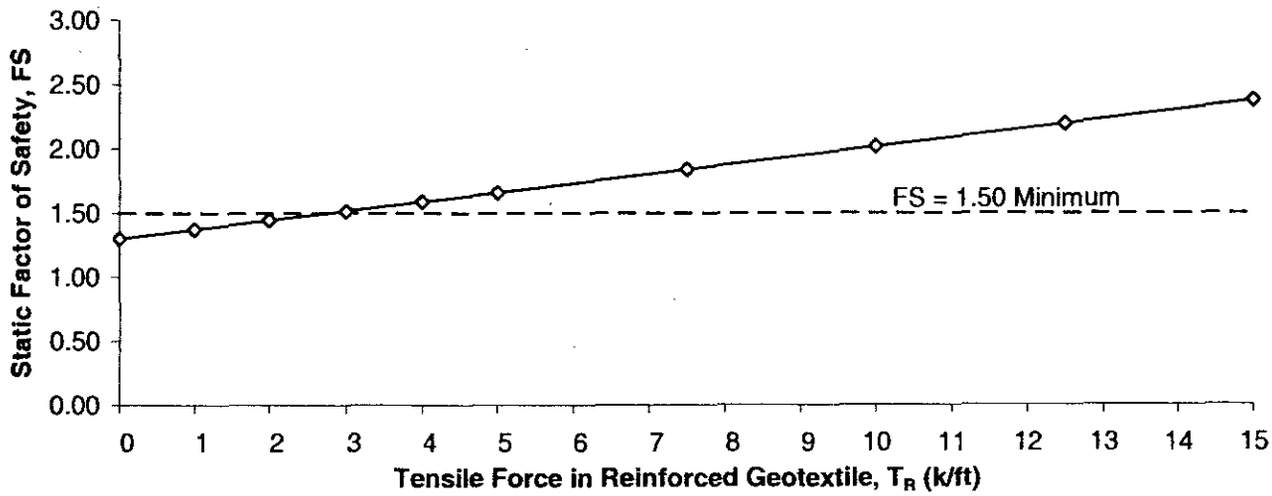
The permanent deformations for the Cell 2 liner and LCRS were estimated from the Makdisi and Seed chart version of the Newmark method (EPA, 1995). These estimates are presented on Figure 5-1.

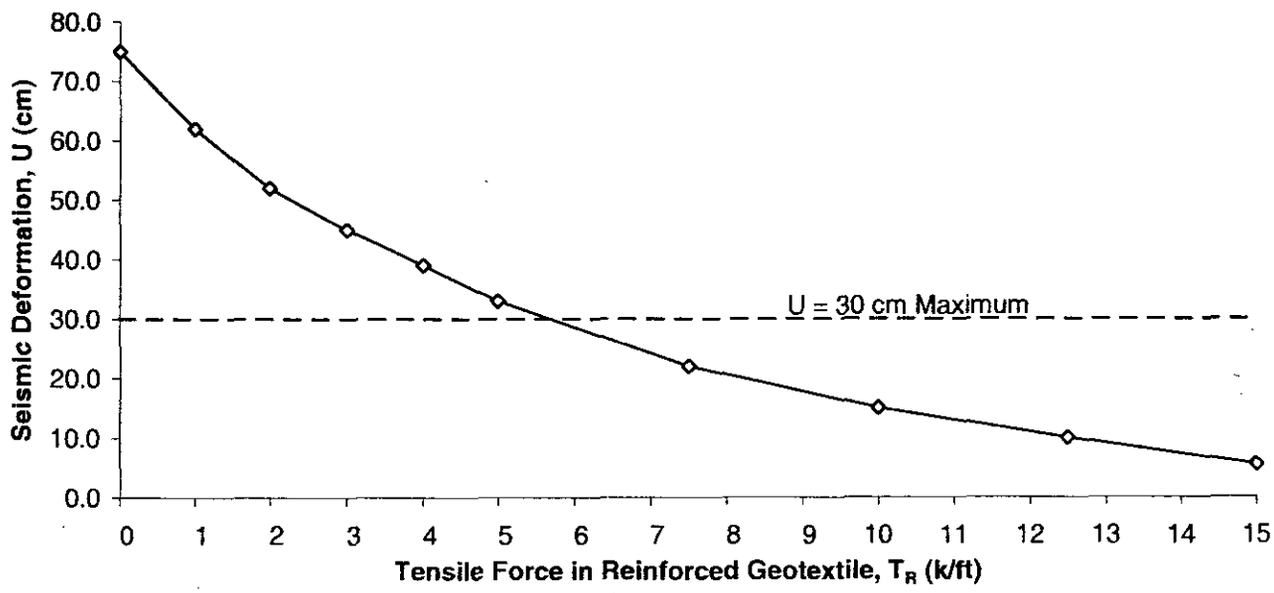
As shown on Figure 5-1, the 18° interface between the 60 mil textured HDPE and GCL requires a minimum tensile reinforcement of 5.7 kips per linear foot (klf) to limit permanent deformations to less than 30 cm.

5.5 Closure Cap System

The permanent deformations for the Cell 2 closure cap were estimated from the Hynes and Franklin chart version of the Newmark method (EPA, 1995). None of the estimated deformations exceed 10 cm. No reinforcement is required for this proposed closure cap.

Figure 5-1
70' High 1V:1H Slope
Interface Friction = 18°





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HDR Engineering, Inc.

Cell 2 Liner and LCRS Deformations

South Utah Valley Solid Waste District
Bayview Landfill

Date: August 2003

Figure: 5-1

SECTION 6.0
FINDINGS AND CONCLUSIONS

6.1 Findings

The Bayview Landfill site is located in a Seismic Impact Zone. Both deterministic and probabilistic methods indicate a peak bedrock acceleration of 0.5g. The dense granular soils offer little amplification or attenuation of the bedrock acceleration through the overlying soil column.

The cut and fill slopes have adequate static factor of safety and indicate minimal permanent deformations (U < 1 cm) in response to the design seismic event.

The side slope liner and LCRS system will require a geosynthetic reinforcement to increase the static factor of safety and limit permanent deformations in response to the design seismic event. Either sand or a geotextile can be used as a cushion beneath the geomembrane.

The closure cap system has an adequate static factor of safety and indicates acceptable permanent deformation (U < 10 cm) in response to the design seismic event. No reinforcement is required.

6.2 Conclusions

These demonstration analyses indicate that the proposed Bayview Landfill components are designed to resist the "maximum horizontal acceleration" at the site.

Liner and Leachate Collection and Recovery System (LCRS) Summary (from bottom to top):

- Non-woven cushion geotextile with a minimum weight of 20 ounces per square yard or sand cushion
- Geosynthetic clay liner (GCL)
- 60 mil textured HDPE
- Woven reinforced geotextile with a minimum weight of 3 ounces per square yard and minimum long term allowable design strength (LTADS) of 5700 pounds per linear foot (actual ultimate design strength to be determined using appropriate reduction factors during final design)
- Granular LCRS: two feet of native dune sand (poorly graded sand and silty sand, SP-SM) with the gradation noted in Attachment E and 8" diameter Schedule 80 perforated PVC pipe.

Closure Cap Summary:

- A minimum of 34 inches of native olive brown silty sand (SM) with the gradation noted in Attachment E.

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Job No. | No.

HDR Computation

HDR

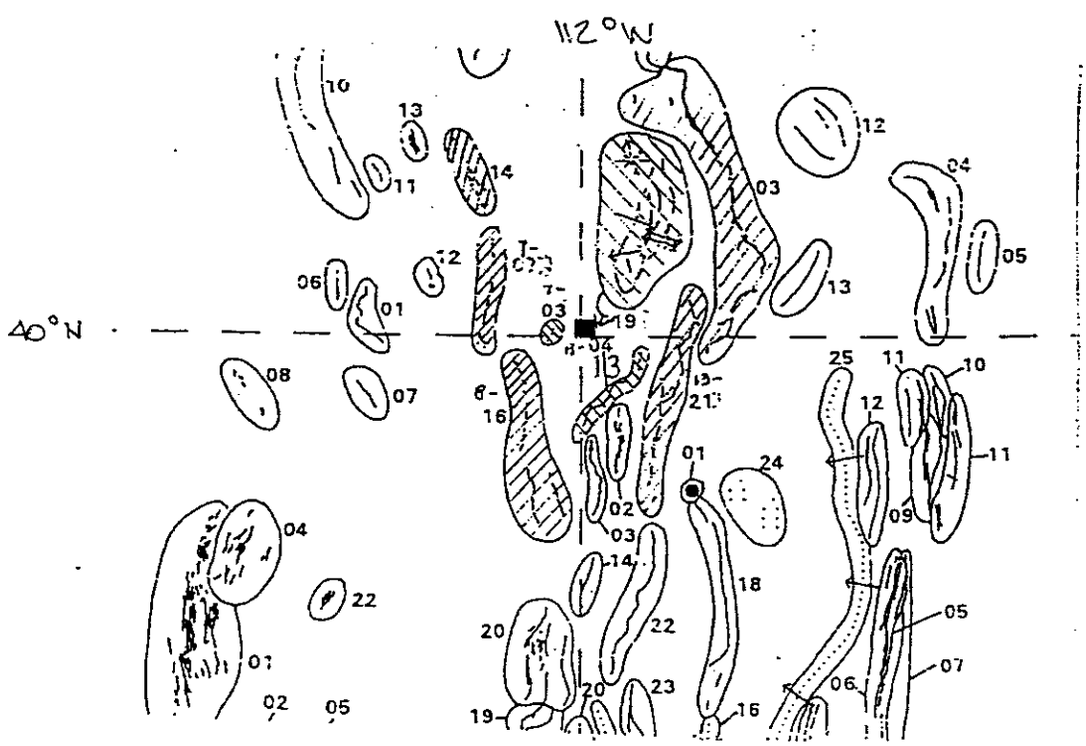
Project	BAYVIEW LANDFILL – CELL 2	Computed RLD	Date 4-29-96
Subject	LANDFILL SEISMIC EVALUATION	Checked PHP	Date 6-4-96
Task	SELECT DESIGN EQ & MOTIONS	Sheet 1	Of 4
		✓ PHP	7-18-03

OBJECTIVES : 1) DETERMINE CAPABLE FAULTS AROUND SITE
2) DETERMINE MAXIMUM CREDIBLE EARTHQUAKE (MCE) OF CAPABLE FAULTS
3) DETERMINE MMI, a_g AT SITE

REFERENCES : 1) HECKER, S., (1993), "QUATERNARY TECTONICS OF UTAH WITH EMPHASIS ON EARTHQUAKE-HAZARD CHARACTERIZATION," BULLETIN 127, UTAH GEOLOGICAL SURVEY, SALT LAKE CITY, UT.
2) KRINITSKY, E.L., (1989), "EMPIRICAL EARTHQUAKE GROUND MOTIONS FOR AN ENGINEERING SITE WITH FAULT SOURCES: TOOELE ARMY DEPOT, UTAH," BULLETIN OF THE ASSOCIATION OF ENGINEERING GEOLOGISTS, VOL. 26, NO. 3, 1989, pps 283-308.

1. DETERMINE CAPABLE FAULTS AROUND SITE

USE REF 1, APPENDIX C INDEX MAP, BELOW
SELECTED FAULTS SHOWN AS HATCHED



Job No. | No.

HDR Computation

HDR

Project	Bayview Landfill	Computed	Date
Subject	Cell 2	Checked DHP	Date 7-18-03
Task		Sheet 2	Of 4

1.2 EVALUATE FOR "CAPABLE" OR "ACTIVE" FAULTS

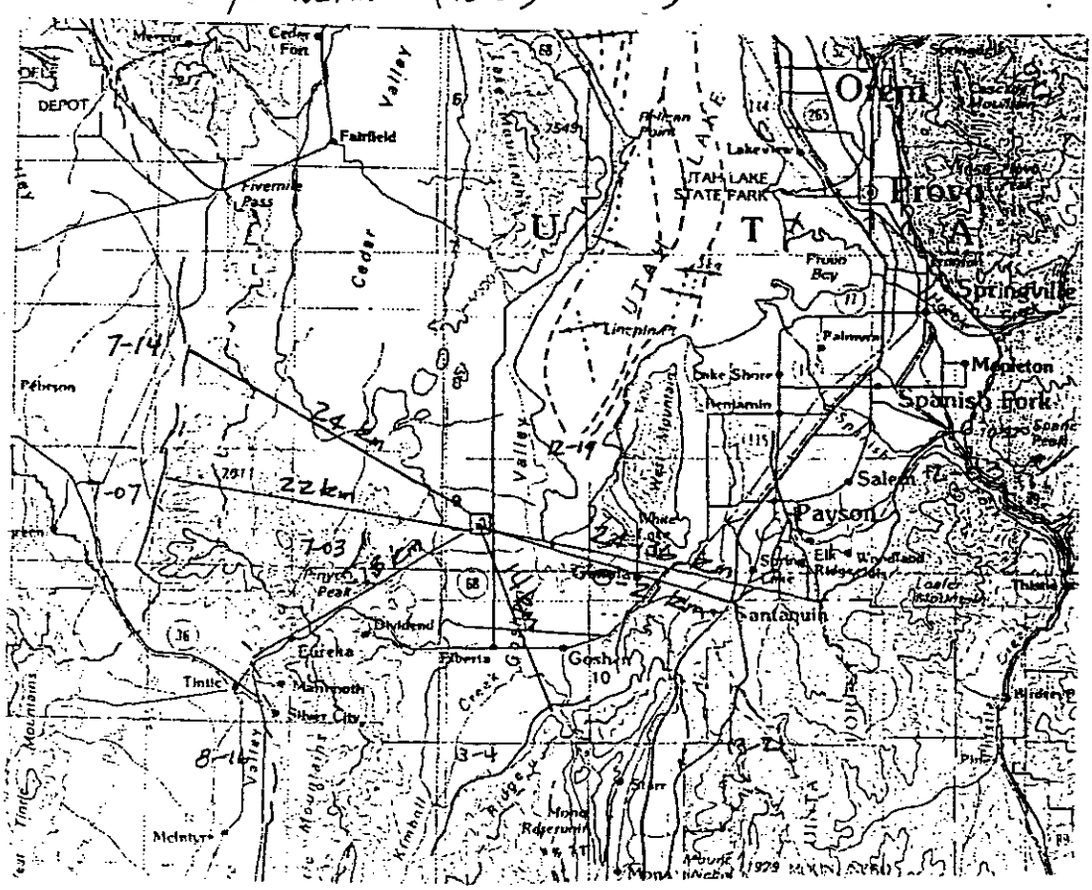
CRITERIA (REF 2, APPENDIX E) BASED ON NRC TITLE 10, CHPT 1, PART 100

- MOVEMENT AT/NEAR GROUND SURFACE WITHIN PAST 35,000 yr, AND/OR
- MACROSEISMIC INSTRUMENTATION TO DEMONSTRATE DIRECT RELATIONSHIP W/FAULT, AND/OR
- STRUCTURAL RELATIONSHIP TO ANOTHER CAPABLE FAULT

FROM REF 1, APPENDIX A (PORTIONS ATTACHED)
CAPABLE FAULTS:

- TOPLIFF HILL (7-7)
- MECUR (7-14)
- EAST TINTIC (8-16)
- WASATCH-PROVO (12-3)
- LONG RIDGE (13-4)
- WASATCH-NEPHI (13-21)

} SHOWN BELOW, FROM REF 1, PLATE 1b.



Job No.	No.

HDR Computation

HDR

Project	Bayview Landfill	Computed	Date
Subject	Cell 2	Checked PHP	Date 7-18-03
Task		Sheet 3	Of 4

2. DETERMINE MCE OF CAPABLE FAULTS

2.1 USE REF 2, FIGS 4-1 + 4-2, BELOW

FAULT ID	FAULT NAME	Rupture LENGTH (km)	DISPL (cm)	MAGNITUDE, M_o LENGTH	MAGNITUDE, M_o DISPL	ADOPTED M_o	ADOPTED MMI	DIST TO SITE (km)
7-7	TOPLIFF HILL	12	NA	6.8	NA	6.8	IX	22
7-14	HELENA	16	0.9-1.9	6.9	6.9-7.2	7.0	X	24
8-16	EAST TINTIC MTNS	4-9	NA	6.7	NA	6.7	IX	18
12-3	WASATCH - PROVO	170	1.5-3.0	7.3	7.1-7.3	7.2	X	24-36
13-4	LONG RIDGE	10	NA	6.7	NA	6.7	IX	14
13-21	WASATCH - NEPHI	42	1.4-2.5	7.2	7.1-7.2	7.2	X	18-21 ← ALL NEAR FIELD

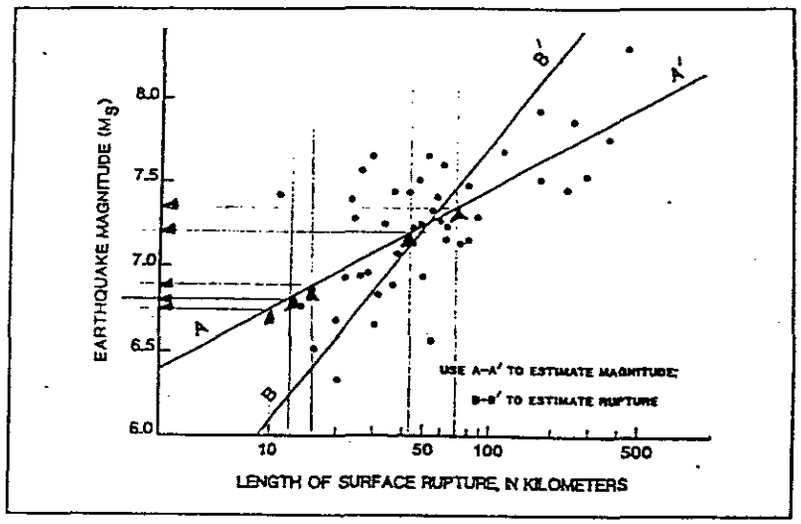


Figure 4-1. Relation of length of surface rupture to earthquake magnitude (Bonilla, Mark, and Lienkaemper 1984)

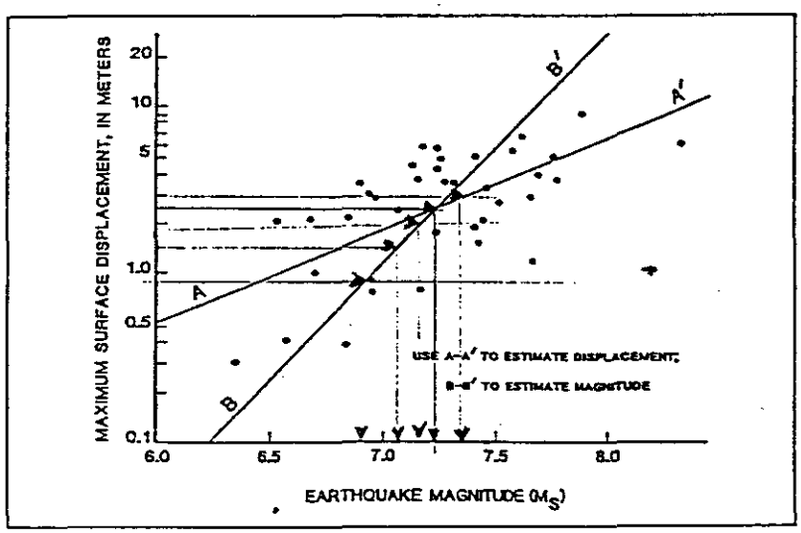


Figure 4-2. Relation of maximum surface displacement to earthquake magnitude (Bonilla, Mark, and Lienkaemper 1984)

Job No. | No.

HDR Computation

HDR

Project: Bayview Landfill		Computed	Date
Subject: Cell 2		Checked PMP	Date 7-18-03
Task		Sheet 4	Of 4

3 DETERMINE a_g AT SITE

HARD SITE CONDITIONS

$V_S > 400$ m/sec BASED on SPT BLOW COUNTS & GEOLOGIC DESCRIPTION

JOYNER & BOORE CURVES OF REF 2, BELOW:

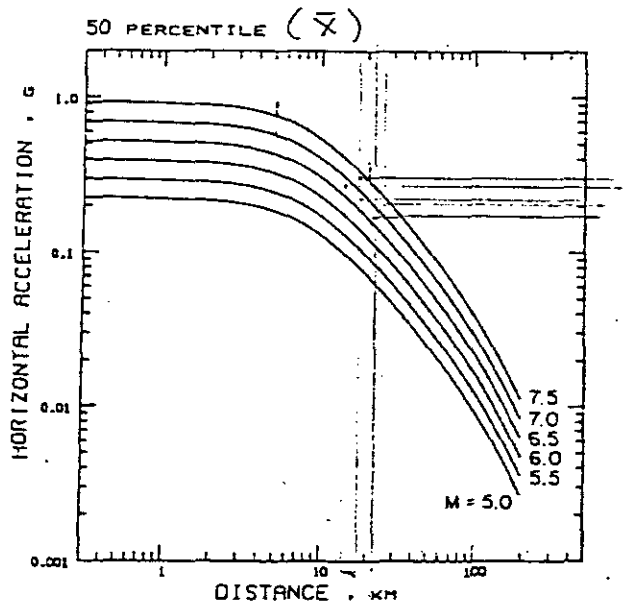


Figure 31. Joyner and Boore (1981) magnitude-distance chart: acceleration, mean.

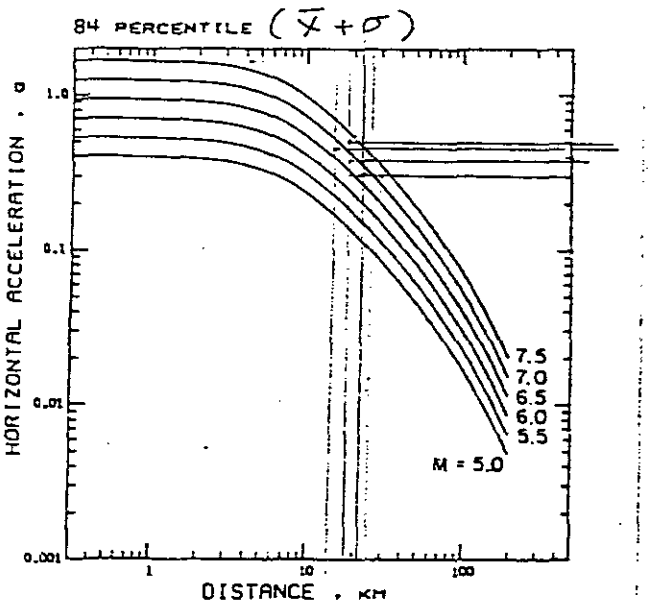


Figure 33. Joyner and Boore (1981) magnitude-distance chart: acceleration, mean and SD.

FAULT DATA				SITE DATA	
FAULT ID	NAME	DISTANCE	MO	$a_g(\bar{X})$	$a_g(\bar{X}+\sigma)$
	TOPLIFF HILL	22	6.8	0.18	0.30
	MERCUR	24	6.9	0.18	0.30
	EAST TINTIC	18	6.7	0.22	0.38
	WASATCH-PROVO	24 MIN ✓	7.3 ✓	0.20 ✓	0.40 ✓
	LONE RIDGE	14	6.7	0.27	0.47
	WASATCH-NEPHI	18 MIN	7.2	0.30	0.50 ← ✓

USE $a_g = 0.50g$ (490 cm/sec²) AT BAYVIEW SITE

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
Goose Creek Mountains (faults) (6-18)					
Parameter values:	Quaternary(?)				

Age Criteria : fault control of bedrock-alluvium contact
References : Doelling and others, 1980

Grouse Creek and Dove Creek Mountains (faults) (6-19)

Parameter values:	middle to late Pleistocene(?)				

Age Criteria : faulted colluvium
References : Compton, 1972
Comments : Faults are mapped as Quaternary(?) (plate 1) where faulting has uplifted Pliocene to early Pleistocene gravels, and where lineaments and aligned springs suggest active faulting (Todd, 1973; this study).

Sheeprock fault zone (7-1)

Parameter values:	late Pleistocene(?)				

Age Criteria : scarp morphology
References : Barnhard and Dodge, 1988
Comments : From scarp-profile data, the Sheeprock scarps appear to be older than the Topliff Hill, Stansbury, and Mercur scarps (location nos. 7-7, 7-10, and 7-14). Diffusion-equation modeling of the scarps, which probably represent multiple events (with a cumulative displacement of <11.5 meters), yielded an age of about 53,000 years (Hanks and others, 1984). In contrast, Everitt and Kaliser (1980) concluded that scarp morphology suggests a possible Holocene age for latest faulting. The embayed character of the range front suggests a long period of inactivity preceding the recent episode of faulting (Everitt and Kaliser, 1980).

Silver Island Mountains - southeast side (fault) (7-2)

Parameter values:	3 - 5 ?			0.6 ?	

Age Criteria : artifacts
References : D.B. Madsen, written and verbal communication, 1987, 1988
Comments : Lake Bonneville deposits are vertically displaced 0.6 meters across the fault. Diagnostic artifacts in faulted sediments near fault-line springs and correlations between basal spring-related peat layers and Holocene lake levels provide an estimate of the time of origin of the springs and, presumably, the time of faulting.

Cedar Valley - south end (fault) (7-3)

Parameter values:	late Quaternary(?) 0-500,000 yr				

Age Criteria : range-front morphology
References : Anderson and Miller, 1979
Comments : Anderson and Miller (1979) indicated that Quaternary(?) alluvium may be displaced, and they mapped the fault as late Pleistocene (<500,000 years old), although an aerial photo check for this study yielded no clear evidence of faulted alluvium.

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
Silver Island Mountains - west side (fault) (7-4)					
Parameter values:	Quaternary(?)				

Age Criteria : fault control of bedrock-alluvium contact
References : Moore and Sorensen, 1979

Lakeside Mountains - west side (fault) (7-5)

| Parameter values: | Quaternary(?) | | | | |

Age Criteria : fault control of bedrock-alluvium contact
References : Moore and Sorensen, 1979; Young, 1955
Comments : Arabasz and others (1989) included the fault (queried as to state of activity) in a compilation of seismic sources in the region. They reference T.P. Barnhard as having identified the feature as a lineament that he feels is probably not related to faulting because it parallels topographic contours, and thus may be a shoreline feature.

Lookout Pass - south side (fault) (7-6)

| Parameter values: | Quaternary(?) | | | | |

Age Criteria : fault control of bedrock-alluvium contact
References : Moore and Sorensen, 1979

Topliff Hill fault zone (7-7)

| Parameter values: | late Pleistocene(?) 10,000–130,000 yr | | | | 12 * |

Age Criteria : scarp morphology; shoreline relations
References : Barnhard and Dodge, 1988
Comments : Everitt and Kaliser (1980) interpreted a faulted alluvial fan as younger than the Bonneville shoreline, whereas Barnhard and Dodge (1988) mapped the same surface as wave-etched and older than the Bonneville shoreline. From scarp-profile data, the Topliff Hill scarps appear to be younger than the Sheeprock, Stansbury, and Mercur fault scarps (location nos. 7-1, 7-10, and 7-14). The Topliff Hill scarps show evidence for recurrent movement, with a cumulative maximum displacement of 5.8 meters. South of the scarps, the range-front (mapped as a Quaternary(?) fault, plate 1) rises in elevation, is linear and faceted, and has an active alluvial apron (Everitt and Kaliser, 1980).

* FROM KRINITSKY, REF 2.

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
Saint John Station fault zone (7-13)					
Parameter values:	late Pleistocene				

Age Criteria : presence of scarps on alluvium; relations to lacustrine features
References : Barnhard and Dodge, 1988; Everitt and Kaliser, 1980
Comments : Small-displacement faults in alluvium (not shown on plate 1) lie several kilometers southeast of the Saint John Station fault zone within a portion of the Tooele Army Depot and are buried beneath an unfaulted soil estimated to be older than 125,000 years (Krinitzsky, 1989: U.S. Department of the Army, 1989).

Mercur fault zone (7-14)					
Parameter values:	late Pleistocene(?) 10,000 - 130,000 yr			0.9 - 1.9 *	16 *

Age Criteria : scarp morphology; lacustrine stratigraphy
References : Barnhard and Dodge, 1988
Comments : Reinterpretation of a trench log that was presented by Everitt and Kaliser (1980) as evidence for post-Bonneville faulting shows a pre-existing fault scarp buried by Bonneville transgressive deposits. A shallow trench excavated across a feature identified by Everitt and Kaliser (1980) as a fault scarp in a post-lake terrace likewise revealed a buried pre-Bonneville fault scarp. From scarp profile data, the Mercur scarps record displacements of 1.8-5.6 meters and appear to be younger than the Sheeprock and Stansbury scarps (location nos. 7-1 and 7-10), but older than the Topliff Hill scarps (location no. 7-7). Faulted alluvium exposed in a mining shaft, together with an uplifted bedrock pediment, suggest a minimum of 60 meters of Quaternary displacement on the fault (Everitt and Kaliser, 1980).

northern Oquirrh fault zone (7-15)					
Parameter values:	9 - 13.5	0.21 - 0.53 *dm (<9 - 13.5)		2.9 - 4.8 h	

Age Criteria : scarp morphology; shoreline relations
References : Barnhard and Dodge, 1988; Everitt and Kaliser, 1980
Comments : Scarp morphology is more similar to the Bonneville shoreline scarps than to the Drum Mountains fault scarps (location no. 8-1), which have been dated at about 9,000 years old. This suggests an age close to but not greater than the Provo shoreline, which has been offset across the fault. Compound scarps, with as much as twice the height of the single-event scarps (and with surface displacements of up to 7.3 meters), record an older, pre-Bonneville displacement modified by lacustrine erosion. Hanks and others (1984) considered the Oquirrh Mountain fault scarps to be older than the Bonneville shoreline and tentatively assigned them a poorly constrained diffusion-model age of 32,000 years. The southern half of the mapped fault is expressed as a prominent break in slope at the base of the range front, where Barnhard and Dodge (1988) found no direct evidence of post-Bonneville faulting. However, Tooker and Roberts (1988) mapped several short faults in Bonneville and post-Bonneville(?) deposits at the north end of the range-front embayment. Because the calculated slip rate is based on scarp height rather than displacement, the values may be too high by a factor of two. Youngs and others (1987, in press) inferred a slip rate of 0.1-0.2 mm/yr for the fault.

* FROM KRINITSKY, REF 2.

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
East Tintic Mountains - west side (faults) (8-16)					
Parameter values:	middle to late Pleistocene 10,000 - 750,000 yr				4-9 (PLATE 1)

Age Criteria : scarp morphology
References : Bucknam and Anderson, 1979a
Comments : Alluvial scarps appear on aerial photos as isolated, highly dissected remnants surrounded by several different ages of unfaulted alluvium and appear to be among the oldest in western Utah. Steep faceted bedrock spurs north and south of Silver City (Goode, 1959) suggest active uplift north of the scarps. In addition, faults in alluvium (not shown on plate 1) were observed northwest of Eureka, about 2 kilometers east of the range front (Goode, 1959). Anderson and Miller (1979) mapped buried Quaternary(?) faults extending to the north and south of the alluvial scarps. These faults and faults that form bedrock-alluvium contacts at the south end of the East Tintic Mountains (Morris, 1987) are mapped as Quaternary(?) on plate 1. On the east side of the mountain range, faults in pre-Bonneville alluvium (not shown on plate 1) were recognized in a tunnel at the south end of Goshen Valley (Goode, 1959).

Maple Grove (faults) (8-17)					
Parameter values:	late Pleistocene(?)				

Age Criteria : scarp morphology; fault control of bedrock-alluvium contact
References : Bucknam and Anderson, 1979a; Oviatt, 1992
Comments : Crestal rounding and dissection suggest that fault scarps are older than the Bonneville shoreline. The steepness of scarp slopes (up to 47°) is attributed to the coarseness of the alluvium. Evidence of Holocene faulting, present in scarps to the north and south, was not noted for the Maple Grove scarps. The scarps represent displacements of up to 12 meters.

Scipio (faults) (8-18)					
Parameter values:	late Pleistocene				

Age Criteria : scarp morphology
References : Bucknam and Anderson, 1979a; Oviatt, 1992
Comments : Evidence of Holocene faulting, present in scarps to the north and south, is not seen in the subdued morphology of the Scipio fault scarps. Faults mapped as Quaternary(?) in age on plate 1 are concealed valley-fill structures.

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
Towanta Flat graben (12-2)					
Parameter values:	130 - 500		60 (130-500)	0 n	

Age Criteria : soil development; cobble weathering
References : Martin and others, 1985; Nelson and Weisser, 1985
Comments : Some workers (Hansen, 1969a, 1969b; Utah Geological and Mineral Survey, 1977) have assigned late Pleistocene and Holocene ages to the scarps, based on estimated ages of faulted deposits and the freshness of the scarps. Nelson and Weisser (1985) concluded that there is no significant net tectonic displacement across the graben (although the throw across individual scarps has been 2.1-2.6 meters per event). This lack of net slip, together with an orientation that differs from planes defined by microseismicity, the limited extent of the scarps, and an average recurrence interval that is less than half as long as the time since the most recent event, suggests that the faults may not have a seismogenic origin and may not be capable of significant future surface-rupturing events. A reported late Pleistocene fault east of Tabiona that lies along the projected strike of the Towanta Flat faults (Ritzma, referenced in Anderson and Miller, 1979) shows no displacement in bedrock. An anomalous linear drainage used to infer the presence of the fault (Ritzma, referenced in Martin and others, 1985) is apparently a strike stream.

Wasatch fault zone - Provo segment (12-3)					
Parameter values:	0.5 - 0.6 e 500-600 ye	1.1 - 1.3 (<5.3) 1.0 - 1.7 * (<15)	2.4 (<5.3)	1.5 - 3.0 n	69.5

Age Criteria : ^{14}C; TL; lacustrine stratigraphy
References : Lund and others, 1991; Machette, 1989, in press; Machette and others, 1991, 1992
Comments : Based on fault geometry and apparent recency of movement as indicated by scarp morphology, Machette and others (1986) tentatively subdivided the Provo segment (as originally proposed by Schwartz and Coppersmith, 1984) into three subsegments (from north to south, the American Fork, Provo "restricted sense," and Spanish Fork). However, based on the timing of the last two events deciphered from trench studies, the entire length of the Wasatch fault zone in Utah Valley appears to be a single segment (Machette, 1989, in press; Lund and others, 1991; Machette and others, 1991). The penultimate event occurred about 2,600-3,000 years ago; based on results from the northern end of the segment (at American Fork), the prior two events occurred about 5,300 and 5,500-8,000 years ago. A conflicting chronology of faulting from a site near the southern boundary of the segment (at Water Canyon, where two events have occurred in the last 1,000 years) may be explained by spatial overlap of the Nephi and Provo segments, whereby events from both segments are recorded at the site (Machette, 1989, in press; Ostenaa, 1990). The slip-rate and recurrence data are from the American Fork site, where rates of activity appear to have been constant during post-Bonneville time. However, at the Hobble Creek site (east of Spanish Fork), there is two-to-three times more displacement recorded in Bonneville transgressive deposits than in Provo-age regressive deposits. Twenty to thirty meters of displacement in just a few thousand years represents slip rates as high as 10 mm/yr and may be related to the presence of Lake Bonneville. Six or seven post-Provo events are inferred to have occurred at the site, yielding an average recurrence interval of 1,700-2,600 years. The Woodland Hills splay of the Spanish Fork subsegment has evidence for three or four events, totaling 3 meters of displacement, in about the past 130,000 years, yielding a slip rate of 0.01-0.02 mm/yr and an average recurrence interval of about 40,000-65,000 years. Movement on the splay apparently occurs during only some of the events on the main fault, although the most recent event on the splay occurred about 1,000 years ago and may be correlative with the most recent event on the main fault. Movement on a couple of short subsidiary faults at the northern end of Utah Valley appears to have occurred during, and may be related to, the recession of Lake Bonneville.

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
East Canyon fault - southern segment (12-17)					
Parameter values:	late Quaternary(?)				12 ?

Age Criteria : range-front morphology
References : Sullivan, Nelson, and others, 1988
Comments : For the purpose of seismic-hazard assessment, values for slip rate, recurrence interval, and single-event displacement are inferred to be similar to those calculated for the Morgan fault (location no. 11-18), based on similarities in fault length and escarpment morphology. The estimated maximum credible earthquake for the fault is 6.5-6.75 (M_s).

Bear River fault zone (12-18)					
Parameter values:	2.4 ? e	0.8 - 2.7 ? (<4.6)	2.3 - 2.4+ ? (<4.6)	<1 - 5+ n	34-40

Age Criteria : ^{14}C
References : West, 1988 , 1989, in press
Comments : The Bear River fault zone (BRFZ) extends from southeast of Evanston, Wyoming to the Uinta Mountains in Utah, where it ends at a complex juncture with the North Flank fault. The trend of scarps at the southern end of the zone is sharply discordant with the main, northerly trend of faulting, perhaps due to the buttressing effect of the Uinta Mountains. The fault lies between the leading edges of the Absaroka and Darby-Hogsback thrust faults and appears to be a new (Holocene) feature superimposed on older thrust-belt structure. The independent seismic potential of the Absaroka and Darby-Hogsback faults is unclear. A 5-kilometer-long Holocene scarp (the Martin Ranch scarp), together with at least 10 kilometers of related surface warping, lies west of the BRFZ in Wyoming and is coincident with the Absaroka thrust. The age of most recent movement on this fault is consistent with that on the BRFZ, suggesting that it represents movement that is simultaneous and sympathetic with that on the main fault zone. Scarp heights and tectonic displacements increase markedly from north to south along the BRFZ. The southernmost scarp, which displaces Pinedale glacial deposits, is 15+ meters high, suggesting that it may have formed from more than two Holocene events. The range in slip rates reflects the range in displacement along the fault zone. Fault-activity parameters for the BRFZ are comparable to values for the Wasatch fault zone (see location nos. 6-6, 11-22, 12-3, 12-6, and 13-21). There is no evidence to suggest that the BRFZ is segmented. Documented ages of faulting (4,600 and ~2,400 years ago) are considered to be maximum estimates because the residence times of organic matter in the dated soils have not been incorporated into the ages. The youthfulness of faulting is demonstrated by the presence of beheaded and reversed drainages, sag ponds, and displacements in the youngest flood-plain deposits. Northern portions of the BRFZ in Utah are expressed only as drainage lineaments or are obscured by recent landsliding. Assuming that it is planar and basement-penetrating, the BRFZ may be capable of producing earthquakes as large as 7.5 (M_s).

Utah Lake (faults and folds) (12-19)					
Parameter values:	latest Pleistocene to Holocene(?) 0 – 30,000 yr				

Age Criteria : lacustrine stratigraphy; depth to faulted sediments
References : Brimhall and Merritt, 1981
Comments : Fault locations, based on widely spaced seismic-reflection transects, are uncertain. Acoustical profiles show a persistent 8-15 meter-deep layer identified as the Provo Formation that is displaced from <2 to 5 meters across individual faults and folds beneath the lake. Machette (1989, in press) interpreted the layer as lake bottom sediments probably deposited during the regressive phase of Lake Bonneville. The reflection profiles suggest that displacements decrease upward in strata above the marker horizon and occur within several meters of the lake bottom.

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
Salt Creek area (fold) (13-1)					
Parameter values:	Quaternary(?)				

Age Criteria : deposit characteristics
References : Witkind and Sprinkel, 1982
Comments : Pleistocene(?) deposits are tilted northwestward on the flank of a small diapiric fold.

Juab Valley
- west side (faults)
(13-2)

Parameter values:	late Quaternary				

Age Criteria : presence of scarps on alluvium
References : R.M. Robison, written communication, 1989; Sullivan and Baltzer, 1986
Comments : The scarps, which show a cumulative displacement of ~1 meter, are most likely tectonic, but alternatively may be related to lateral spreading. Although not defined by a bedrock escarpment, a fault has been inferred along the east side of Juab Valley near the contact between Tertiary volcanic rocks and unconsolidated valley fill. The east-dipping fault is thought to intersect the Wasatch fault zone well above the seismogenic crust and thus to be antithetic to the Wasatch fault zone and not an independent seismic source.

Long Ridge
- west side (fault)
(13-3)

Parameter values:	middle to late Pleistocene(?)				

Age Criteria : presence of scarps on alluvium
References : Meibos, 1983
Comments : The fault both cuts and is covered by "older" unconsolidated alluvium and forms the contact between bedrock and alluvium along much of its length.

Long Ridge
- northwest side (fault)
(13-4)

Parameter values:	Quaternary(?) 0 - 1,650,000 yr				10 (PLATE 1)

Age Criteria : range-front morphology
References : Sullivan and Baltzer, 1986

NAME OR LOCATION OF FEATURE (Location No.)	AGE OF MOST RECENT MOVEMENT $X10^3$ years	SLIP RATE mm/yr (Time Period $X10^3$ years ago)	RECURRENCE INTERVAL $X10^3$ years (Time Period $X10^3$ years ago)	DISPLACEMENT PER EVENT meters	RUPTURE LENGTH kilometers
Price River area (faults) (13-19)					
Parameter values:	Quaternary(?)				

Age Criteria : geomorphic position; structural setting; presence of lineaments
References : Howard and others, 1978; Osterwald and others, 1981
Comments : Some faults within the zone displace pre-Wisconsin-age pediments less than 2 meters. Most are normal faults that dip steeply or vertically. Structural relations indicate that the fault zone forms the crest of a broad, collapsed anticline. The fault zone is similar in trend, pattern, and length to faults along the crest of the Moab-Spanish Valley anticline (primarily location no. 18-2), although it is not as strongly developed. The faults are inferred to be related to a salt anticline at the northern margin of the Paradox basin. Early to middle Pleistocene pediments north of the fault zone steepen sharply at the base of the Book Cliffs and may be warped due to elastic rebound of the Mancos Shale during erosional unloading and/or monoclinal folding (not indicated on plate 1). The ancestral course of Whitmore Canyon (near Sunnyside) also appears to be warped.

Japanese and Cal Valleys (faults) (13-20)					
Parameter values:	middle to late Pleistocene				

Age Criteria : scarp morphology; fault control of bedrock-alluvium contact; basin closure
References : Anderson and others, 1978; Oviatt, 1992; Willis, 1991; Witkind and others, 1987
Comments : Alluvial scarps are up to 4 meters high. The pattern of faulting in Japanese Valley suggested to Witkind and others (1987) that the graben-formed valley may be a collapse feature, perhaps related to dissolution of salt from the underlying Arapien Shale. However, Willis (1991) interpreted the faults as basin-range-type extensional faults.

Wasatch fault zone - Nephi segment (13-21)					
Parameter values:	0.3 - 0.5 ? e 300 - 500 yr	0.8 - 1.3 ? (<5.5 ?)	1.7 - 2.7 ? (<5.5 ?)	1.4 - 2.5 n	42.5

Age Criteria : ^{14}C; scarp morphology
References : Jackson, 1991; Machette and others, 1991, 1992; Schwartz and Coppersmith, 1984
Comments : Scarp morphology and continuity suggest very recent displacement (~300-500 years ago), although a combination of ^{14}C and TL dates suggest an age of about 1,200 years for the most recent event. Schwartz and Coppersmith (1984) determined that the penultimate event occurred before about 4,000 years ago, whereas Jackson (1991) constrained the event between about 3,000 and 3,500 years ago. The third-to-last event may have occurred between 4,000 and 4,500 years ago (Jackson, 1991). Thus, actual middle to late Holocene recurrence intervals may vary from less than 1,000 years to more than 3,000 years. Three middle to late Holocene events post-date a late Pleistocene(?) fan at the southern end of the segment (at Red Canyon), suggesting a possible hiatus in faulting activity during latest Pleistocene to early Holocene time (Jackson, 1991). The range in displacement-per-event and slip-rate values reflects a systematic decrease in slip between the middle (larger values) and southern end (smaller values) of the segment. The Benjamin fault, which extends into Utah Valley, may be the northern extension of the Nephi segment (which would then total about 50 kilometers in length). Sediments of the Provo phase of the Bonneville lake cycle are offset as much as 2 meters along this fault (Machette, 1989, in press). There is a 15-kilometer-long gap in Holocene faulting between the Nephi segment and the Levan segment to the south. Faults associated with young scarps north of the town of Nephi are probably continuous with near-surface faults in the town identified from seismic-reflection data (Crone and Harding, 1984b). A number of small faults in Quaternary deposits have been identified on the western flank of the Gunnison Plateau east of Nephi (not shown on plate 1; Biek, 1991).

ATTACHMENT B

STATIC AND PSEUDO-STATIC SLOPE STABILITY ANALYSES

Objective

Determine Static FS & Seismic Yield Acceleration (a_y) For:

- Cell 2 Excavation Cut-Slopes
- Cell 2 Liner & LCRS System
- Cell 2 Operational Waste Fill-Slopes
- Cell 2 Finished Waste Fill-Slopes
- Cell 2 Closure Cap

References

A) Corps of Engineers, "Stability of Earth and Rock-Fill Dams," EM 1110-2-1902, Department of the Army, 1970.

B) Geosynthetic Research Institute, "Stability of Multi-Lined Slopes in Landfill Applications," GRI Report No. 8.

C) Geotechnical Reports by Chen & Associates, 1980 and Rollins, Brown and Gunnell, 1983.

D) EPA, "RCRA Subtitle D Seismic Design Guidance For MSWLF, 1995.

E) PCSTABL, Slope Stability Analysis, Joint Highway Research Project & University of Purdue (1978), and H.W. VanAller (STED, 1994).

F) Kleinfelder, "Source Material Investigation", South Utah Valley Landfill, Utah County, Utah, 2003. (As Attachment E)

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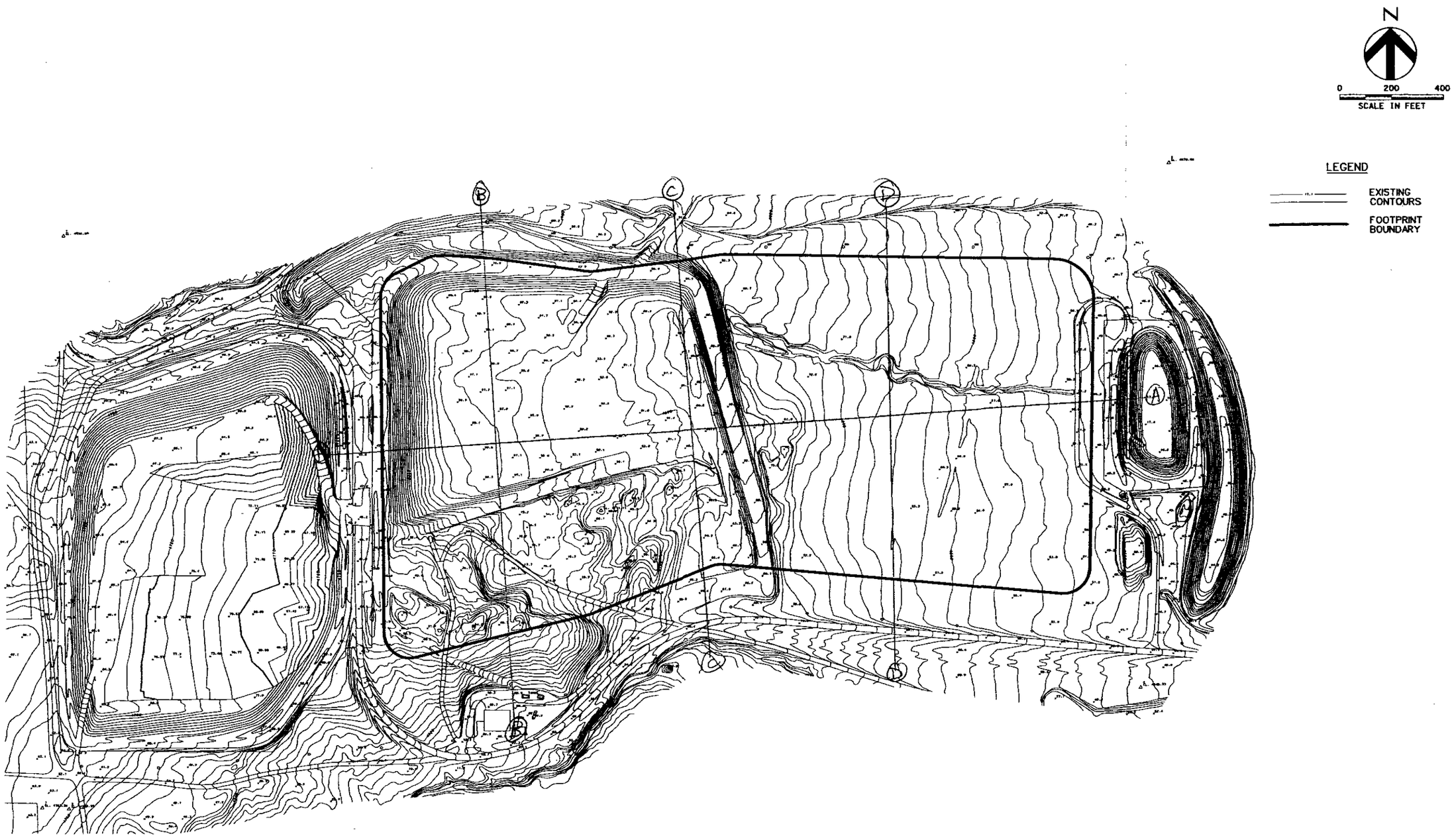
Project:	Bayview Landfill	Computed:	NPD	Date:	07/09/03
Subject:	Cell 2	Checked:	PHP	Date:	7-23-03
Task:	Slope Stability	Page:	2	of:	9
Job #:	3879	No:			

Soil Profile & Material Properties

Soils, From Ref. C, D & F

Depth/Feature	γ	c	ϕ	Material
0-100'	110 pcf	0 psf	40°	Interbedded Dense Dry Sands, Silts & Gravels Becoming Coarser and More Cemented w/ Depth Including Cobbles & Boulders
100'-800'	120 pcf	0 psf	45°	
800'-?	N/A	N/A	N/A	
WASTE	50 pcf	150 psf	22°	See Ref D, Singh & Murphy
LCRS	100 pcf	0 psf	32°	SP-SM - Dune Sand
CAP	110 pcf	0 psf	30°	SM - Olive Brown

ATTACHMENT A
DESIGN EARTHQUAKE MOTIONS



HDR

HDR Engineering, Inc.
17111 Preston Road
Suite 200
Dallas, Texas 75248

Revision No.	Description	Date	Drwn.	Chkd.	Resp. Engr.	Proj. Mgr.

Project Manager: M. ODEN	
Architect	I&C/Process
Civil: M. ODEN	Mechanical
Electrical	Structural
Designed: M.DAVISION	Drawn By: J.ZEPEDA

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

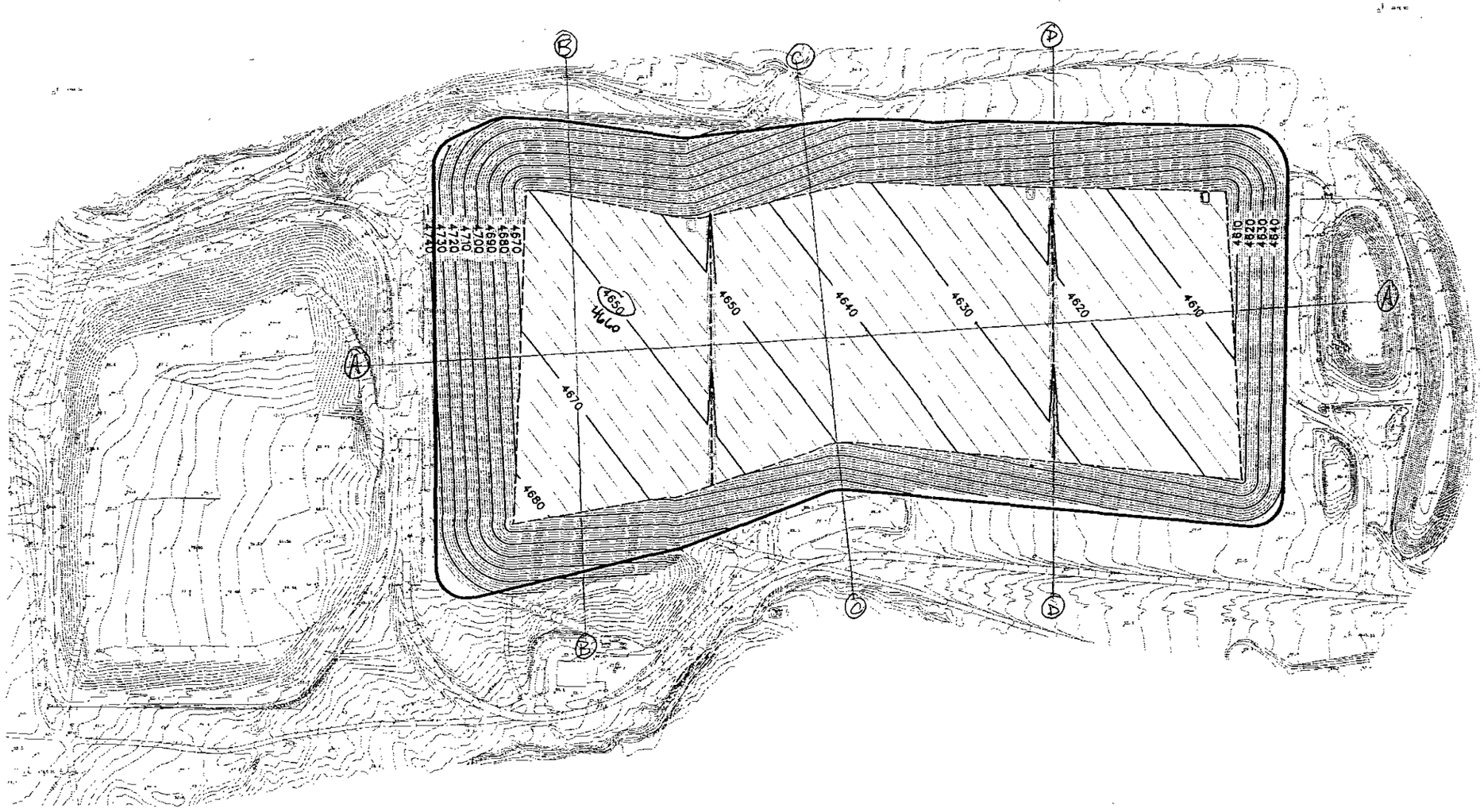
BAYVIEW LANDFILL MASTER PLAN UPDATE

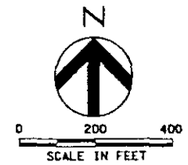
CELL 2 PERMIT

EXISTING CONTOURS

Date	Project No.	Figure No.	Issue
JUNE, 2003	03289-143	1	0

Scale: AS SHOWN





LEGEND

- EXISTING TOPO
- 4670 PROPOSED TOPO
- FOOTPRINT BOUNDARY

FOR INFORMATION ONLY

HDR

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Project Manager: M. ODEN	
Architect	H&C/Process
Civil: M. ODEN	Mechanical
Electrical	Structural
Designed: M.DAVISION	Drawn By: J.ZEPEDA

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL MASTER PLAN UPDATE

CELL 2 PERMIT

LINER CONTOURS

Date	Project No.	Figure No.	Issue
JUNE, 2003	03289-143	2	0

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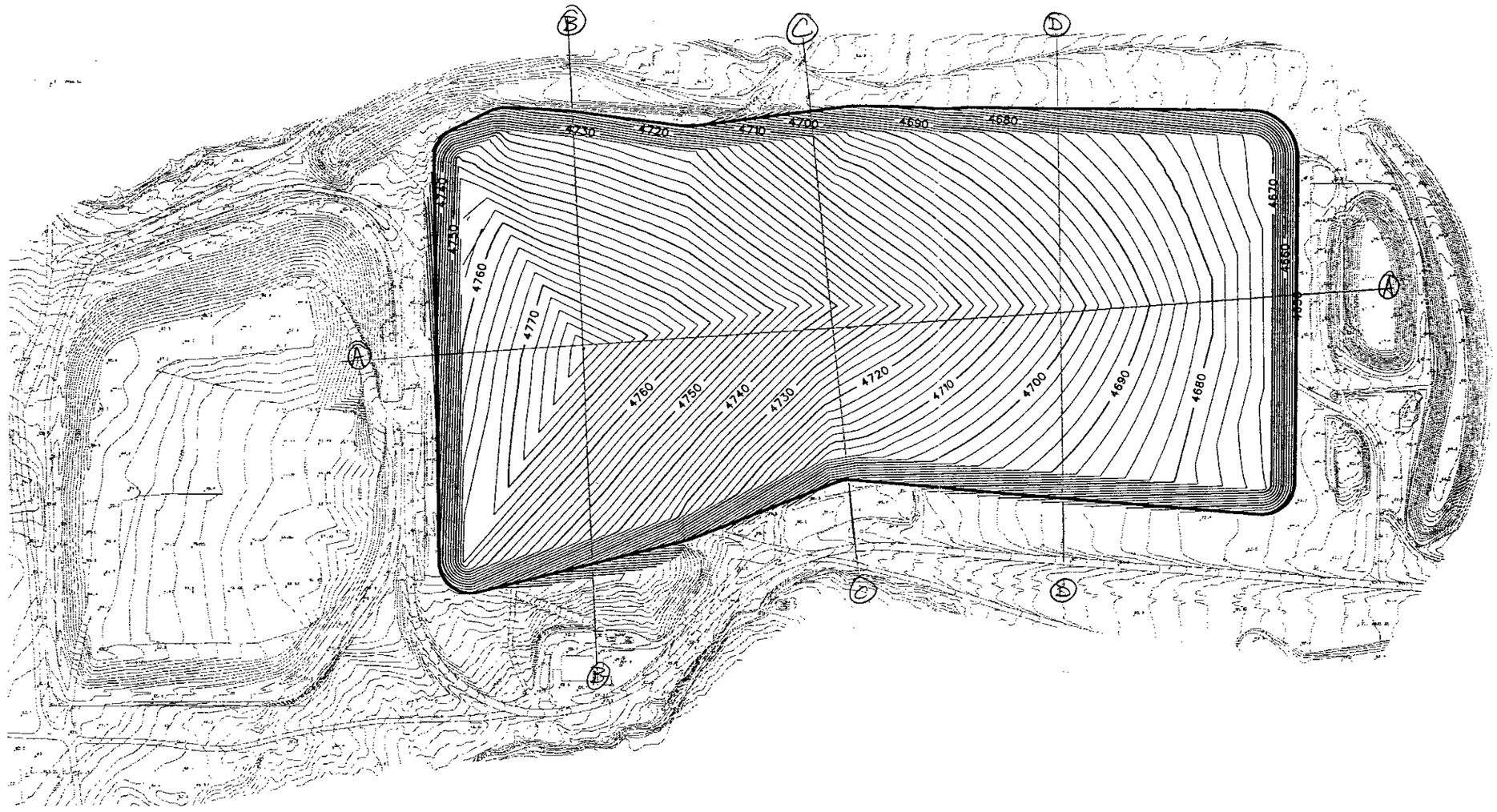

N

0 200 400

SCALE IN FEET

LEGEND

	EXISTING TOPO
4670	PROPOSED TOPO
	FOOTPRINT BOUNDARY

FOR INFORMATION ONLY

HDR

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17111 Preston Road
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Revision No.	Description	Date	Drwn	Chkd.	Resp Engr.	Proj. Mgr.

Project Manager: M. ODEN
Architect
M&C/Process
Civil: M. ODEN
Mechanical
Electrical
Structural
Designed: M.DAVISION
Drawn By: J.ZEPEDA

SOUTH UTAH VALLEY
SOLID WASTE DISTRICT

BAYVIEW LANDFILL
MASTER PLAN UPDATE

CELL 2 PERMIT

FINAL CONTOURS

Date	Project No.	Figure No.	Issue
JUNE, 2003	03289-143	3	0

Scale: AS SHOWN

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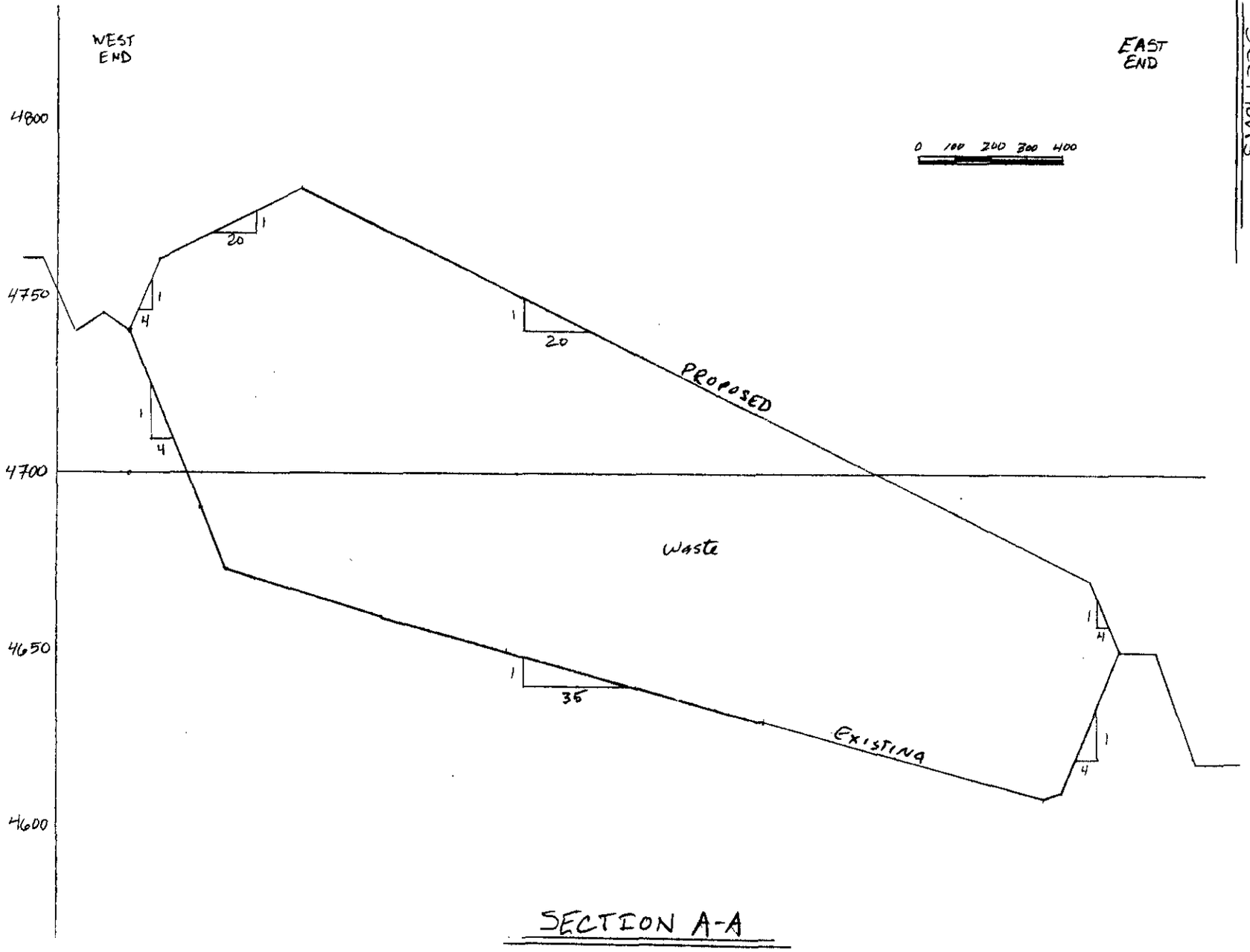
Project: Bayview Landfill
Subject: Cell 2
Task: Slope Stability
Job #: 3879

Computed: NPD
Checked: PKP
Date: 07/09/03
Date: 7-23-03
Page: 6 of: 9
No:

Sections



SECTION A-A

CONT. →

Project:	Bayview Landfill	Computed:	NPD	Date:	07/09/03
Subject:	Cell 2	Checked:	PWP	Date:	7-23-03
Task:	Slope Stability	Page:	7	of:	9
Job #:	3879	No:			

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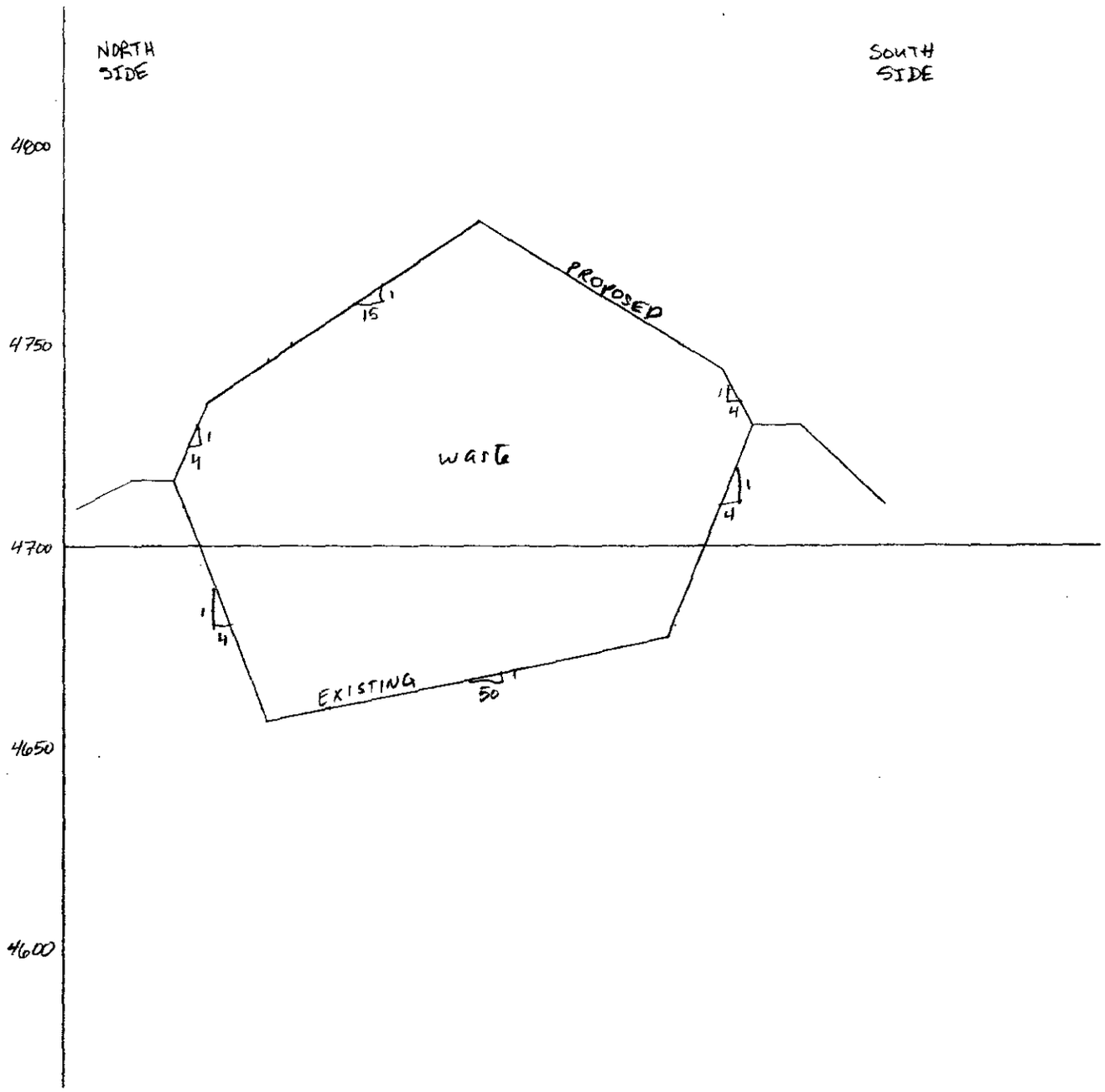
Sections (Cont.)

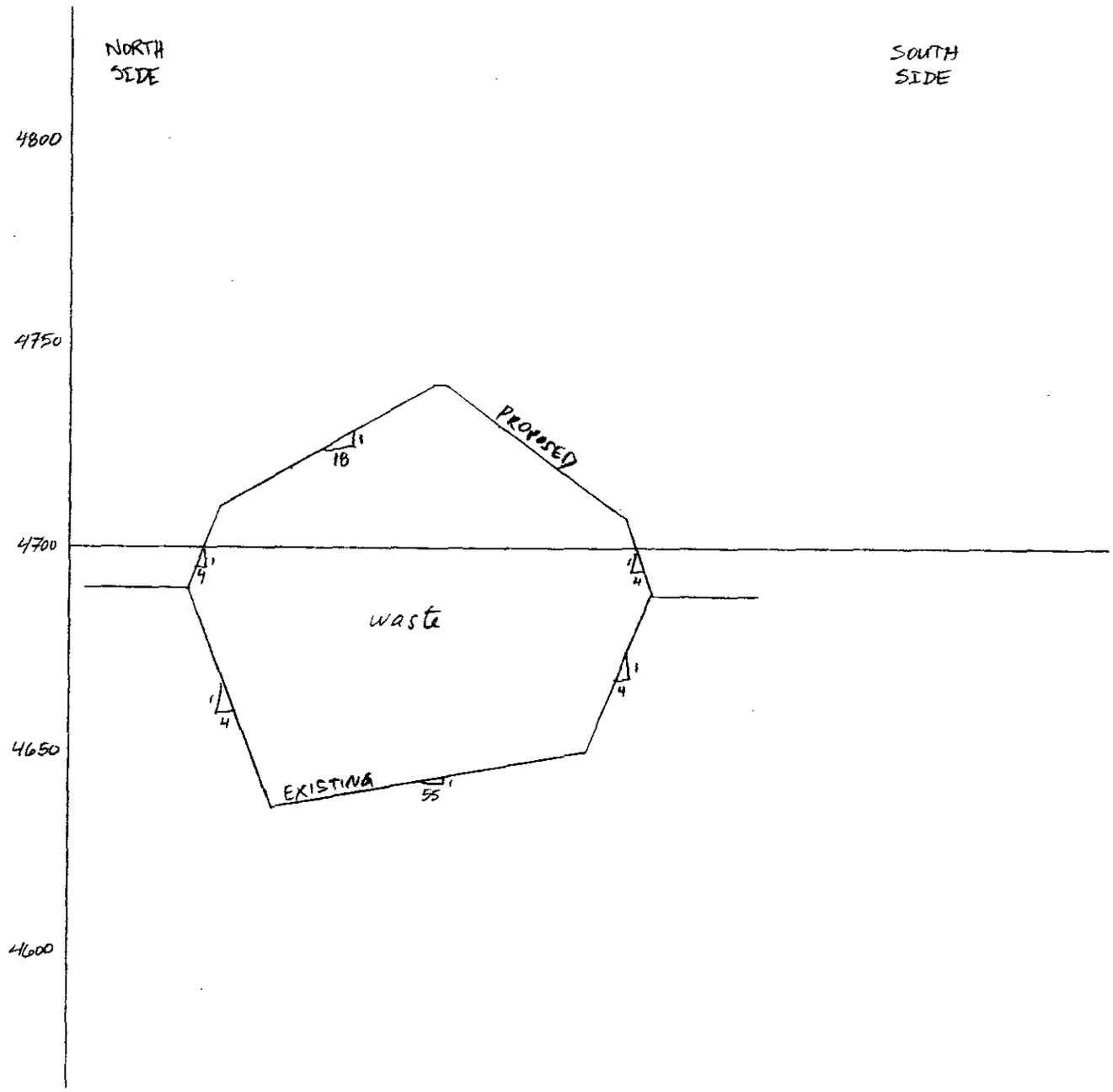


SECTION B-B

CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/09/03		
	Subject: Cell 2	Checked: PHP	Date: 7-23-03		
	Task: Slope Stability	Page: 8	of: 9		
	Job #: 3879	No:			

Sections (Cont.)

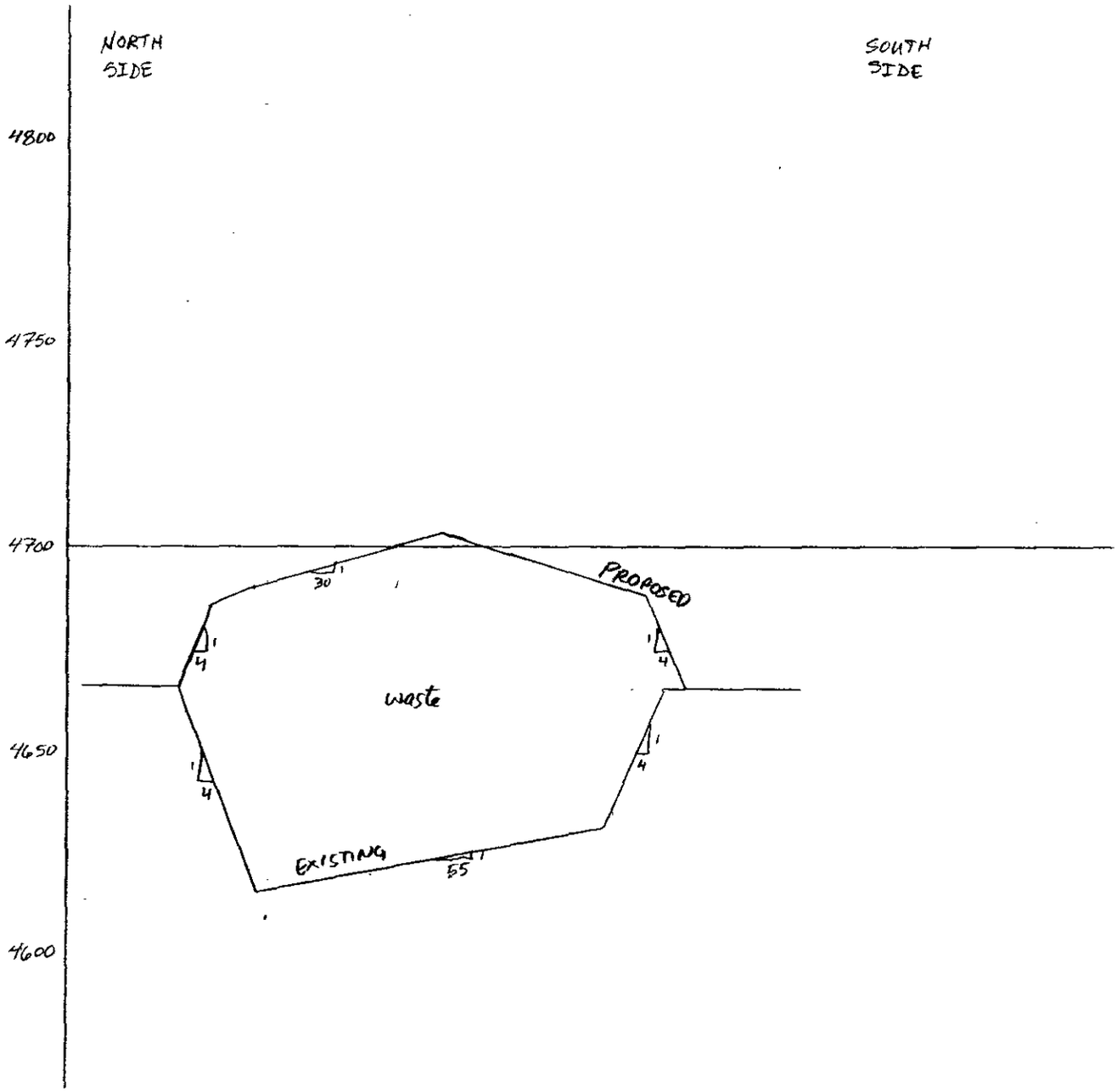


SECTION C-C

CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/09/03		
	Subject: Cell 2	Checked: PMP	Date: 7-23-03		
	Task: Slope Stability	Page: 9	of: 9		
	Job #: 3879	No:			

Sections (Cont.)

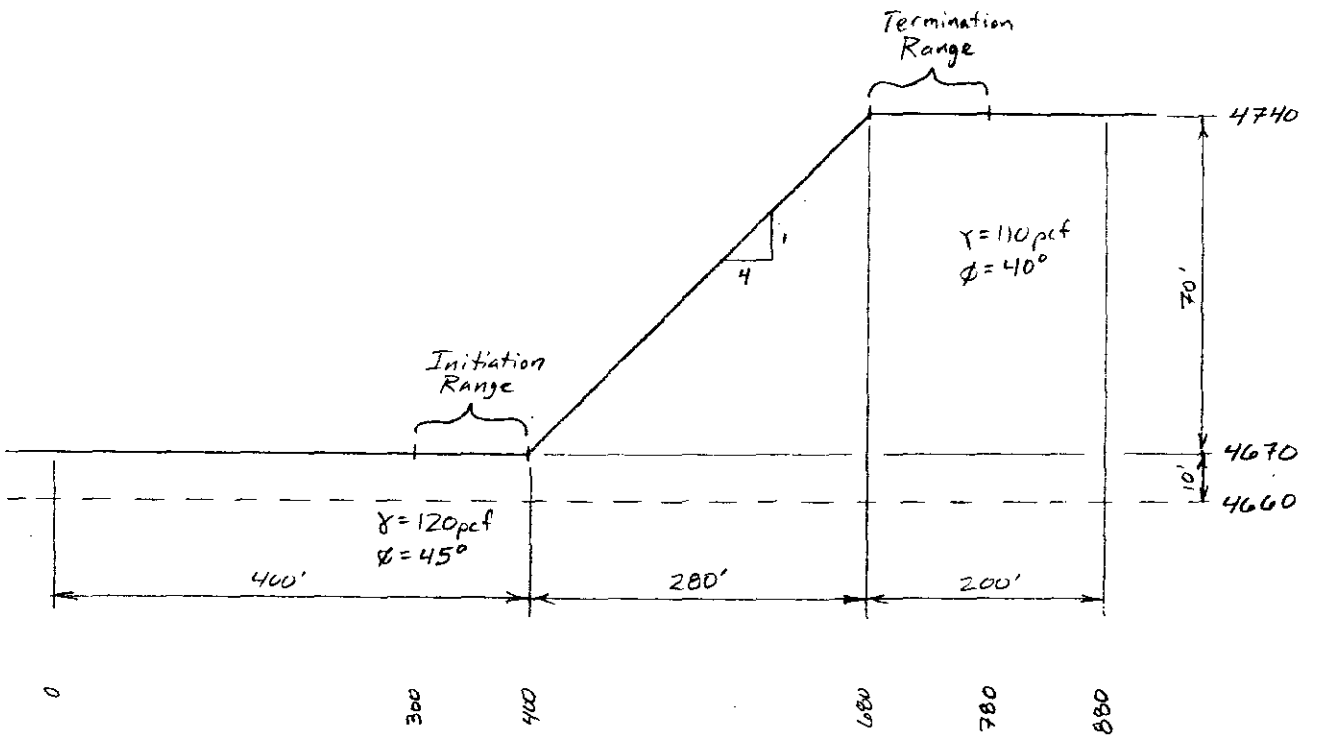


SECTION D-D

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/09/03		
	Subject: Cell 2	Checked: PHP	Date: 7-18-03		
	Task: Slope Stability	Page: 1	of: 2		
	Job #: 3879	No:			

Cut Slope

Geometry / Soils



Origin (0, 4600)

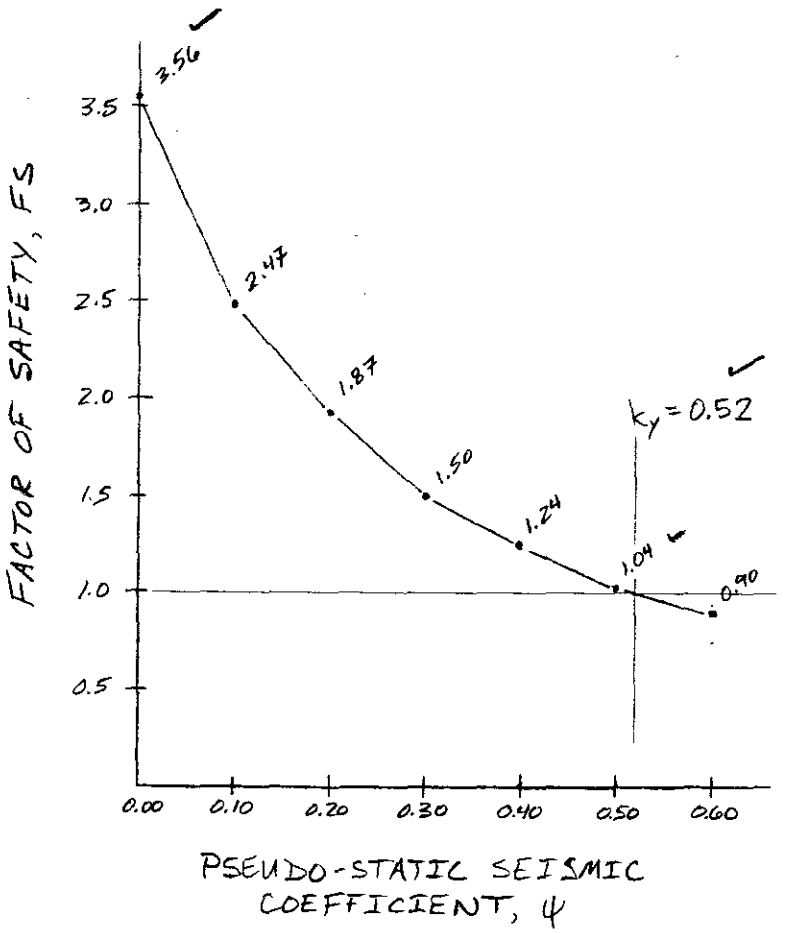
25 pts @ 4' Spacing
25 circles at each pt
10' segment lengths

CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/10/03		
	Subject: Cell 2	Checked: PHP	Date: 7-18-03		
	Task: Slope Stability	Page: 2	of: 2		
	Job #: 3879	No:			

Cut Slope (Cont.)

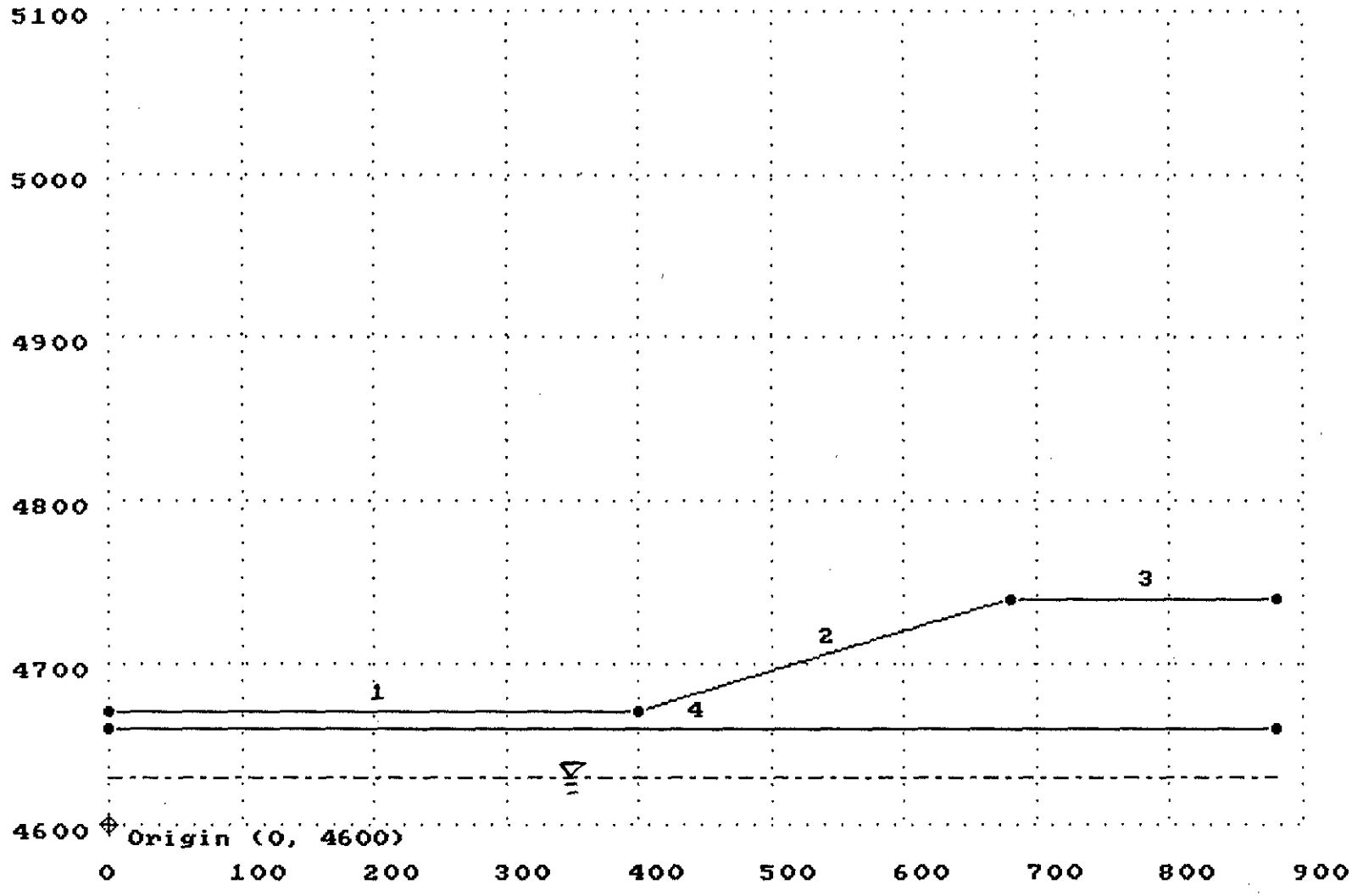
Stability Summary (Static & Pseudo-static)



∴ Yield Acceleration for Cut Slope, $a_y = 0.52g$

CONT. →

BAYVIEW LANDFILL: CUT SLOPE
Geometry Preview. Coordinates not adjusted.



✓ PHP 7-23-91

*rB

✓ PMY 7-23-01

BAY_C_0.OUT
** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	07-10-03
Time of Run:	1:59pm
Run By:	NPD
Input Data Filename:	C:BAY_C_0.IN
Output Filename:	C:BAY_C_0.OUT
Plotted Output Filename:	C:BAY_C_0.PLT

PROBLEM DESCRIPTION Bayview Landfill: Cut Slope

BOUNDARY COORDINATES

3 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	70.00	400.00	70.00	1
2	400.00	70.00	680.00	140.00	1
3	680.00	140.00	880.00	140.00	1
4	.00	60.00	880.00	60.00	2

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	112.0	.0	40.0	.00	.0	0
2	120.0	122.0	.0	45.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

✓ PHP 7-23-01

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	30.00
2	880.00	30.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

625 Trial Surfaces Have Been Generated.

25 Surfaces Initiate From Each Of 25 Points Equally Spaced Along The Ground Surface Between X = 300.00 ft.
and X = 400.00 ft.

Each Surface Terminates Between X = 680.00 ft.
and X = 780.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	362.50	70.00
2	372.44	68.89
3	382.40	67.97
4	392.37	67.24
5	402.36	66.71
6	412.35	66.38
7	422.35	66.25
8	432.35	66.31
9	442.35	66.56
10	452.34	67.02
11	462.31	67.67

12	472.28	68.51
13	482.22	69.55
14	492.15	70.79
15	502.05	72.21
16	511.91	73.84
17	521.75	75.65
18	531.54	77.66
19	541.30	79.86
20	551.01	82.26
21	560.67	84.84
22	570.28	87.61
23	579.83	90.57
24	589.32	93.71
25	598.75	97.04
26	608.11	100.56
27	617.40	104.26
28	626.62	108.14
29	635.76	112.20
30	644.81	116.44
31	653.79	120.85
32	662.67	125.45
33	671.46	130.21
34	680.16	135.15
35	688.33	140.00

Circle Center At X = 424.3 ; Y = 575.9 and Radius, 509.7

*** 3.562 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	383.33	70.00
2	393.23	68.57
3	403.16	67.39
4	413.12	66.44
5	423.09	65.73
6	433.08	65.26
7	443.08	65.03
8	453.08	65.05
9	463.07	65.30
10	473.06	65.79
11	483.03	66.53
12	492.99	67.50
13	502.91	68.72
14	512.81	70.17
15	522.66	71.86
16	532.48	73.79
17	542.24	75.95
18	551.95	78.34
19	561.60	80.97
20	571.18	83.84
21	580.69	86.93
22	590.12	90.25
23	599.47	93.79
24	608.73	97.56
25	617.90	101.55

26	626.97	105.76
27	635.94	110.19
28	644.80	114.83
29	653.54	119.68
30	662.16	124.75
31	670.66	130.01
32	679.03	135.49
33	685.59	140.00

Circle Center At X = 447.5 ; Y = 480.5 and Radius, 415.4

*** 3.582 ***

1

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	366.67	70.00
2	376.58	68.66
3	386.51	67.54
4	396.47	66.62
5	406.45	65.92
6	416.44	65.44
7	426.43	65.16
8	436.43	65.10
9	446.43	65.26
10	456.42	65.63
11	466.41	66.21
12	476.37	67.01
13	486.32	68.02
14	496.25	69.24
15	506.15	70.67
16	516.01	72.32
17	525.83	74.18
18	535.62	76.24
19	545.36	78.52
20	555.04	81.00
21	564.68	83.69
22	574.25	86.59
23	583.75	89.69
24	593.19	92.99
25	602.56	96.49
26	611.85	100.19
27	621.06	104.09
28	630.18	108.19
29	639.21	112.48
30	648.15	116.97
31	656.99	121.64
32	665.73	126.50
33	674.36	131.55
34	682.88	136.78
35	687.89	140.00

Circle Center At X = 434.2 ; Y = 532.4 and Radius, 467.3

*** 3.585 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	375.00	70.00
2	384.87	68.40
3	394.78	67.04
4	404.72	65.93
5	414.68	65.07
6	424.66	64.45
7	434.65	64.07
8	444.65	63.95
9	454.65	64.07
10	464.65	64.43
11	474.63	65.05
12	484.59	65.90
13	494.53	67.01
14	504.44	68.36
15	514.31	69.95
16	524.14	71.78
17	533.92	73.86
18	543.65	76.18
19	553.32	78.74
20	562.92	81.53
21	572.45	84.56
22	581.90	87.82
23	591.27	91.32
24	600.55	95.05
25	609.73	99.00
26	618.82	103.18
27	627.80	107.58
28	636.67	112.20
29	645.42	117.04
30	654.05	122.10
31	662.55	127.36
32	670.92	132.83
33	679.15	138.51
34	681.20	140.00

Circle Center At X = 444.8 ; Y = 469.5 and Radius, 405.6

*** 3.602 ***

1

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	337.50	70.00
2	347.43	68.80
3	357.38	67.77
4	367.34	66.93
5	377.32	66.26

6	387.31	65.78
7	397.30	65.48
8	407.30	65.36
9	417.30	65.42
10	427.30	65.66
11	437.29	66.08
12	447.27	66.69
13	457.24	67.47
14	467.19	68.44
15	477.13	69.58
16	487.04	70.90
17	496.93	72.41
18	506.78	74.09
19	516.61	75.95
20	526.40	77.99
21	536.15	80.20
22	545.86	82.59
23	555.53	85.16
24	565.14	87.90
25	574.71	90.81
26	584.22	93.90
27	593.67	97.16
28	603.07	100.59
29	612.40	104.19
30	621.66	107.95
31	630.85	111.89
32	639.98	115.99
33	649.02	120.25
34	657.99	124.68
35	666.87	129.27
36	675.67	134.02
37	684.39	138.93
38	686.22	140.00

Circle Center At X = 409.0 ; Y = 617.7 and Radius, 552.3

*** 3.628 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	358.33	70.00
2	368.21	68.44
3	378.12	67.08
4	388.05	65.94
5	398.01	65.00
6	407.98	64.26
7	417.97	63.74
8	427.96	63.42
9	437.96	63.32
10	447.96	63.42
11	457.96	63.73
12	467.94	64.25
13	477.92	64.98
14	487.87	65.91
15	497.81	67.06
16	507.72	68.41

17	517.59	69.96
18	527.44	71.72
19	537.24	73.69
20	547.00	75.86
21	556.72	78.24
22	566.38	80.82
23	575.99	83.59
24	585.53	86.57
25	595.01	89.75
26	604.43	93.12
27	613.77	96.69
28	623.03	100.46
29	632.22	104.41
30	641.32	108.56
31	650.33	112.90
32	659.25	117.42
33	668.07	122.13
34	676.79	127.02
35	685.41	132.09
36	693.92	137.34
37	698.03	140.00

Circle Center At X = 438.1 ; Y = 542.5 and Radius, 479.1

*** 3.662 ***

1

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	358.33	70.00
2	368.18	68.27
3	378.07	66.75
4	387.98	65.46
5	397.93	64.39
6	407.89	63.54
7	417.87	62.91
8	427.86	62.51
9	437.86	62.33
10	447.86	62.36
11	457.86	62.63
12	467.84	63.11
13	477.82	63.82
14	487.78	64.75
15	497.71	65.90
16	507.62	67.27
17	517.49	68.86
18	527.32	70.67
19	537.12	72.70
20	546.86	74.95
21	556.55	77.41
22	566.19	80.09
23	575.76	82.98
24	585.27	86.08
25	594.70	89.40
26	604.06	92.92
27	613.34	96.65

28	622.53	100.59
29	631.63	104.73
30	640.64	109.07
31	649.55	113.61
32	658.35	118.35
33	667.05	123.29
34	675.64	128.41
35	684.11	133.73
36	692.46	139.23
37	693.57	140.00

Circle Center At X = 441.1 ; Y = 511.5 and Radius, 449.2

*** 3.669 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	358.33	70.00
2	368.28	68.97
3	378.24	68.11
4	388.22	67.41
5	398.20	66.88
6	408.20	66.52
7	418.20	66.33
8	428.20	66.31
9	438.20	66.45
10	448.19	66.76
11	458.18	67.24
12	468.16	67.89
13	478.12	68.71
14	488.08	69.69
15	498.01	70.85
16	507.92	72.16
17	517.81	73.65
18	527.67	75.30
19	537.51	77.12
20	547.31	79.10
21	557.08	81.24
22	566.81	83.55
23	576.50	86.03
24	586.14	88.66
25	595.74	91.46
26	605.29	94.42
27	614.80	97.54
28	624.24	100.82
29	633.63	104.26
30	642.97	107.85
31	652.23	111.60
32	661.44	115.51
33	670.58	119.57
34	679.65	123.78
35	688.64	128.15
36	697.57	132.66
37	706.41	137.33
38	711.27	140.00

Circle Center At X = 424.6 ; Y = 660.8 and Radius, 594.5

*** 3.673 ***

1

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	366.67	70.00
2	376.55	68.48
3	386.46	67.17
4	396.40	66.06
5	406.36	65.16
6	416.34	64.47
7	426.33	63.99
8	436.32	63.71
9	446.32	63.64
10	456.32	63.78
11	466.32	64.13
12	476.30	64.69
13	486.27	65.46
14	496.22	66.43
15	506.15	67.61
16	516.06	69.00
17	525.93	70.59
18	535.77	72.39
19	545.56	74.39
20	555.32	76.60
21	565.02	79.01
22	574.67	81.62
23	584.27	84.43
24	593.81	87.45
25	603.28	90.65
26	612.68	94.06
27	622.01	97.66
28	631.26	101.46
29	640.43	105.44
30	649.52	109.62
31	658.52	113.98
32	667.42	118.54
33	676.23	123.27
34	684.93	128.19
35	693.54	133.29
36	702.03	138.57
37	704.23	140.00

Circle Center At X = 444.5 ; Y = 543.6 and Radius, 479.9

*** 3.676 ***

Failure Surface Specified By 38 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	350.00	70.00
2	359.92	68.70
3	369.85	67.58
4	379.81	66.64
5	389.78	65.88
6	399.76	65.31
7	409.76	64.91
8	419.75	64.70
9	429.75	64.66
10	439.75	64.81
11	449.75	65.14
12	459.73	65.65
13	469.71	66.34
14	479.67	67.21
15	489.62	68.26
16	499.54	69.50
17	509.44	70.91
18	519.31	72.50
19	529.15	74.27
20	538.96	76.22
21	548.73	78.34
22	558.47	80.65
23	568.15	83.12
24	577.79	85.78
25	587.39	88.61
26	596.93	91.61
27	606.41	94.78
28	615.83	98.13
29	625.19	101.64
30	634.49	105.33
31	643.72	109.18
32	652.87	113.20
33	661.96	117.39
34	670.96	121.73
35	679.89	126.25
36	688.73	130.92
37	697.48	135.75
38	704.86	140.00

Circle Center At X = 426.6 ; Y = 616.1 and Radius, 551.5

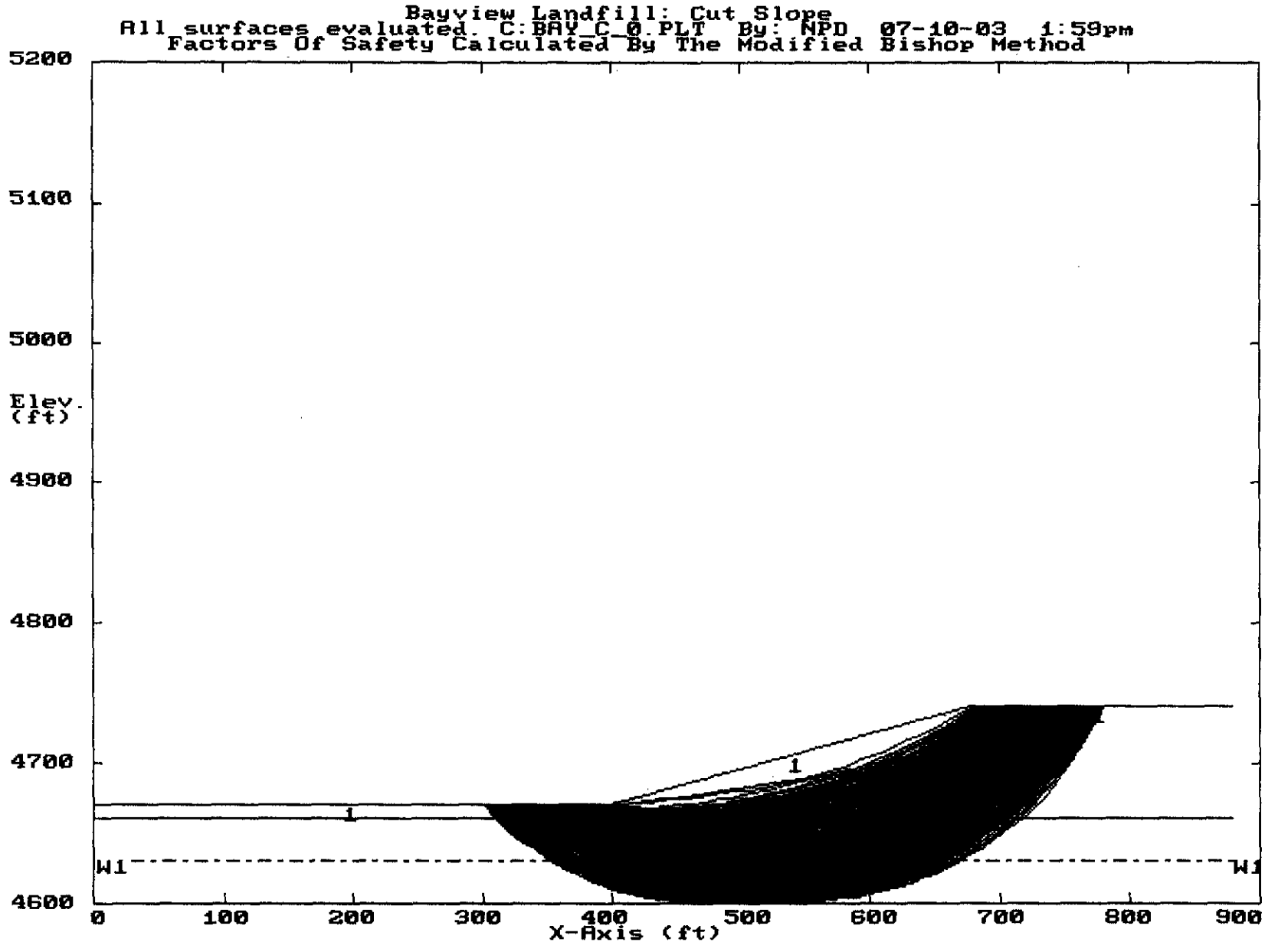
*** 3.677 ***

1

```
            Y            A     X     I     S            F     T

             .00    110.00    220.00    330.00    440.00    550.00

X        .00 +--W-**---+---------+---------+---------+---------+
             -
             -
             -
             -
             -
     110.00 +
             -
```

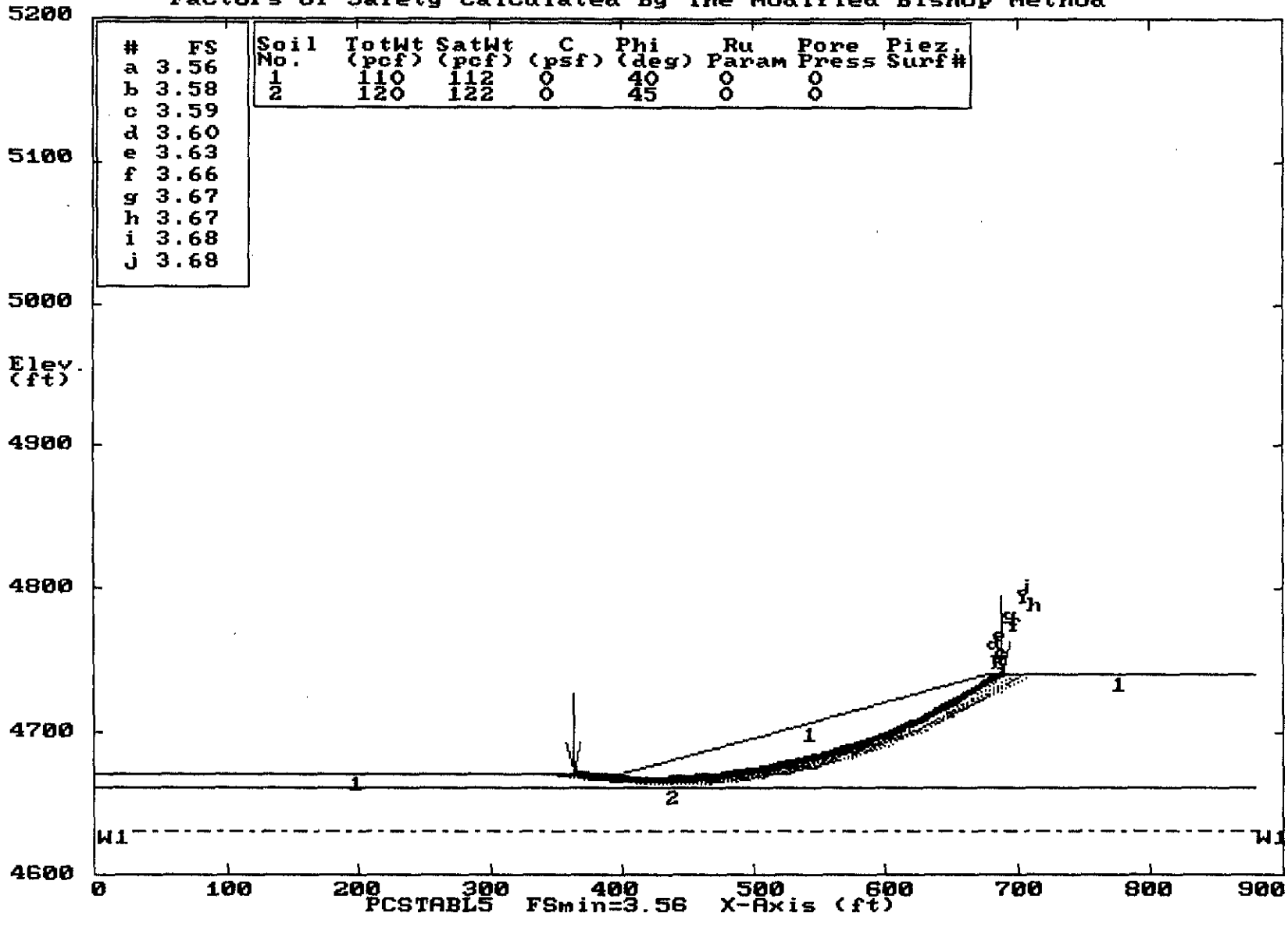
```
                 -
                 -
                 -
                 -
A     220.00 +
                 -
                 -
                 -
                 -     .
                 -    ..
X     330.00 +  ...5
                 -  ...5
                 - ....1
                 -.....1
                 -.....*
                 ......1.
I     440.00 ......1.
                 ......1.
                 ......1.
                 ......11
                 ......21.
                 ......71.
S     550.00 .......15
                 .......21.
                 ........11
                 ........61.
                 -........11
                 -........811
      660.00 + ........813
                 -  ........81*
                 -   ........61
                 -    .......88
                 -     ........
                 -       ......
F     770.00 +          ....
                 -            .
                 -
                 -
                 -
                 -
T     880.00 +  W *       *
```

```
PROFIL       C:BAY_C_0.IN  PCSTABL Version 5 /O(0, 4600)
Bayview Landfill: Cut Slope
4 3
0. 70. 400. 70. 1
400. 70. 680. 140. 1
680. 140. 880. 140. 1
0. 60. 880. 60. 2
SOIL  0-100   100-800
2
110. 112. 0. 40. 0. 0. 0
120. 122. 0. 45. 0. 0. 0
WATER
1 62.4
2
0. 30.
880. 30.
CIRCL2-Bishop circular, search.
25 25
300. 400. 680. 780. 0. 10. 0. 0.
```


Bayview Landfill: Cut Slope
All surfaces evaluated. C:BAY_C_0.PLT By: NPD 07-10-03 1:59pm
Factors Of Safety Calculated By The Modified Bishop Method
5200
5100
5000
Elev.
(ft)
4900
4800
4700
4600
1
1
W1
W1
0
100
200
300
400
500
600
700
800
900
X-Axis (ft)

*rB

Bayview Landfill: Cut Slope
Ten Most Critical. C:BAY_C_0.PLT By: NPD 07-10-03 1:59pm
Factors Of Safety Calculated By The Modified Bishop Method



#	FS
a	3.56
b	3.58
c	3.59
d	3.60
e	3.63
f	3.66
g	3.67
h	3.67
i	3.68
j	3.68

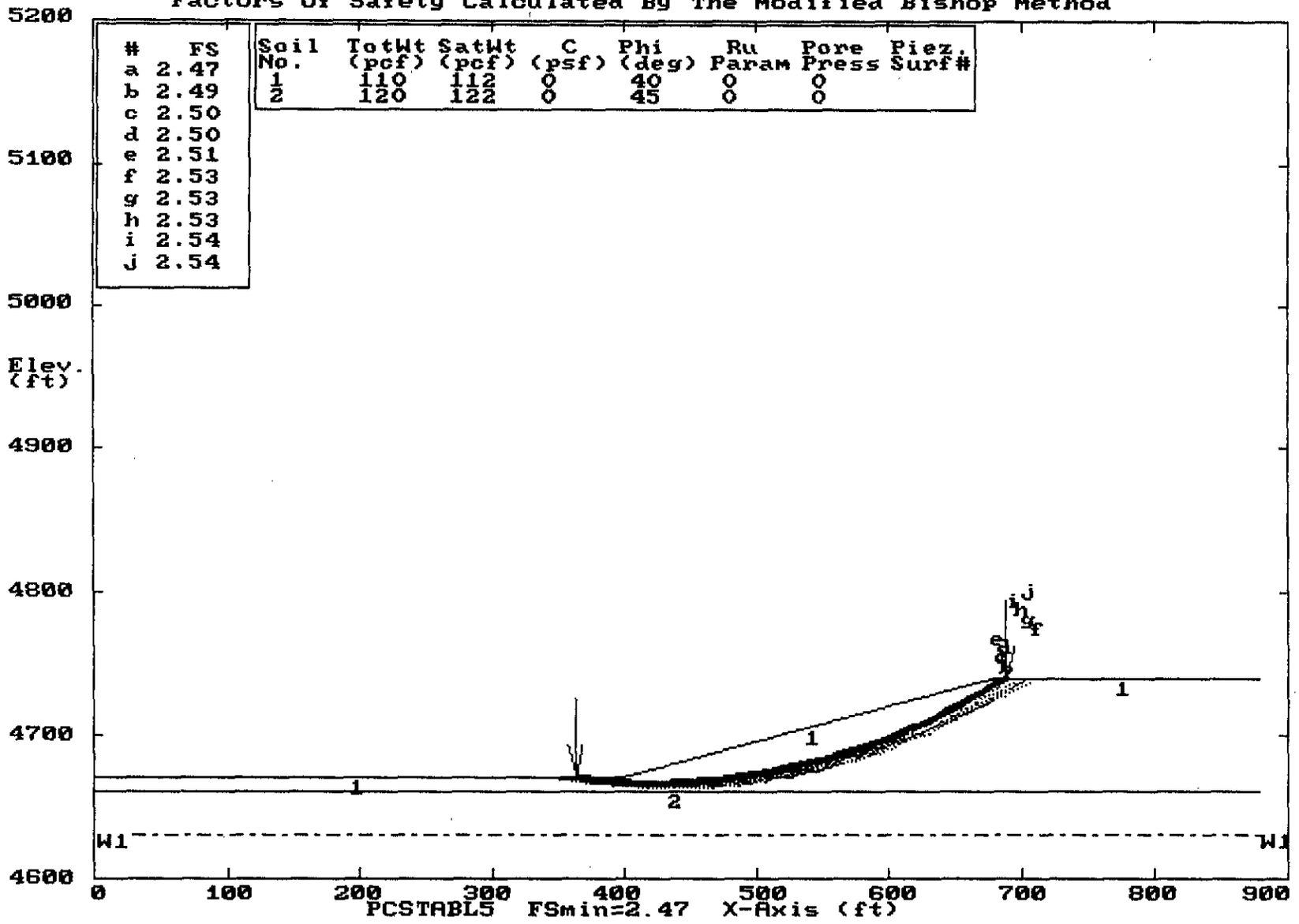
Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	

*rB

Bayview Landfill: Cut Slope, Eq=0.10g
Ten Most Critical. C:BAY_C_1.PLT By: NPD 07-10-03 2:02pm
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	2.47
b	2.49
c	2.50
d	2.50
e	2.51
f	2.53
g	2.53
h	2.53
i	2.54
j	2.54

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	

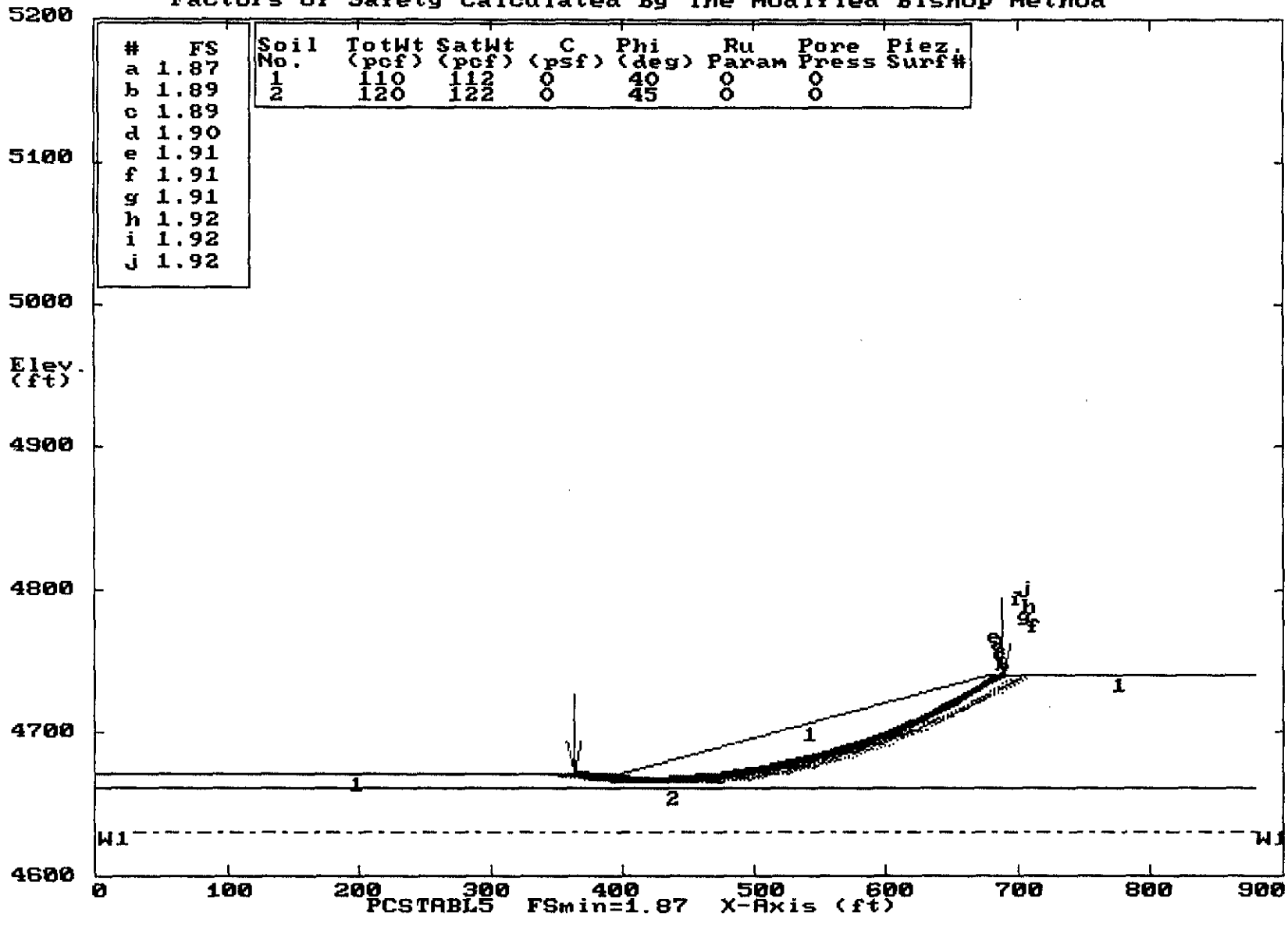


*rB

Bayview Landfill: Cut Slope, Eq=0.20g
Ten Most Critical. C:BAY_C_2.PLT By: NPD 07-10-03 2:05pm
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	1.87
b	1.89
c	1.89
d	1.90
e	1.91
f	1.91
g	1.91
h	1.92
i	1.92
j	1.92

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	

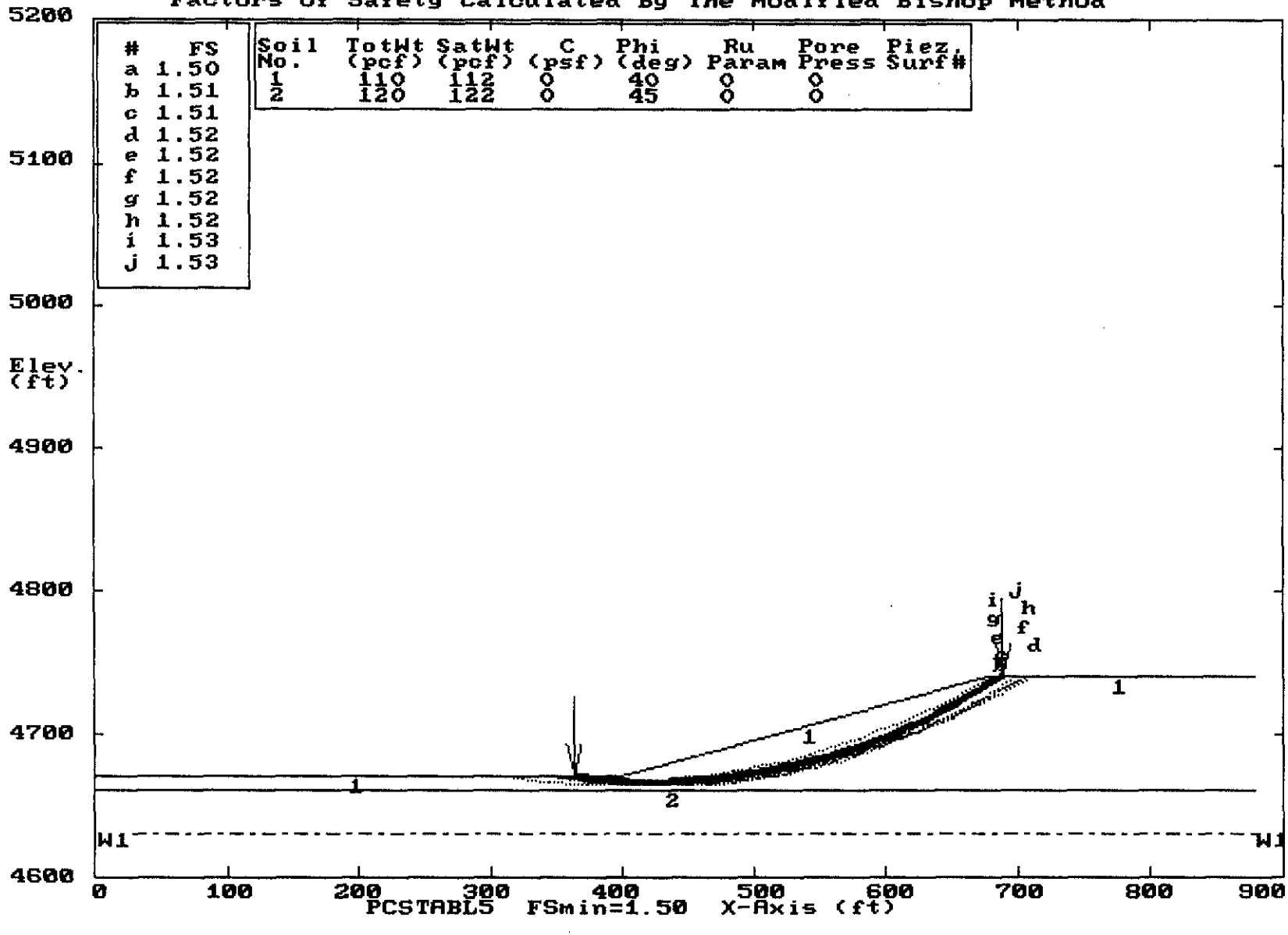


*rB

Bayview Landfill: Cut Slope, Eq=0.30g
Ten Most Critical. C:BAY_C_3.PLT By: NPD 07-10-03 2:06pm
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	1.50
b	1.51
c	1.51
d	1.52
e	1.52
f	1.52
g	1.52
h	1.52
i	1.53
j	1.53

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	

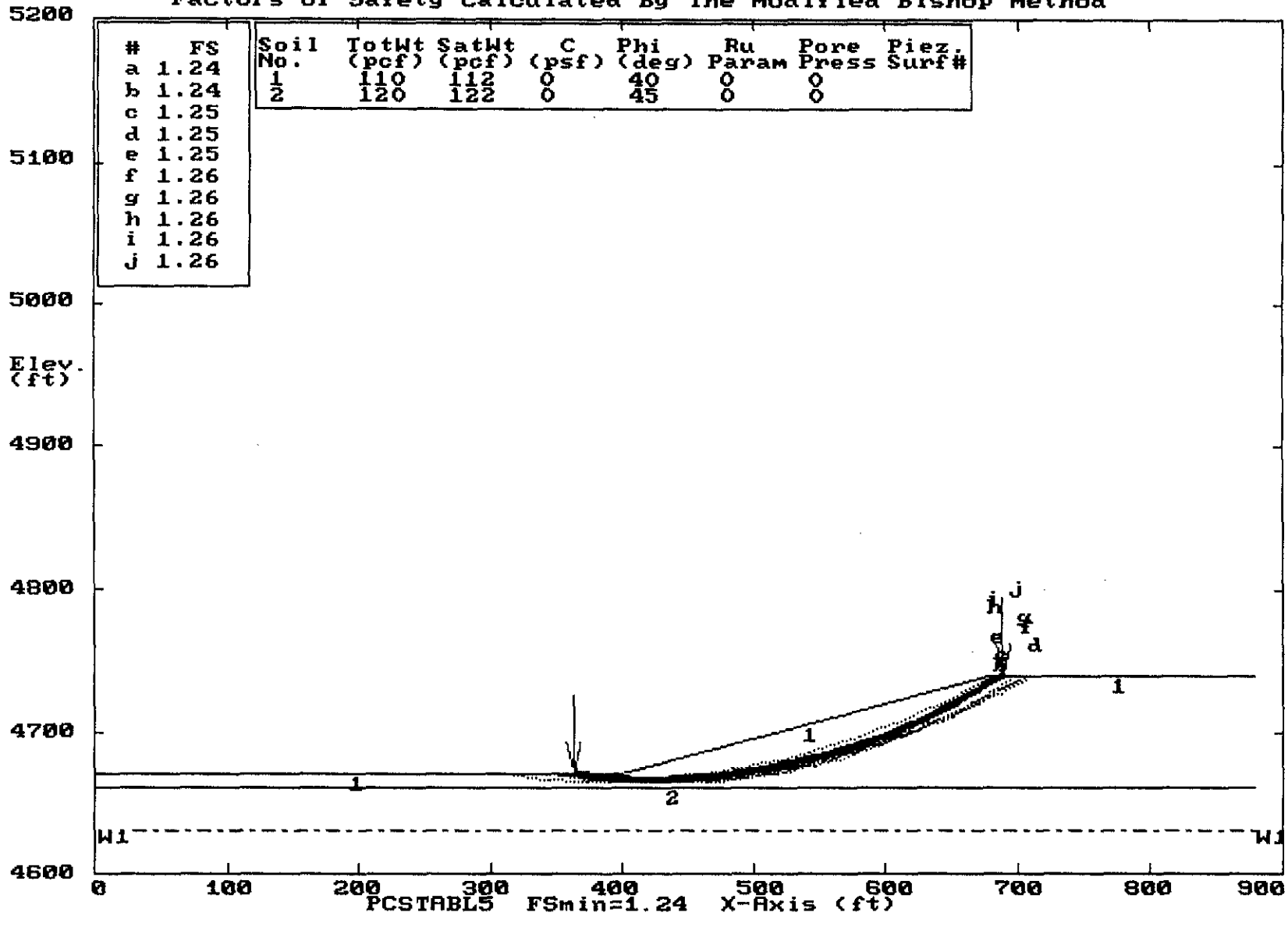


*rB

Bayview Landfill: Cut Slope, Eq=0.40g
Ten Most Critical. C:BAY_C_4.PLT By: NPD 07-10-03 2:07pm
Factors Of Safety Calculated By The Modified Bishop Method

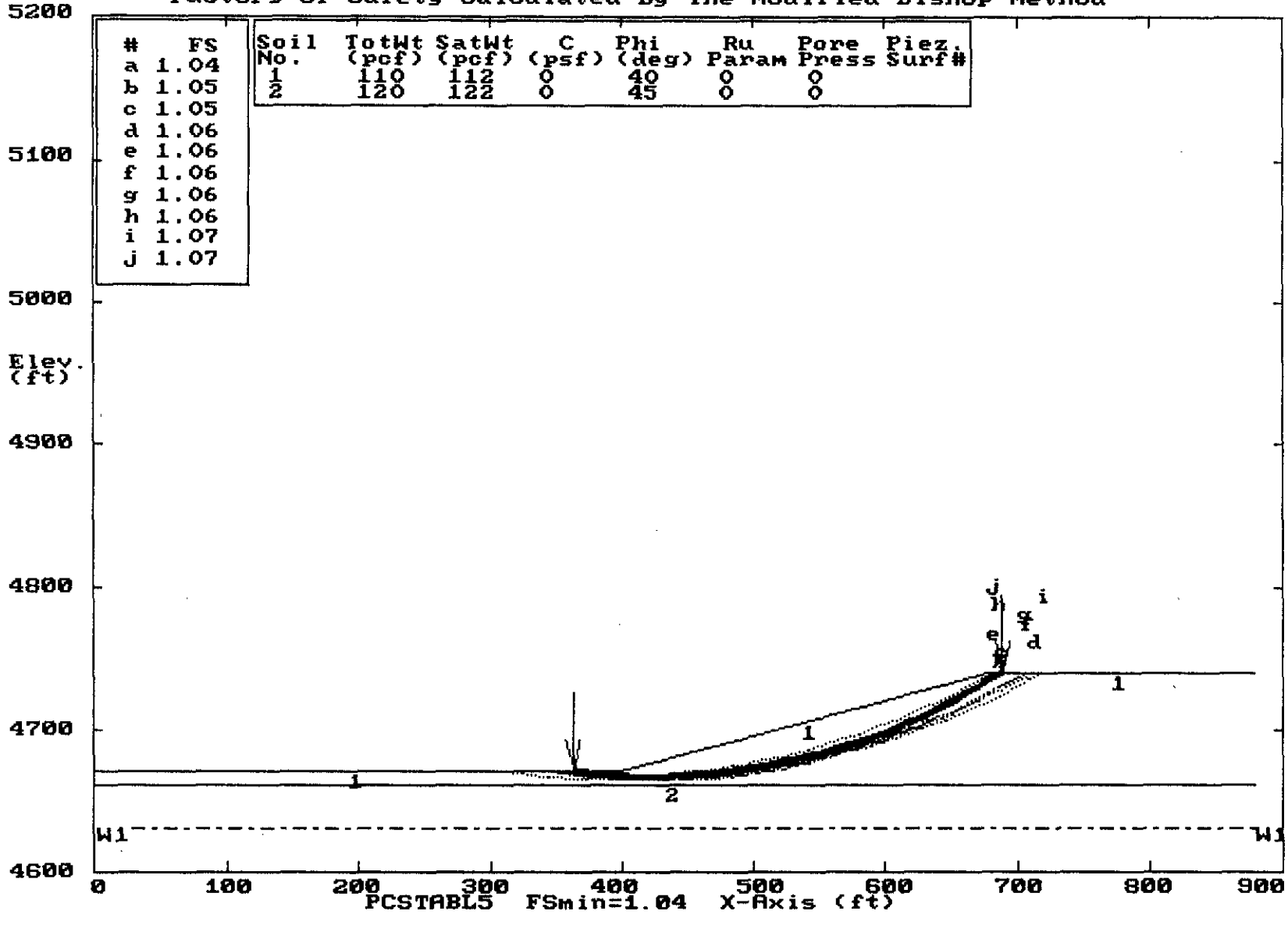
#	FS
a	1.24
b	1.24
c	1.25
d	1.25
e	1.25
f	1.26
g	1.26
h	1.26
i	1.26
j	1.26

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	



*rB

Bayview Landfill: Cut Slope, Eq=0.50g
Ten Most Critical. C:BAY_C_5.PLT By: NPD 07-10-03 2:08pm
Factors Of Safety Calculated By The Modified Bishop Method

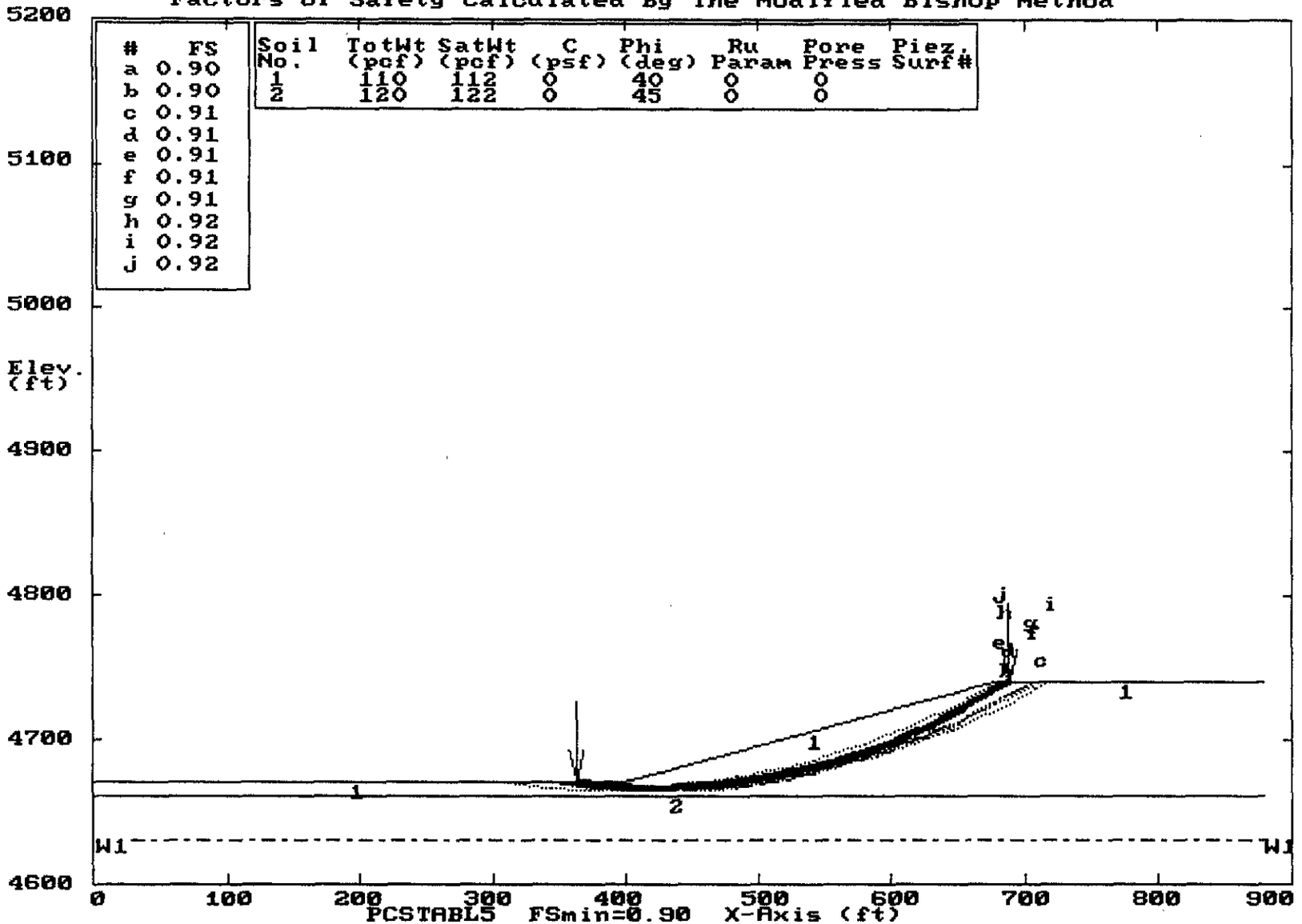


#	FS
a	1.04
b	1.05
c	1.05
d	1.06
e	1.06
f	1.06
g	1.06
h	1.06
i	1.07
j	1.07

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	

*rB

Bayview Landfill: Cut Slope, Eq=0.60g
Ten Most Critical. C:BAY_C_6.PLT By: NPD 07-10-03 2:08pm
Factors Of Safety Calculated By The Modified Bishop Method



#	FS
a	0.90
b	0.90
c	0.91
d	0.91
e	0.91
f	0.91
g	0.91
h	0.92
i	0.92
j	0.92

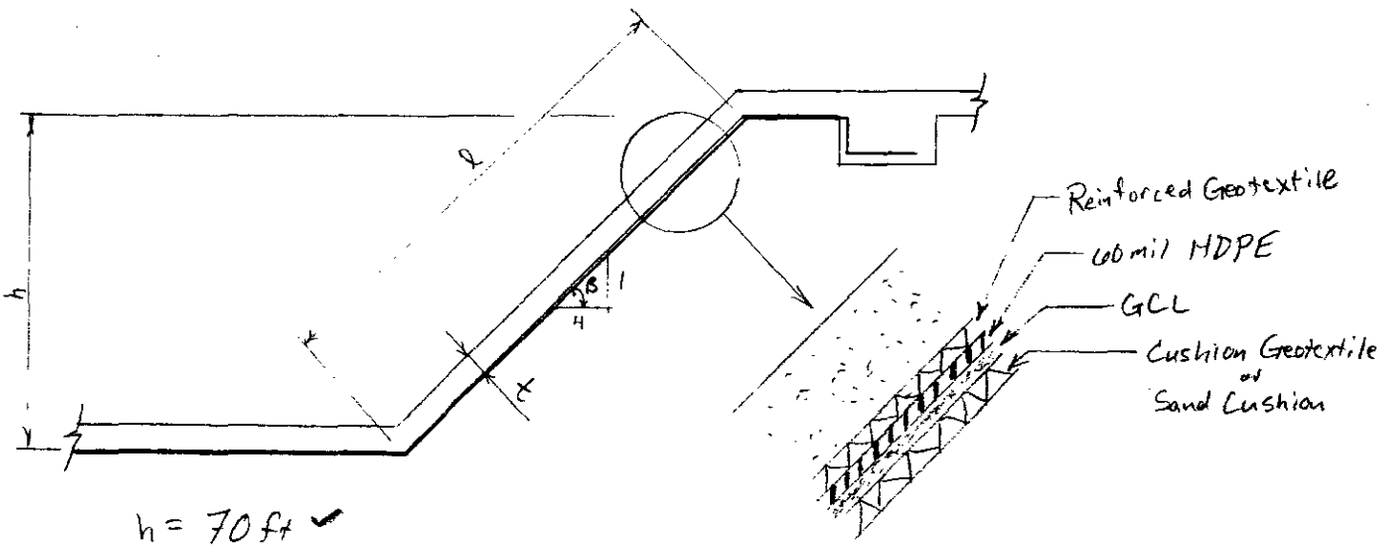
Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	110	112	0	40	0	0	
2	120	122	0	45	0	0	

*rB

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/15/03		
	Subject: Cell 2	Checked: PHP	Date: 7-20-03		
	Task: Slope Stability	Page: 1	of: 6		
	Job #: 3879	No:			

Cell Liner & LCRS

Geometry / Materials



$h = 70\ ft$ ✓
$t = 2\ ft$
$\ell = h/\sin\beta = 288.6\ ft$

Materials At Interface	Interface Friction, $\delta°$ ②
2' LCRS / Reinforced GT/NW	27° ①
GT / 60 mil Textured HDPE	27°
HDPE / GCL	18° *
GCL / Cushion GT/NW	18° *
GCL / Sand Cushion	N/A > 18°
Cushion GT / Exist Subgrade	27° ①

* Critical Value For Stability Analysis
① Matches July 1996 Permit Value
✓ ② Verify Interface Friction Using Proposed Materials Prior To Construction

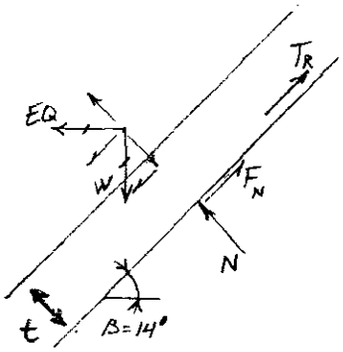
All interface friction values were taken from literature and file of test results.

CONT. →

Cell Liner & LCRS (Cont)

Static & Pseudo-Static Stability

* Use Infinite Slope Method to Determine Factors of Safety



$W = \gamma t \ell = 0.100(2.0)\ell = 0.200\ell$ (k/ft) ✓

$W\cos\beta = 0.200\ell\cos 14° = 0.194\ell$ (k/ft)

$W\sin\beta = 0.200\ell\sin 14° = 0.049\ell$ (k/ft)

$EQ = W\psi = 0.200\ell\psi$ (k/ft) ✓

$EQ\sin\beta = 0.200\ell\psi\sin 14° = 0.049\ell\psi$ (k/ft) ✓

$EQ\cos\beta = 0.200\ell\psi\cos 14° = 0.194\ell\psi$ (k/ft) ✓

$N = W\cos\beta - EQ\sin\beta = 0.194\ell - 0.049\ell\psi$ (k/ft) ✓

$F_N = N\tan\delta = (0.194\ell - 0.049\ell\psi)\tan\delta$ (k/ft) ✓

STATIC: $FS_{stat} = (F_N + T_R)/W\sin\beta = (0.194\ell\tan\delta + T_R)/0.049\ell$
$(\psi = 0)$

PSEUDO-STATIC: $FS_{PS} = (F_N + T_R)/(W\sin\beta + EQ\cos\beta)$ ✓
$(\psi > 0)$ $= [(0.194\ell - 0.049\ell\psi)\tan\delta + T_R]/(0.049\ell + 0.194\ell\psi)$

* Iterate For T_R & ψ With δ & ℓ From Geometry/Materials Section

CONT. →

Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary

- Stability Calculation by Infinite Slope Method

GEOMETRY

Slope	4.00 Horizontal to 1.00 Vertical	β = 14.036°
Height	70.0 ft	
Length	288.6 ft	

LCRS GEOMETRY/MATERIAL

Thickness	2.0 ft
Unit Weight	0.100 kcf

INTERFACE MATERIALS

Top Material	Geocomposite Clay Liner
Bottom Material	Cushion Geotextile
Minimum Interface Friction	18 °

CALCULATED FACTORS OF SAFETY

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Coefficient, ψ						
	0.00	0.10	0.20	0.30	0.40	0.50	0.60
0.0	1.30	0.91	0.69	0.55	0.45	0.38	0.32
1.0	1.37	0.96	0.73	0.58	0.48	0.40	0.35
2.0	1.44	1.01	0.77	0.61	0.50	0.43	0.37
3.0	1.51	1.06	0.80	0.64	0.53	0.45	0.39
4.0	1.59	1.11	0.84	0.68	0.56	0.47	0.41
5.0	1.66	1.16	0.88	0.71	0.59	0.50	0.43
7.5	1.84	1.29	0.98	0.79	0.66	0.56	0.48
10.0	2.01	1.42	1.08	0.87	0.72	0.62	0.54
12.5	2.19	1.54	1.18	0.95	0.79	0.68	0.59
15.0	2.37	1.67	1.28	1.03	0.86	0.74	0.64

WEIGHTS & FORCES

Weight	57.72 k/ft
Static Driving Force	14.00 k/ft
Static Resisting Force	18.20 k/ft
Earthquake Horizontal Force	57.72 (ψ) k/ft
Earthquake Driving Force	14.00 + 56.00 (ψ) k/ft
Earthquake Resisting Force	18.20 - 4.550 (ψ) k/ft

RESULTS

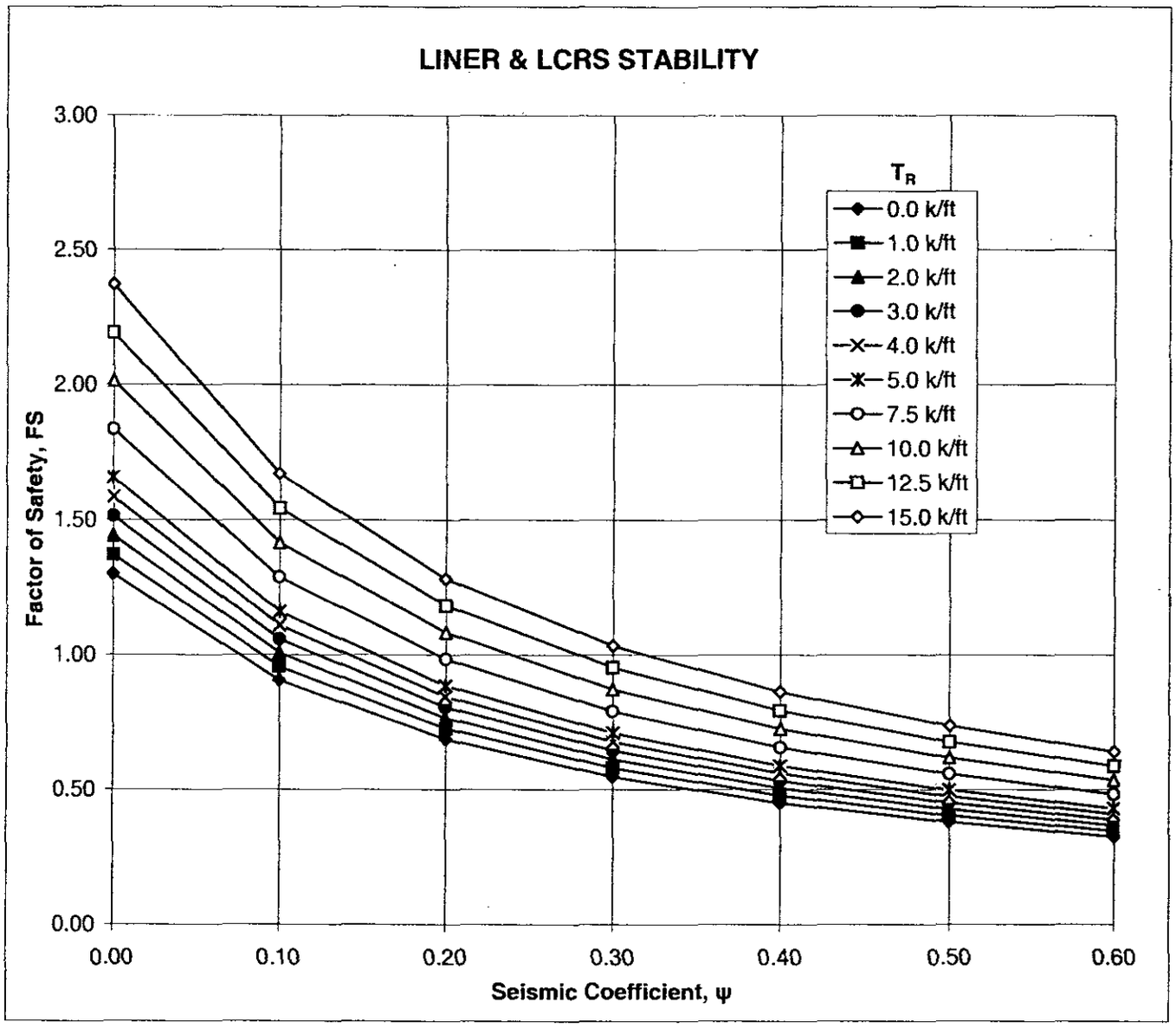
	Static	Seismic					
$FS_{req'd}$	1.30	1.00	1.00	1.00	1.00	1.00	1.00
ψ	0.00	0.10	0.16	0.20	0.30	0.40	0.50
$T_{Rreq'd}$ (klf)	0.00	1.86	5.70	7.91	13.97	20.02	26.08

Project:	Bayview Landfill	Computed:	NPD	Date:	07/16/03
Subject:	Cell 2 Design	Checked:	PHP	Date:	7-23-03
Task:	Slope Stability	Page:	4	of:	6
Job #:	3879	No:			

HDR | ONE COMPANY *Many Solutions*™

Cell Liner & LCRS (Cont.)

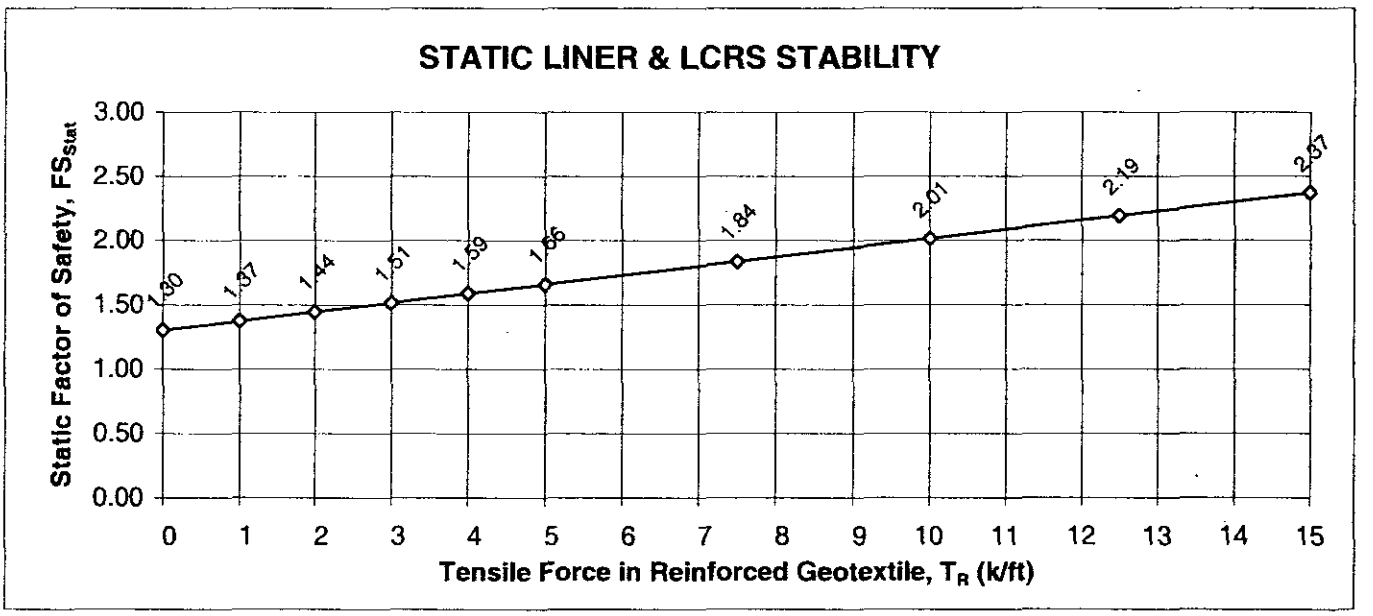
Liner & LCRS Stability Summary

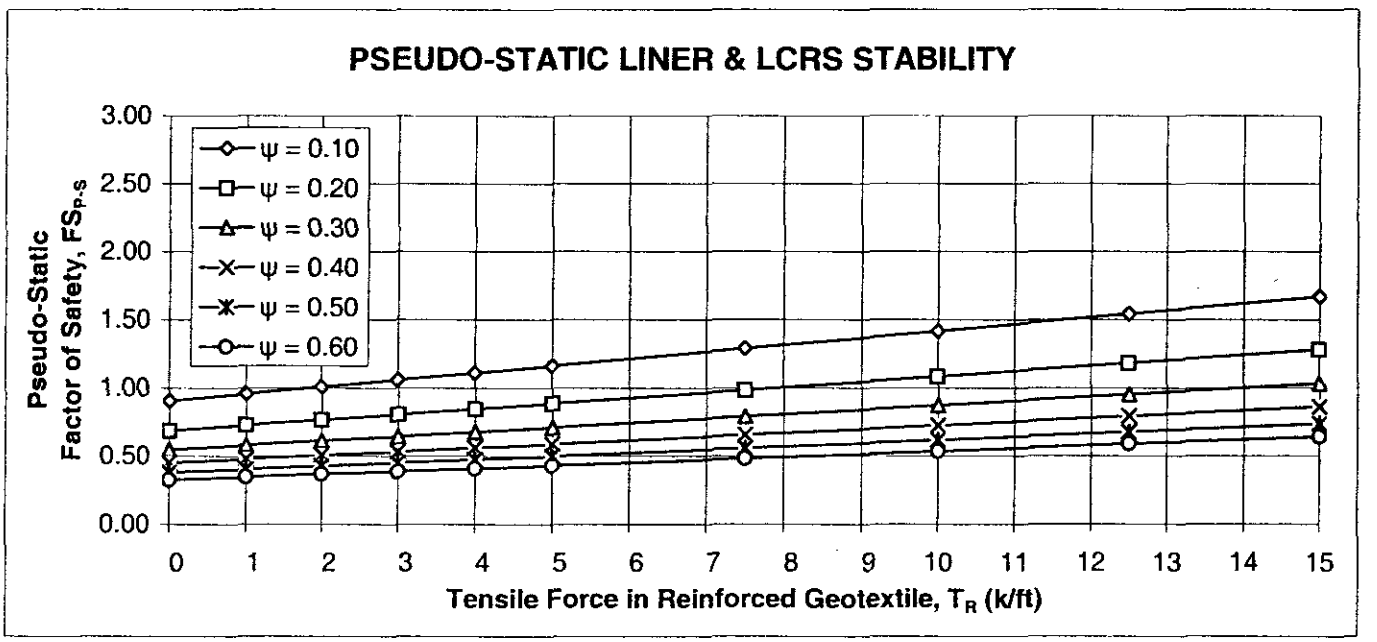


HDR ONE COMPANY *Many Solutions*™	Project:	Bayview Landfill	Computed: NPD	Date:	07/16/03
	Subject:	Cell 2 Design	Checked: PHP	Date:	7-23-03
	Task:	Slope Stability	Page: 5	of:	6
	Job #:	3879	No:		

Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary



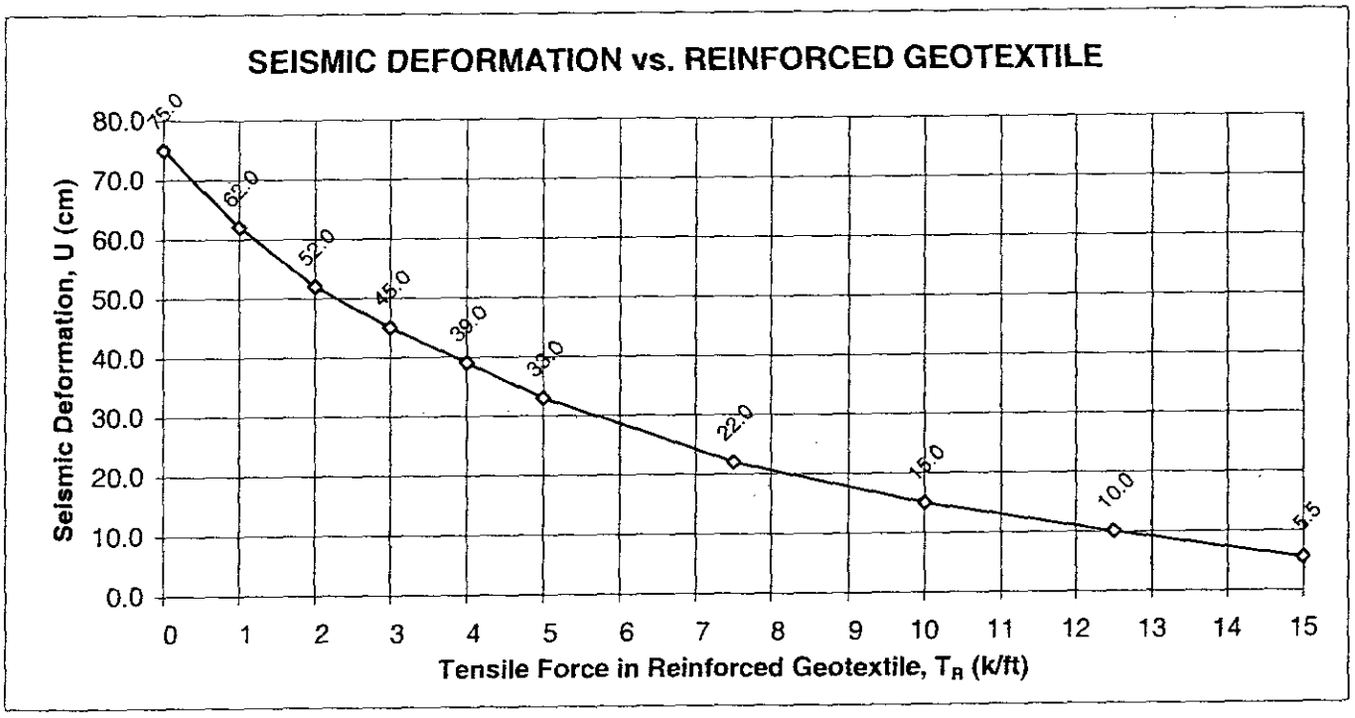


HDR ONE COMPANY Many Solutions	Project:	Bayview Landfill	Computed: NPD	Date:	07/16/03
	Subject:	Cell 2 Design	Checked: PHP	Date:	7-23-03
	Task:	Slope Stability	Page: 6	of:	6
	Job #:	3879	No:		

Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary

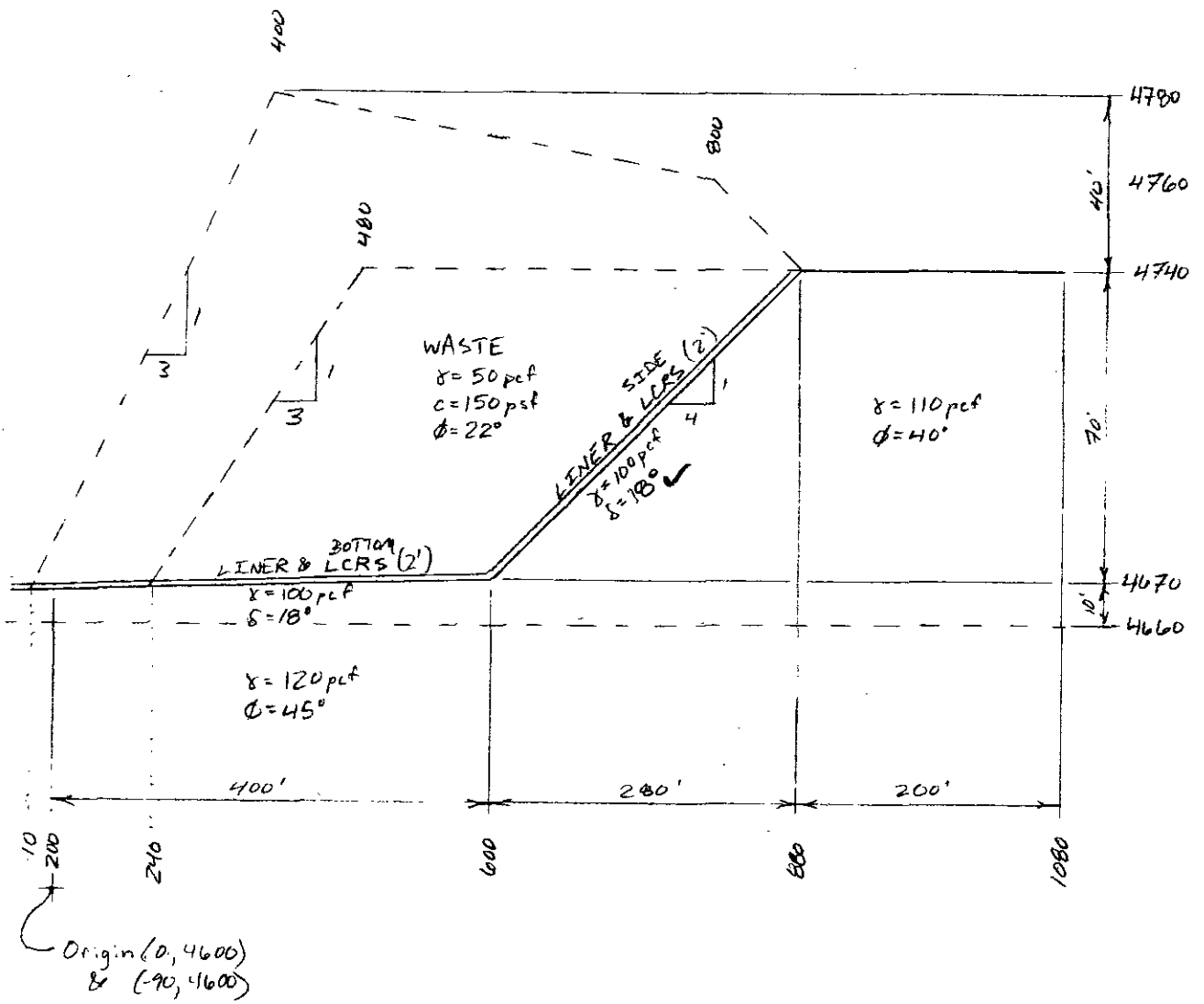
Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Deformation for M ≈ 7.2, U (cm)
0.0	75.0
1.0	62.0
2.0	52.0
3.0	45.0
4.0	39.0
5.0	33.0
7.5	22.0
10.0	15.0
12.5	10.0
15.0	5.5



HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/10/03		
	Subject: Cell 2	Checked: PHP	Date: 7-20-03		
	Task: Slope Stability	Page: 1	of: 2		
	Job #: 3879	No:			

Operational Slopes

Geometry / Soils



Sliding Block Failure
Failure Surface Along Liner & LCRS

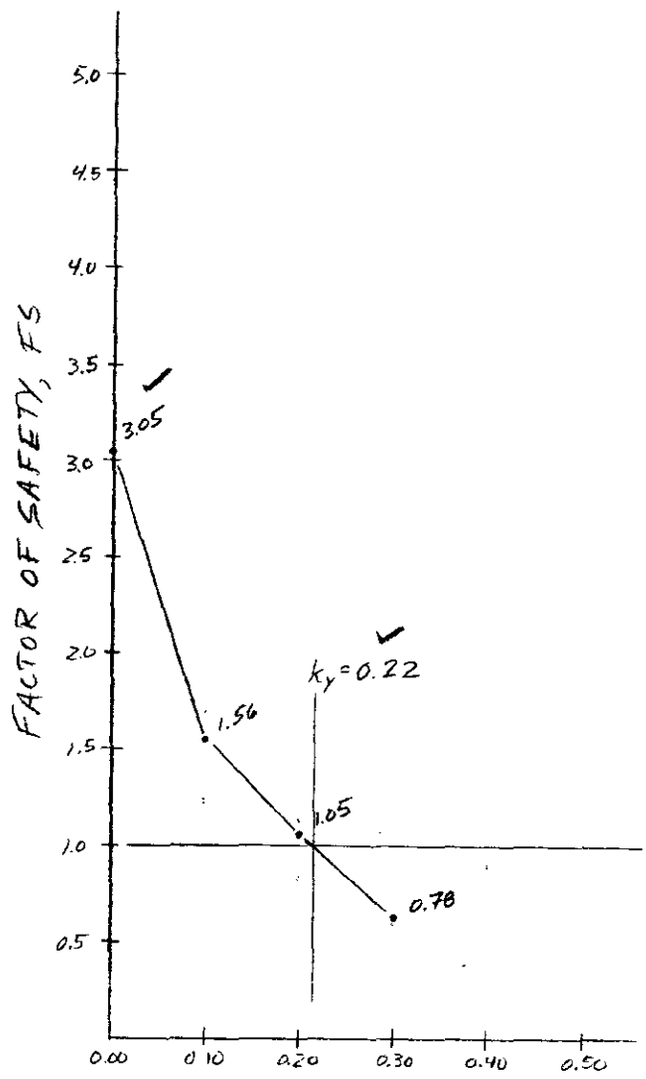
CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/11/03		
	Subject: Cell 2	Checked: PHP	Date: 7-20-03		
	Task: Slope Stability	Page: 2	of: 2		
	Job #: 3879	No:			

Operational Slopes (Cont.)

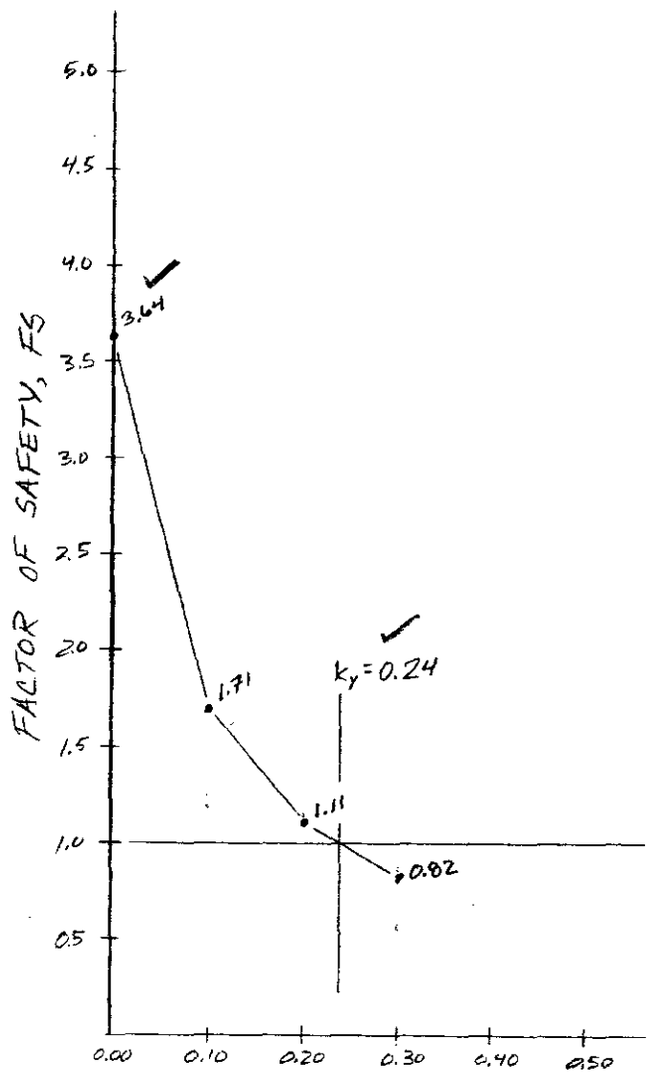
Stability Summary (Static & Pseudo-static)

Fill to Elev. 4740



$\delta = 18°$ Yield Acceleration, $a_y = 0.22g$

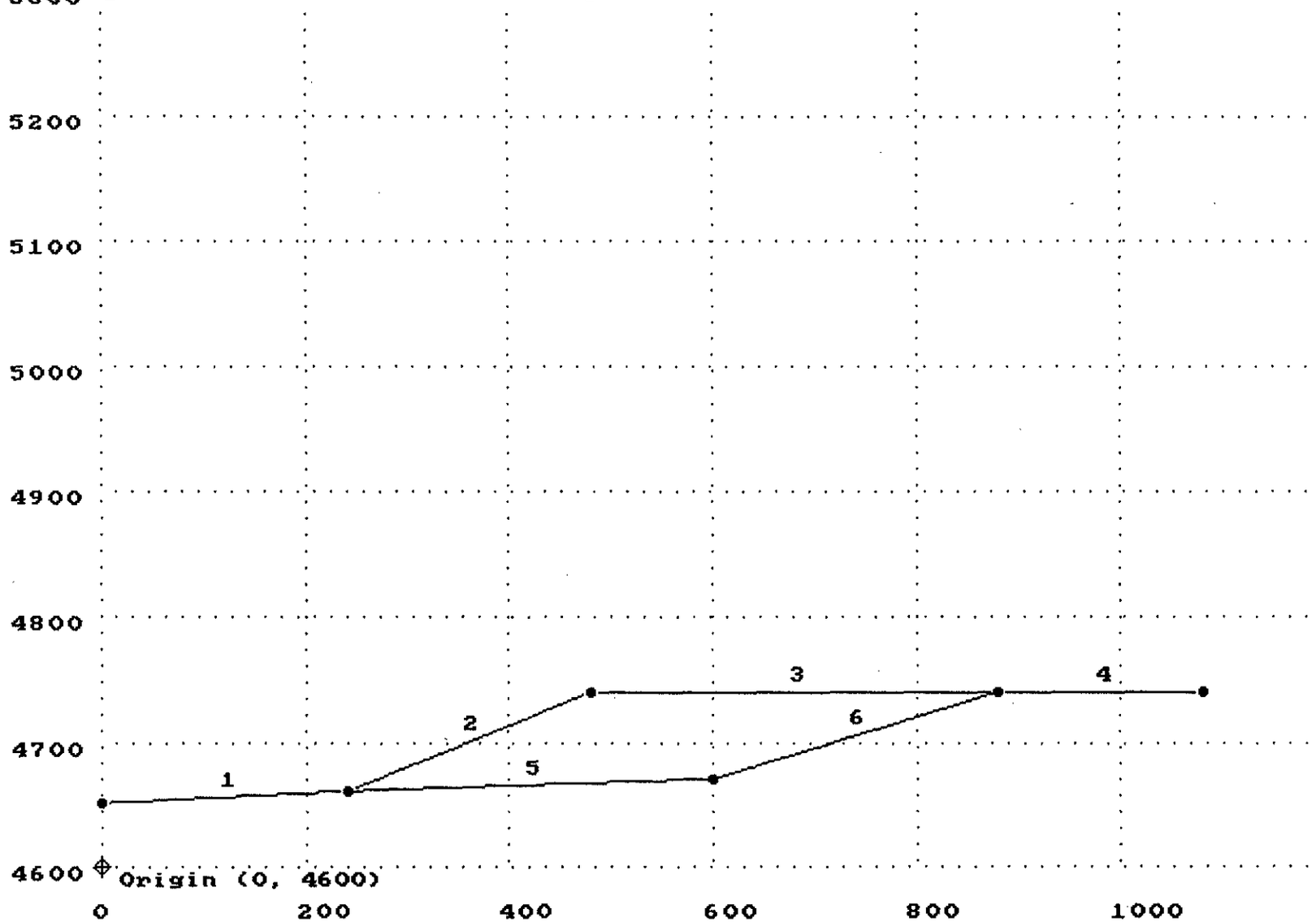
Fill to Elev. 4780



$\delta = 18°$ Yield Acceleration, $a_y = 0.24g$

CONT. →

BAYVIEW LANDFILL: OPERATIONAL SLOPE FILL TO ELEV. 4740
Geometry Preview. Coordinates not adjusted.



✓ POP 7-23-03

*rB

BAY_W1_0.OUT
** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	07-17-03
Time of Run:	8:49pm
Run By:	NPD
Input Data Filename:	C:BAY_W1_0.IN
Output Filename:	C:BAY_W1_0.OUT
Plotted Output Filename:	C:BAY_W1_0.PLT

PROBLEM DESCRIPTION Bayview Landfill: Operational Slope
Fill to Elev. 4740

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	50.00	240.00	60.00	3
2	240.00	60.00	480.00	140.00	1
3	480.00	140.00	880.00	140.00	1
4	880.00	140.00	1080.00	140.00	2
5	240.00	60.00	600.00	70.00	3
6	600.00	70.00	880.00	140.00	2

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	50.0	52.0	150.0	22.0	.00	.0	0
2	100.0	102.0	.0	18.0	.00	.0	0
3	100.0	102.0	.0	18.0	.00	.0	0

1

Trial Failure Surface Specified By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	240.00	60.00
2	600.10	69.90
3	880.10	140.00

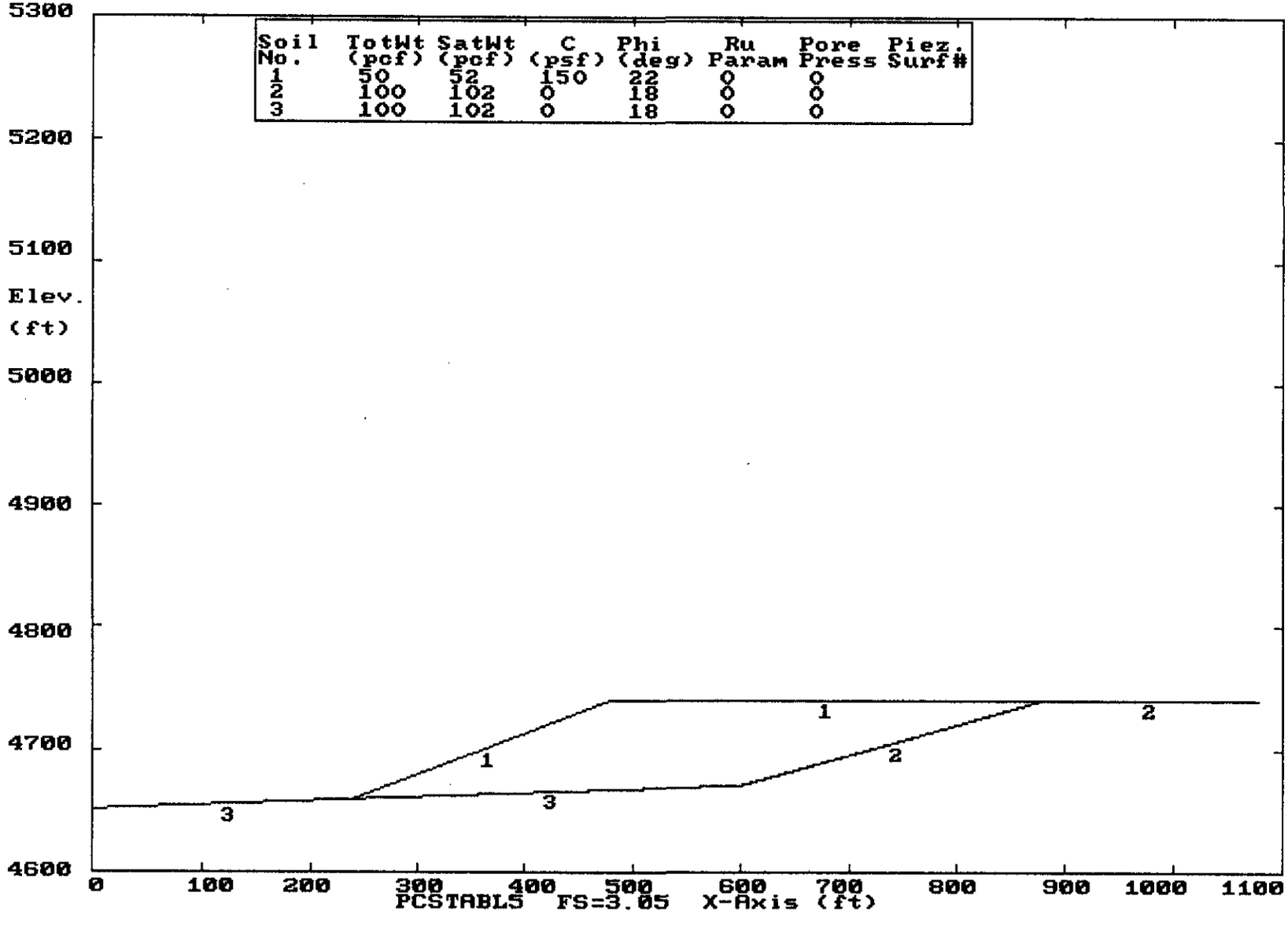
Factor Of Safety For The Preceding Specified Surface = 3.047

```
1

            Y            A     X     I     S            F     T

             .00    135.00    270.00    405.00    540.00    675.00

X        .00 +---*-----+---------+---------+---------+---------+
             -
             -
             -
             -
             -
     135.00 +
             -
             -
             -
             -
             -   *
A    270.00 +
             -
             -
             -
             -
             -
X    405.00 +
             -
             -
             -         *
             -
             -
I    540.00 +
             -
             -
             -    *
             -
             -
S    675.00 +
             -
             -
             -
             -
             -
     810.00 +
             -
             -
             -         *
             -
             -
F    945.00 +
             -
```

```
                    -
                    -
                    -
                    -
T    1080.00 +          *
```

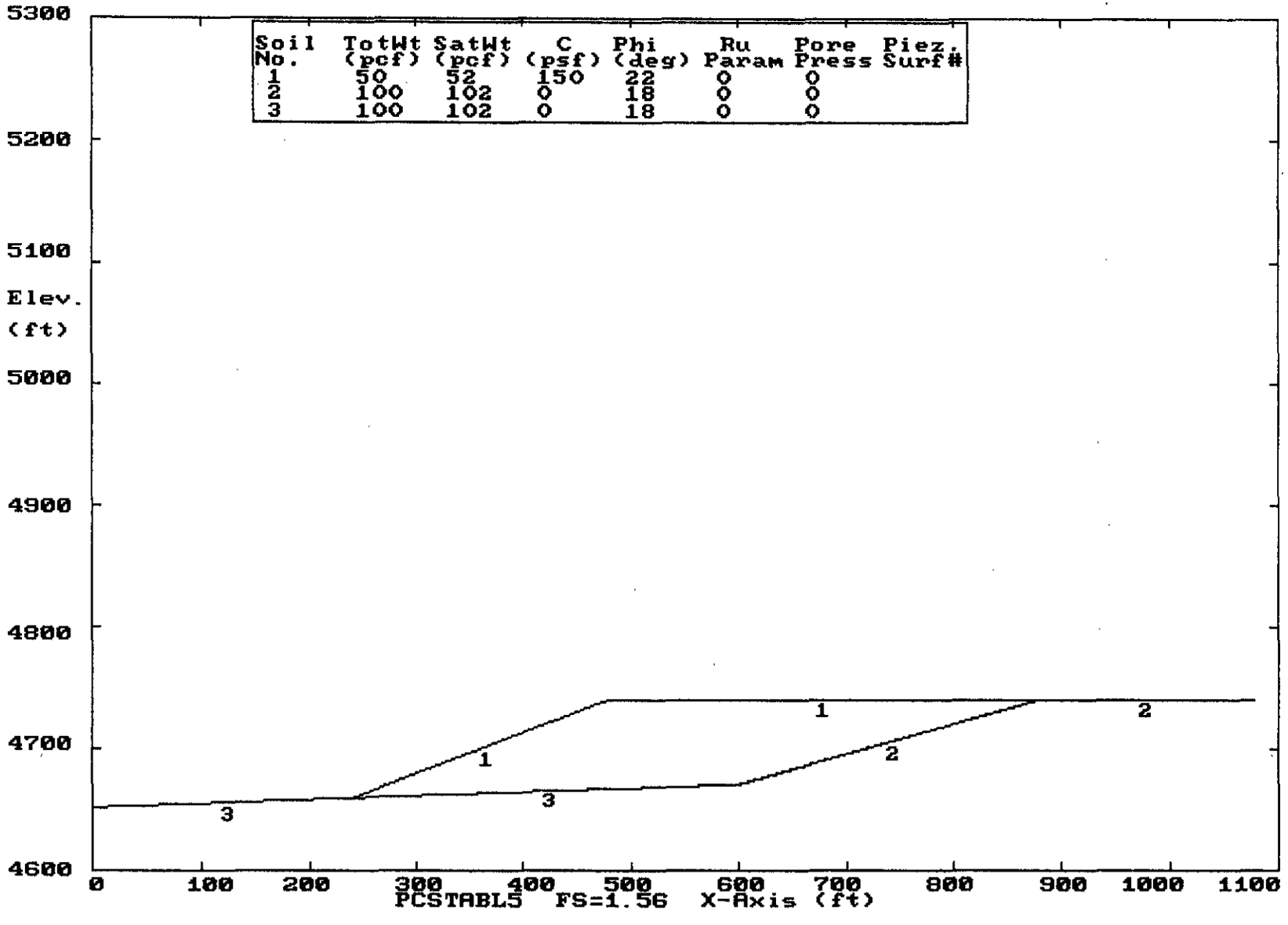
```
PROFIL        C:BAY_W1_0.IN  PCSTABL Version 5 /O(0, 4600)
Bayview Landfill: Operational Slope     Fill to Elev. 4740
6 4
0. 50. 240. 60. 3
240. 60. 480. 140. 1
480. 140. 880. 140. 1
880. 140. 1080. 140. 2
240. 60. 600. 70. 3
600. 70. 880. 140. 2
SOIL  Waste   Side    Bottom
3
50. 52. 150. 22. 0. 0. 0
100. 102. 0. 18. 0. 0. 0
100. 102. 0. 18. 0. 0. 0
SURFAC
3
240. 60.
600.1 69.9
880.1 140.
EXECUT
```

Bayview Landfill: Operational Slope Fill to Elev. 4740
Specified Surface. C:BAY_W1_0.PLT By: NPD 07-17-03 8:49pm



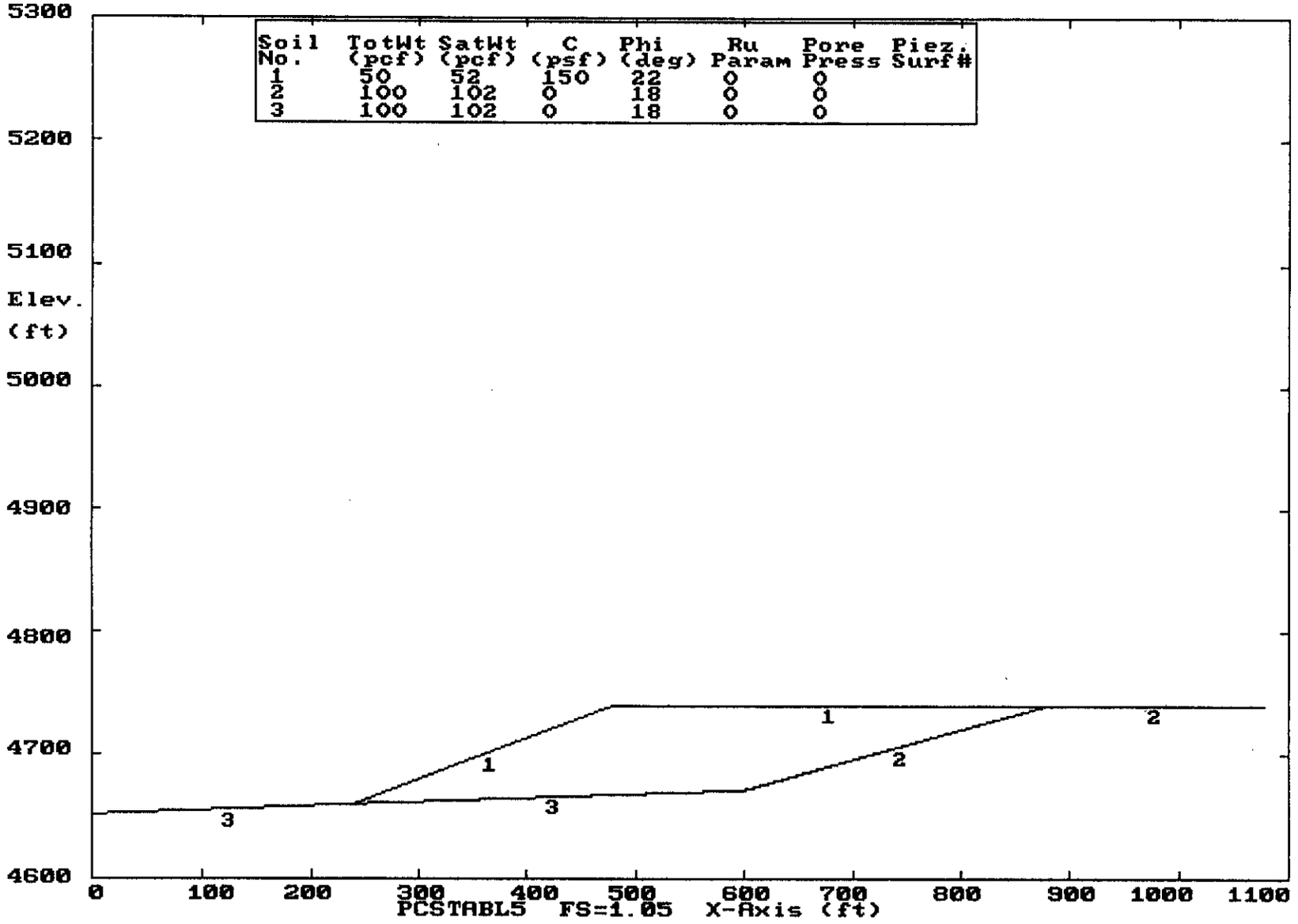
*rB

Bayview Landfill: Operational Slope Fill to Elev. 4740, Eq = 0.10g
Specified Surface. C:BAY_W1_1.PLT By: NPD 07-17-03 8:49pm



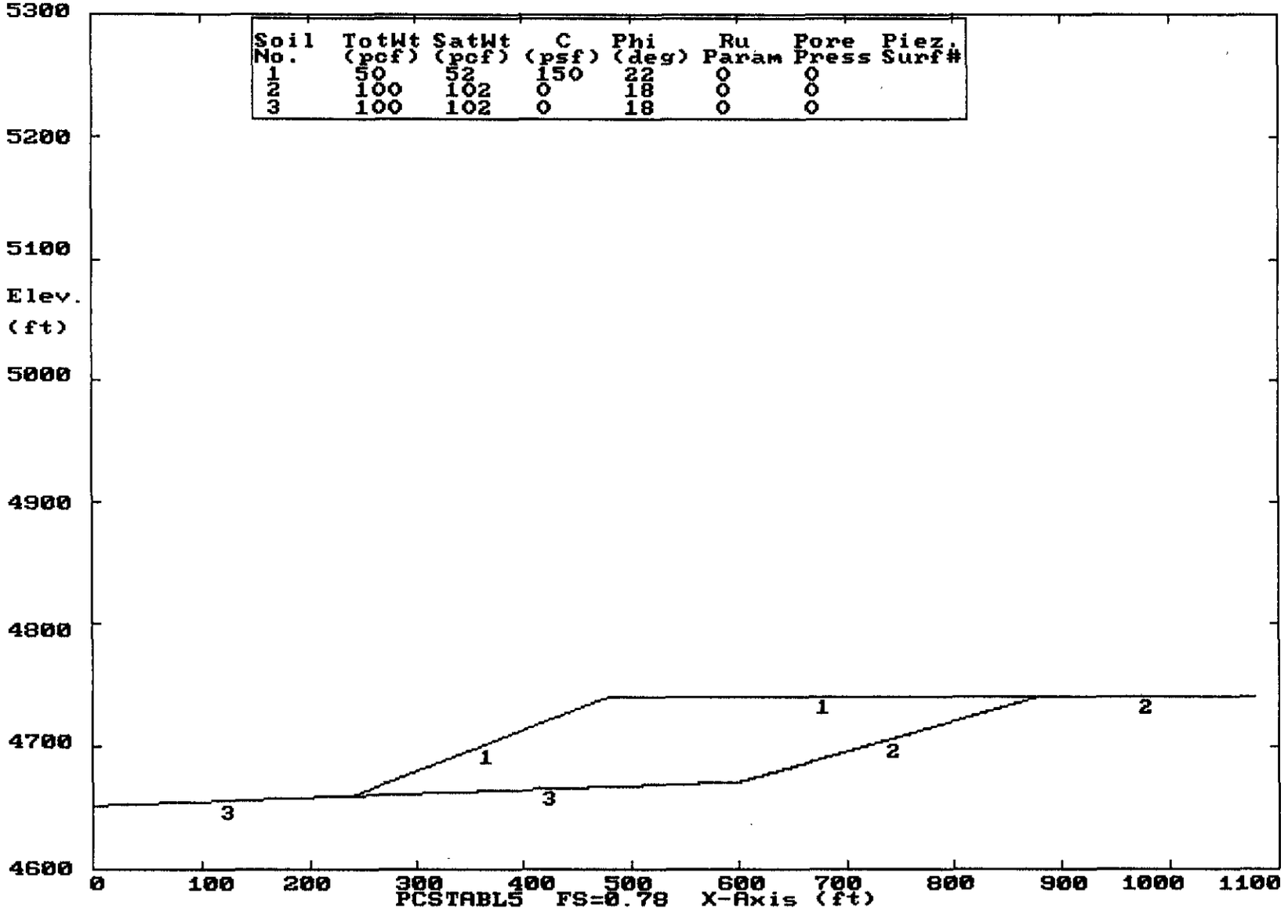
*rB

Bayview Landfill: Operational Slope Fill to Elev. 4740, Eq = 0.20g
Specified Surface. C:BAY_W1_2.PLT By: NPD 07-17-03 8:49pm



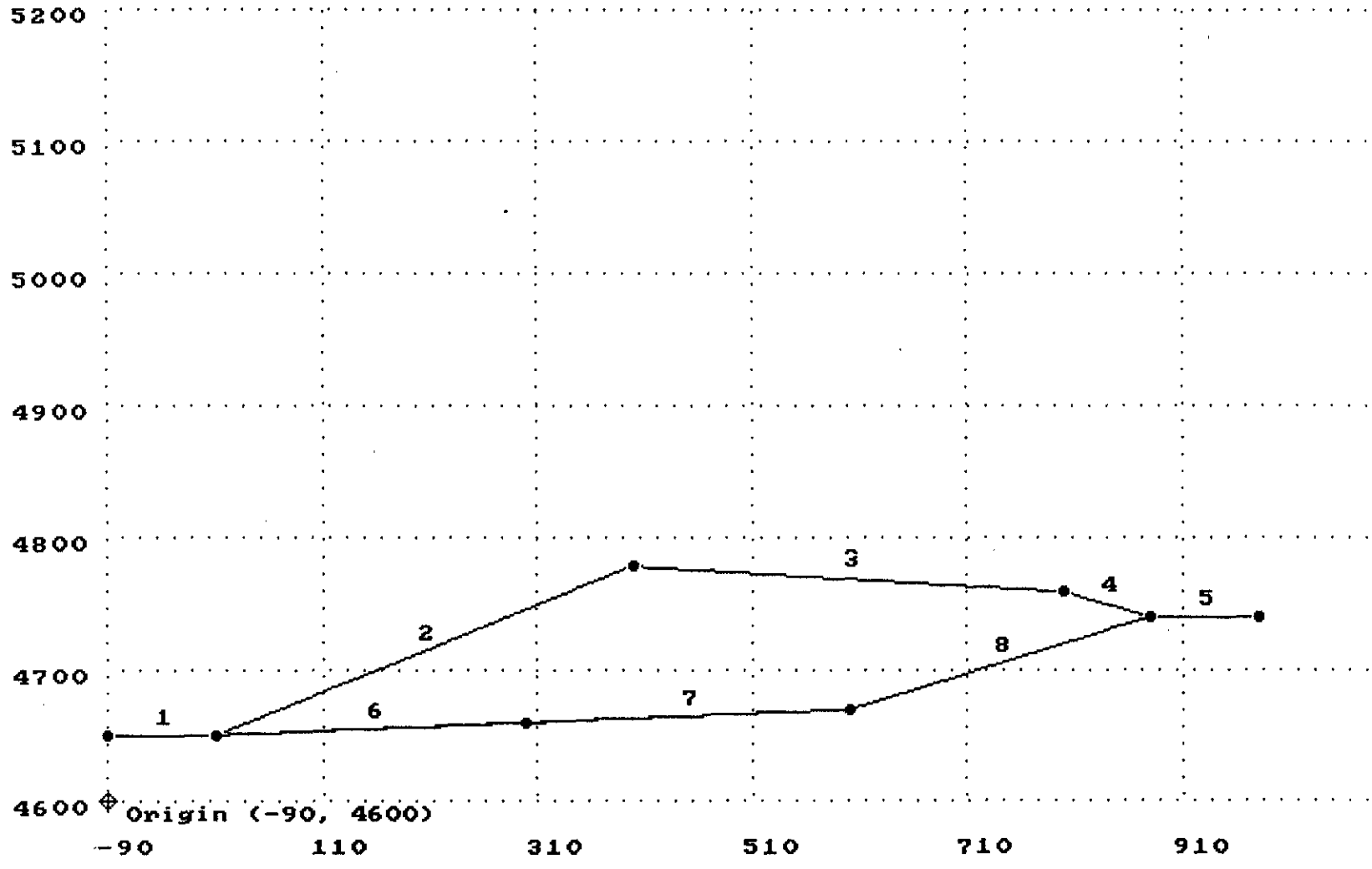
*rB

Bayview Landfill: Operational Slope Fill to Elev. 4740, Eq = 0.30g
Specified Surface. C:BAY_W1_3.PLT By: NPD 07-17-03 8:50pm



*rB

BAYVIEW LANDFILL: OPERATIONAL SLOPE FILL TO ELEV. 4780
Geometry Preview. Coordinates not adjusted.



*rB

BAY_W2_0.OUT
** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	07-17-03
Time of Run:	8:51pm
Run By:	NPD
Input Data Filename:	C:BAY_W2_0.IN
Output Filename:	C:BAY_W2_0.OUT
Plotted Output Filename:	C:BAY_W2_0.PLT

PROBLEM DESCRIPTION Bayview Landfill: Operational Slope
Fill to Elev. 4780

BOUNDARY COORDINATES

5 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	50.00	100.00	50.00	3
2	100.00	50.00	490.00	180.00	1
3	490.00	180.00	890.00	160.00	1
4	890.00	160.00	970.00	140.00	1
5	970.00	140.00	1070.00	140.00	2
6	100.00	50.00	390.00	60.00	3
7	390.00	60.00	690.00	70.00	3
8	690.00	70.00	970.00	140.00	2

1

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	50.0	52.0	150.0	22.0	.00	.0	0
2	100.0	102.0	.0	18.0	.00	.0	0
3	100.0	102.0	.0	18.0	.00	.0	0

1

Trial Failure Surface Specified By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	100.00	50.00
2	690.10	69.90
3	970.10	140.00

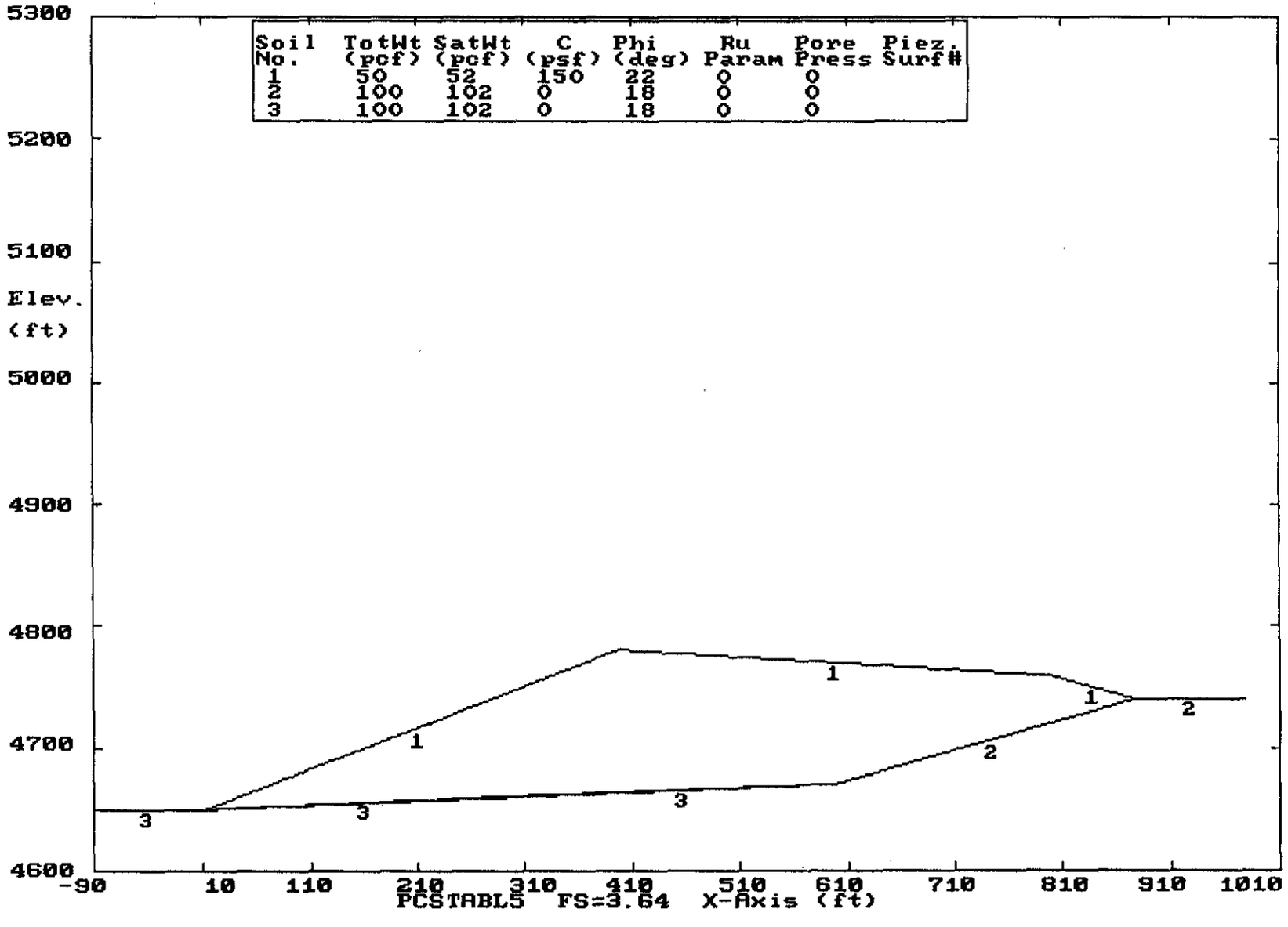
Factor Of Safety For The Preceding Specified Surface = 3.643

```
1

            Y            A     X     I     S            F     T

             .00    133.75    267.50    401.25    535.00    668.75

X        .00 +---*-----+---------+---------+---------+---------+
             -
             -
             -
             -   *
             -
     133.75 +
             -
             -
             -
             -
             -
A    267.50 +
             -
             -
             -
             -
             -   *
X    401.25 +
             -
             -
             -
             -            *
             -
I    535.00 +
             -
             -
             -
             -
             -
S    668.75 +
             -    *
             -
             -
             -
             -
     802.50 +
             -
             -
             -
             -           *
             -
```

```
F     936.25 +
             -
             -        *
             -
             -
             -
T    1070.00 +        *
```

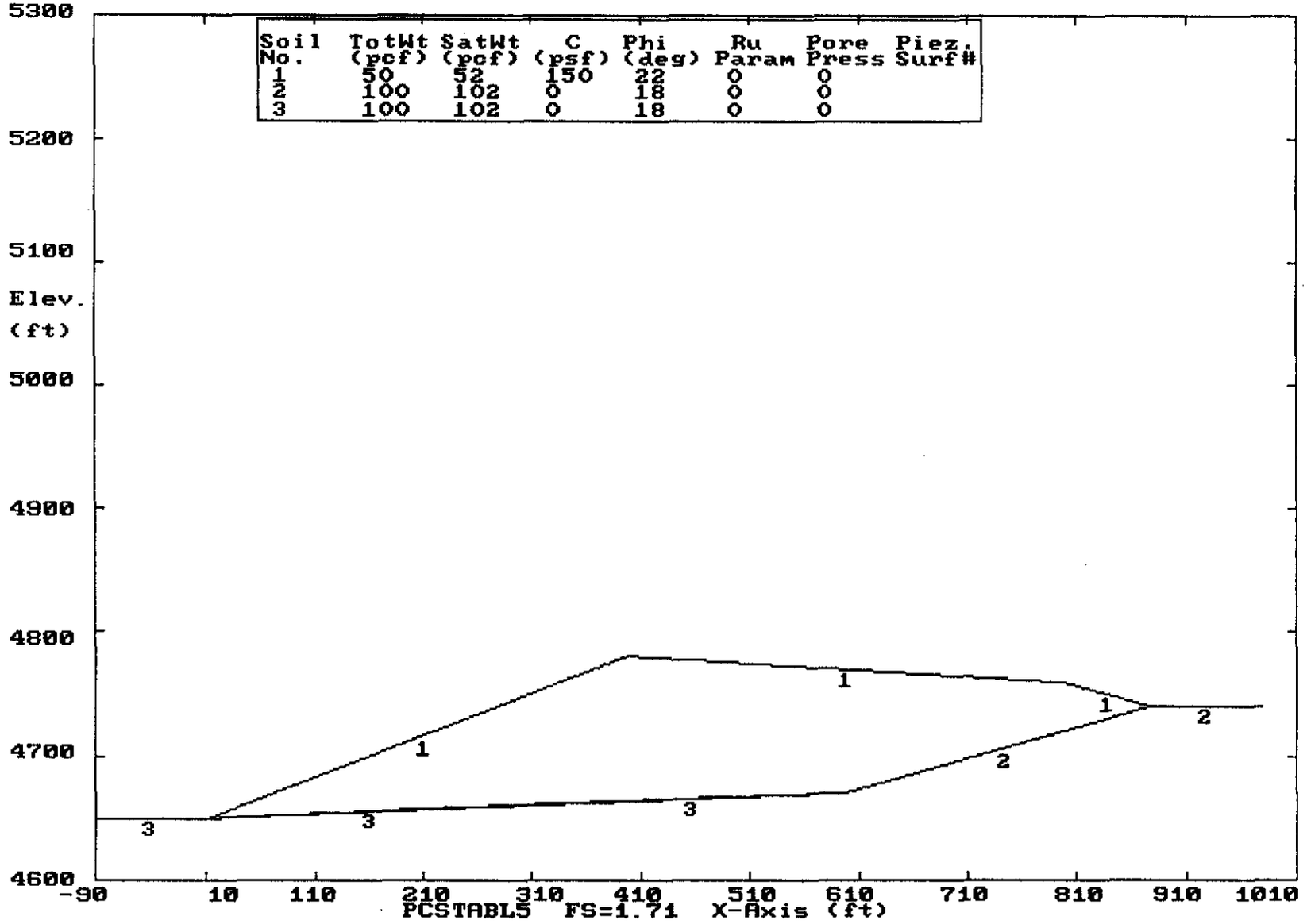
```
PROFIL        C:BAY_W2_0.IN  PCSTABL Version 5 /O(-90, 4600)
Bayview Landfill: Operational Slope     Fill to Elev. 4780
8 5
0. 50. 100. 50. 3
100. 50. 490. 180. 1
490. 180. 890. 160. 1
890. 160. 970. 140. 1
970. 140. 1070. 140. 2
100. 50. 390. 60. 3
390. 60. 690. 70. 3
690. 70. 970. 140. 2
SOIL  Waste   Side    Bottom
3
50. 52. 150. 22. 0. 0. 0
100. 102. 0. 18. 0. 0. 0
100. 102. 0. 18. 0. 0. 0
SURFAC
3
100. 50.
690.1 69.9
970.1 140.
EXECUT
```

Bayview Landfill: Operational Slope Fill to Elev. 4780
Specified Surface. C:BAY_W2_0.PLT By: NPD 07-17-03 8:51pm



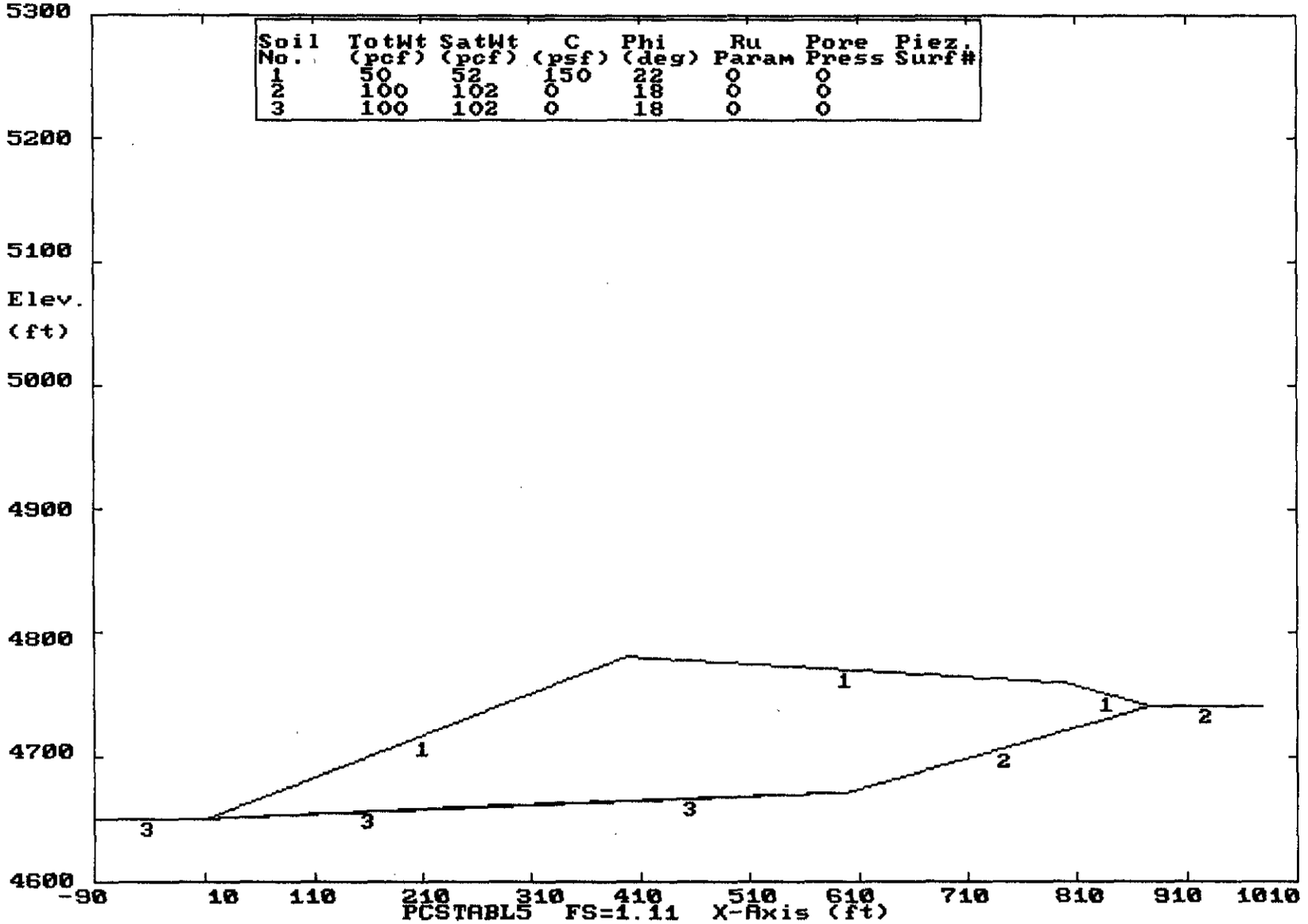
*rB

Bayview Landfill: Operational Slope Fill to Elev. 4780, Eq = 0.10g
Specified Surface. C:BAY_W2_1.PLT By: NPD 07-17-03 8:51pm



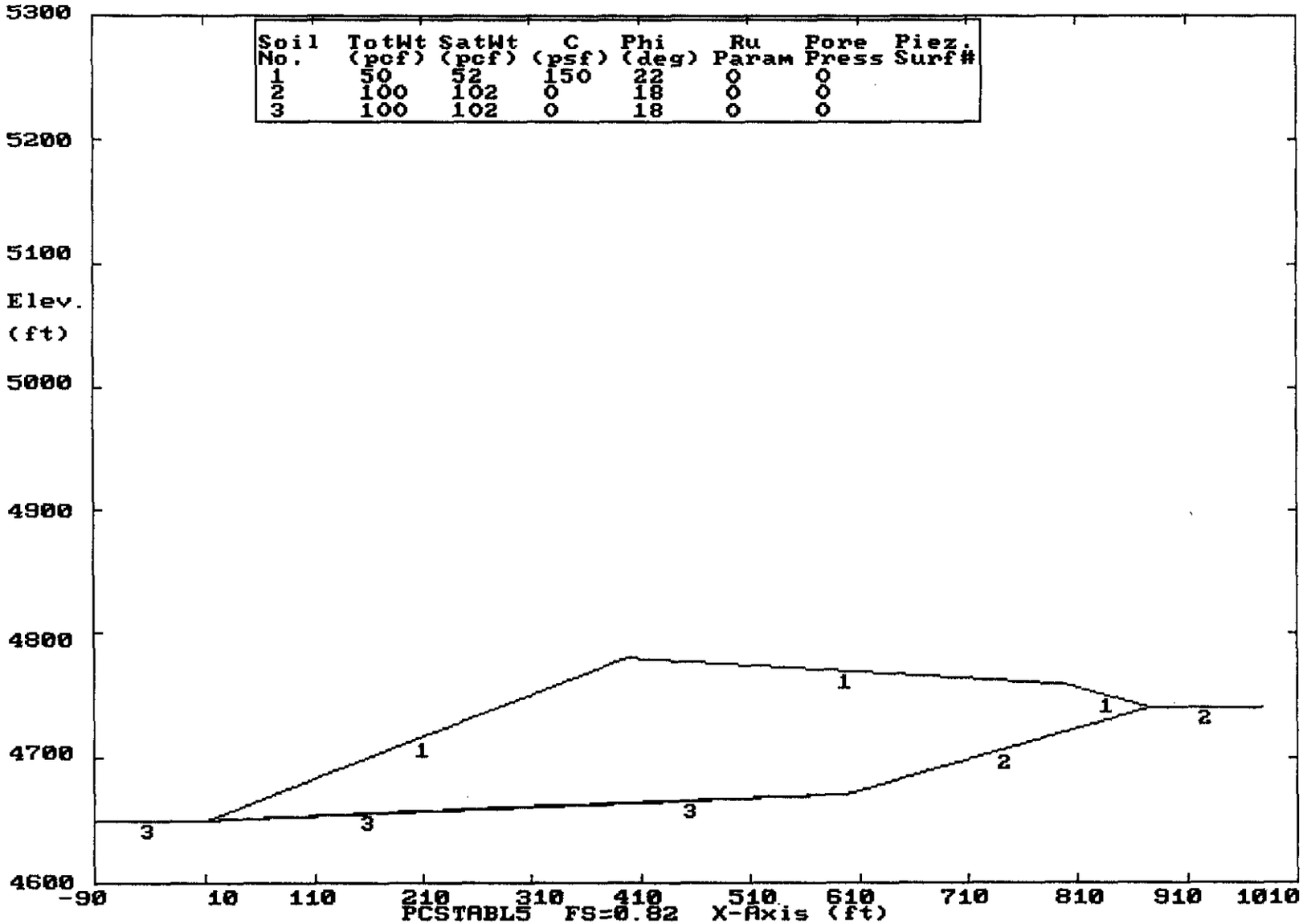
*rB

Bayview Landfill: Operational Slope Fill to Elev. 4780, Eq = 0.20g
Specified Surface. C:BAY_W2_2.PLT By: NPD 07-17-03 8:52pm



*rB

Bayview Landfill: Operational Slope Fill to Elev. 4780, Eq = 0.30g
Specified Surface. C:BAY_W2_3.PLT By: NPD 07-17-03 8:52pm



*rB

Project:	Bayview Landfill	Computed:	NPD	Date:	07/11/03
Subject:	Cell 2	Checked:	PHP	Date:	7-20-03
Task:	Slope Stability	Page:	1	of.	2
Job #:	3879	No:			

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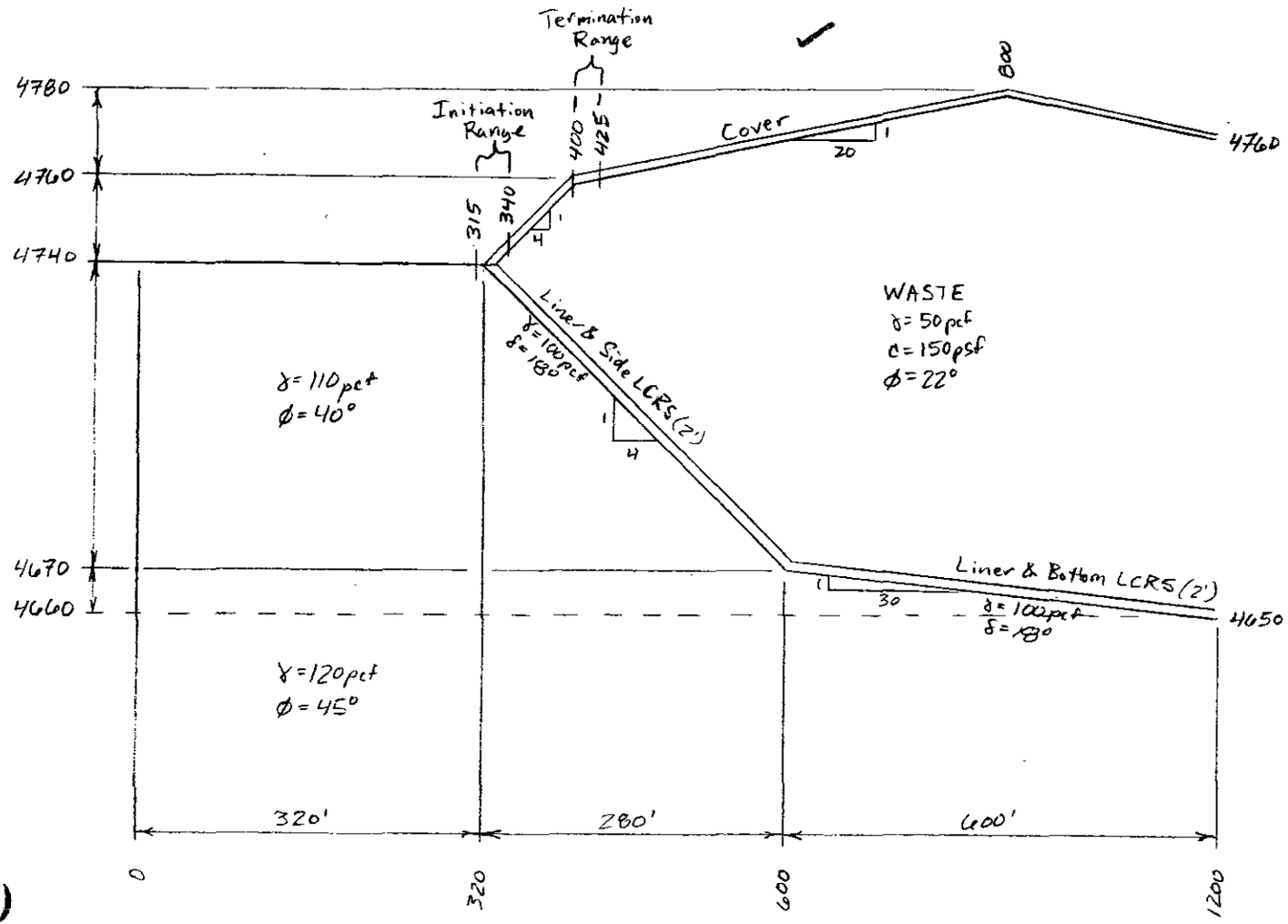
Finished Fill Slope

Geometry / Soils

25 pts @ 1' Spacing
25 circles at each pt
10' segment lengths

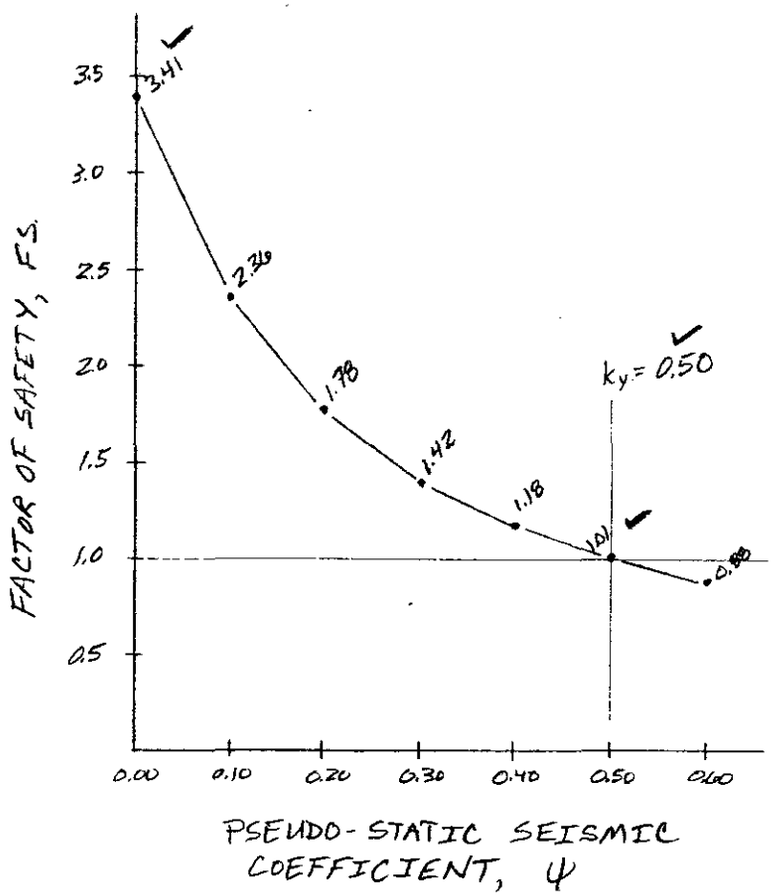


CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/11/03		
	Subject: Cell 2	Checked: PHP	Date: 7-20-03		
	Task: Slope Stability	Page: 2	of: 2		
	Job #: 3879	No:			

Finished Fill Slope (cont.)

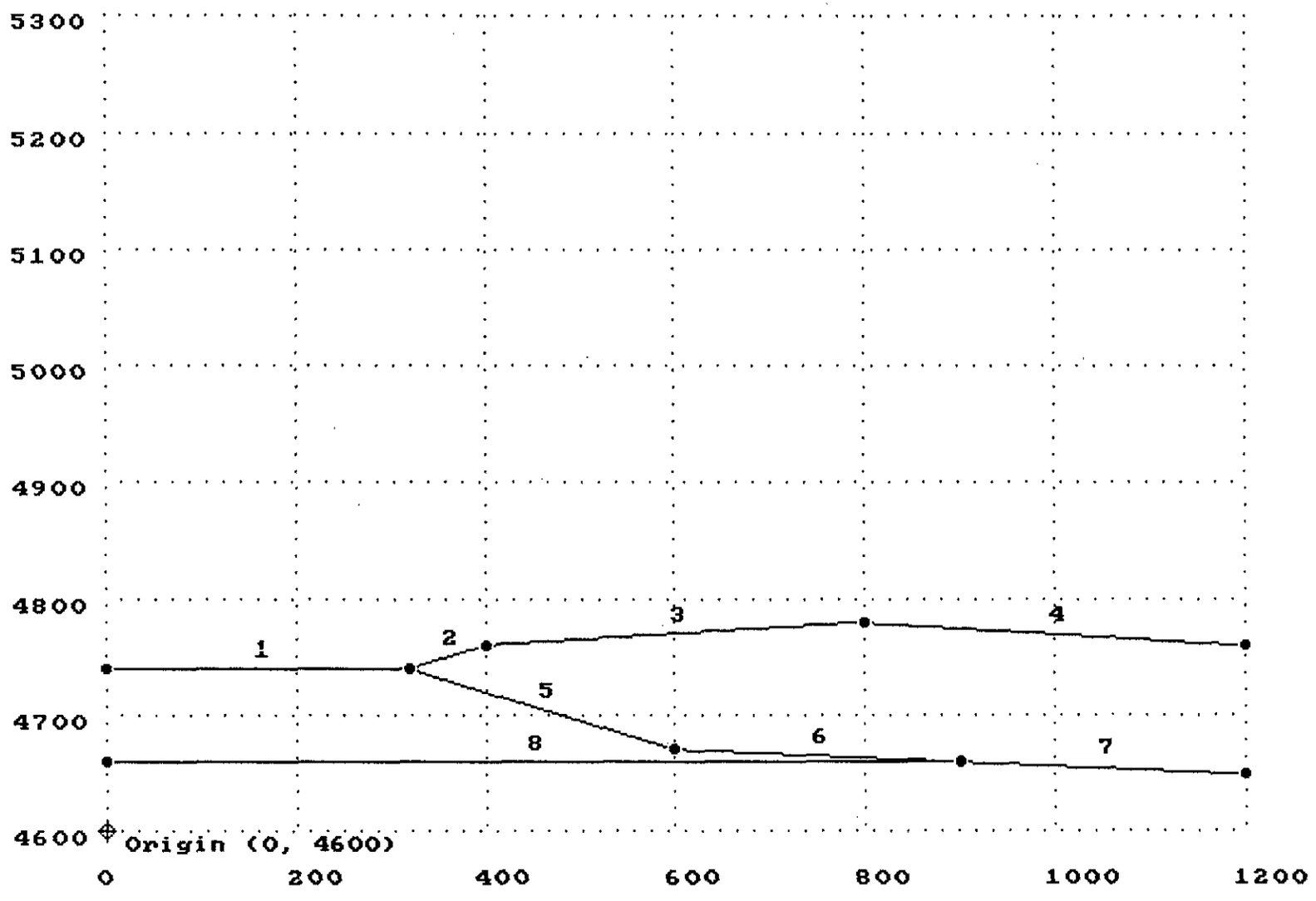
Stability Summary (Static & Pseudo-static)



$\therefore$ Yield Acceleration for Fill Slope, $a_y = 0.50g$

CONT. →

BAYVIEW LANDFILL: FINISHED FILL SLOPE
Geometry Preview. Coordinates not adjusted.



✓ PHP 7-23-03

*rB

BAY_F_0.OUT
** PCSTABL5 **

by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	07-14-03
Time of Run:	9:11am
Run By:	NPD
Input Data Filename:	C:BAY_F_0.IN
Output Filename:	C:BAY_F_0.OUT
Plotted Output Filename:	C:BAY_F_0.PLT

PROBLEM DESCRIPTION Bayview Landfill: Finished Fill Slope

BOUNDARY COORDINATES

4 Top Boundaries
8 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	140.00	320.00	140.00	2
2	320.00	140.00	400.00	160.00	1
3	400.00	160.00	800.00	180.00	1
4	800.00	180.00	1200.00	160.00	1
5	320.00	140.00	600.00	70.00	2
6	600.00	70.00	900.00	60.00	2
7	900.00	60.00	1200.00	50.00	3
8	.00	60.00	900.00	60.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	50.0	52.0	150.0	22.0	.00	.0	0
2	110.0	112.0	.0	40.0	.00	.0	0
3	120.0	122.0	.0	45.0	.00	.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

625 Trial Surfaces Have Been Generated.

25 Surfaces Initiate From Each Of 25 Points Equally Spaced Along The Ground Surface Between X = 315.00 ft.
and X = 340.00 ft.

Each Surface Terminates Between X = 400.00 ft.
and X = 425.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	319.17	140.00
2	328.91	137.76
3	338.84	136.53
4	348.83	136.31
5	358.80	137.12
6	368.63	138.94
7	378.23	141.75
8	387.49	145.53
9	396.32	150.23
10	404.62	155.81
11	410.27	160.51

Circle Center At X = 345.9 ; Y = 234.2 and Radius, 97.9

*** 3.413 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	318.13	140.00
2	327.78	137.40
3	337.67	135.88
4	347.66	135.45
5	357.63	136.12
6	367.48	137.88
7	377.07	140.70
8	386.30	144.56
9	395.04	149.41
10	403.21	155.19
11	409.15	160.46

Circle Center At X = 346.6 ; Y = 226.6 and Radius, 91.1

*** 3.430 ***

1

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	323.33	140.83
2	332.72	137.39
3	342.46	135.13
4	352.41	134.08
5	362.41	134.26
6	372.31	135.67
7	381.96	138.27
8	391.22	142.05
9	399.95	146.93
10	408.02	152.84
11	415.30	159.70
12	416.22	160.81

Circle Center At X = 356.0 ; Y = 215.4 and Radius, 81.4

*** 3.463 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	317.08	140.00
2	326.86	137.88
3	336.78	136.68
4	346.78	136.41
5	356.76	137.08
6	366.63	138.67
7	376.31	141.17
8	385.72	144.57
9	394.76	148.83
10	403.37	153.92

11	411.47	159.79
12	412.43	160.62

Circle Center At X = 344.7 ; Y = 243.5 and Radius, 107.1

*** 3.464 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	324.38	141.09
2	333.72	137.54
3	343.48	135.33
4	353.44	134.50
5	363.43	135.07
6	373.23	137.02
7	382.67	140.32
8	391.56	144.91
9	399.72	150.69
10	407.00	157.55
11	409.33	160.47

Circle Center At X = 354.4 ; Y = 206.1 and Radius, 71.6

*** 3.475 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	323.33	140.83
2	332.75	137.47
3	342.50	135.23
4	352.44	134.15
5	362.44	134.24
6	372.36	135.50
7	382.06	137.92
8	391.42	141.45
9	400.30	146.05
10	408.58	151.66
11	416.14	158.20
12	418.64	160.93

Circle Center At X = 356.7 ; Y = 219.4 and Radius, 85.3

*** 3.478 ***

1

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	323.33	140.83
2	332.72	137.39
3	342.45	135.06
4	352.38	133.88
5	362.38	133.86
6	372.31	135.01
7	382.04	137.30
8	391.44	140.71
9	400.38	145.19
10	408.74	150.69
11	416.40	157.11
12	420.07	161.00

Circle Center At X = 357.5 ; Y = 219.5 and Radius, 85.8

*** 3.487 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	318.13	140.00
2	327.78	137.38
3	337.62	135.62
4	347.58	134.75
5	357.58	134.76
6	367.54	135.67
7	377.38	137.46
8	387.02	140.11
9	396.39	143.61
10	405.41	147.93
11	414.00	153.04
12	422.11	158.89
13	424.83	161.24

Circle Center At X = 352.4 ; Y = 247.0 and Radius, 112.4

*** 3.494 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	319.17	140.00
2	328.74	137.11
3	338.55	135.15

4	348.50	134.14
5	358.50	134.07
6	368.46	134.96
7	378.29	136.80
8	387.90	139.56
9	397.20	143.22
10	406.11	147.76
11	414.55	153.12
12	422.44	159.27
13	424.51	161.23

Circle Center At X = 354.2 ; Y = 238.8 and Radius, 104.8

*** 3.502 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	325.42	141.35
2	334.42	137.00
3	343.99	134.09
4	353.89	132.69
5	363.89	132.84
6	373.74	134.53
7	383.22	137.72
8	392.09	142.33
9	400.15	148.26
10	407.19	155.36
11	410.94	160.55

Circle Center At X = 357.9 ; Y = 197.2 and Radius, 64.6

*** 3.507 ***

1

```
            Y            A     X     I     S            F     T

             .00    150.00    300.00    450.00    600.00    750.00

X        .00 +---*----*+---------+---------+---------+---------+
             -
             -
             -
             -
             -
     150.00 +
             -
             -
             -
             -
             -
A    300.00 +
```

```
                    -        .*.
                    -        .1.
                    -        .11
                    -        .31*
                    -         .73
X     450.00 +
                    -
                    -
                    -
                    -
                    -
I     600.00 +     *
                    -
                    -
                    -
                    -
                    -
S     750.00 +
                    -
                    -            *
                    -
                    -
                    -
      900.00 +    *
                    -
                    -
                    -
                    -
                    -
F    1050.00 +
                    -
                    -
                    -
                    -
                    -
T    1200.00 +   *        *
```

```
PROFIL       C:BAY_F_0.IN  PCSTABL Version 5 /O(0, 4600)
Bayview Landfill: Finished Fill Slope
8 4
0. 140. 320. 140. 2
320. 140. 400. 160. 1
400. 160. 800. 180. 1
800. 180. 1200. 160. 1
320. 140. 600. 70. 2
600. 70. 900. 60. 2
900. 60. 1200. 50. 3
0. 60. 900. 60. 3
SOIL  Waste   0-100   100-800
3
50. 52. 150. 22. 0. 0. 0
110. 112. 0. 40. 0. 0. 0
120. 122. 0. 45. 0. 0. 0
CIRCL2-Bishop circular, search.
25 25
315. 340. 400. 425. 0. 10. 0. 0.
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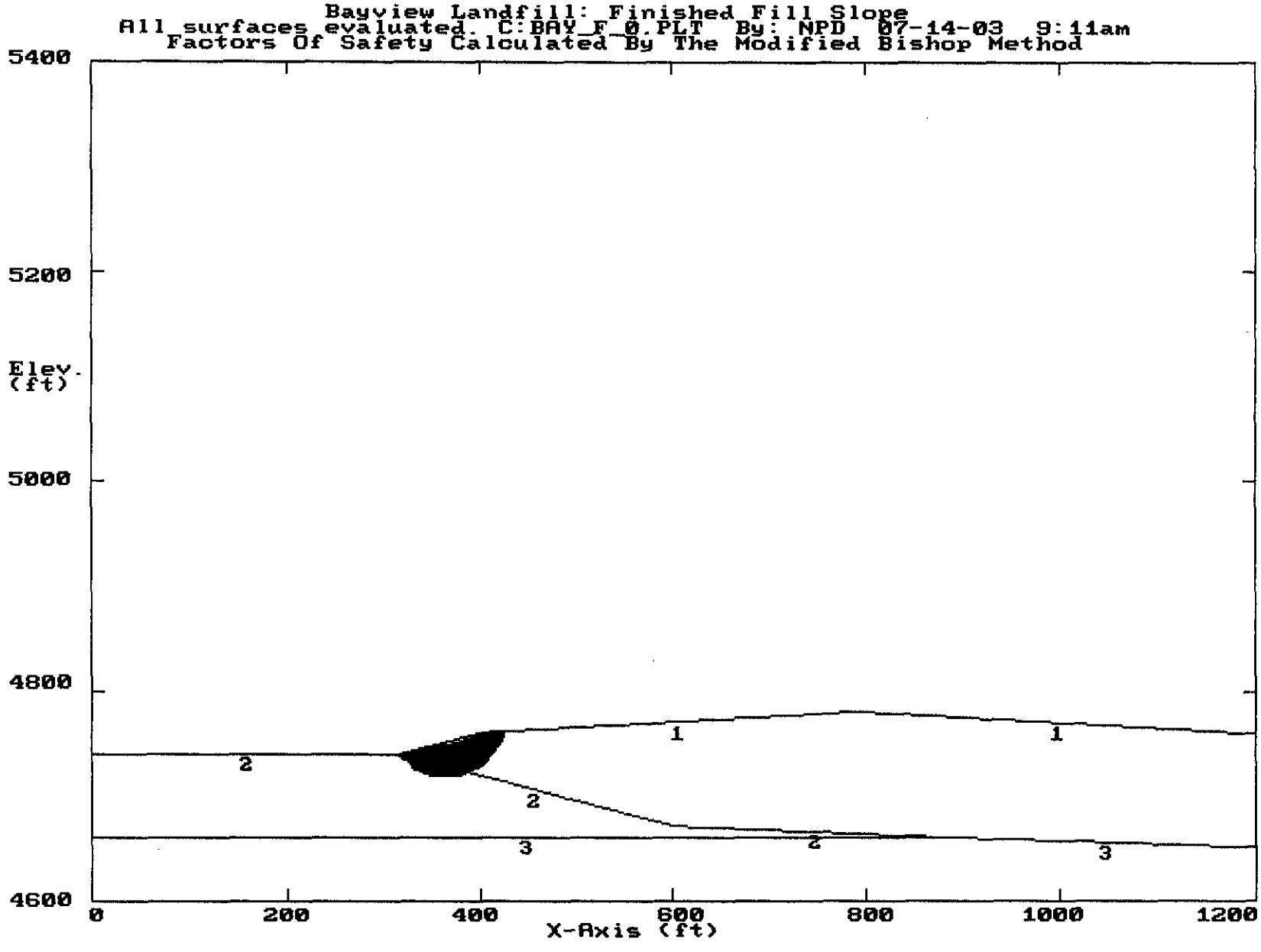
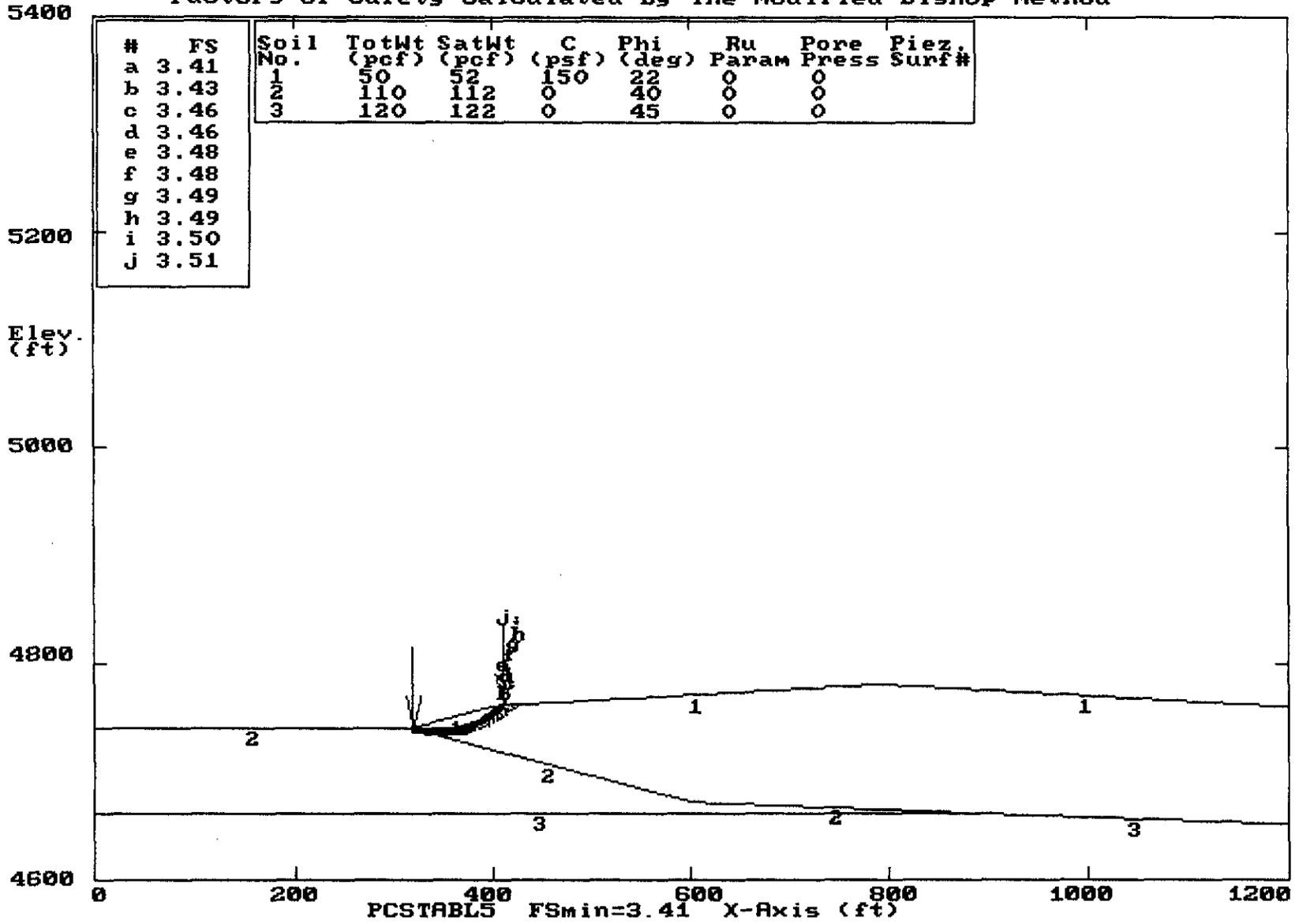

Bayview Landfill: Finished Fill Slope
All surfaces evaluated. C:BAY_F_0.PLT By: NPD 07-14-03 9:11am
Factors Of Safety Calculated By The Modified Bishop Method
5400
5200
5000
4800
4600
Elev. (ft)
0
200
400
600
800
1000
1200
X-Axis (ft)
1
1
2
2
2
3
3

BX*

Bayview Landfill: Finished Fill Slope
Ten Most Critical. C:BAY_F_0.PLT By: NPD 07-14-03 9:11am
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	3.41
b	3.43
c	3.46
d	3.46
e	3.48
f	3.48
g	3.49
h	3.49
i	3.50
j	3.51

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	

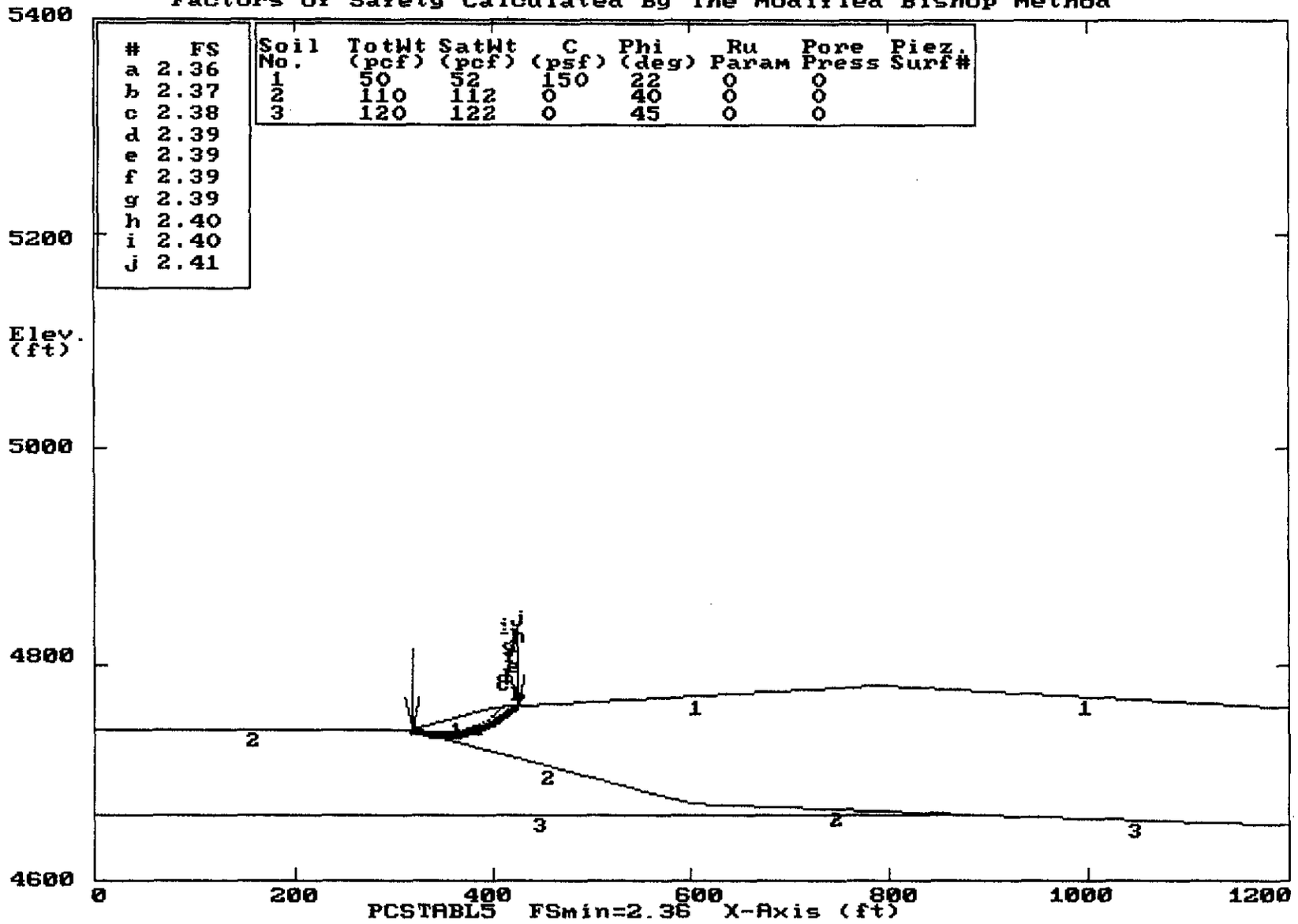


*rB

Bayview Landfill: Fill Slope, Eq = 0.10g
Ten Most Critical. C:BAY_F_1.PLT By: NPD 07-14-03 9:14am
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	2.36
b	2.37
c	2.38
d	2.39
e	2.39
f	2.39
g	2.39
h	2.40
i	2.40
j	2.41

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	



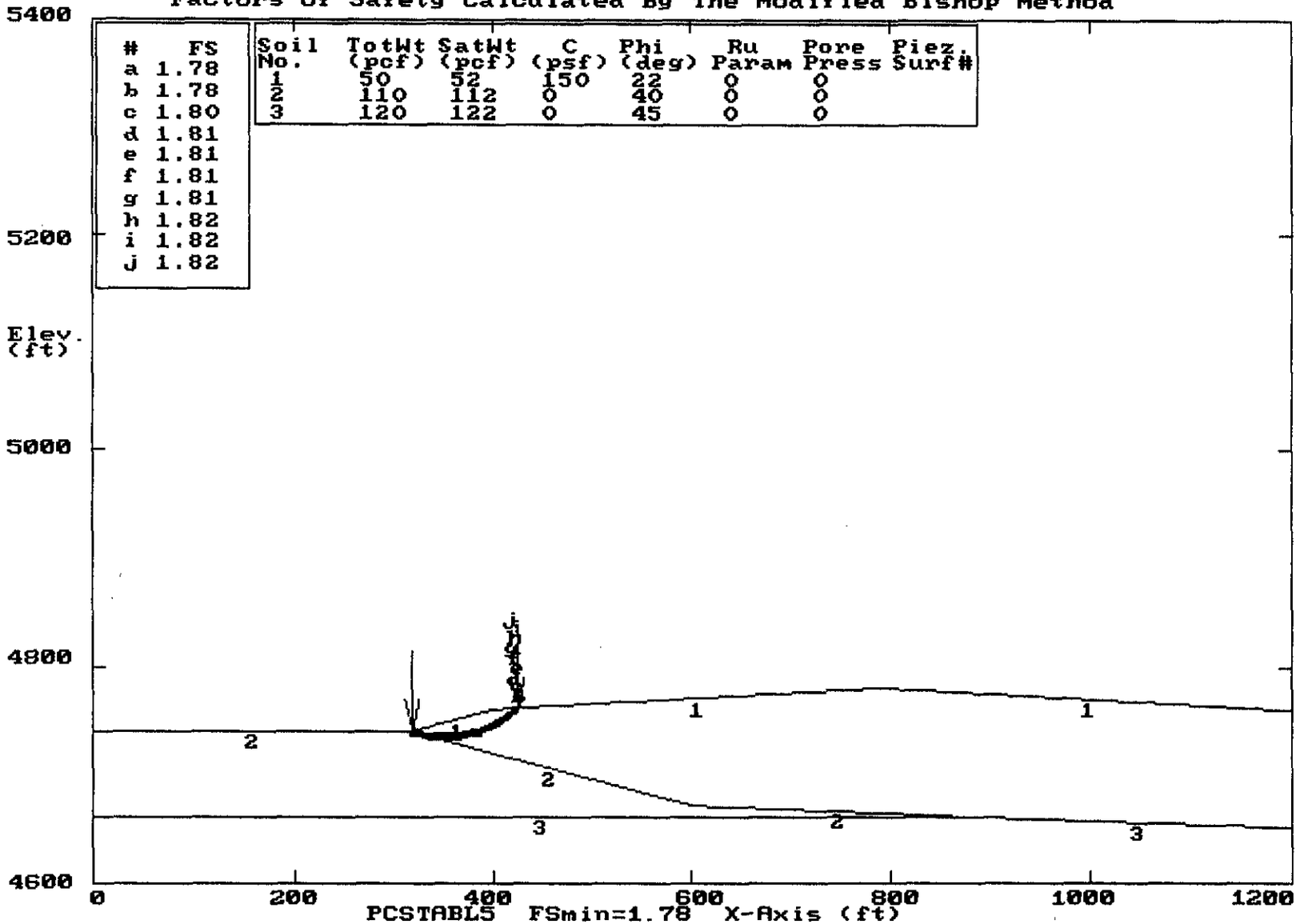
PCSTABL5 FSmin=2.36 X-Axis (ft)

*YB

Bayview Landfill: Fill Slope, Eq = 0.20g
Ten Most Critical. C:BAY_F_2.PLT By: NPD 07-14-03 9:17am
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	1.78
b	1.78
c	1.80
d	1.81
e	1.81
f	1.81
g	1.81
h	1.82
i	1.82
j	1.82

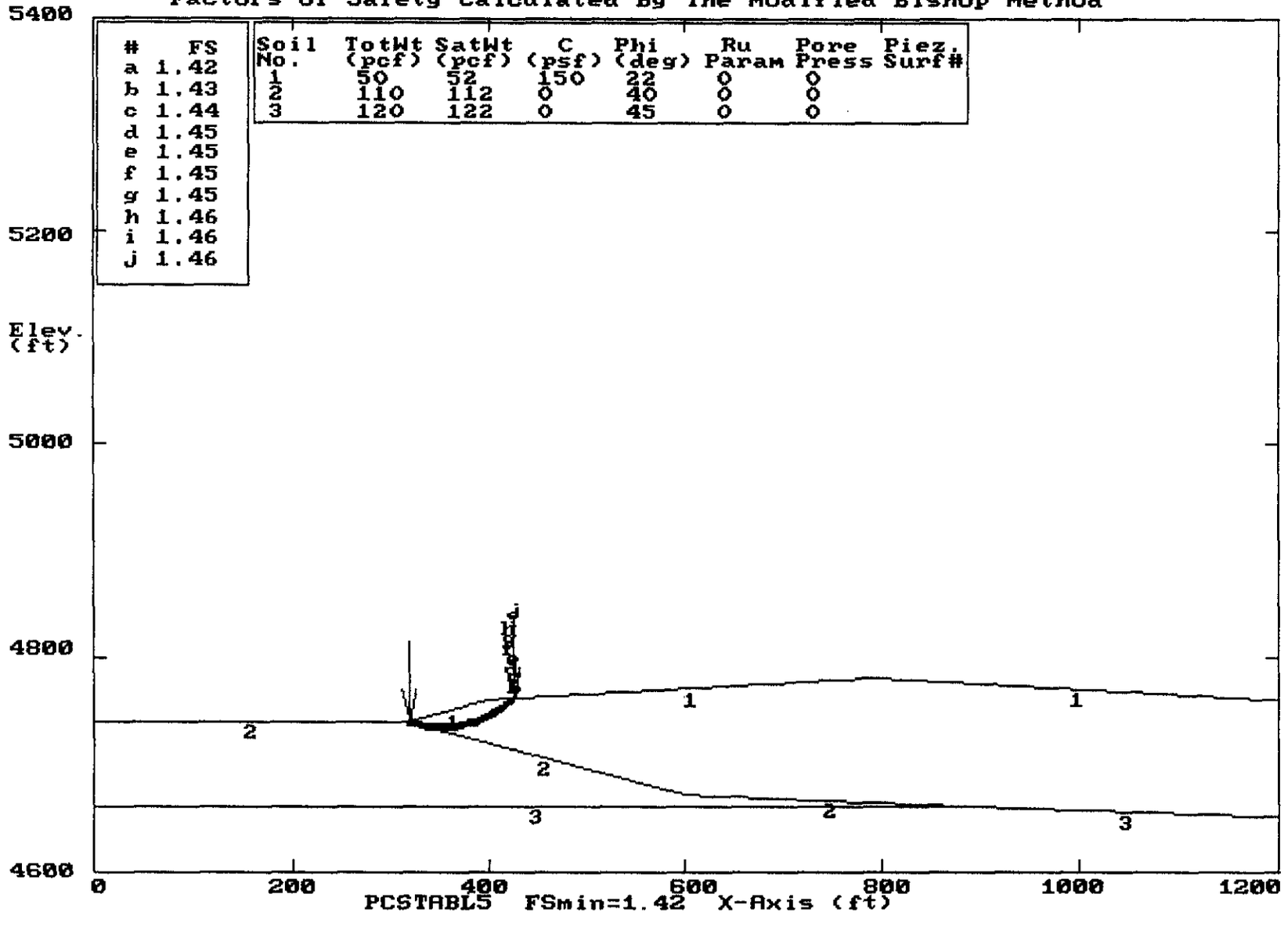
Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	



PCSTABL5 FSmin=1.78 X-Axis (ft)

*rB

Bayview Landfill: Fill Slope, Eq = 0.30g
Ten Most Critical. C:BAY_F_3.PLT By: NPD 07-14-03 9:18am
Factors Of Safety Calculated By The Modified Bishop Method



#	FS
a	1.42
b	1.43
c	1.44
d	1.45
e	1.45
f	1.45
g	1.45
h	1.46
i	1.46
j	1.46

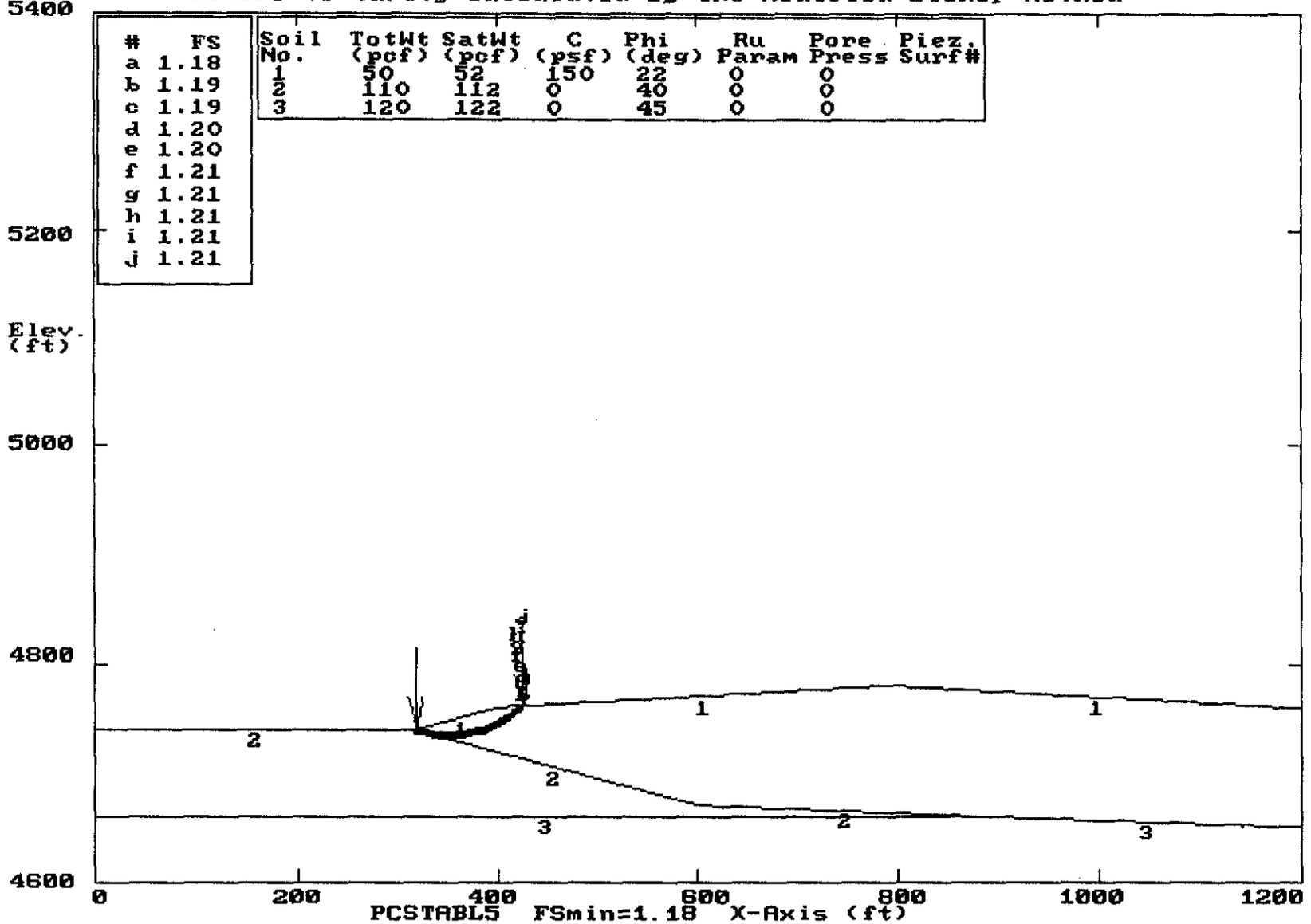
Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	

*rB

Bayview Landfill: Fill Slope, Eq = 0.40g
Ten Most Critical. C:BAY_F_4.PLT By: NPD 07-14-03 9:18am
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	1.18
b	1.19
c	1.19
d	1.20
e	1.20
f	1.21
g	1.21
h	1.21
i	1.21
j	1.21

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	



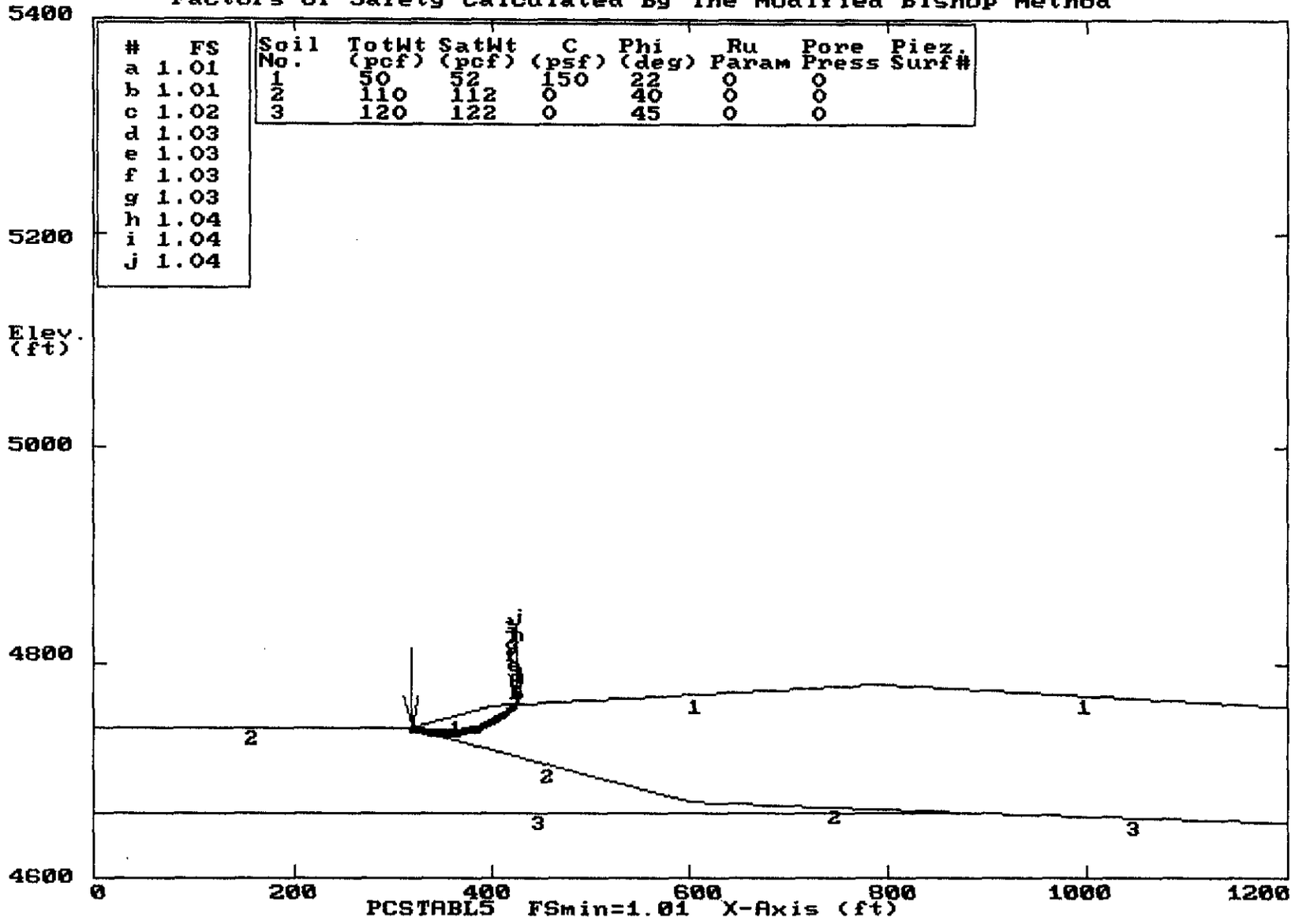
PCSTABL5 FSmin=1.18 X-Axis (ft)

*rB

Bayview Landfill: Fill Slope, Eq = 0.50g
Ten Most Critical. C:BAY_F_5.PLT By: NPD 07-14-03 9:18am
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	1.01
b	1.01
c	1.02
d	1.03
e	1.03
f	1.03
g	1.03
h	1.04
i	1.04
j	1.04

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	



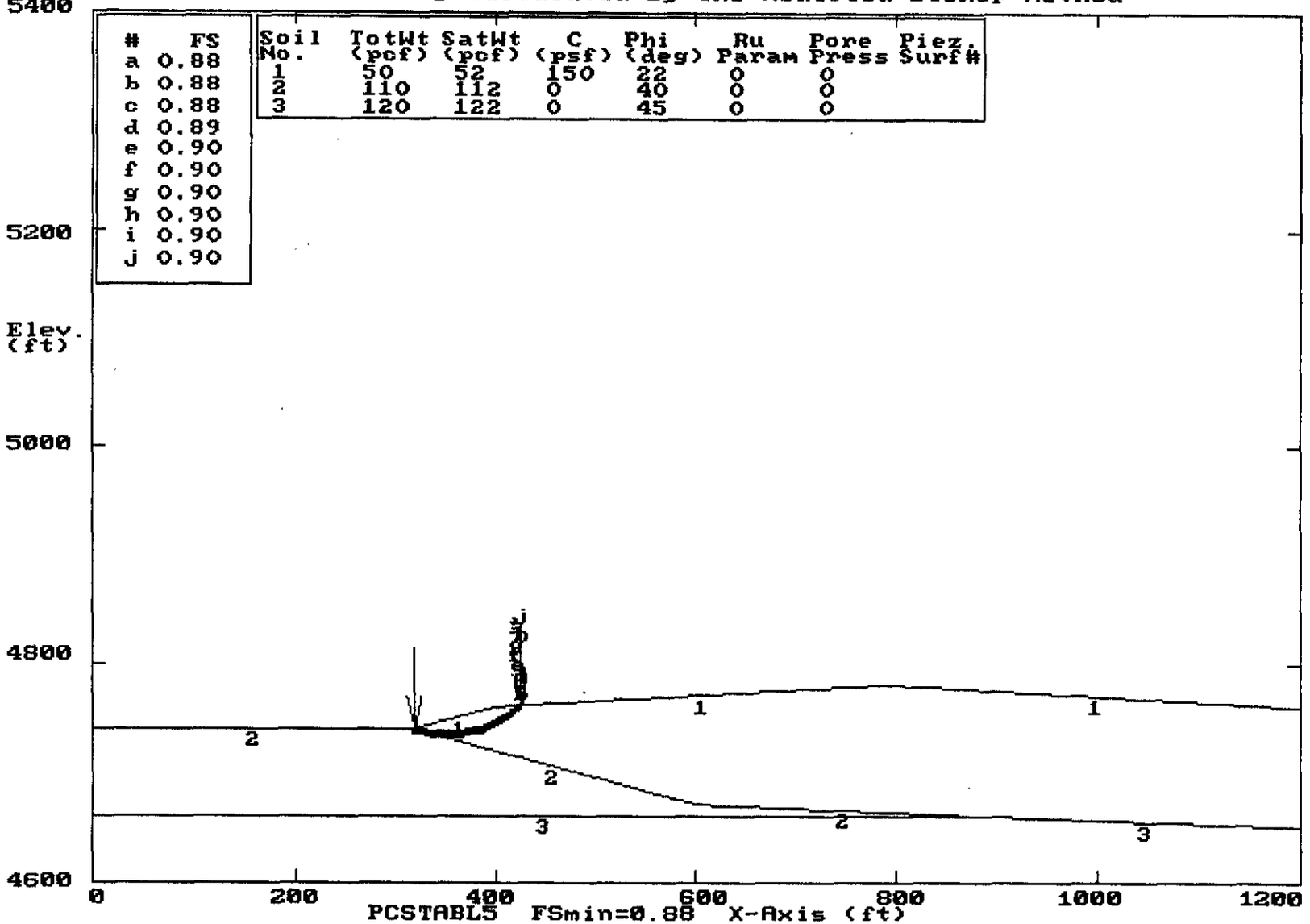
PCSTABL5 FSmin=1.01 X-Axis (ft)

*rB

Bayview Landfill: Fill Slope, Eq = 0.60g
Ten Most Critical. C:BAY_F_6.PLT By: NPD 07-14-03 9:19am
Factors Of Safety Calculated By The Modified Bishop Method

#	FS
a	0.88
b	0.88
c	0.88
d	0.89
e	0.90
f	0.90
g	0.90
h	0.90
i	0.90
j	0.90

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	50	52	150	22	0	0	
2	110	112	0	40	0	0	
3	120	122	0	45	0	0	

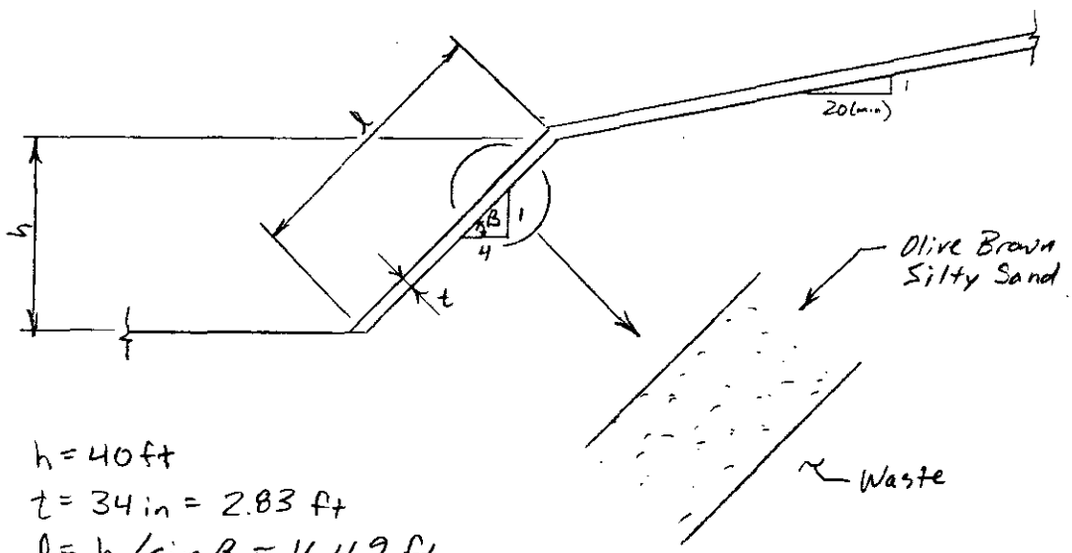


*rB

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/16/03		
	Subject: Cell 2	Checked: PHP	Date: 7-23-03		
	Task: Slope Stability	Page: 1	of: 5		
	Job #: 3879	No:			

Closure Cap

Geometry / Soils



$h = 40$ ft

$t = 34$ in $= 2.83$ ft

$l = h/\sin\beta = 164.9$ ft

Interface Friction, $\delta°$ For Silty Sand on Waste

Silty Sand $\phi = 30°$, $c = 0$ psf, $\gamma = 110$ pcf

Waste $\phi = 22°$, $c = 150$ psf (use ϕ for analysis), $\gamma = 50$ pcf

$\therefore$ Use $\delta = 22°$ ✓

Closure Cap (Cont.)

Closure Cap Stability Summary

- Stability Calculation by Infinite Slope Method

GEOMETRY

Slope	4.00 Horizontal to 1.00 Vertical	β = 14.036°
Height	40.0 ft	
Length	164.9 ft	

LCRS GEOMETRY/MATERIAL

Thickness	2.8 ft
Unit Weight	0.110 kcf

INTERFACE MATERIALS

Top Material	Olive Brown Silty Sand
Bottom Material	Waste
Minimum Interface Friction	22 °

CALCULATED FACTORS OF SAFETY

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Coefficient, ψ						
	0.00	0.10	0.20	0.30	0.40	0.50	0.60
0.0	1.62	1.13	0.85	0.68	0.56	0.47	0.40
1.0	1.70	1.18	0.90	0.72	0.59	0.50	0.43
2.0	1.78	1.24	0.94	0.75	0.62	0.52	0.45
3.0	1.86	1.30	0.99	0.79	0.65	0.55	0.47
4.0	1.94	1.35	1.03	0.83	0.68	0.58	0.50
5.0	2.02	1.41	1.08	0.86	0.71	0.61	0.52
7.5	2.22	1.56	1.19	0.95	0.79	0.67	0.58
10.0	2.42	1.70	1.30	1.04	0.87	0.74	0.64
12.5	2.62	1.84	1.41	1.14	0.95	0.81	0.70
15.0	2.82	1.98	1.52	1.23	1.02	0.87	0.76

WEIGHTS & FORCES

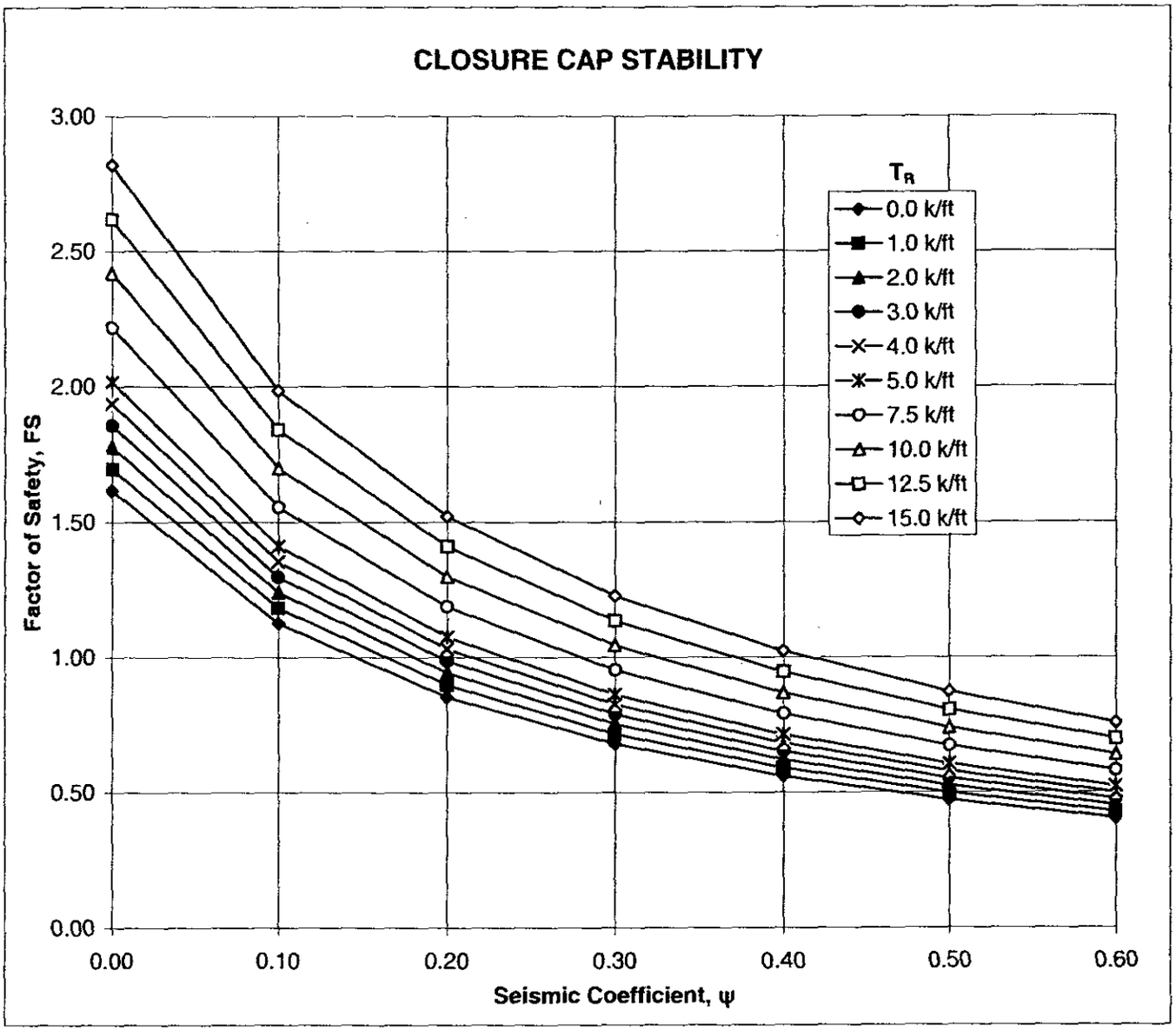
Weight	51.40 k/ft
Static Driving Force	12.47 k/ft
Static Resisting Force	20.15 k/ft
Earthquake Horizontal Force	51.40 (ψ) k/ft
Earthquake Driving Force	12.47 + 49.87 (ψ) k/ft
Earthquake Resisting Force	20.15 - 5.040 (ψ) k/ft

RESULTS

	Static	Seismic					
$FS_{req'd}$	1.30	1.00	1.00	1.00	1.00	1.00	1.00
ψ	0.00	0.10	0.20	0.30	0.40	0.50	0.60
$T_{Rreq'd}$ (klf)	-3.94	-2.19	3.30	8.79	14.28	19.77	25.26

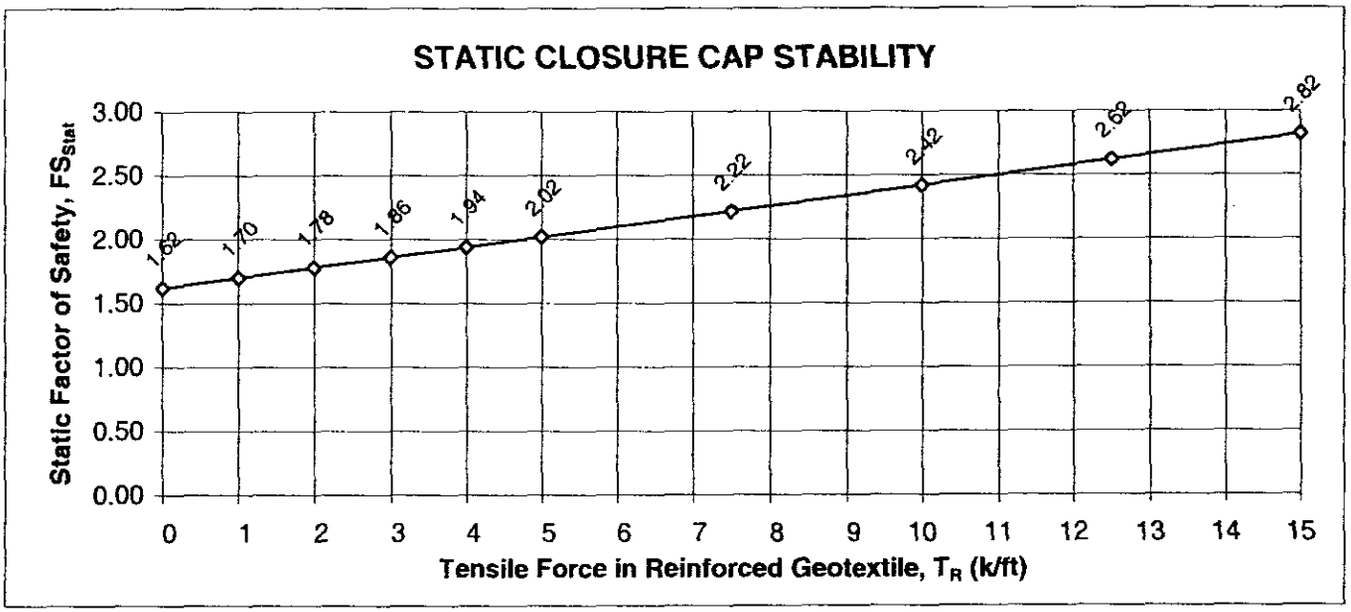
Closure Cap (Cont.)

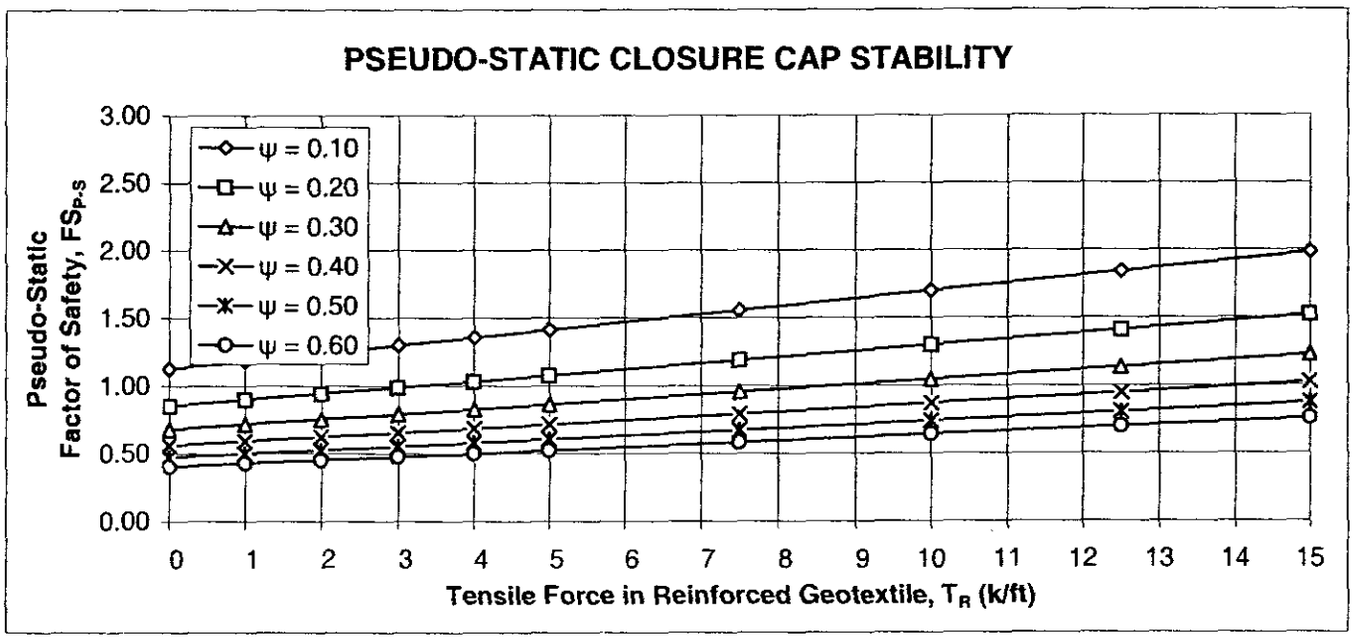
Closure Cap Stability Summary



Closure Cap (Cont.)

Closure Cap Stability Summary





Project:	Bayview Landfill	Computed:	NPD	Date:	07/16/03
Subject:	Cell 2 Design	Checked:	PHP	Date:	7-23-03
Task:	Slope Stability	Page:	5	of:	5
Job #:	3879	No:			

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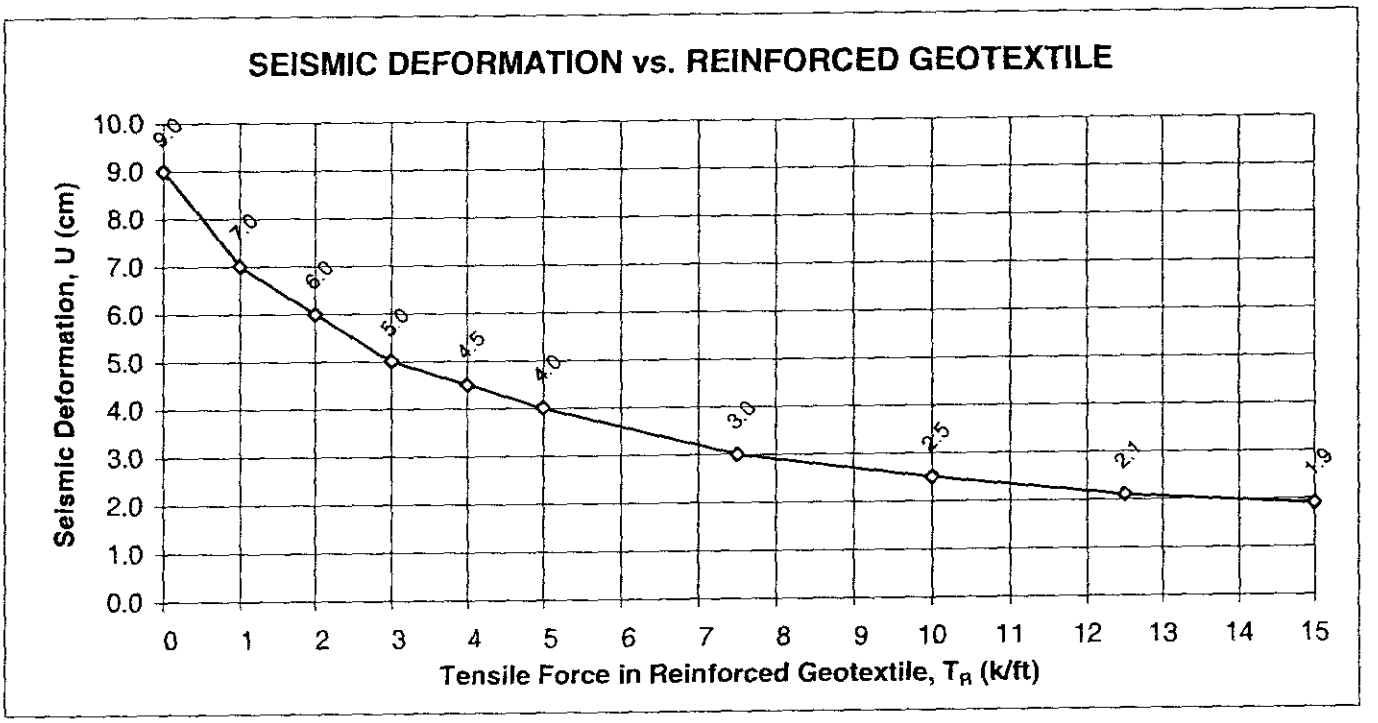
Closure Cap (Cont.)

Closure Cap Stability Summary

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Deformation for M = 7.2, U (cm)
0.0	9.0
1.0	7.0
2.0	6.0
3.0	5.0
4.0	4.5
5.0	4.0
7.5	3.0
10.0	2.5
12.5	2.1
15.0	1.9



ATTACHMENT C
SITE SEISMIC RESPONSE ANALYSES

Job No. | No.

HDR Computation

HDR

Project	BAYVIEW LANDFILL – CELL 2	Computed R.L.D.	Date 7-8-96
Subject	LANDFILL SEISMIC EVALUATION	Checked PMP	Date 6-9-96
Task	SITE SEISMIC RESPONSE ANALYSES	Sheet 1	Of 3
		PMP	7-20-03

OBJECTIVE: DETERMINE SEISMIC RESPONSE FROM PEAK BEDROCK ACCELERATION OF ADOPTED DESIGN EQ ($a_g = 0.50g$) FOR:
- BASE OF LINER / LCRS SYSTEM FOR CELL 1
- CLOSURE CAP FOR CELL 1

REFERENCES:
A) EPA, "RCRA SUBTITLE D (258) SEISMIC DESIGN GUIDANCE FOR MUNICIPAL SOLID WASTE LANDFILLS, EPA/600/R-95/051
B) GEOTECHNICAL REPORTS BY GEN; ASSOCIATES, 1980; ROLLINS, BROWN AND GUNNELL, 1983
C) NAVDOCKS DM-7.3, "SOIL DYNAMICS..."

---

1 CLASSIFY SITE

1.1 DETERMINE SHEAR WAVE VELOCITY, V_S, IN TOP 100' OF FDN.

- UTAH G.S CLASSIFIES SITE AS "HARD SITE", i.e. $V_S \geq 400$ m/sec

- BASED ON REFS B:
  SPT $N_{AVG} = 50$
  $\gamma_{AVG} = 110$ pcf

- FROM REF C:
  $G_{T/SF} = 120 N^{0.8} = 120 \cdot 50^{0.8}$
  $= 2744$ T/SF $\cdot$ 2000 #/T $= 5.49 \times 10^6$ #/SF

- FROM REF A:
  $V_S^2 = \sqrt{\frac{G}{\gamma/g}} = \sqrt{\frac{5.49 \times 10^6 \text{ \#/SF}}{110 \text{ \#/CF} / 32.2 \text{ FT/sec}^2}}$

  $= 1270$ FT/sec, 386 m/sec

Job No. | No.

HDR Computation

HDR

Project	Bayview Landfill	Computed	Date
Subject	Cell 2	Checked PHP	Date 7-20-03
Task		Sheet 2	Of 3

1.2 From Ref A:

CLASSIFICATION	AVERAGE SHEAR WAVE VELOCITY	
Special Study	Less than 100 m/s	(330ft/s)
Soft	100 to 200 m/s	(330 to 660 ft/s)
Medium Stiff	200 to 375 m/s	(600 to 1,230 ft/s) ← Vs
Stiff	375 to 700 m/s	(1,230 to 2,300 ft/s)
Rock	Greater than 700 m/s	(2,300 ft/s)

∴ Check site response w/ medium stiff + stiff response
Use simplified analysis

2. Determine Acceleration at Base of Landfill

2.1 For medium stiff soil (Ref A)

MHA (Max horizontal acceleration in bedrock) = 0.50g ✓
PGA (Peak horizontal acceleration at ground surf) = 0.50g

2.2 For stiff soil (Ref A)

MHA = 0.50 g
PGA = 0.50 g

2.3 ∴ Use PGA = 0.50g ✓ for liner & LCRS evaluation

Job No. | No.

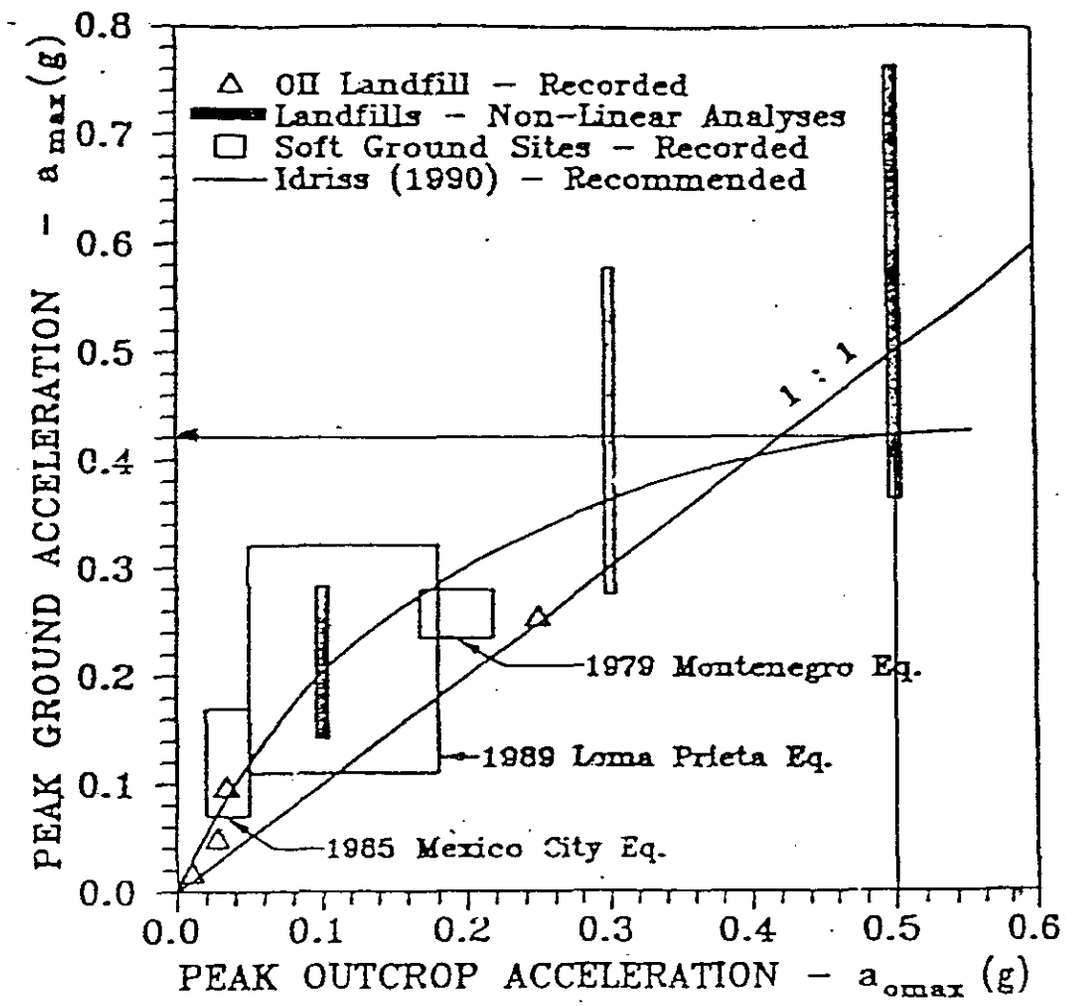
HDR Computation

HDR

Project	Bayview Landfill	Computed	Date
Subject	Cell 2	Checked PHP	Date 7-20-03
Task		Sheet 3	Of 3

3. DETERMINE ACCELERATION AT TOP OF LANDFILL

USE PGA AT BASE AND ATTENUATE THROUGH WASTE MASS USING "IDRISS (1990)" CURVE, FIGURE 4-5 OF REF A



∴ USE PGA = 0.42g FOR CLOSURE CAP EVALUATION

ATTACHMENT D
SEISMIC DEFORMATION ANALYSES

Objective

Estimate Seismic Displacements For:

- Cell 2 Cut-Slope Excavation
- Cell 2 Liner & LCRS System
- Cell 2 Operational Waste Fill-Slopes
- Cell 2 Finished Waste Fill-Slopes
- Cell 2 Closure Cap

References

A) EPA, "RCRA Subtitle D Seismic Design Guidance for MSWLF", EPA/600/R-95/051, 1995.

Approach

1) Determine Yield Acceleration, a_y For FS = 1.0 From Pseudo-Static Stability Analyses (From Attachment B)

2) Compute the Acceleration Ratio: a_y / a_{max},
Where $a_{max} = 0.50g$ For Cut-Slope, Liner, LCRS & Waste
$a_{max} = 0.42g$ For Closure Cap
(From Attachment C)

3) Estimate Displacements (From Ref.
- Use Makdisi & Seed Permanent Displacement Chart For Cut-Slope, Liner, LCRS & Waste – Use $M_o = 7.2$ Curve (Fig 6-6, Ref A)
- Use Hynes & Franklin Perm. Disp. Chart For Closure Cap (Fig C-5, Ref A)

4) Evaluate Displacements

Job No. | No.

HDR Computation

HDR

Project: Bayview Landfill	Computed: NPD	Date: 07/17/03
Subject: Cell 2	Checked: PHP	Date: 7-23-03
Task:	Sheet: 2	Of: 8

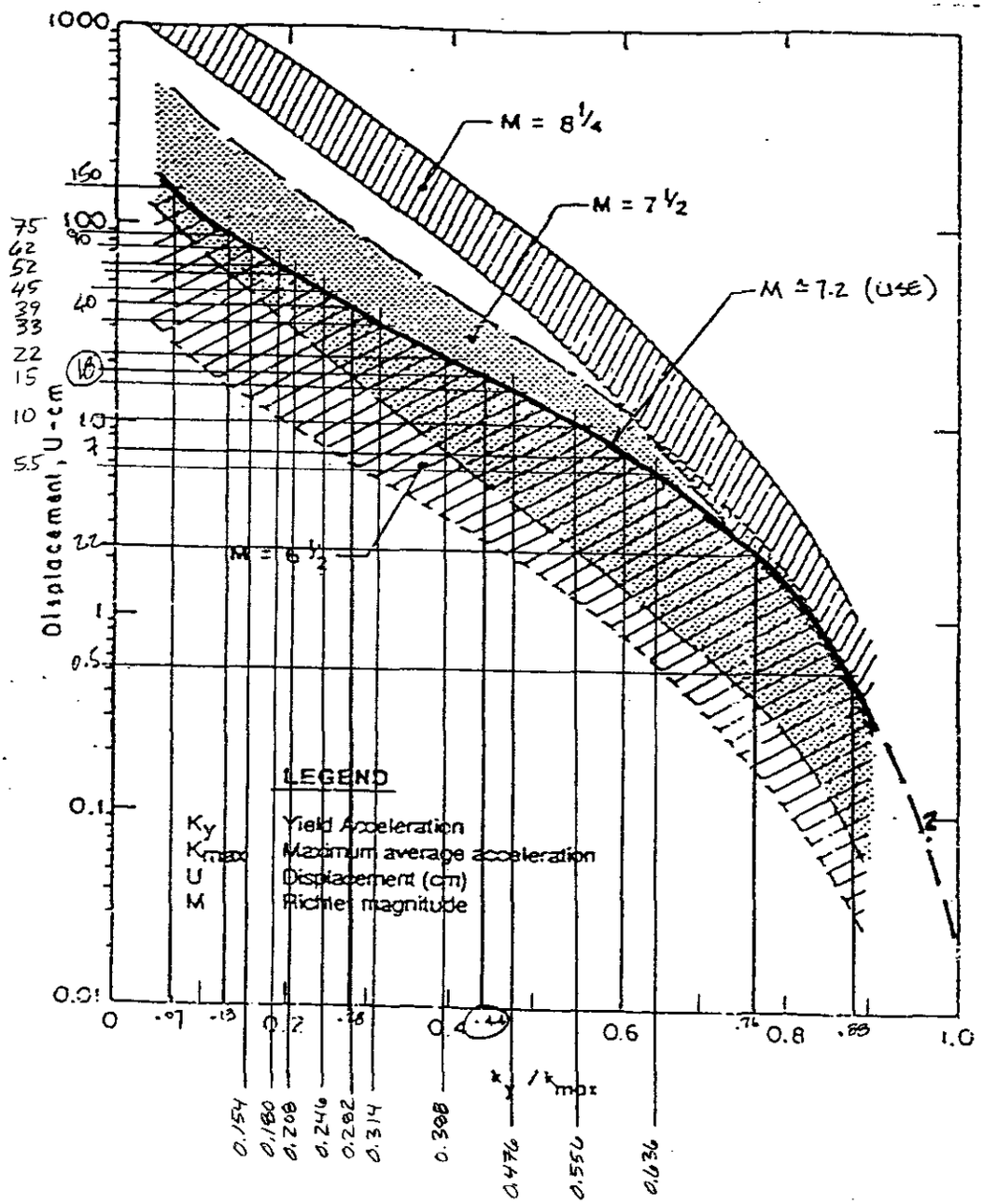


Figure 6.6 Makdisi and Seed Permanent Displacement Chart (Makdisi and Seed, 1978). FOR LINER & WASTE MASS

Job No. | No.

HDR Computation

HDR

Project: Bay view Land fill	Computed: NPD	Date: 07/17/03
Subject: Cell 2	Checked: PDP	Date: 7-23-03
Task:	Sheet: 3	Of: 8

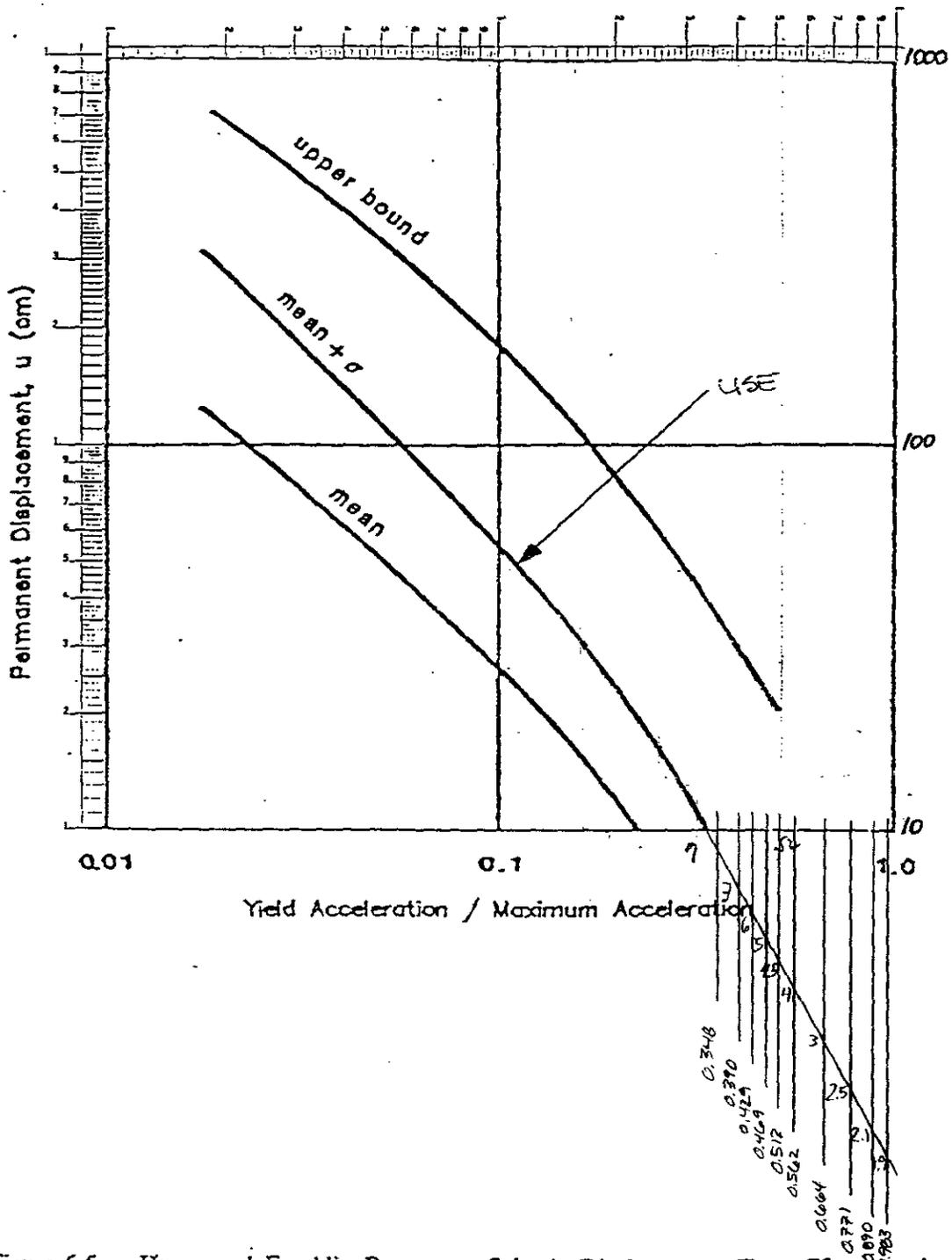


Figure 6.5 Hynes and Franklin Permanent Seismic Displacement Chart (Hynes and Franklin, 1984). FOR COVER SYSTEM

Cut-Slope

$a_y = 0.52g$ (From Attachment B)

$a_{max} = 0.50g$ (From Attachment C)

$a_y/a_{max} = 0.52/0.50 = 1.04$

$U \leq 1$ cm (From Makdisi & Seed Curve for $M \approx 7.2$)

$U < 30$ cm OK

Liner & LCRS System

k_y = See Below (From Attachment B)

$a_{max} = 0.50g$ (From Attachment C)

For $\delta = 18°$ & $a_y = k_y g$:

$T_{Req'd}$ (k/ft)	FS_{stat}	k_y	a_y/a_{max}	U (cm)*
0	1.30	0.077	0.154	75
1	1.37	0.090	0.180	62
2	1.44	0.104	0.208	52
3	1.51	0.123	0.246	45
4	1.59	0.141	0.282	39
5	1.66	0.157	0.314	33
7.5	1.84	0.194	0.388	22
10	2.01	0.238	0.476	15
12.5	2.19	0.278	0.556	10
15	2.37	0.318	0.636	5.5

* From Makdisi & Seed Curve for $M \approx 7.2$.

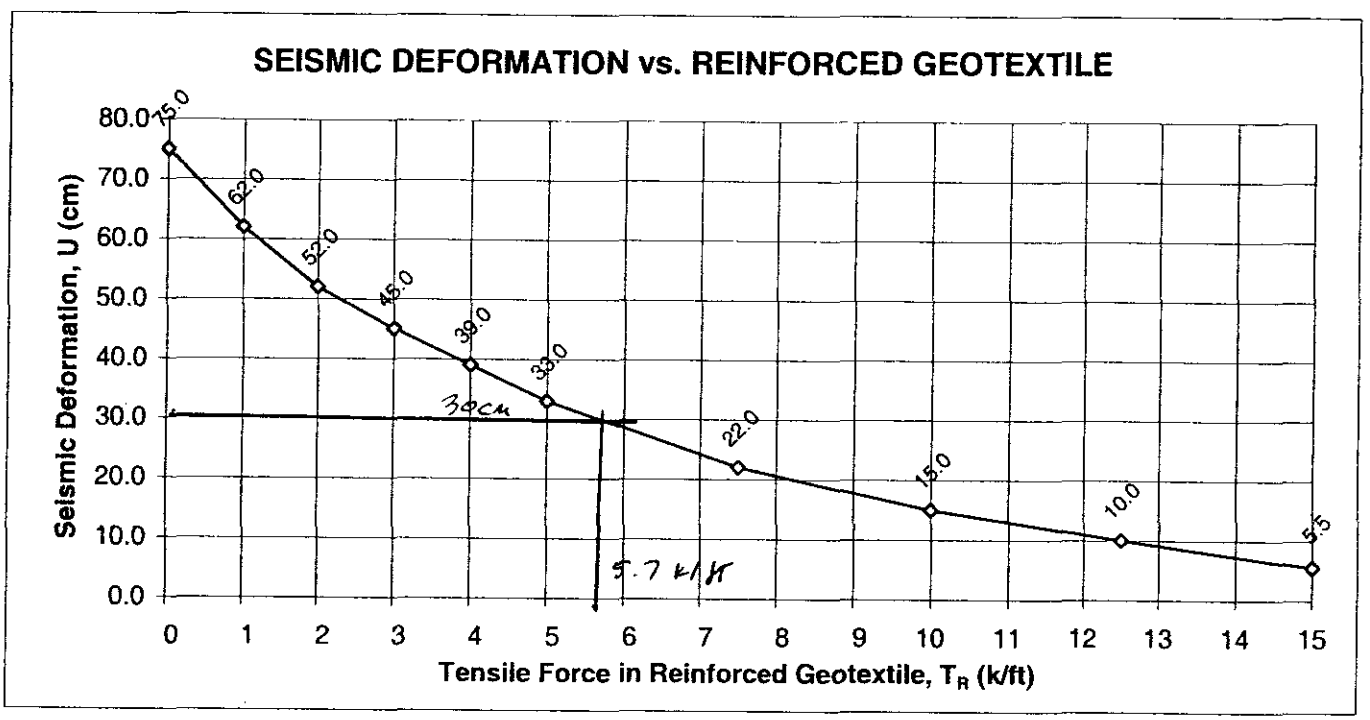
See Attached Plot

CONT. →

Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Deformation for M = 7.2, U (cm)
0.0	75.0
1.0	62.0
2.0	52.0
3.0	45.0
4.0	39.0
5.0	33.0
7.5	22.0
10.0	15.0
12.5	10.0
15.0	5.5



$T_{req'd}$ = 5.7 k/ft @ u = 30 cm

For $T_{req'd} \geq$ 5.7 k/ft, u < 30 cm OK

Operational Fill-Slopes

Fill to Elev. 4740

$a_y = 0.22g$ (From Attachment B)

$a_{max} = 0.50g$ (From Attachment C)

$a_y/a_{max} = 0.22/0.50 = 0.44$

$U = 18\,cm$ (From Makdisi & Seed Curve for $M \approx 7.2$)

$U < 30\,cm$ OK ✓

Fill to Elev. 4780

$a_y = 0.24g$ (From Attachment B)

$a_{max} = 0.50g$ (From Attachment C)

$a_y/a_{max} = 0.24/0.50 = 0.48$

$U = 14\,cm$ (From Makdisi & Seed Curve for $M \approx 7.2$)

$U < 30\,cm$ OK ✓

Finished Waste Fill-Slope

$a_y = 0.50g$ (From Attachment B)

$a_{max} = 0.50g$ (From Attachment C)

$a_y/a_{max} = 0.50/0.50 = 1.00$

$U \leq 1\,cm < 30\,cm$ OK ✓ (From Makdisi & Seed Curve for $M \approx 7.2$)

CONT. →

Closure Cap

k_y = See Below (From Attachment B)

$a_{max} = 0.42g$ (From Attachment C)

For $\delta = 22°$ & $a_y = k_y g$:

T_{Reqd} (k/ft)	FS_{stat}	k_y	a_y/a_{max}	U (cm)*
0	1.62	0.146	0.348	9
1	1.70	0.164	0.390	7
2	1.78	0.180	0.429	6
3	1.86	0.197	0.469	5
4	1.94	0.215	0.512	4.5
5	2.02	0.236	0.562	4
7.5	2.22	0.279	0.664	3
10	2.42	0.324	0.771	2.5
12.5	2.62	0.374	0.890	2.1
15	2.82	0.413	0.983	1.9

ALL <10cm

* From Hynes & Franklin Curve for Mean + σ

T_{Reqd} = 0.0 k/ft Based on Seismic Deformation < 30cm

For $T_R \geq 0.0$ k/ft, U < 30cm OK ✓

no reinforced geotextile required.

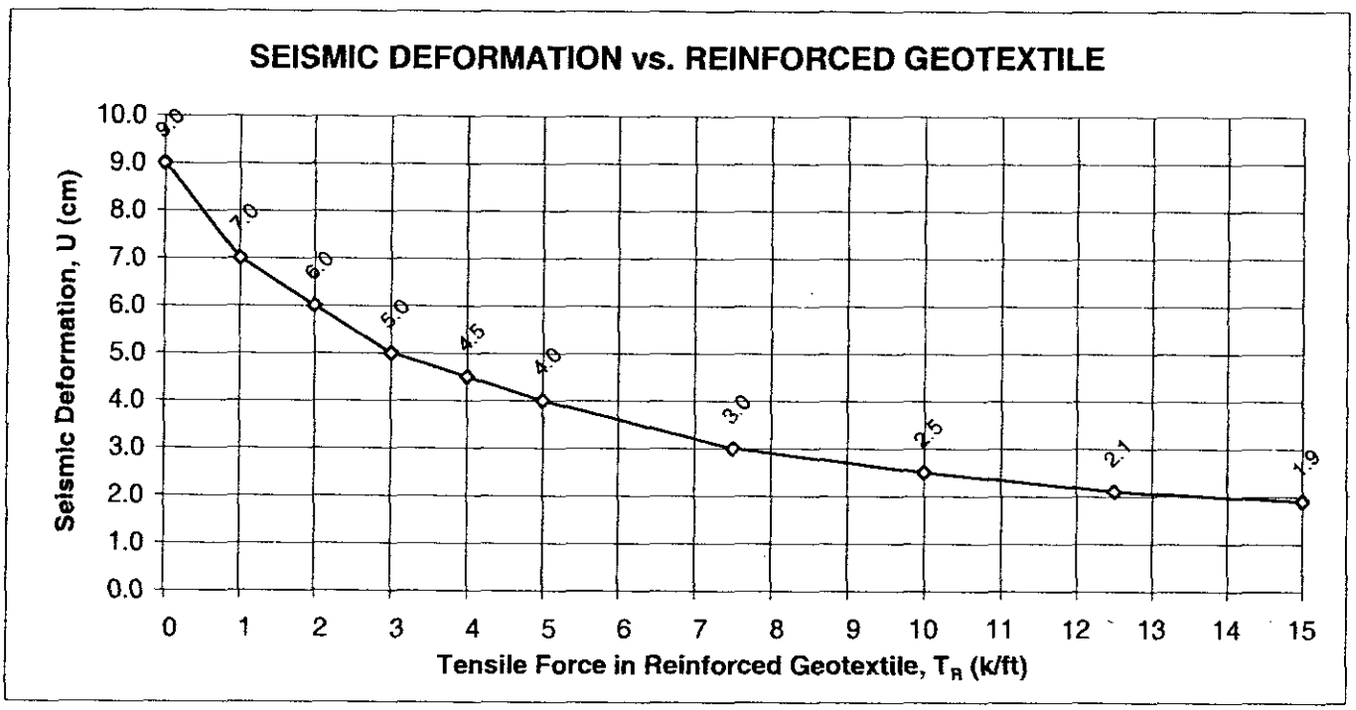
See Attached Plot

CONT. →

Closure Cap (Cont.)

Closure Cap Stability Summary

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Deformation for M ≈ 7.2, U (cm)
0.0	9.0
1.0	7.0
2.0	6.0
3.0	5.0
4.0	4.5
5.0	4.0
7.5	3.0
10.0	2.5
12.5	2.1
15.0	1.9



ATTACHMENT E
SOURCE MATERIAL INVESTIGATION

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SOURCE MATERIAL INVESTIGATION
SOUTH UTAH VALLEY LANDFILL
(BAYVIEW LANDFILL)
UTAH COUNTY, UTAH

For: HDR

HDR Engineering, Inc.

July 1, 2003

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KLEINFELDER

A Report Prepared For:

Mr. Terry Warner
HDR Engineering, Inc.
3995 South 700 East, Suite 100
Salt Lake City, UT 84107

SOURCE MATERIAL INVESTIGATION
SOUTH UTAH VALLEY LANDFILL
(BAYVIEW LANDFILL)
UTAH COUNTY, UTAH

File No.: 30268.001

Prepared By:

Nigel Miller, P.E.
Project Engineer

Renee Zollinger, P.G.
Senior Geologist

KLEINFELDER, INC.
2677 East Parley's Way
Salt Lake City, UT 84109

July 1, 2003

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1.2	Project Description	1
2.	METHODS OF STUDY	2
2.1	Field Investigation	2
2.2	Laboratory Investigation	3
3.	GENERAL SITE CONDITIONS	4
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3.2	Subsurface Conditions	4
3.2.1	Soils	4
3.2.2	Groundwater	5
3.3	Source Material Descriptions	5
3.3.1	Protective Cap Material	5
3.3.2	Drainage Sand	5
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FIGURES

1 Site Vicinity Map
2 Boring Location Map

APPENDICES

A Boring Logs
B Laboratory Test Results
C Application for Authorization to Use

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1. INTRODUCTION

1.1 PURPOSE AND SCOPE OF WORK

This report presents the results of our source material investigation performed for proposed construction activities located at the Bayview Landfill. In general, the purposes of this investigation were to investigate and characterize the general soil conditions at the stockpile north of Cell 1, the dune sand area south of Cell 2, and under the current bottom of Cell 2. The investigation included subsurface exploration, representative soil sampling, field and laboratory testing, and preparation of this report.

1.2 PROJECT DESCRIPTION

Bayview Landfill, also called the South Utah Valley Landfill, is located approximately 5 miles north of Elberta, Utah, along State Road 68 (Figure 1). This landfill is a Class I municipal solid waste landfill and began accepting solid waste in 1990. Cell 1 is scheduled for closure during the next year, and the South Utah Valley Solid Waste District wishes cap Cell 1 and begin placing solid waste in Cell 2.

In Kleinfelder's report dated April 11, 2003, the uppermost soils in the stockpile north of Cell 1 (BVLF-2 and BVLF-3) were identified as suitable material for capping Cell 1. This investigation focused on evaluating the uniformity of the materials in the stockpile north of Cell 1 and the potential for additional suitable material in the bottom of Cell 2. We also evaluated the sand dune area south of Cell 2 to assess the suitability of those soils for use as the leachate collection system drainage layer for Cell 2.

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2. METHODS OF STUDY

2.1 FIELD INVESTIGATION

In Kleinfelder's previous assessment (reported April 11, 2003), we collected surface soils at four locations (BVLF-1 through BVLF-4) and tested them for unsaturated hydraulic parameters. A fifth surface soil sample (BVLF-5) was collected from the sand dunes in early May 2003.

In May 2003, the soil conditions at the sites were further explored by drilling three borings within the stockpile north of Cell 1 (B-1 through B-3) and two borings within the dune sand area south of Cell 2 (B-4 and B-5). Soils samples from two test pits within Cell 2 (TP-1 and TP-2) were collected for testing. Borings extended to depths of approximately 45 to 57 feet below existing grade.

The approximate locations of the borings, test pits, and grab samples are shown on Figure 2, entitled "Boring Location Map." Logs of the subsurface conditions, as encountered in the borings, were recorded at the time of drilling and are presented on the boring logs, Figures A-1 through A-12. A key to soil symbols and terms used on the logs is found on Figure A-13. All figures are presented in the Appendices.

Drilling was accomplished with a hollow-stem auger drill rig equipped for soil sampling. Representative soil samples were obtained using a standard split spoon (SPT) soil sampler driven by a 140-pound hammer free falling through a distance of 30 inches. Sampler driving resistance, expressed as "blows per foot of penetration," is presented on the boring logs at the respective sampling depths.

All samples were visually classified in the field by an engineer or a geologist, and selected portions of each sample were packaged and transported to our laboratory for testing. The information provided on the boring logs contained in this report includes soil descriptions, consistency evaluations, boring depths, and sampling intervals.

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2.2 LABORATORY INVESTIGATION

Representative samples were tested in the laboratory to evaluate the pertinent physical and engineering properties of the soils. Natural moisture content, dry density, percent passing the Number 200 sieve (fines content), grain size distribution, and Atterberg Limit determinations were performed on selected samples to aid in classification of the soils. One falling head permeability test was performed on the dune sand (BVLF-5). The results of all laboratory tests are presented on the Boring Logs, Figures A-1 through A-12, and in Appendix B.

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3. GENERAL SITE CONDITIONS

3.1 SURFACE CONDITIONS

At the time of our investigation, construction activity was primarily excavating material from within Cell 2 and placing it on the stockpile north of Cell 1. Vegetation in the dune sand area south of Cell 2 consisted primarily of scattered sagebrush, weeds, and cacti. The Bayview Landfill is bound on the east by State Road 68, and on the north, south, and west by vacant land. The site is sloping downward to the east towards Utah Lake.

3.2 SUBSURFACE CONDITIONS

3.2.1 Soils

Based on the three borings drilled through the stockpile north of Cell 1, soils in the stockpile generally consist of Silty SAND to Sandy SILT down to approximately 31 to 37 feet. The stockpiled soils are underlain by native stiff SILT down to approximately 50 feet. In Boring B-1 the stiff SILT was underlain by dense Silty SAND with gravel down to 57 feet. Within the stockpile the material had some pockets of Silty SAND and SILT that are different than the suitable soils selected for the landfill cap material.

Based on the two borings drilled in the dune sand area south of Cell 2, the native sand dune soils consist of poorly graded SAND with silt (SP-SM) down to 14 to 20 feet below dune surface. These soils are underlain by layers of SILT, Silty SAND, and Silty GRAVEL. The boring logs presented on Figures A-1 through A-12 should be referred to for more detailed information.

Test pits TP-1 and TP-2 were excavated by others within Cell 2 to a depth of approximately 8 feet. Each test pit contained approximately 6 to 7 feet of the olive brown Silty SAND material underlain by the reddish brown Silty SAND with gravel.

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3.2.2 Groundwater

Groundwater was not encountered in the borings during the field investigation. It should be noted that groundwater levels may fluctuate at this site in response to seasonal changes, precipitation, and groundwater recharge and withdrawal.

3.3 SOURCE MATERIAL DESCRIPTIONS

3.3.1 Protective Cap Material

The olive-brown Silty SAND material (BVLF-2 and BVLF-3) described in the April 11, 2003 report is the predominant material in the stockpile north of Cell 1. The gradations for this material range from 30 to 70 percent passing the No. 200 sieve with little or no gravel. We recommend the lenses or pockets within the stockpile that do not fall within this band be excluded from use in the protective cap layer unless further testing and analysis is performed to evaluate their suitability. We estimate these pockets of unsuitable material may be up to 5 feet thick.

3.3.2 Drainage Sand

The dune sand (BVLF-5) classifies as poorly graded SAND with silt (SP-SM) with approximately 5 to 15 percent passing the No. 200 sieve with little or no gravel. The dune sand appears to be consistent in borings B-4 and B-5 down to 19.5 and 14 feet, respectively. The laboratory test results on sample BVLF-5 indicate the falling-head permeability is on the order of 1.4×10^{-3} cm/sec.

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4. LIMITATIONS

4.1 LIMITATIONS

The information contained in this report is based on our field explorations, laboratory testing, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the five borings drilled for this investigation. It is possible that variations in the soil and groundwater conditions could exist between the points explored. The nature and extent of variations may not be evident until construction occurs.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, express or implied, is made.

It is the Client's responsibility to see that all parties to the project, including the Designer, Contractor, Subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk.

4.2 ADDITIONAL SERVICES

We recommendation that an adequate program of testing and observations be made during construction to verify suitability of the materials. These tests and observations should include, but not necessarily be limited to, the following:

- Observations and testing during site preparation and earthwork
- Consultation as may be required during construction.

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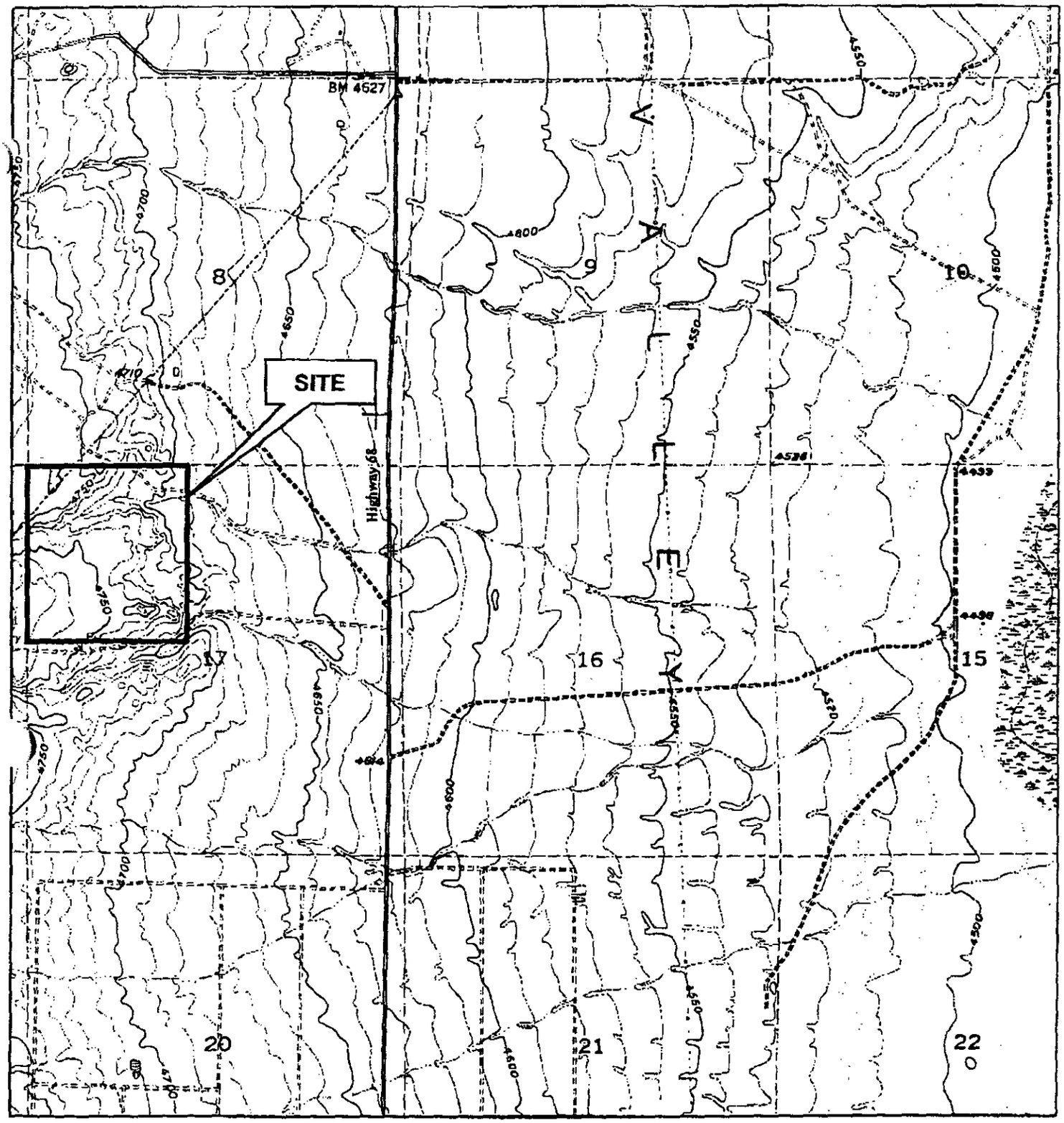
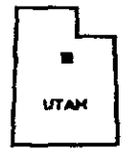


BASE MAP:
GOSHEN VALLEY NORTH, UTAH
U.S.G.S. 7.5 MINUTE QUADRANGLES
PHOTOREVISED 1975

0' 1000' 2000'

SCALE 1:24,000
1" = 2000'
CONTOUR INTERVAL 10 FEET



QUADRANGLE LOCATION

SLC3Q162.ppt

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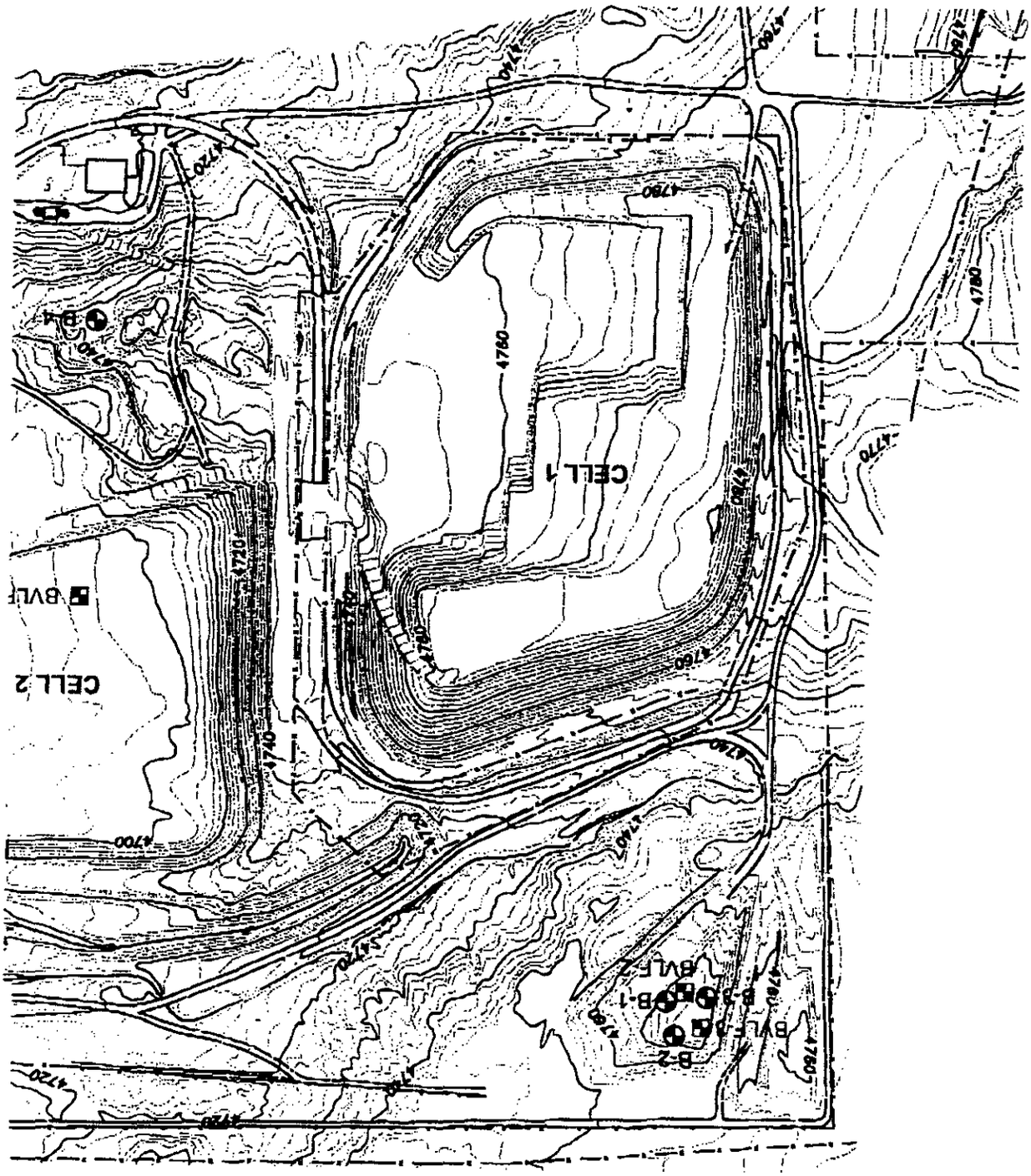
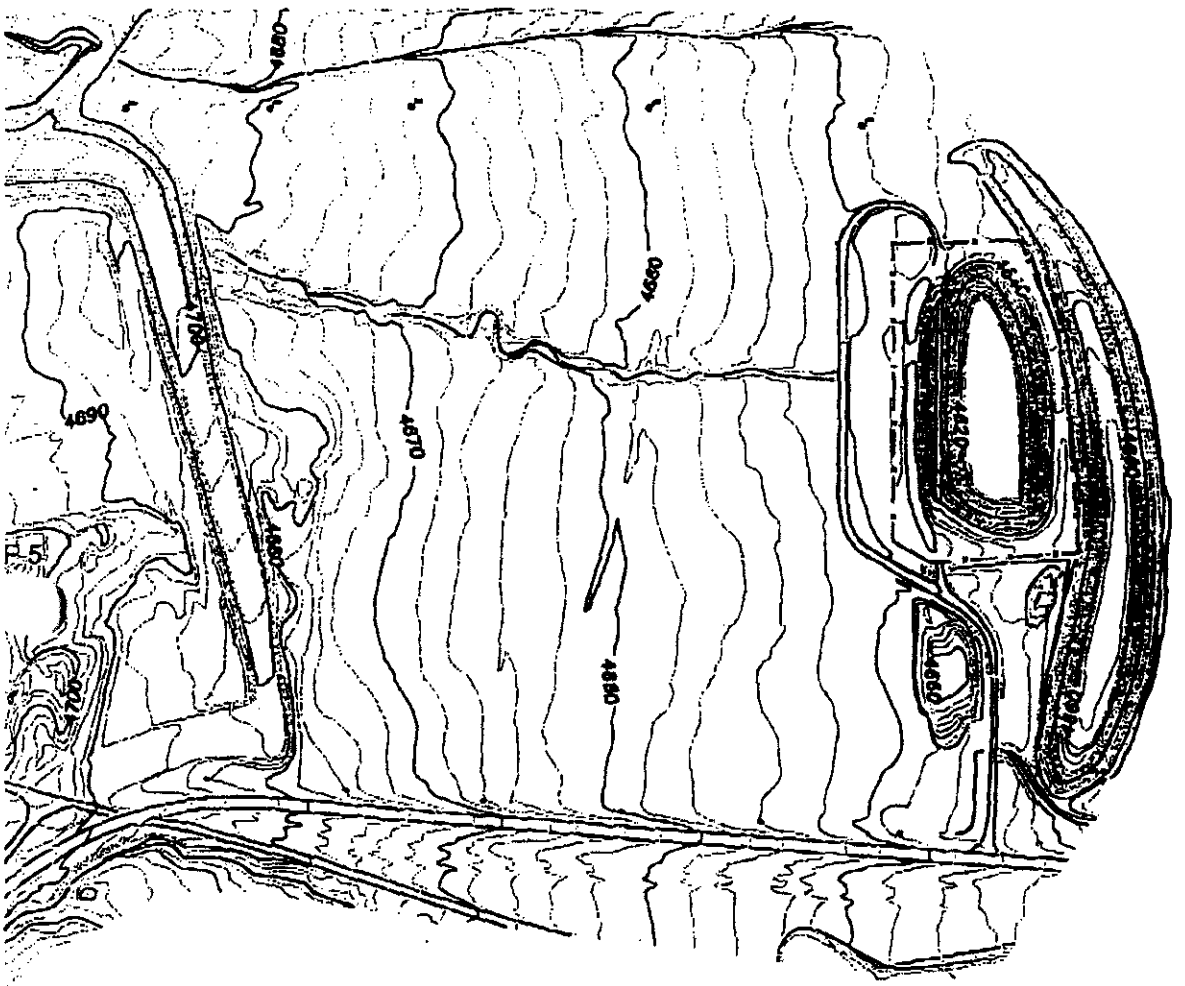
Project Nur

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE

1


CELL 1
CELL 2
BVLF
BVLF 2
B-1
B-2
B-3
B-4
4700
4720
4740
4760
4780



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Date: 06/13/03
Project Number 30288.001

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

BORING LOCATION MAP

FIGURE
2

Depth (ft)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
0						13		SM	FILL: Silty SAND - medium dense, moist, olive brown
2									
4									
5	39				SV PI	19			
6									
8									
10	36			12	SV	19			
12									- occasional light tan silt zones
14									
15						20			
16									
18									
20	32				SV	21			
22									- some fine gravel
24									

DEPTH IN FEET

DATE DRILLED: 5-20-03
TOTAL DEPTH: 57.0 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

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PROJECT NO. 30268.001

LOG OF BORING B- 1

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE
A-1

Depth in Feet	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
26						12		SM	FILL: Silty SAND - medium dense, moist, olive brown (continued)
28									
30	44				SV	20			- some fine gravel
32									
34									
36						29			
37.5								MH	Sandy SILT - stiff to very stiff, moist, olive brown, trace of very fine gravel
38									
40	53				PI	21			
42									
44									
46						15			
48									
50									

DATE DRILLED: 5-20-03
TOTAL DEPTH: 57.0 feet
DIAMETER OF BORING: Inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

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PROJECT NO. 30268.001

LOG OF BORING B- 1

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE
A-2

Depth (DEPTH IN FEET)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
50						41			
51.0								SM	Silty SAND with gravel - dense to very dense, moist, brown to reddish brown
52						45			
54									-.less fine gravel
55				3		71			
57.0									
56									
58									
60									
62									
64									
66									
68									
70									
72									
74									

DATE DRILLED: 5-20-03
TOTAL DEPTH: 57.0 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

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PROJECT NO. 30268.001

LOG OF BORING B- 1

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-3

Depth in Feet	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	Soil Description
0								SM	FILL: Silty SAND - medium dense, moist, olive brown
2									
4									
6									
8									
10	35				SV	9			
12									
14									
						11			
16									medium dense with some angular clay clasts observed, some coarser sand noted
18									
20	16			6	SV	18			
									- less silt
22									
24									
25.0									

DATE DRILLED: 5-19-03
TOTAL DEPTH: 52.2 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

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PROJECT NO. 30268.001

LOG OF BORING B- 2

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-4

Depth (Feet)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
	51				SV PI	20		ML	FILL: Sandy SILT - stiff, moist, olive brown
26									
28									
30						25			
32									
34									
									35.0
	56				SV	15		ML	Sandy SILT - stiff to very stiff, moist, gray brown, with rust spots, rust along some silty bedding partings and some traces of manganese
36									
38									
40						19			
42									
44									
	50		76	27	PI	25			
46									- fine sand lense
48									
50									

DEPTH IN FEET

DATE DRILLED: 5-19-03
TOTAL DEPTH: 52.2 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 2

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-5

Depth (Feet)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
50						40		ML	Sandy SILT - stiff to very stiff, moist, gray brown, with rust spots, rust along some silty bedding partings and some traces of manganese (continued)
52									52.0
54									
56									
58									
60									
62									
64									
66									
68									
70									
72									
74									

DEPTH IN FEET

DATE DRILLED: 5-19-03
TOTAL DEPTH: 52.2 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 2

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE
A-6

Depth (DEPTH IN FEET)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
0								SM	FILL: Silty SAND - medium dense, moist, olive brown
2									
4									
	18			8	SV	40			
6									
						19			
8									
10									10.0
	94				SV PI	35		ML	FILL: SILT - stiff, moist, olive brown - trace gravel
12						37			
14									15.0
	32					36		SM	FILL: Silty SAND - medium dense, moist, olive brown
16									
						33			
18									
20						39			
22	23				SV PI	25			
24									

DATE DRILLED: 5-19-03
TOTAL DEPTH: 49.0 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 3

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-7

Depth (DEPTH IN FEET)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
26						34		SM	FILL: Silty SAND - medium dense, moist, olive brown (continued) - trace gravel
28						12			
30	62			17	SV	24			
								ML	31.0 Sandy SILT - stiff, moist, gray brown with rust spots
32						15			
34									
36						15			
38	67				PI	17			
40						27			
42	34				SV	19			- more sand
44									
46						32			
48	53				SV	30			
50									49.0

DATE DRILLED: 5-19-03
TOTAL DEPTH: 49.0 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 3

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE
A-8

Depth (ft)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Samples	USCS	SOIL DESCRIPTION
0								SP-SM	Poorly graded SAND with silt - loose to medium dense, slighly moist, brown, fine grained
2									
4									
5	6				SV	11			
6									
8									
10						12			
12									
14	9			6	SV	10			
16									
18									
19.5								ML	Sandy SILT - medium stiff, moist, light yellow to white
20						8			
22	68		58	53	SV PI	20			
23.5								SP-SM	Poorly graded SAND with silt - loose to medium dense, slighly moist, brown, fine grained
24									

DEPTH IN FEET

DATE DRILLED: 5-21-03
TOTAL DEPTH: 45.5 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 4

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-9

Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
					12			
44				PI	13		SM	30.0 Silty SAND - medium dense, moist, light tan to gray, manganese near vertical fractures
18				SV	66 for 1		GM	35.0 Silty GRAVEL with sand - very dense, slighly moist, gray to reddish brown
					96			
					50 for 5			45.5

DEPTH IN FEET: 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50

DATE DRILLED: 5-21-03
TOTAL DEPTH: 45.5 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 4

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-10

Depth (ft)	Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
0								SP-SM	Poorly graded SAND with silt - loose to medium dense, slighly moist, brown, fine grained
2									
4									
5	8				SV	10			
6									
8									
10				6		16			
12									
14.0								MH	Sandy SILT - stiff, moist, tan, rusty, medium to coarse grained sand
15						9			
16									
18									
20	64				PI	8			
22									
24									

DEPTH IN FEET

DATE DRILLED: 5-20-03
TOTAL DEPTH: 49.0 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 5

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-11

Percent Passing #200	Unconfined Compression (psf)	Dry Density (pcf)	Moisture Content (%)	Other Tests	Blows per foot	Sample	USCS	SOIL DESCRIPTION
13				SV PI	62		SM	25.5 Silty SAND - dense, slightly moist, very light reddish-brown
2				SV	72		GW	30.5 Well graded GRAVEL with sand - very dense, moist, dark brown, fine to coarse, with a few 2" gravel clasts
					71 for 1			
					89 for 9			
					50 for 2			44.5 - practical auger refusal at 44'

DEPTH IN FEET: 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50

DATE DRILLED: 5-20-03
TOTAL DEPTH: 49.0 feet
DIAMETER OF BORING: inches

LOGGED BY: M. Ivers
EQUIPMENT: Diedrich D120
ELEVATION: Not Measured

KLEINFELDER

PROJECT NO. 30268.001

LOG OF BORING B- 5

South Utah Valley Landfill
5 Miles North of Elberta
Utah County, Utah

FIGURE A-12

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION			ATTERBERG LIMITS		OTHER TESTS*	UNIFIED SOIL CLASSIFICATION
BORING NO.	DEPTH (ft)			GRAVEL (%)	SAND (%)	SILT AND CLAY (%)	LIQUID LIMIT	PLASTICITY INDEX		
B-1	5			0	61	39	23	NP		Silty SAND (SM)
B-1	10	12		1	64	36				Silty SAND (SM)
B-1	20			0	68	32				Silty SAND (SM)
B-1	30			6	50	44				Silty SAND (SM)
B-1	40					53	67	21		Sandy SILT (MH)
B-1	55	3								Silty SAND with gravel (SM)
B-2	10			0	64	35				Silty SAND (SM)
B-2	20	6		1	83	16				Silty SAND (SM)
B-2	25			6	43	51	25	NP		Sandy SILT (ML)
B-2	35			0	44	56				Sandy SILT (ML)
B-2	45	27	76			50	41	13		Sandy SILT (ML)
B-3	5	8		0	82	18				Silty SAND (SM)
B-3	10			1	5	94	25	NP		SILT (ML)
B-3	15					32				Silty SAND (SM)
B-3	22			2	75	23	20	NP		Silty SAND (SM)
B-3	30	17		0	38	62				Sandy SILT (ML)
B-3	37					67	52	14		Sandy SILT (MH)
B-3	42			5	61	34				Silty SAND (SM)
B-3	47			1	46	53				Sandy SILT (ML)
B-4	5			0	94	6				Poorly graded SAND with silt
										(SP-SM)
B-4	14	6		0	91	9				Poorly graded SAND with silt
										(SP-SM)
B-4	22	53	58	0	32	68	41	9		Sandy SILT (ML)
B-4	30					44	47	16		Silty SAND (SM)

*R = Resistivity (ohms-cm); WSS = Water Soluble Sulfates (ppm); UC = Unconfined Compression (psf); TV = Torvane (psf); C = Consolidation Test, CBR = California Bearing Ratio (%), S = Swell Potential (%), ND = Non Detect

KLEINFELDER

PROJECT NO. 30268.001

SUMMARY OF LABORATORY TEST RESULTS

South Utah Valley Landfill

5 Miles North of Elberta

FIGURE

B-1

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION			ATTERBERG LIMITS		OTHER TESTS*	UNIFIED SOIL CLASSIFICATION
BORING NO.	DEPTH (ft)			GRAVEL (%)	SAND (%)	SILT AND CLAY (%)	LIQUID LIMIT	PLASTICITY INDEX		
B-4	35			43	39	18				Silty GRAVEL with sand (GM)
B-5	5			0	92	8				Poorly graded SAND with silt
										(SP-SM)
B-5	10	6								Poorly graded SAND with silt
										(SP-SM)
B-5	20					64	51	11		Sandy SILT (MH)
B-5	25			6	82	13	44	NP		Silty SAND (SM)
B-5	30			51	47	2				Well graded GRAVEL with sand
										(GW)
BVLF-1	0			0	5	95				SILT (ML)
BVLF-2	0			0	46	54				Sandy SILT (ML)
BVLF-3	0			0	52	48				Silty SAND (SM)
BVLF-4	0			30	59	11				Well graded SAND with silt and gravel
										(SW-SM)
BVLF-5	0			0	99	1				Poorly graded SAND (SP)
TP-1	0			2	34	64				Sandy SILT (ML)
TP-2	7			58	37	5				Well graded GRAVEL with sand
										(GW)

*R = Resistivity (ohms-cm); WSS = Water Soluble Sulfates (ppm); UC = Unconfined Compression (psf); TV = Torvane (psf); C = Consolidation Test, CBR = California Bearing Ratio (%), S = Swell Potential (%), ND = Non Detect

KLEINFELDER

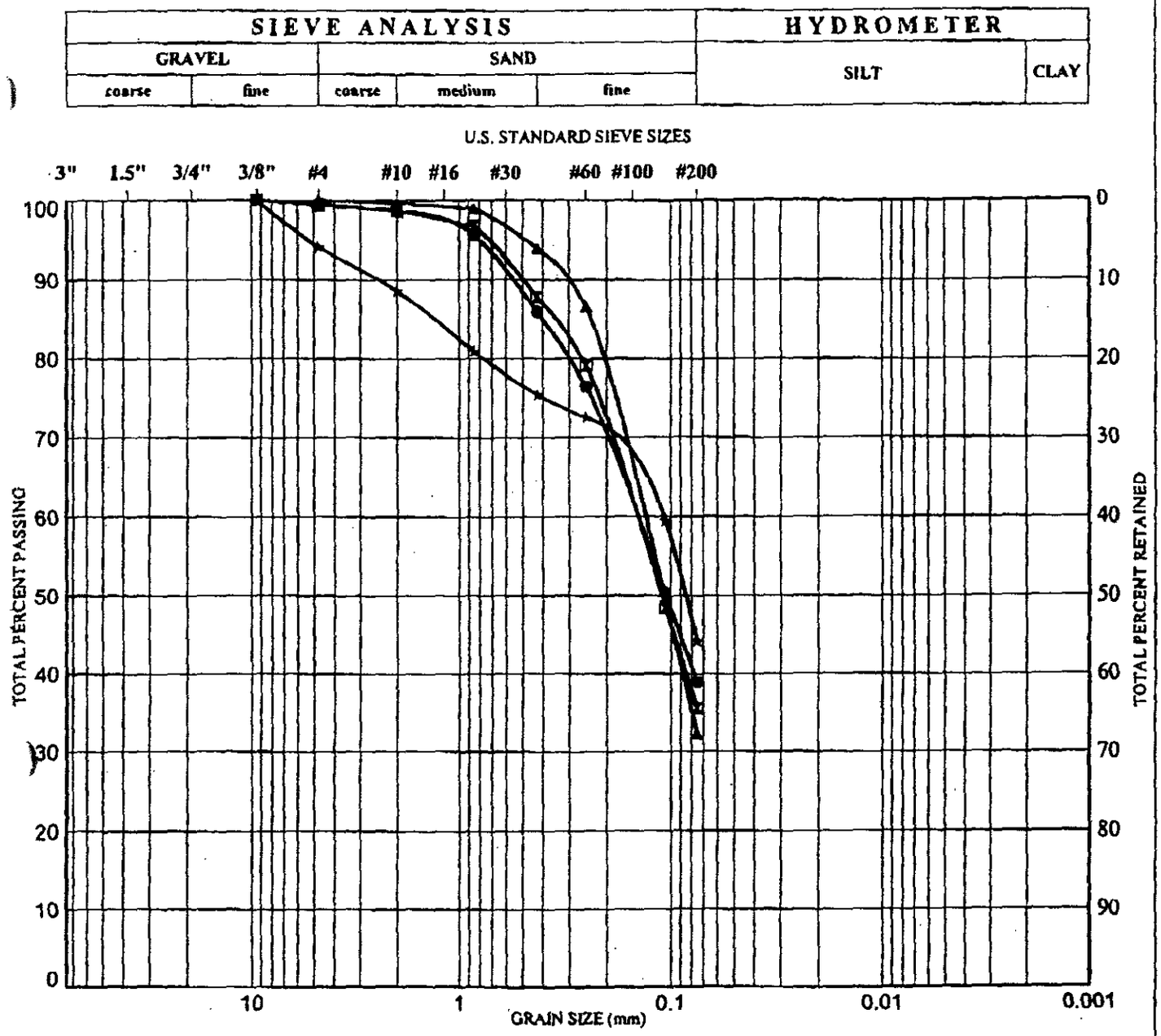
PROJECT NO. 30268.001

SUMMARY OF LABORATORY TEST RESULTS

South Utah Valley Landfill

5 Miles North of Elberta

FIGURE **B-2**



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-1	5.0	Silty SAND	SM
⊠	B-1	10.0	Silty SAND	SM
▲	B-1	20.0	Silty SAND	SM
★	B-1	30.0	Silty SAND	SM

KLEINFELDER

PROJECT NO. 30268.001

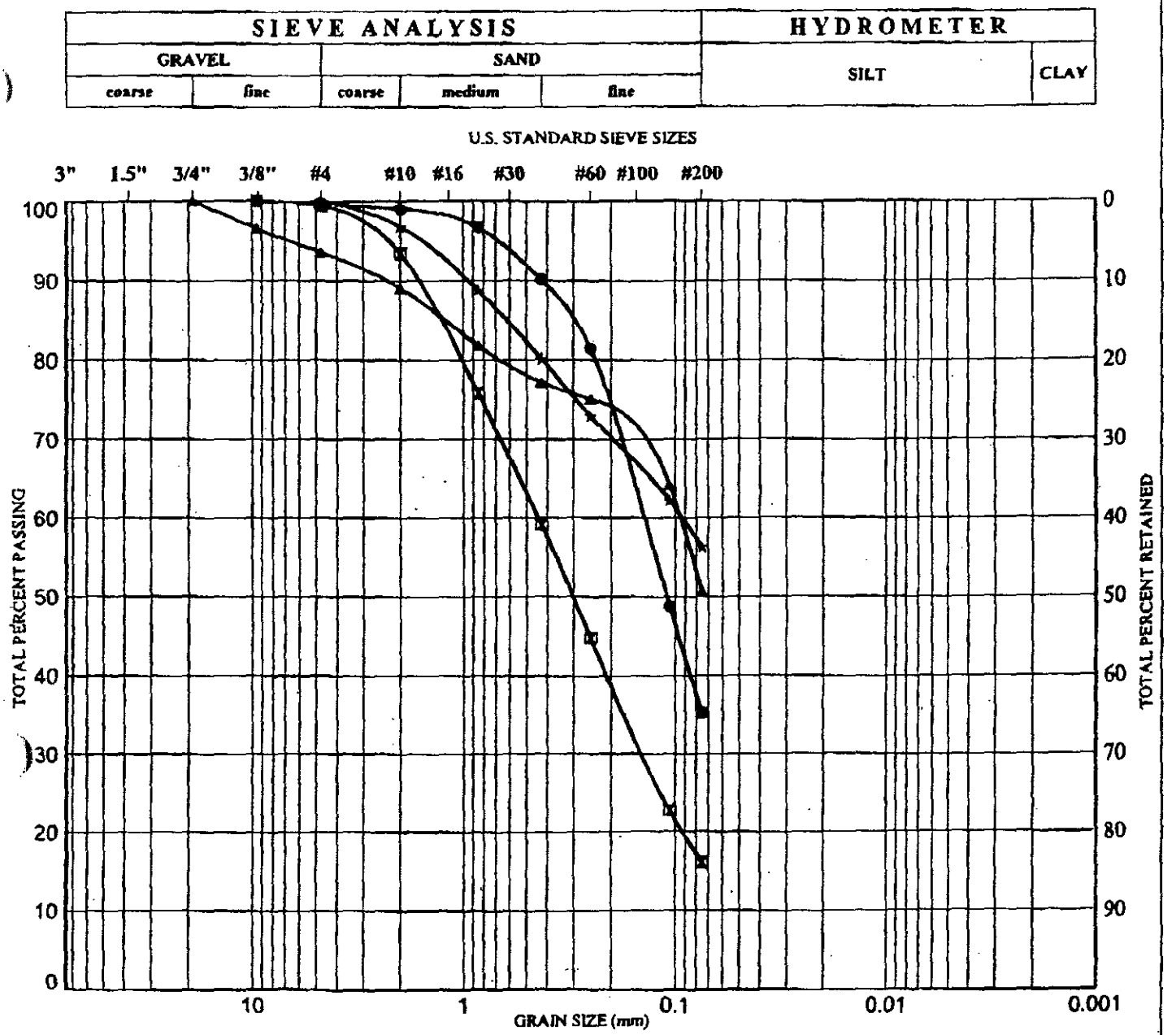
South Utah Valley Landfill

Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-3



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-2	10.0	Silty SAND	SM
⊠	B-2	20.0	Silty SAND	SM
▲	B-2	25.0	Sandy SILT	ML
★	B-2	35.0	Sandy SILT	ML

KLEINFELDER

PROJECT NO. 30268.001

South Utah Valley Landfill

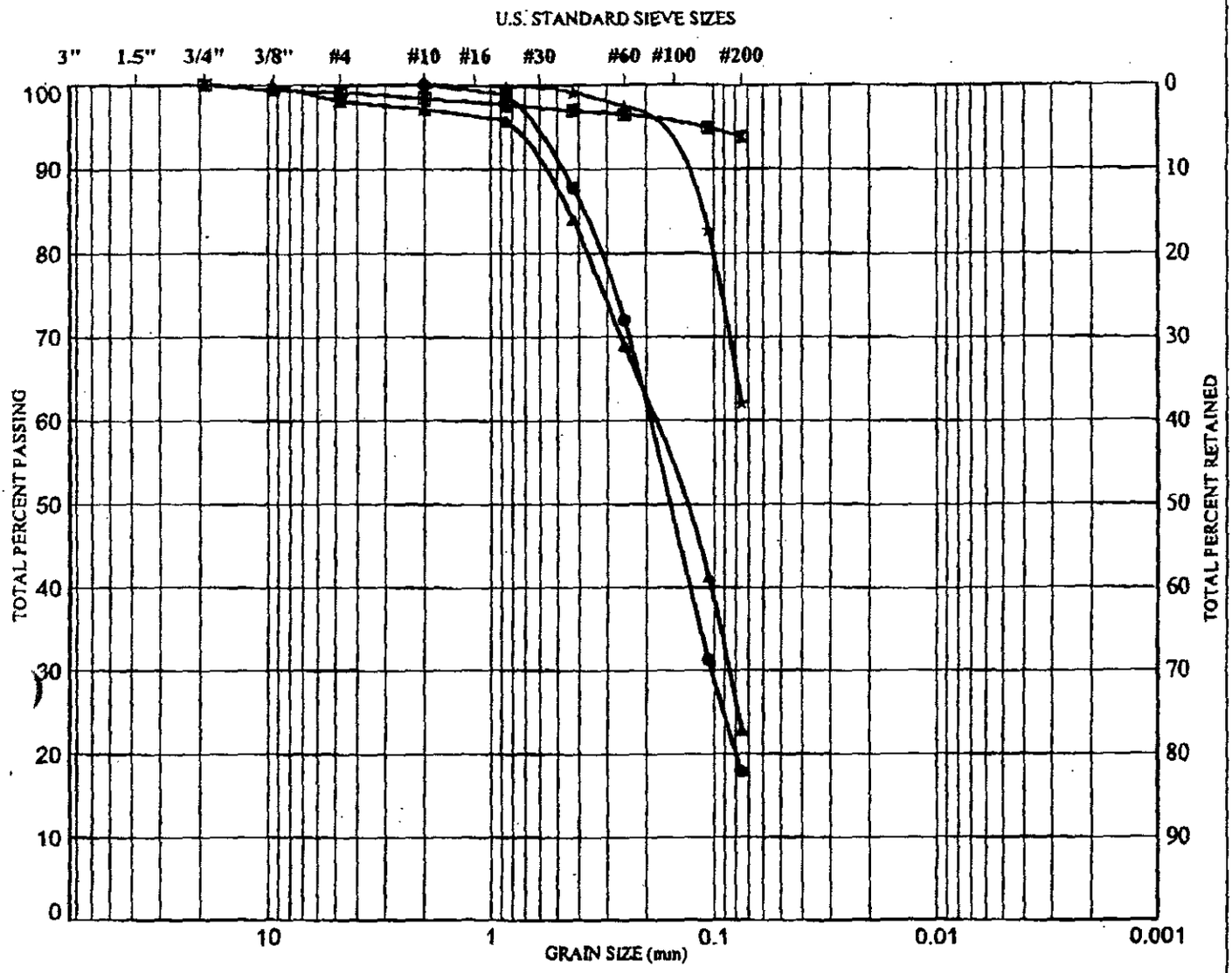
Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-4

SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-3	5.0	Silty SAND	SM
⊠	B-3	10.0	SILT	ML
▲	B-3	22.0	Silty SAND	SM
★	B-3	30.0	Sandy SILT	ML

KLEINFELDER

PROJECT NO. 30268.001

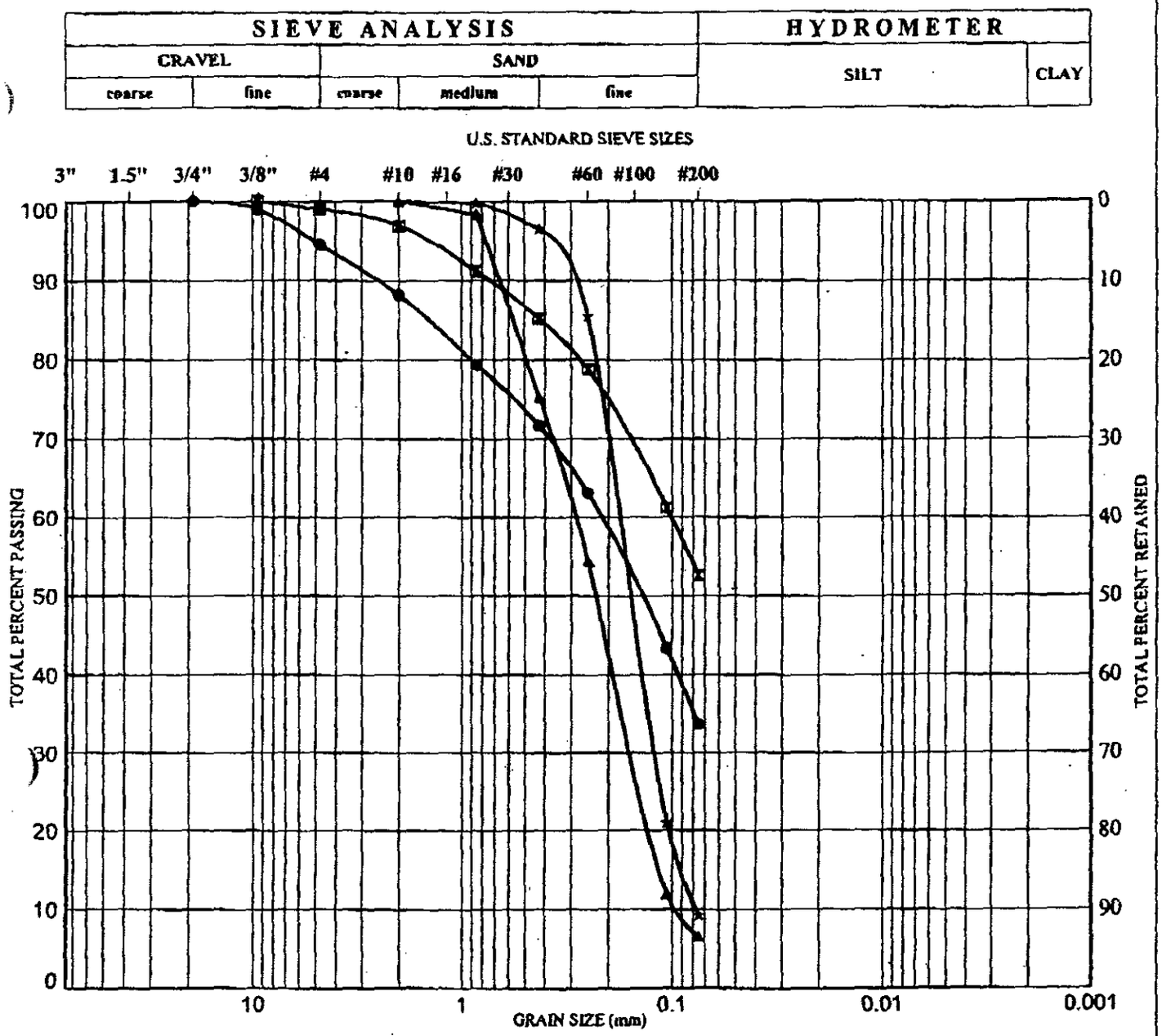
South Utah Valley Landfill

Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-5



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-3	42.0	Silty SAND	SM
⊠	B-3	47.0	Sandy SILT	ML
▲	B-4	5.0	Poorly graded SAND with silt	SP-SM
★	B-4	14.0	Poorly graded SAND with silt	SP-SM

KLEINFELDER

PROJECT NO. 30268.001

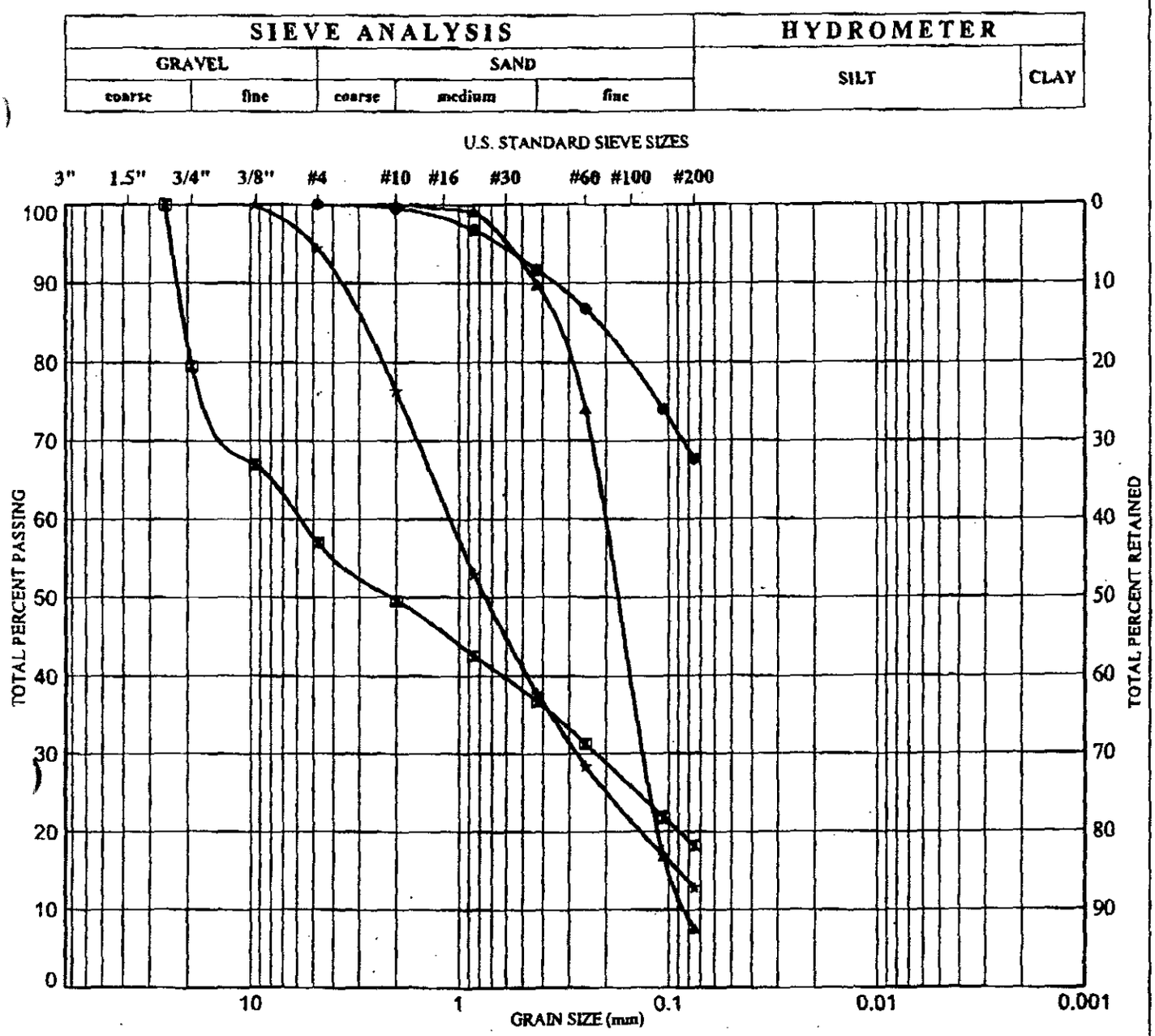
South Utah Valley Landfill

Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-6



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-4	22.0	Sandy SILT	ML
⊠	B-4	35.0	Silty GRAVEL with sand	GM
▲	B-5	5.0	Poorly graded SAND with silt	SP-SM
★	B-5	25.0	Silty SAND	SM

KLEINFELDER

PROJECT NO. 30268.001

South Utah Valley Landfill

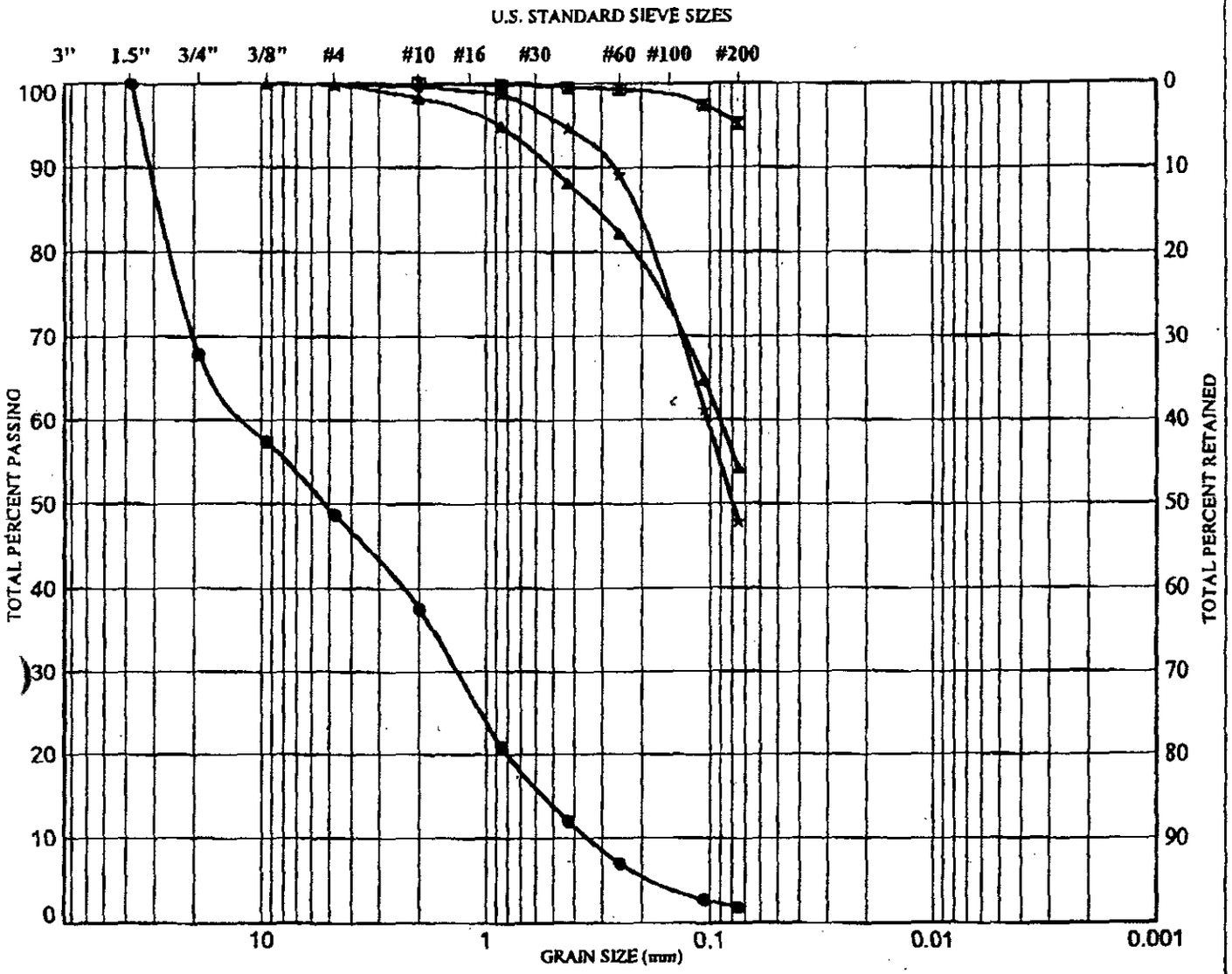
Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-7

SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B- 5	30.0	Well graded GRAVEL with sand	GW
⊠	BVLF- 1	0.0	SILT	ML
▲	BVLF- 2	0.0	Sandy SILT	ML
★	BVLF- 3	0.0	Silty SAND	SM

KLEINFELDER

PROJECT NO. 30268.001

South Utah Valley Landfill

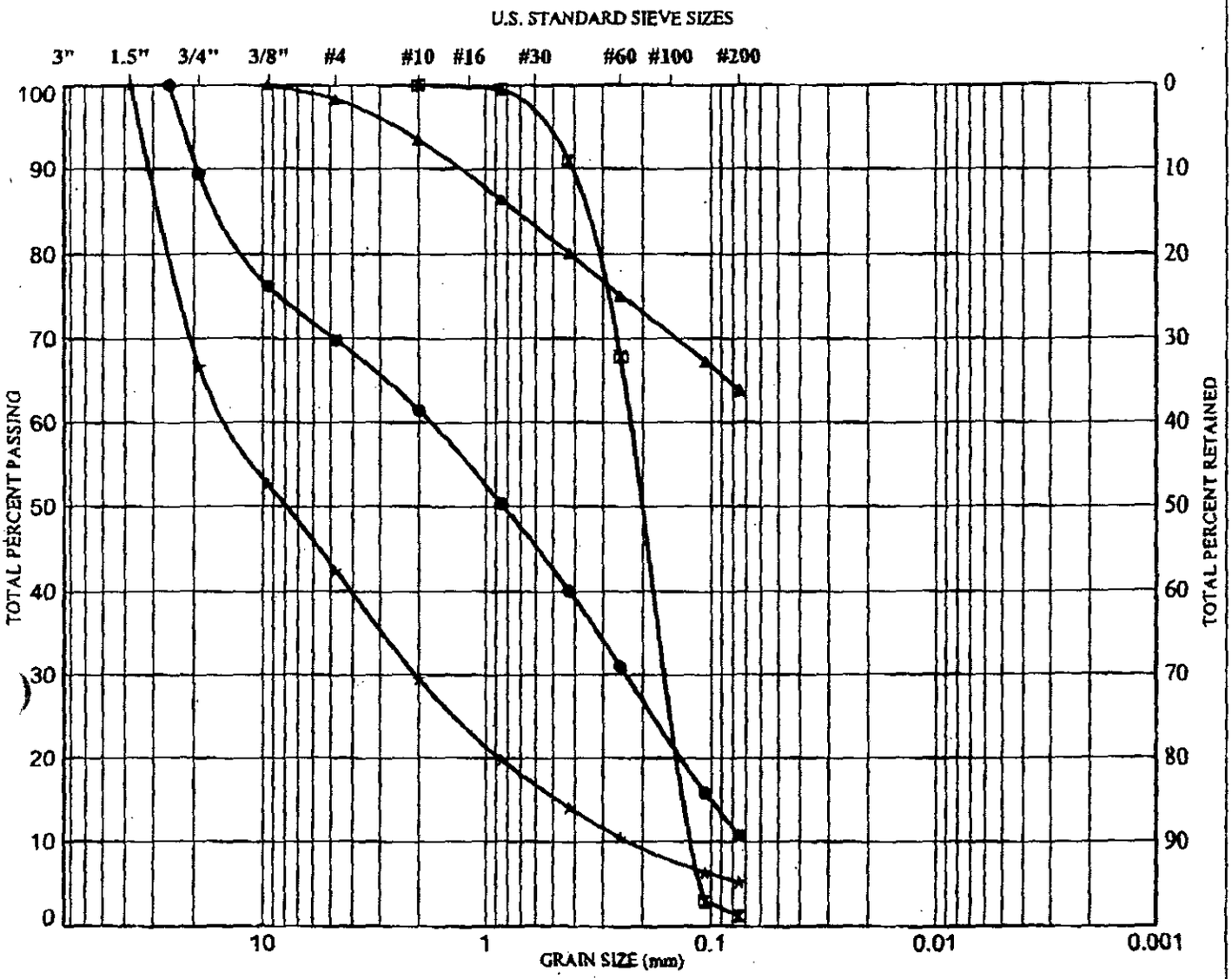
Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-8

SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	BVLF-4	0.0	Well graded SAND with silt and gravel	SW-SM
⊠	BVLF-5	0.0	Poorly graded SAND	SP
▲	TP-1	0.0	Sandy SILT	ML
★	TP-2	7.0	Well graded GRAVEL with sand	GW

KLEINFELDER

PROJECT NO. 30268.001

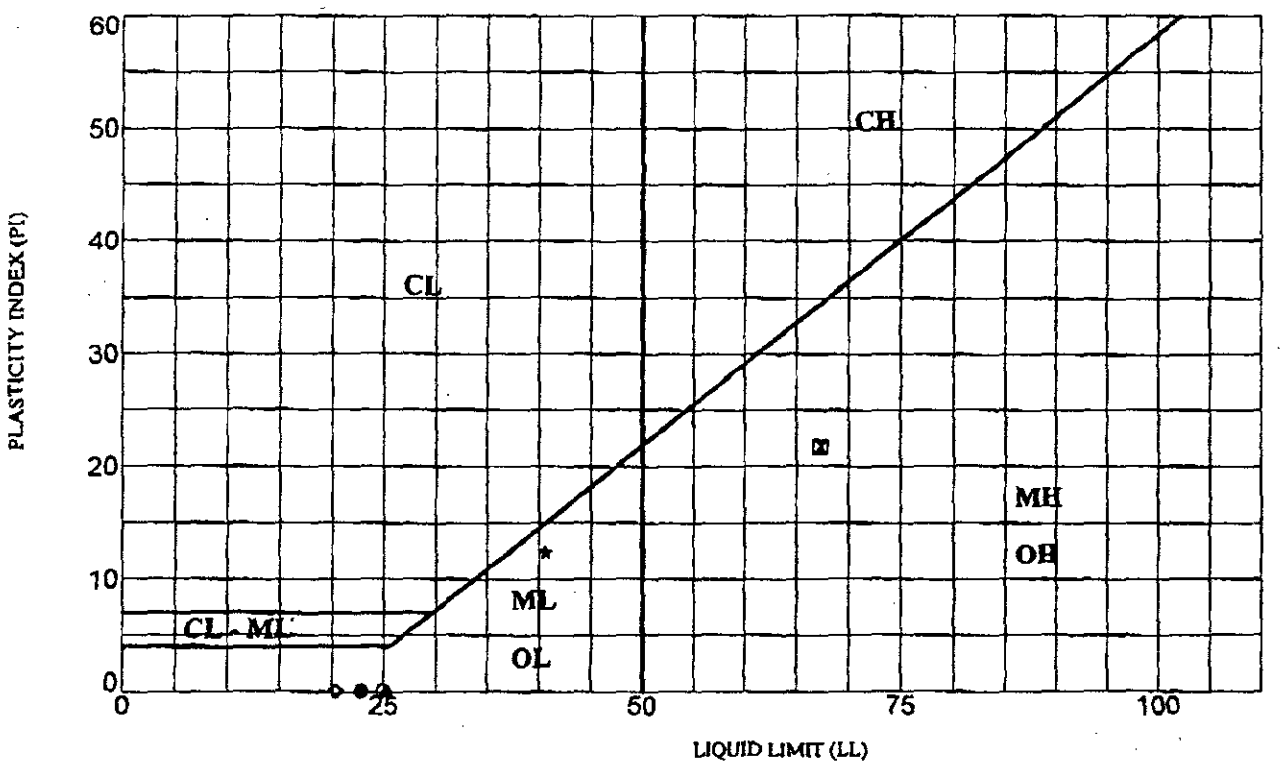
South Utah Valley Landfill

Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-9



Specimen Identification		USCS Classification	LL	PL	PI
●	B- 1 at 5.0 feet	Silty SAND (SM)	23	NP	NP
⊠	B- 1 at 40.0 feet	Sandy SILT (MH)	67	46	21
▲	B- 2 at 25.0 feet	Sandy SILT (ML)	25	NP	NP
★	B- 2 at 45.0 feet	Sandy SILT (ML)	41	28	13
○	B- 3 at 10.0 feet	SILT (ML)	25	NP	NP
✿	B- 3 at 22.0 feet	Silty SAND (SM)	20	NP	NP

LL - Liquid Limit **PL - Plastic Limit** **PI - Plasticity Index**

Unified Soil Classification
Fine Grained Soil Groups

	LL < 50
ML	Inorganic silts and clayey silts to very fine sands of low plasticity
CL	Inorganic clays of low to medium plasticity
OL	Organic silts and organic silty clays of low plasticity

	LL ≥ 50
MH	Inorganic silts and clayey silts of high plasticity
CH	Inorganic clays of high plasticity
OH	Organic clays of high plasticity, organic silts

KLEINFELDER

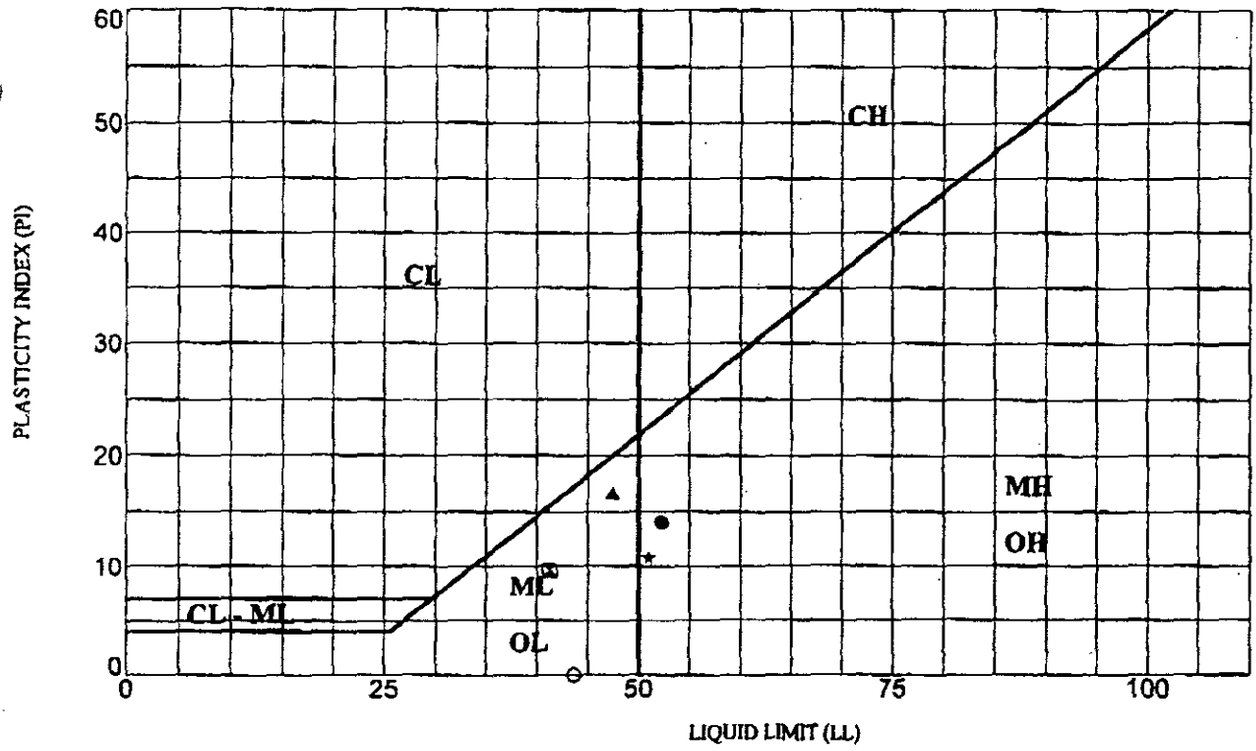
PROJECT NO. 30268.001

South Utah Valley Landfill
5 Miles North of Elberta

PLASTICITY CHART

FIGURE

B-10



Specimen Identification		USCS Classification	LL	PL	PI
●	B- 3 at 37.0 feet	Sandy SILT (MH)	52	38	14
⊠	B- 4 at 22.0 feet	Sandy SILT (ML)	41	32	9
▲	B- 4 at 30.0 feet	Silty SAND (SM)	47	31	16
★	B- 5 at 20.0 feet	Sandy SILT (MH)	51	40	11
○	B- 5 at 25.0 feet	Silty SAND (SM)	44	NP	NP

LL - Liquid Limit **PL - Plastic Limit** **PI - Plasticity Index**

Unified Soil Classification
Fine Grained Soil Groups

	LL < 50
ML	Inorganic silts and clayey silts to very fine sands of low plasticity
CL	Inorganic clays of low to medium plasticity
OL	Organic silts and organic silty clays of low plasticity

	LL ≥ 50
MH	Inorganic silts and clayey silts of high plasticity
CH	Inorganic clays of high plasticity
OH	Organic clays of high plasticity, organic silts

KLEINFELDER

PROJECT NO. 30268.001

South Utah Valley Landfill
5 Miles North of Elberta

PLASTICITY CHART

FIGURE

B-11

KLEINFELDER

APPLICATION FOR AUTHORIZATION TO USE

Source Material Investigation
South Utah Valley Landfill (Bayview Landfill)
Utah County, Utah
Report originally prepared for ***HDR Engineering, Inc.***

File Number: 30268.001 Report Date: July 1, 2003

KLEINFELDER, INC.
2677 East Parley's Way
Salt Lake City, Utah
(801) 466-6769
(801) 466-6788

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_____ _____
(address) *(Signature)*

_____ Title: _____
(city, state, zip)

_____ _____ Date: _____
(telephone) *(FAX)*

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APPENDIX K

LEACHATE GENERATION CALCULATIONS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

APPENDIX K – LEACHATE GENERATION CLACULATIONS

INTRODUCTION

All assumptions and calculations used to obtain the hydraulic head on top of the Flexible Membrane Liner (FML) are included in this appendix, as well as the Hydrologic Evaluation of Landfill Performance (HELP) model results. Leachate includes stormwater that has come into contact with waste or daily cover.

The following is a list of attachments:

K-1: Accumulated Run-off from Cell 2, Stage 1 and Stage 2

K-2: Leachate Generation/Hydraulic Head on Liner

K-3: Flow Capacity of the Leachate Collection Pipe

APPENDIX K

ATTACHMENT 1:
ACCUMULATED RUN-OFF FROM CELL 2, STAGE 1 AND STAGE 2

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03	
Subject Site Drainage	Checked MO	Date 6/24/03	
Task Accumulated run-off from Stage 1 & 2 Cell 2	Sheet 1	Of 5	

Based on boring logs, the texture of material used for intermediate cover for Cell 2 is a sandy loam; Resulting in a hydrologic soil group of "A." (See REF. 2)

Since the hydrologic soil group is "A," the curve number (CN) for bare soil is 77 (see REF. 2). Use CN of 80 which increases run-off.

Rainfall from a 25-year 24-hour storm at Bayview Landfill is 2.10" (see pg. 4 Isopluvial of 25-year 24-hour precipitation).

The run-off depth from a 25-year 24-hour storm for Cell 2 is estimated using Table 3.21 (REF. 2, pg. 5). The run-off depth is interpolated to be:

$$D = 0.56 + \frac{.1}{.5}(.89 - .56)$$

$$= .626 \text{ inches}$$

$$\approx .63 \text{ inches}$$

REF. 2

Group	Minimum Infiltration Rate (in./hr)	Texture[a]
A	0.3–0.45	Sand, loamy sand, or sandy loam
B	0.15–0.30	Silt loam or loam
C	0.05–0.15	Sandy clay loam
D	0–0.05	Clay loam, silty clay loam, sandy clay, silty clay, or clay

[a]Reproduced from U.S. Soil Conservation Service (1986).

pg. 3/5

TABLE 3.19 CURVE NUMBERS FOR ANTECEDENT MOISTURE CONDITION II

REF. 2

Use	Cover Type	Treatment	Hydrologic Condition	Hydrologic soil group A	B	C	D
Urban	Fully developed						
	Open space (lawns, parks)		Poor (cover <50%)	68	79	86	89
			Fair	49	69	79	84
			Good (grass cover >75%)	39	61	74	80
	Impervious areas (paved parking, roofs, driveways, paved roads)			98	98	98	98
	Dirt roads			72	82	87	89
	Urban districts						
	Commercial and business			89	92	94	95
	Industrial			81	88	91	93
	Developing areas			77	86	91	94
Cultivated agriculture lands	Fallow	Bare soil	...	77	86	91	94
	Row crops	Straight row	Poor	72	81	88	91
		Straight row	Good	67	78	85	89
		Contoured	Poor	70	79	84	88
		Contoured	Good	65	75	82	86
		Contoured and terraced	Poor	66	74	80	82
		Contoured and terraced	Good	62	71	78	81
	Small grain	Straight row	Poor	65	76	84	88
		Straight row	Good	63	75	83	87
		Contoured	Poor	63	74	82	85
		Contoured	Good	61	73	81	84
		Contoured and terraced	Poor	61	72	79	82
		Contoured and terraced	Good	59	70	78	81
	Close-seeded legumes or rotation meadow	Straight row	Poor	66	77	85	89
		Straight row	Good	58	72	81	85
		Contoured	Poor	64	75	83	85
		Contoured	Good	55	69	78	83
		Contoured and terraced	Poor	63	73	80	83
		Contoured and terraced	Good	51	67	76	80

CN

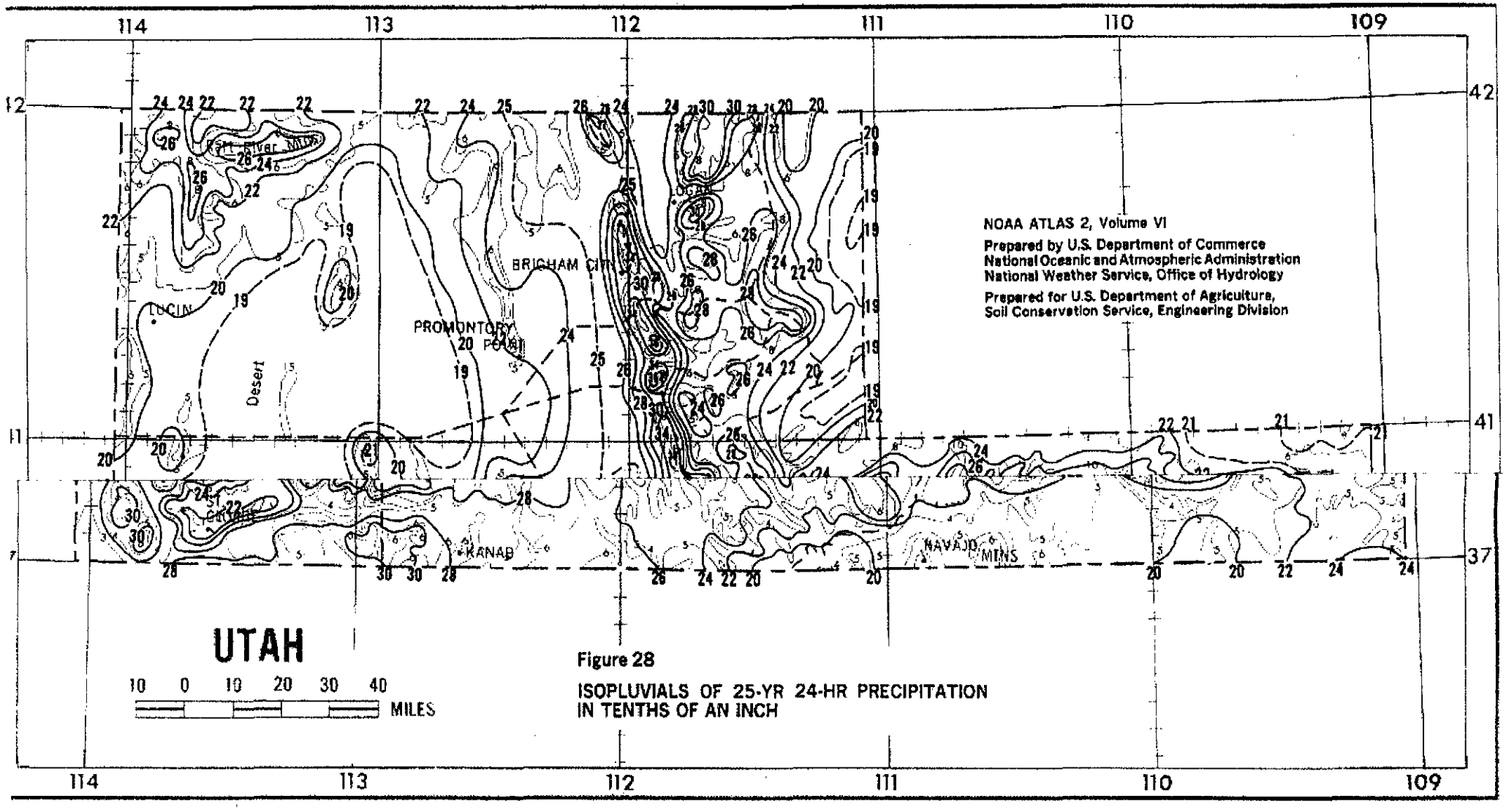


Figure 28

ISOPLUVIALS OF 25-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

pg. 5/5

REF. 2

Table 3.21

Rainfall	Runoff Depth (in.) for Curve Number of:												
	40	45	50	55	60	65	70	75	80	85	90	95	98
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.15	0.27	0.46	0.74	0.99
1.4	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.13	0.24	0.39	0.61	0.92	1.18
1.6	0.00	0.00	0.00	0.00	0.01	0.05	0.11	0.20	0.34	0.52	0.76	1.11	1.38
1.8	0.00	0.00	0.00	0.00	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.0	0.00	0.00	0.00	0.02	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.5	0.00	0.00	0.02	0.08	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.0	0.00	0.02	0.09	0.19	0.33	0.51	0.71	0.96	1.25	1.59	1.98	2.45	2.77
3.5	0.02	0.08	0.20	0.35	0.53	0.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	0.06	0.18	0.33	0.53	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	0.14	0.30	0.50	0.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	0.24	0.44	0.69	0.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	0.50	0.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	0.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

*Interpolate the values shown to obtain runoff depths for CNs or rainfall amounts not shown.
Source: U.S. Soil Conservation Service (1986).

APPENDIX K

ATTACHMENT 2:

LEACHATE GENERATION/ HYDAULIC HEAD ON LINER

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03	
Subject Leachate Collection System	Checked mwl	Date 6/24/03	
Task Leachate Generation/Hydraulic Head on Liner	Sheet 1	Of 25	

1.0 Progression of Cell 2 (Stage 1 and 2)

Cell 2 has a total area of approximately 82 acres, however only the first 30 acres to be filled were considered in the Hydrologic Evaluation of Landfill Performance (HELP) model. The first 30 acres of Cell 2 will have a life of approximately 15 years. Therefore, the following progression is used:

(1) one acre with an initial lift of 10 feet and 6" of daily cover for 1 year

(2) one acre with 130 feet of waste and 12" of intermediate cover for 30 years

(One acre is used as the default area for all HELP model runs. The results may be extrapolated to obtain results for any area.)

For condition one, the HELP model used a user specified precipitation file that contained the five wettest years at the landfill location.

For condition two, the HELP model used synthetic precipitation data for Salt Lake City, Utah to simulate 30 years of rainfall falling on the landfill.

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03
Subject Leachate Collection System	Checked SMO	Date 6/24/03
Task	Sheet 2	Of 25

2.0 Climatologic and Rainfall Data

The five wettest year precipitation file was used to simulate precipitation for the first year of life for Cell 2.

The synthetic rainfall generator (SRG) was used for Salt Lake City, Utah for 30 years. The SRG was then adjusted to Bayview Landfill using monthly temperature and precipitation data (REF. 4) for Fairfield, Utah.

The maximum leaf area index for Bare Ground and poor stand of grass is 0 and 1, respectively.

Evaporative zone depth for bare ground for Salt Lake City is 16 inches.

REF. 4

Fairfield

County: Utah Latitude: 40°16' Longitude: 112°05' Elevation: 4880 feet Period: 1950-1992*

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Normal max temp	37.1	43.4	52.6	62.2	71.8	81.8	88.9	87.2	78.9	65.7	50.4	38.5	63.2
Normal min temp	10.2	16.9	24.2	29.2	36.1	43.7	50.9	48.8	39.5	29.3	21.2	12.2	30.2
Normal mean temp	23.6	30.1	38.3	45.7	54.0	62.7	69.9	68.0	59.2	47.5	35.8	25.4	46.7
Record high temp	63	70	77	86	91	99	100	99	95	88	78	65	100
Record low temp	-29	-36	-11	10	16	17	32	27	16	4	-20	-29	-36
Normal pcpn	0.98	0.95	1.11	1.01	1.06	0.79	1.09	1.15	1.09	1.25	0.99	0.91	12.39
Record mly pcpn	2.37	3.29	3.86	2.53	3.41	2.90	5.23	4.77	5.29	3.02	2.70	3.08	5.29
Record dly pcpn	0.85	1.03	1.31	1.01	2.00	0.98	1.50	1.26	1.13	1.55	0.87	0.77	2.00
Normal snowfall	9.2	6.2	5.8	2.1	0.3	0.0	0.0	0.0	0.0	1.2	4.6	8.8	38.2
Record mly snow	27.0	28.5	13.0	20.0	4.0	0.0	0.0	0.0	0.5	6.0	18.0	32.0	32.0
Record dly snow	12.0	12.0	7.0	6.0	4.0	0.0	0.0	0.0	0.5	4.0	10.0	10.5	12.0
Evapotranspiration	0.86	1.38	2.62	4.12	6.08	7.43	8.38	7.31	5.06	3.07	1.40	0.83	48.57

*Percentage of period with data: 89% for temperature, 92% for precipitation, 89% for snowfall.

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03
Subject Leachate Collection System	Checked [illegible]	Date 6/24/03
Task	Sheet 4	Of 25

3.0 Soil and Layer Data

Default layer types and soil textures in the HELP model were used for the following conditions:

Condition 1

6" of daily cover (Texture 6)
10" of waste (Texture 18)
24" of lateral drainage (Texture 6)
Flexible Membrane Liner (Texture 35)
Bentonite Mat (Texture 17)

Condition 2

12" of intermediate cover (Texture 6)
1560" of waste (Texture 18)
24" of lateral drainage (Texture 6)
Flexible Membrane Liner (Texture 35)
Bentonite Mat (Texture 17)

To be conservative, the intermediate cover, daily cover, lateral drainage layer and the barrier soil liner were all assumed to be saturated at the beginning of the simulation for both conditions. Based on Davis County Solid Waste Management and Energy Recovery Special Service District records, the solid waste moisture content for this area averaged 16 to 18% by weight.

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03
Subject Leachate Collection System	Checked [illegible]	Date 6/24/03
Task	Sheet 5	Of 25

Using 17% moisture by weight (weight of water by weight of waste), initial moisture content by volume (volume of water per volume of waste) for incorporation into the HELP model was estimated as follows:

$\Theta \equiv$ moisture content by volume $= w(\tau_d/\rho_w)$

$w \equiv$ moisture content by weight $= 17\%$
$\tau_d \equiv$ dry density of waste $= 41\ lb/ft^3$
$\rho_w \equiv$ density of water @ $50°F = 62.4\ lb/ft^3$

$$\Theta = .17\left(\frac{41}{62.4}\right) = .11$$

4.0 Landfill Profiles and Layer Properties

Condition 1

6" daily cover } Type 1
10' of waste }
* 24" of Lateral Drainage - Type 2
** 60-mil FML - Type 4
*** .25" Bentonite Mat - Type 3

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03
Subject Leachate Collection System	Checked MWO	Date 6/24/03
Task	Sheet 6	Of 25

Condition 2

12" Intermediate cover } Type 1
130' of Waste }
*24" Lateral Drainage Layer - Type 2
** 60-mil FML - Type 4
***.25" Bentonite Mat - Type 3

Type 1 ≡ vertical percolation layer
Type 2 ≡ lateral drainage layer
Type 3 ≡ Bentonite mat
Type 4 ≡ FML

* Geotextile used as filter layer for leachate collection track was not considered as a vertical drainage layer; resulting in a conservative impingement rate.

** Assumed pinhole density = 0.75 holes/acre; Installed defects = 2 holes/acre; good placement quality

*** Geotextile used as cushion underneath barrier soil was not considered as a vertical drainage layer.

TABLE 4. DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

REF. 1

Classification			Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	USDA	USCS	vol/vol	vol/vol	vol/vol	cm/sec
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-2}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.265	1.7×10^{-5}
16	Barrier Soil		0.427	0.418	0.367	1.0×10^{-7}
17	Bentonite Mat (0.6 cm)		0.750	0.747	0.400	3.0×10^{-9}
18	Municipal Waste (900 lb/yd^3 or 312 kg/m^3)		0.671	0.292	0.077	1.0×10^{-3}
19	Municipal Waste (channeling and dead zones)		0.168	0.073	0.019	1.0×10^{-3}
20	Drainage Net (0.5 cm)		0.850	0.010	0.005	$1.0 \times 10^{+1}$
21	Gravel		0.397	0.032	0.013	3.0×10^{-1}
22	L*	ML	0.419	0.307	0.180	1.9×10^{-5}
23	SiL*	ML	0.461	0.360	0.203	9.0×10^{-6}
24	SCL*	SC	0.365	0.305	0.202	2.7×10^{-6}
25	CL*	CL	0.437	0.373	0.266	3.6×10^{-6}
26	SiCL*	CL	0.445	0.393	0.277	1.9×10^{-6}
27	SC*	SC	0.400	0.366	0.288	7.8×10^{-7}
28	SiC*	CH	0.452	0.411	0.311	1.2×10^{-6}
29	C*	CH	0.451	0.419	0.332	6.8×10^{-7}
30	Coal-Burning Electric Plant Fly Ash*		0.541	0.187	0.047	5.0×10^{-5}
31	Coal-Burning Electric Plant Bottom Ash*		0.578	0.076	0.025	4.1×10^{-3}
32	Municipal Incinerator Fly Ash*		0.450	0.116	0.049	1.0×10^{-2}
33	Fine Copper Slag*		0.375	0.055	0.020	4.1×10^{-2}
34	Drainage Net (0.6 cm)		0.850	0.010	0.005	$3.3 \times 10^{+1}$

* Moderately Compacted

(Continued)

TABLE 4 (continued). DEFAULT SOIL, WASTE, AND GEOSYNTHETIC CHARACTERISTICS

REF. 1

Classification		Total Porosity	Field Capacity	Wilting Point	Saturated Hydraulic Conductivity
HELP	Geomembrane Material	vol/vol	vol/vol	vol/vol	cm/sec
35 ●	High Density Polyethylene (HDPE)				2.0×10^{-13}
36	Low Density Polyethylene (LDPE)				4.0×10^{-13}
37	Polyvinyl Chloride (PVC)				2.0×10^{-11}
38	Butyl Rubber				1.0×10^{-12}
39	Chlorinated Polyethylene (CPE)				4.0×10^{-12}
40	Hypalon or Chlorosulfonated Polyethylene (CSPE)				3.0×10^{-12}
41	Ethylene-Propylene Diene Monomer (EPDM)				2.0×10^{-12}
42	Neoprene				3.0×10^{-12}

(concluded)

The maximum drainage pathway is 1400 feet; 230 feet at 25% slope and 1170 feet at 3% slope (page 10). Since two slopes contribute to the drainage pathway, the maximum drainage pathway is estimated as follows:

$$L_E' = L_E + L_E (Q_1/Q_2)$$

$L_E' \equiv$ maximum drainage pathway
$L_E \equiv$ 1400 feet
$Q_1 \equiv$ leachate flowrate at 25% slope
$Q_2 \equiv$ leachate flowrate at 3% slope

Based on impingment rates from a 25% slope, Q_1 is estimated as zero.

$$\Rightarrow L_E' = 1400' + \cancel{1400'(0/Q_2)}^{\,0} = 1400'$$

For HELP Model, 1170 feet at 3% slope will be used.

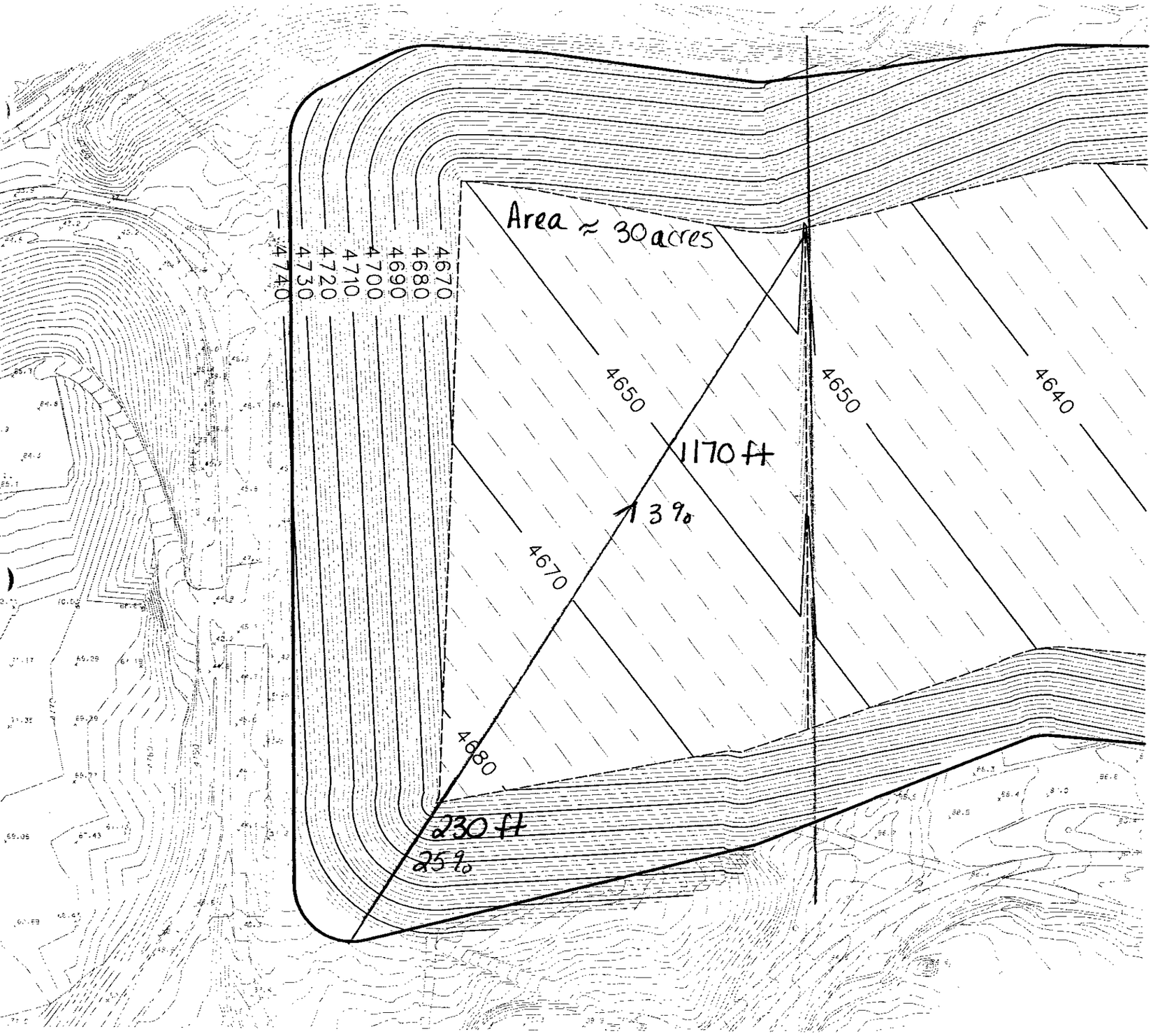
5.0 Leachate Generation

From the HELP model, the following leachate generations were estimated:

Condition 1

1 acre area with 10' of waste and 6" of daily cover for a drainage pathway of 1170' at a 3% slope = 0 in/day (page 11).

pg. 10/25



N

0 200 400
SCALE IN FEET

HDR

HDR Engineering, Inc.
2211 Preston Road
Suite 200

Revision	Description	Date	Drwn.	Chkd	Resp.	Proj.

Project Manager: M. ODEN
Architect | I&C/Process
Civil: M. ODEN | Mechanical
Electrical | Structural
Designed | Drawn By

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL

CELL 2 PERMIT

BOTTOM CONTOURS

Date: JUNE, 2003 | Project No. | Figure No. | Issue

Condition 2

1 acre area with 130' of waste and 12" of intermediate cover for a drainage pathway of 1170' at a 3% slope = 0 in/day (page 24).

6.0 Maximum Depth of Hydraulic Head on Liner System

Since the maximum lateral drainage rate (pg. 17 and 24) is approximately 0 in/day for each condition, the maximum head on the liner system approaches 0 feet. This is less than the 12 inch limit established in R315 - Environmental Quality, Solid and Hazardous waste.

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\SUV\WET5_AV.D4
TEMPERATURE DATA FILE:       C:\HELP3\SUV\FAIRFIED.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\SUV\SLCDFLT.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\SUV\SLCDFLT.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\SUV\BVIEW1YR.D10
OUTPUT DATA FILE:            C:\HELP3\SUV\BVIEW1YR.OUT


TIME:  11:14     DATE:   6/26/2003


******************************************************************************

     TITLE:  Bayview Cell#2  Year 1

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
          THICKNESS                    =      6.00   INCHES
          POROSITY                     =      0.4530 VOL/VOL
          FIELD CAPACITY               =      0.1900 VOL/VOL
          WILTING POINT                =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	120.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4530	VOL/VOL
FIELD CAPACITY	=	0.1900	VOL/VOL
WILTING POINT	=	0.0850	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1900	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.720000011000E-03	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	1170.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.75	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	77.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.240	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.428	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.280	INCHES
INITIAL SNOW WATER	=	2.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	19.087	INCHES
TOTAL INITIAL WATER	=	21.087	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SALT LAKE CITY UTAH

STATION LATITUDE	=	40.76	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	117	
END OF GROWING SEASON (JULIAN DATE)	=	289	
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	48.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	39.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	65.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SALT LAKE CITY UTAH

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.37	1.63	2.06	1.07	1.30	1.12
2.07	1.40	2.21	1.30	1.50	1.20

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SALT LAKE CITY UTAH

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
25.20	30.30	38.50	45.70	54.20	62.70
69.80	68.50	59.50	47.90	35.30	26.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SALT LAKE CITY UTAH
AND STATION LATITUDE = 40.27 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 1

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.45	0.93	1.84	0.47	0.63	0.46
	1.42	2.50	1.91	2.28	1.20	1.21
STD. DEVIATIONS	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.736	0.869	2.260	1.548	0.488	0.356

	0.831	2.814	1.653	2.151	1.039	0.679
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 1

	INCHES		CU. FEET	PERCENT
PRECIPITATION	15.30	(0.000)	55539.0	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	15.423	(0.0000)	55986.77	100.806
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.000	0.00000

AVERAGE HEAD ON TOP OF LAYER 4	0.000 (	0.000)		
CHANGE IN WATER STORAGE	-0.123	(0.0000)	-447.75	-0.806

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 1

	(INCHES)	(CU. FT.)
PRECIPITATION	0.89	3230.700
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	
MAXIMUM HEAD ON TOP OF LAYER 4	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.00	7260.0000

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2600
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0999

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 1

LAYER	(INCHES)	(VOL/VOL)
1	1.5758	0.2626
2	14.4955	0.1208
3	4.5600	0.1900
4	0.0000	0.0000
5	0.1875	0.7500
SNOW WATER	0.145	

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\SUV\BVPRECP.D4
TEMPERATURE DATA FILE:        C:\HELP3\SUV\BVTEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\SUV\BVRAD.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\SUV\BVEVAP.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\SUV\BAYVIEW3.D10
OUTPUT DATA FILE:             C:\HELP3\SUV\BAYVIEW3.OUT


TIME:  11:20     DATE:   6/26/2003


******************************************************************************

     TITLE:  Bayview Cell#2 Year 5

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
          THICKNESS                    =      12.00   INCHES
          POROSITY                     =       0.4530 VOL/VOL
          FIELD CAPACITY               =       0.1900 VOL/VOL
          WILTING POINT                =       0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT   =       0.1900 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.720000011000E-03 CM/SEC
```

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	1560.00	INCHES
POROSITY	=	0.6710	VOL/VOL
FIELD CAPACITY	=	0.2920	VOL/VOL
WILTING POINT	=	0.0770	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 6

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4530	VOL/VOL
FIELD CAPACITY	=	0.1900	VOL/VOL
WILTING POINT	=	0.0850	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1900	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.720000011000E-03	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	1170.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	0.75	HOLES/ACRE
FML INSTALLATION DEFECTS	=	2.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	77.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.720	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	8.120	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.328	INCHES
INITIAL SNOW WATER	=	2.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	178.628	INCHES
TOTAL INITIAL WATER	=	180.628	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
SALT LAKE CITY UTAH

STATION LATITUDE	=	40.76	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	117	
END OF GROWING SEASON (JULIAN DATE)	=	289	
EVAPORATIVE ZONE DEPTH	=	16.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	48.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	39.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	65.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SALT LAKE CITY UTAH

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.35	1.33	1.72	2.21	1.47	0.97
0.72	0.92	0.89	1.14	1.22	1.37

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SALT LAKE CITY UTAH

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.60	34.10	40.70	49.20	58.80	68.30
77.50	74.90	65.00	53.00	39.70	30.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR SALT LAKE CITY UTAH
AND STATION LATITUDE = 40.27 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.16	1.20	1.95	2.04	1.30	1.03
	0.69	0.85	0.84	1.05	1.31	1.46
STD. DEVIATIONS	0.60	0.54	0.77	0.87	0.68	0.74
	0.48	0.80	0.61	0.82	0.73	0.59
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.572	0.673	2.225	2.301	1.525	1.048

	0.706	0.840	0.789	0.922	0.823	0.763
STD. DEVIATIONS	0.258	0.379	0.644	0.918	0.694	0.719
	0.495	0.809	0.590	0.662	0.363	0.199

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	14.88	(2.435)	54009.6	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	13.186	(2.0492)	47864.84	88.623
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.000	0.00000

AVERAGE HEAD ON TOP OF LAYER 4	0.000 (	0.000)		
CHANGE IN WATER STORAGE	1.693	(1.1317)	6144.74	11.377

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30

	(INCHES)	(CU. FT.)
PRECIPITATION	1.66	6025.800
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	
MAXIMUM HEAD ON TOP OF LAYER 4	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.96	10733.1621

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4143
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0830

*** *Maximum heads are computed using McEnroe's equations.* ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	2.6547	0.2212
2	224.0082	0.1436
3	4.5600	0.1900
4	0.0000	0.0000
5	0.1875	0.7500
SNOW WATER	0.000	

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APPENDIX K

ATTACHMENT 3:
FLOW CAPACITY OF THE LEACHATE COLLECTION PIPE

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill	Computed KDG	Date 6/23/03	
Subject Leachate Collection System	Checked MMD	Date 6/24/03	
Task Flow capacity of Leachate Collection Pipe	Sheet 1	Of 2	

Based on Manning's equation, the flow capacity for a 8 inch leachate pipe on a 2% slope is 1.114 cubic feet per second (or 719,824 gallons per day). (See page 2)

The HELP model output (K-2; pgs. 12-25) indicates that negligible leachate will be generated for either condition analyzed. Therefore, a 8 inch pipe will be able to handle the peak flow with an ample factor of safety.

However, stormwater that comes into contact with solid waste or daily cover is typically allowed to infiltrate into the waste to be managed by the leachate collection system. Contaminated stormwater will be minimized by keeping the active face as small as possible and by placing soil cover on all waste-filled areas not currently being utilized for disposal.

Since the waste is not at field capacity when placed in the landfill and the soil cover is not saturated, there is a large potential for these components to absorb and hold any contaminated water that may infiltrate into the landfill cell. Historical practice at the site has shown that the leachate collection system is adequate to handle the minimal leachate generated as well as the contact stormwater.

Additionally, soil berms will be maintained to divert non-contact stormwater around the area to drainage channels.

Q:\ERM\03608 - Closure and Redas Bayview pipe

Job No.	3608	Calc No.	K-3

Computation

HDR

Project	Bayview Landfill	Computed	kdf
System	Leachate and Contaminated Water Plan	Date	Jul-03
Component	Leachate Collection System	Reviewed	MD
Task	Pipe capacity	Date	8-20-03

Purpose

Using Manning's equation, calculate pipe capacity of leachate headers.

Find

Description	Variable	Units
Pipe capacity	Q	gal/day

Given

Description	Value	Source
Pipe diameter [in]	8	leachate pipe diameter
Slope [ft/ft]	0.02	design value
roughness coefficient	0.02	HDPE pipe

Solution

Description	Value	Comment
Pipe capacity	**719,824**	**gallons / day**

Assumptions

Use Manning's Equation

Equations

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

equation 1

A = cross-sectional area [ft^2]
n = Manning's roughness coefficient
R = hydraulic radius [ft]
S = slope [ft/ft]
Q = flow [cfs]

Calculation

Description	Equation	Comment	Value	Verification
solve for area	$A = \pi r^2$	[SF]	0.349	
solve for perimeter	$P = \pi d$	[ft]	2.094	
solve for R	R = A / P	[ft]	0.166666667	
solve for Q	equation 1 above	[cfs]	1.114	
convert to gal/day	1 cfs = 646,272 gpd	[gpd]	719,824	

APPENDIX L

STORMWATER / EVAPORATION POND

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

INTRODUCTION

When disposal in Cell 2 begins, the storm water running off of any area containing waste will be diverted to the retention pond. Therefore, the capacity of the existing retention pond was evaluated to determine if it would contain all (82 acres) run-off from Cell 2. To be conservative, the entire area of Cell 2 is assumed to be contributing to the run-off and must be contained. Although it is unlikely that the entire 82 acres would be developed for the receipt of waste without some portion receiving final cover, this assumption was maintained to be conservative.

The volume for the existing pond was specified in the 1996 Permit for the Bayview Landfill as 909,000 cubic feet. To find the depth of rainfall that the existing pond can accommodate, the volume of the pond was divided by the area contributing to the pond. Since that depth (2.78 inches) was greater than the 25-year, 24-hour storm depth (2.1 inches) and the 100 year, 24 hour storm depth (2.6 inches), the existing pond volume was adequate to accommodate run-off from Cell 2.

In addition to using the volume of the retention pond from the 1996 Permit, a volume was estimated using the Inroads Civil Design Software and topographic mapping completed in July 2002. This program estimated the volume of the pond using the existing water surface elevation of 4618 feet and the top elevation of 4630 feet. However, the bottom of the pond is at an elevation of 4616 feet, so the volume between 4616 feet and 4618 feet was estimated using the surface area of the water surface at 4618 feet and the depth between them. The two volumes were added together to get approximately 808,000 cubic feet. This volume was divided by the area contributing to the pond to find the depth of rainfall that the pond could contain (2.47 inches). Since that depth was greater than the 25-year, 24-hour storm depth, the pond volume was adequate to accommodate run-off from Cell 2. Additionally, the pond is actually lined with 40-mil HDPE to an elevation of 4640 feet; therefore, the pond will hold a storm event of approximately 2.5-inches with a freeboard of ten feet.

Job No.		Calc No.	L-1

Computation

HDR

Project	Bayview Landfill	Computed	kdf
System		Date	May-03
Component		Reviewed	
Task	Pond Volume Calculations	Date	

Purpose

To determine the capacity of existing stormwater retention/leachate pond.

Find

Description	Variable	Units
Maximum Pond Depth	D	inches

Given

Description	Value	Source
Pond Volume, V	**909,000 ft^3**	1996 Permit
Contributing Area, A	**90 acres**	
25 year, 24 hour storm	**2.1 inches**	NOAA Atlas
100 year, 24 hour storm	**2.6 inches**	NOAA Atlas

Solution

Description	Value	Comment
Maximum Depth, D	**2.78 inches**	using pond volume from 1996 Permit
Maximum Depth, D	**2.47 inches**	using Inroads Civil Design Software

Assumptions

The contributing area is the entire Cell 2 acreage, assume 90 acres
No infiltration, all stormwater enters pond.
Worst case scenario because the area will be constructed in phases and some infiltration would occur.
Per 1996 permit, the pond volume (V) at 4630' equals 909,000 cubic feet.

Equations

$$Depth = \frac{V}{A}$$

Calculation

Description	Equation	Comment	Value	Units
Pond Volume, V			909,000	ft^3
Contributing Area, A			90	acres
Contributing Area, A	43560 ft^2/acre		3,920,400	ft^2
Depth, D	D = V/A		0.231864096	ft
Depth, D	12 inches/ft		2.78	inches
Pond Volume, V		from 4618' to 4630'	729,782	ft^3
Surface Area at 4618'			39,098	ft^2
Volume at 4618', V_o	V = D*A	2 feet deep	78,196	ft^3
Total Pond Volume	$V_T = V + V_o$		807,978	ft^3
Contributing Area, A			90	acres
Contributing Area, A	43560 ft^2/acre		3,920,400	ft^2
Depth, D	D = V/A		0.21	ft
Depth, D	12 inches/ft		2.47	inches

Conclusion

Given the conservative assumptions listed above, existing pond would retain 25 year, 24 hour storm event and have capacity for any leachate generated.
The retention pond is surface lined with 40 mil. HDPE to elevation 4640' (i.e., 10 feet of free board)

July , 2003

Mr. Richard Henry, Manager
South Utah Valley Solid Waste District
P.O. Box 507
Springville, UT 84663

Subject: Evaporation Pond Geomembrane Testing

Dear Mr. Henry:

As we have discussed, HDR designed the evaporation pond with two geomembrane liners consisting of a 60-mil HDPE geomembrane and a 40-mil HDPE geomembrane, with a geotextile between the two geomembranes. The 60-mil geomembrane was intended to be the containment member, responsible for controlling leakage of leachate into the environment. The 40-mil geomembrane and geotextile were intended to protect the 60-mil geomembrane from damage, including puncture and environmental weathering (e.g., degradation due to exposure to ultraviolet light).

In 2003, HDR Engineering, Inc. (HDR) submitted several samples taken from the 40-mil geomembrane lining in the evaporation pond to Geosynthetic Institute (GSI) at Drexel University. The samples represented the original material installed, and material exposed to various environmental conditions. They included:

- A sample that I had retained from the initial installation. This sample had been stored in my office during the intervening years, and represents the unexposed original HDPE geomembrane.
- A sample that I had retained during repair of the evaporation pond in 1996. This sample was taken from the southern end of the pond, and represented HDPE exposed to leachate and harsh semi-desert sunlight for 7 years.
- Two samples taken this spring. One was taken from the southwest corner, high above leachate; the second was taken from the northeast corner, at the edge of the concrete bottom liner. These two samples represent HDPE exposed to14 years of harsh sunlight. The sample from the northeast corner would also have been exposed to leachate, while the other sample would not have been.
- One sample taken this summer from the edge of the concrete bottom liner in the southern end of the pond. This sample corresponds better to the sample taken in 1996 than the two samples taken in the spring of 2003, since southern and northern exposures may receive sunlight differently.

GSI tested the samples using standard test methods to determine whether exposure to sunlight and leachate had aged the HDPE. The testing can be separated into two sets of properties. One set of tests measured physical properties, such as thickness and material strength; this set includes the tensile, tear, and puncture properties of the samples. The other set of tests measured the chemical additive packages that protect HDPE from exposure to ultraviolet light and oxidizing chemicals; this set

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includes carbon black content and distribution, and oxidative induction time (OIT). GSI also compared the test results to their current specification for HDPE geomembranes, GM-13, which provides minimum values for 40-mil HDPE to be considered acceptable.

The test results are attached to this letter, and show that the material strength of the HDPE has not yet been affected by exposure to sunlight or leachate. The only differences in the strength property measurements are directly attributable to differences in thickness of the samples.

The carbon black content and distribution are within normal ranges, indicating that one of the two protective pachages was formulated in 1989 to meet 2003 standards. Carbon black essentially prevents ultraviolet light from penetrating deeply into the HDPE matrix, and limits ultraviolet degradation to the surface of the geomembrane.

On the other hand, the OIT results indicate that the second of the two protective packages does not meet 2003 standards, and is degrading with time. Both of these results are expected. This test measures the effectiveness of chemicals, including antioxidants, added to the HDPE to protect it from oxidizing effects of chemicals and ultraviolet light. These chemicals are intended to be consumed to protect the HDPE, so a reduction in oxidative induction time is expected. The fact that GSI reports a measurable oxidative induction time is good, and indicates that the evaporation pond geomembrane is still functioning as intended in the design. Both GSI and HDR recommend that we continue to monitor the OIT periodically so that we can plan to replace the geomembrane before it begins to lose its physical strength and tenacity. I suggest that we plan to sample and test the material again in 5 years, and that we use those test results to determine the next monitoring interval, or to plan replacement of the protective cover.

As I have told you verbally, GSI did this testing gratis and as a favor to HDR.

Sincerely,

HDR, Inc.

Richard T. Sprague, L.S.S.
Vice President

Bayview Landfill 40-mil Geomembrane Test Results

Property	ASTM Test Method	Units	GM 13 Value	1989	1996	2003		
				#1	#2	#3a	#3b	#3c
Thickness (min. ave.)			*40*	43	44	44	39	43
Lowest of 10 values	D 5199	mil	*36*	41	41	42	37	41
Density (min.)	D 792	g/cc	*0.94*	0.948	0.945	0.947	0.951	0.948
Tensile Properties[1] (min. ave.)	Type IV							
Yield Stress	D 638	ppi	*84*	104	110	115	98	108
Break Stress	D 638	ppi	*152*	184	169	173	149	154
Yield Elongation	D 638	ppi	*12*	17.8	16.7	18.0	16.9	18.0
Break Elongation	D 638	ppi	*700*	801	753	691	715	655
Tear Resistance (min. ave.)	D 1004	lb	*28*	33	32	33	31	37
Puncture Resistance (min.ave.)	D 4833	lb	*72*	112	112	114	97	118
Carbon Black Content	D 4218	%	*2 to 3*	2.45	2.50	2.43	2.52	2.83
Carbon Black Dispersion	D 5596	NA	*1 or 2*	1.4	1.3	1.6	1.5	1.7
Oxidative Induction Time (OIT)	D 3895	minutes	*100*	77	30	38	20	33

Notes

1. ASTM D 638 and D 1004 suggest machine direction and cross machine direction average values should be on the basis of 5 test specimens in each direction. This was not possible for the 1996 sample because of small sample size.

2. ASTM D 638 Yield Elongation is calculated using a gage length of 1.3 inches; Break Elongation is calculated using a gage length of 2.0 inches.

3. ASTM D 4218 (muffle furnace) was used for Carbon Black content rather than ASTM D 1603 (tube furnace).

4. ASTM D 5596 Carbon Black dispersion is the average of 10 views.

5. GM 13 is a GSI standard which describes minimum acceptable test values.

APPENDIX M

RUN-ON / RUN-OFF CALCULATIONS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

INTRODUCTION

The run-on/run-off calculations were performed to determine the size of drainage ditches required to control run-on and run-off flows. The run-on/run-off peak flows were calculated using the Rational Method:

$$Q = CiA$$

where Q = Run-off flow (ft^3/sec)
C = Run-off Coefficient
i = rainfall intensity (in/hr)
A = Area contributing to run-off (acres)

The run-off coefficient, C, was multiplied by the run-off coefficient adjustment factor, C_f, of 1.1 to adjust the rational method for a recurrence interval of 25 years.

Once the run-on/run-off flows were calculated, the capacity of the ditch designed to carry the run-on/run-off was calculated using Manning's Equation:

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

where Q = Maximum capacity of ditch (ft^3/sec)
n = Manning's roughness coefficient
A = Cross-sectional area of ditch (ft^2)
R = Hydraulic radius (A/wetted perimeter) (ft)
S = slope of ditch (ft/ft)

If the capacity of the ditch exceeds the run-on/run-off flow, then the ditch is adequate.

The first set of calculations shown in Appendix M, Attachment 1 is for the run-on from Cell 1 onto Cell 2 and from Cell 2 onto Cell 1. The map on page 4 of Attachment M-1 shows the portion of Cell 1 that is directed towards Cell 2 and the portion of Cell 2 that will be directed to Cell 1 after closure with final cover in place. The ditch that will be constructed to go between Cell 1 and Cell 2 will direct the run-on to the north and south to existing drainage channels. The final cover on Cell 1 and Cell 2 will be overlaid with short grass prairie, which has a Manning's roughness coefficient, n, of 0.15. This was considered to be cultivated land on a rural catchment, so a value of 0.30 was chosen as the basic factor for the run-off coefficient, *C*.

The second set of calculations shown in Appendix M, Attachment 2 is for the run-off from the area of Cell 2 filled to capacity prior to installation of the final cap. The calculations were also performed for the initial contours of Cell 2 before it is filled. These calculations were used to find the capacity needed for the ditch that will be constructed on the liner edges to collect contaminated storm water and direct that storm water to the leachate collection and removal system. The condition that produced the maximum run-off (second condition – before Cell 2, Stage 1 is filled) was used to size the drainage ditch around the cell. Since the second condition was used, a Manning's roughness coefficient of 0.025 was used because the excavation would contain soil that would be clean, but weathered. Also, a run-off coefficient basic factor of 0.40 was used for bare ground.

APPENDIX M

ATTACHMENT 1:
REQUIRED CAPACITY OF DRAINAGE DITCH FOR RUN-OFF

Job No. | No.

HDR Computation

HDR

Project: Bayview Landfill | Computed | Date 5/03

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Determine Peak Discharge to Drainage Ditches

$Q = CiA$

Based on the portion of Cell 1 and the proposed Cell 2 that will be draining into the ditch between them in the Northern direction, the maximum area that will be contributing to the ditch in either direction is 18.4 acres. (see page 1a)

Run-off Coefficient of Drainage Area, C.

Based on Ref. 1, a runoff coefficient of drainage area for cultivated land is 0.30. This is multiplied by a frequency factor of 1.1 for a recurrence interval of 25 years, so the coefficient of drainage, C, is 0.33.

Rainfall intensity, i

To determine rainfall intensity, time of concentration, t_c, is required.

Sheet Flow (Overland flow)

$$T_c = \frac{0.007(nL)^{0.8}}{P_2^{0.5} S^{0.4}}$$

n = Manning's roughness coefficient
L = Flow length (total < 300')
P_2 = 2-Year 24-hour Precipitation
S = Land Slope

REF. 1

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Table 5.6-3: Runoff coefficient adjustment factors for Rational Method

Recurrence Interval (years)	C_f
25	1.1
50	1.2
100	1.25

The Rational formula now becomes Equation 5.6-4.

$$Q = \frac{CC_f IA}{360} \quad \text{..... 5.6-4}$$

5.6.6 Procedure for Rational Method

The general procedure for estimating the peak discharge for a watershed using the Rational Method is as follows:

(1) Determine the watershed area in hectares.

(2) With consideration for future characteristics of the watershed, determine the time of concentration as defined in Section 5.5.

(3) Assure consistency with the assumptions and limitations for application of the Rational Method.

(4) According to the locality in Texas and the design frequency, extract the rainfall IDF coefficients e, b, and d values from the list shown in Appendix 5-2.

(5) Using Equation 5.6-2, calculate rainfall intensity.

(6) With consideration for future characteristics of the watershed, select or develop appropriate runoff coefficients for the watershed. Where the watershed comprises more than one characteristic, C values for each area segment must be estimated individually. A weighted C value then may be estimated using Equation 5.6-5.

$$C = \frac{\sum_{n=1}^{m} C_n A_n}{\sum_{n=1}^{m} A_n} \quad \text{..... 5.6-5}$$

where:

C = weighted runoff coefficient
n = nth subarea
m = number of subareas
C_n = runoff coefficient for n^{th} subarea

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Using Planix 6 (see page 4)

Drainage Areas

Northward Flow in Ditch

Cell 1

$A_{1,N} = 24.85\ in^2 \left(\frac{120^2\ ft^2}{1\ in^2}\right) = 8.215$ acres

Cell 2

$A_{2,N} = 13.24\ in^2 \left(\frac{150^2\ ft^2}{1\ in^2}\right) = 6.84$ acres

$A_{3,N} = 3.65\ in^2 \left(\frac{200^2\ ft^2}{1\ in^2}\right) = 3.35$ acres

Total = 18.4 acres

Southward Flow in Ditch

Cell 1

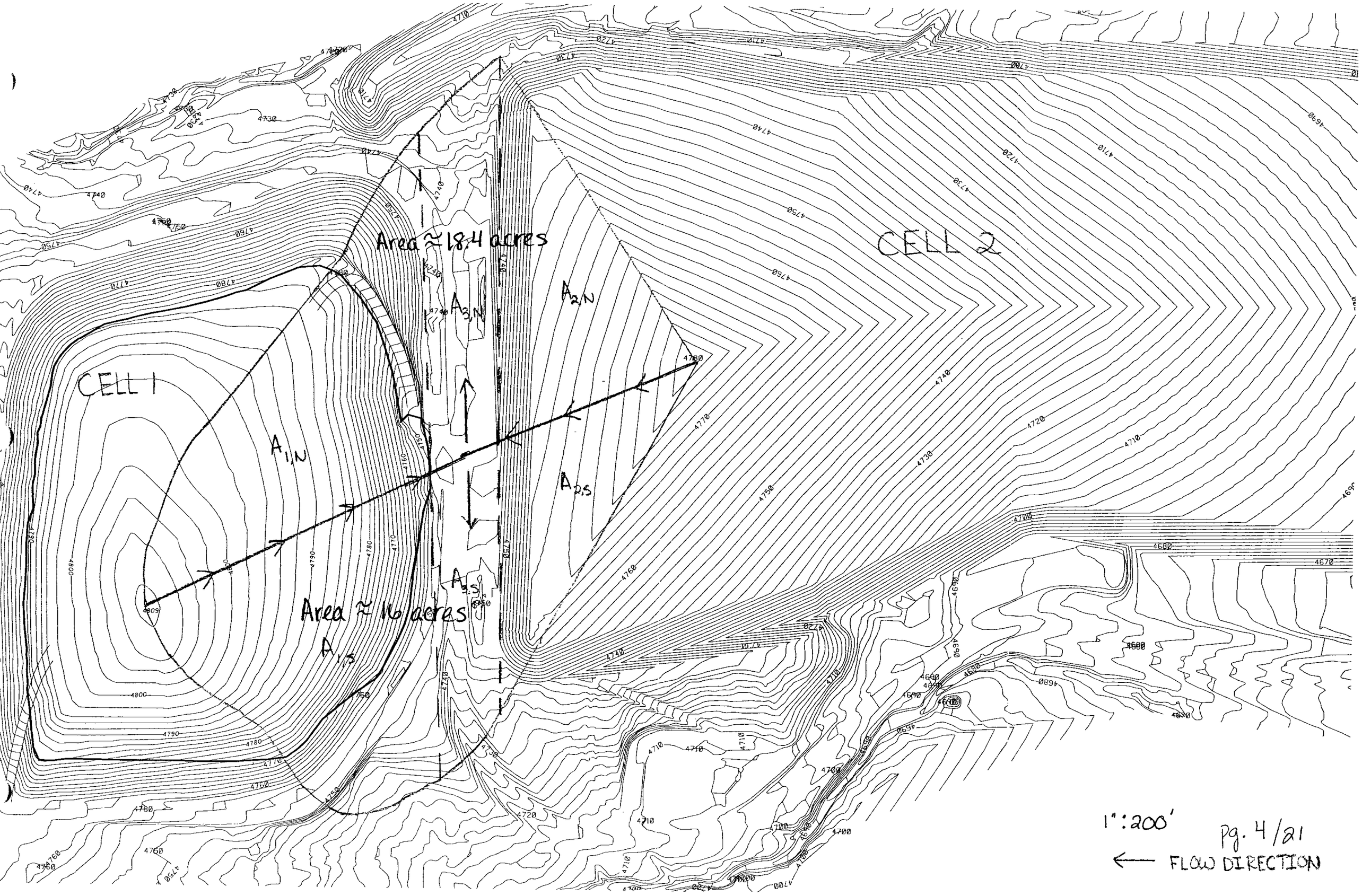
$A_{1,S} = 27.48\ in^2 \left(\frac{120^2\ ft^2}{1\ in^2}\right) = 9.08$ acres

Cell 2

$A_{2,S} = 8.56\ in^2 \left(\frac{150^2\ ft^2}{1\ in^2}\right) = 4.4215$ acres

$A_{3,S} = 2.713\ in^2 \left(\frac{200^2\ ft^2}{1\ in^2}\right) = 2.49$ acres

Total = 16 acres


CELL 1
CELL 2
Area ≈ 18.4 acres
Area ≈ 16 acres
$A_{1,N}$
$A_{1,S}$
$A_{2,N}$
$A_{2,S}$
$A_{3,N}$
$A_{3,S}$
1":200'
FLOW DIRECTION

Surface description - Short grass prairie

$n = 0.15$
$L = 300'$
$P_2 = 1''$
$S = 4\%$

$$T_c = \frac{0.007(0.15 * 300')^{0.8}}{(1'')^{.5}(.04)^{.4}} = .53$$

Shallow concentrated flow (swale flow)

Surface description - Short grass prairie

$L_1 = 276'$
$S_1 = 6.5\%$
V = Average velocity = 4.1 ft/s (from REF. 2) (using S = .065 for unpaved soil)

$$T_{c,1} = \frac{L}{3600V} = \frac{276'}{3600(4.1\ ft/s)} = .019$$

$L_2 = 156'$
$S_2 = 18.8\%$
V = 7 ft/sec (from REF. 2 using S = .188 for unpaved soil)

$$T_{c,2} = \frac{L}{3600V} = \frac{156'}{3600(7\ ft/s)} = .0062$$

Channel Slope

S = 1% ∴ V = 1.6 ft/sec from Ref. 2
Assuming average velocity for a channel is similar to average velocity for shallow concentrated flow

Channel Flow (continued)

$$T_c = \frac{L}{3600V} = \frac{1050\ ft}{3600(1.6\ ft/s)} = .18$$

$$T_{c,TOTAL} = .53 + .019 + .0062 + .18 = .735\ hr\left(\frac{60\ min}{1\ hr}\right) = 44.11\ min$$
(for runoff from Cell 1)

Based on REF. 3, 2-year and 100-year 1-hour storm is estimated as:

$$Y_2 = 0.005 + 0.852[X_1(X_1/X_2)]$$

$$Y_{100} = 0.322 + 0.789[X_3(X_3/X_4)]$$

Y_2 = 2-yr 1-hr estimated value
Y_{100} = 100-yr 1-hr estimated value
X_1 = 2-yr 6-hr value from precipitation-frequency maps
X_2 = 2-yr 24-hr value from precipitation-frequency maps
X_3 = 100-yr 6-hr value from precipitation-frequency maps
X_4 = 100-yr 24-hr value from precipitation-frequency maps

X_1 = 0.7 in (see 2-yr 6-hr precipitation-frequency map)(p. 12)
X_2 = 1.0 in (see 2-yr 24-hr precipitation-frequency map)(p. 9)
X_3 = 1.8 in (see 100-yr 6 hr precipitation-frequency map)(p. 13)
X_4 = 2.6 in (see 100-yr 24-hr precipitation-frequency map)(p. 14)

$$Y_2 = 0.005 + 0.852[0.7(0.7/1.0)] = .4225 \text{ inches}$$

$$Y_{100} = 0.322 + 0.789[1.8(1.8/2.6)] = 1.305 \text{ inches}$$

REF. 1

TABLE 12.5 RATIONAL RUNOFF COEFFICIENT

a. Urban Catchments

General Description	C	Surface	
City	0.7–0.9	Asphalt paving	0.7–0.9
Suburban business	0.5–0.7	Roofs	0.7–0.9
Industrial	0.5–0.9	Lawn heavy soil	
		>7° slope	0.25–0.35
Residential multiunits	0.6–0.7	2–7°	0.18–0.22
Housing estates	0.4–0.6	<2°	0.13–0.17
Bungalows	0.3–0.5	Lawn sandy soil	
		>7°	0.15–0.2
Parks, cemeteries	0.1–0.3	2–7°	0.10–0.15
		<2°	0.05–0.10

b. Rural Catchments (less than 10 km^2)

Ground Cover	Basic Factor	Corrections: Add or Subtract
Bare surface	0.40	Slope < 5%: −0.05
Grassland	0.35	Slope > 10%: +0.05
Cultivated land	0.30	Recurrence interval < 20 yr: −0.05
Timber	0.18	Recurrence interval > 50 yr: +0.05
		Mean annual precipitation < 600 mm: −0.03
		Mean annual precipitation > 900 mm: +0.03

Table 3-1.—Roughness coefficients (Manning's n) for sheet flow

REF. 2

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1]The n values are a composite of information compiled by Engman (1986).
[2]Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
[3]When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

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REF. 2

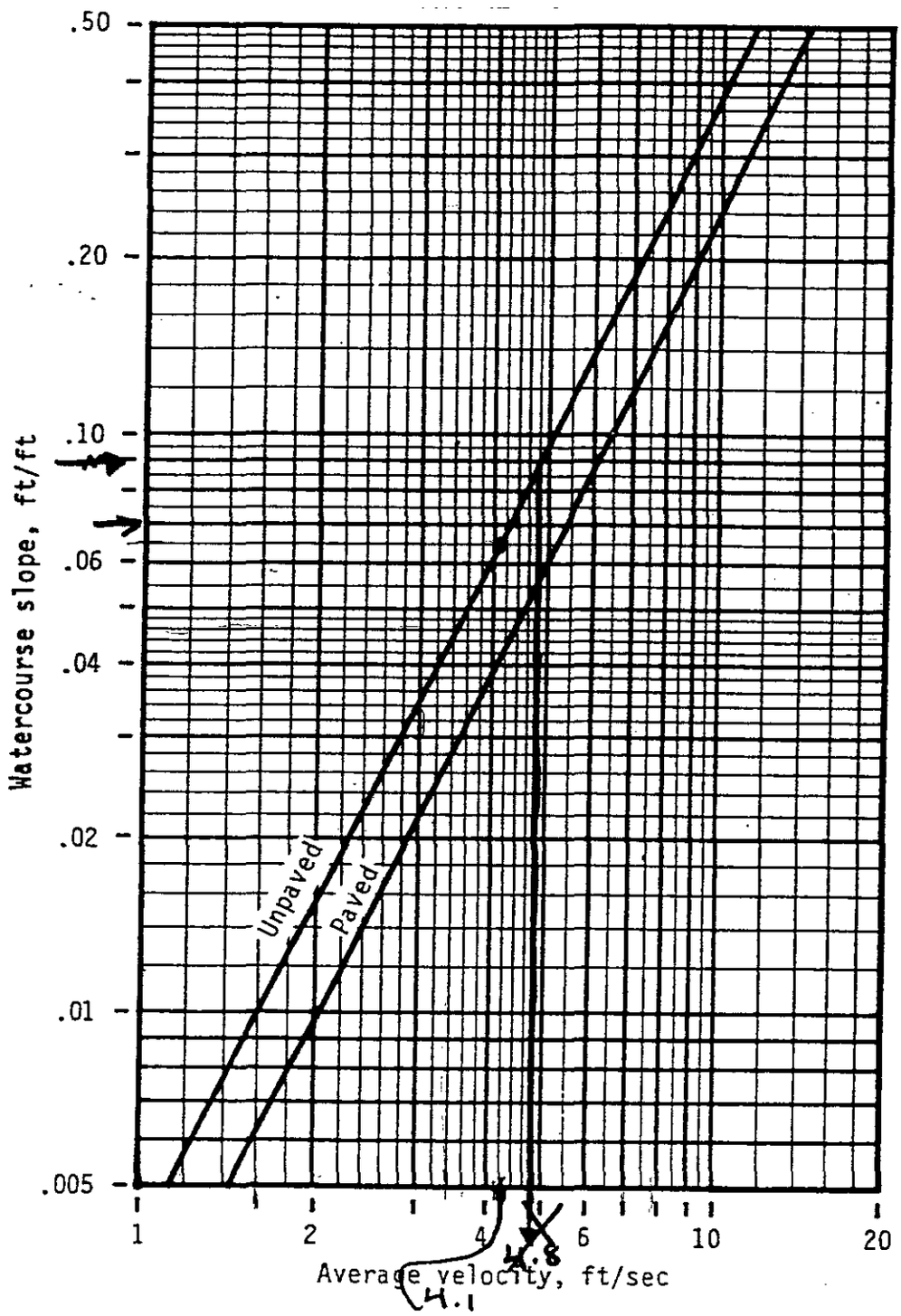

Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.

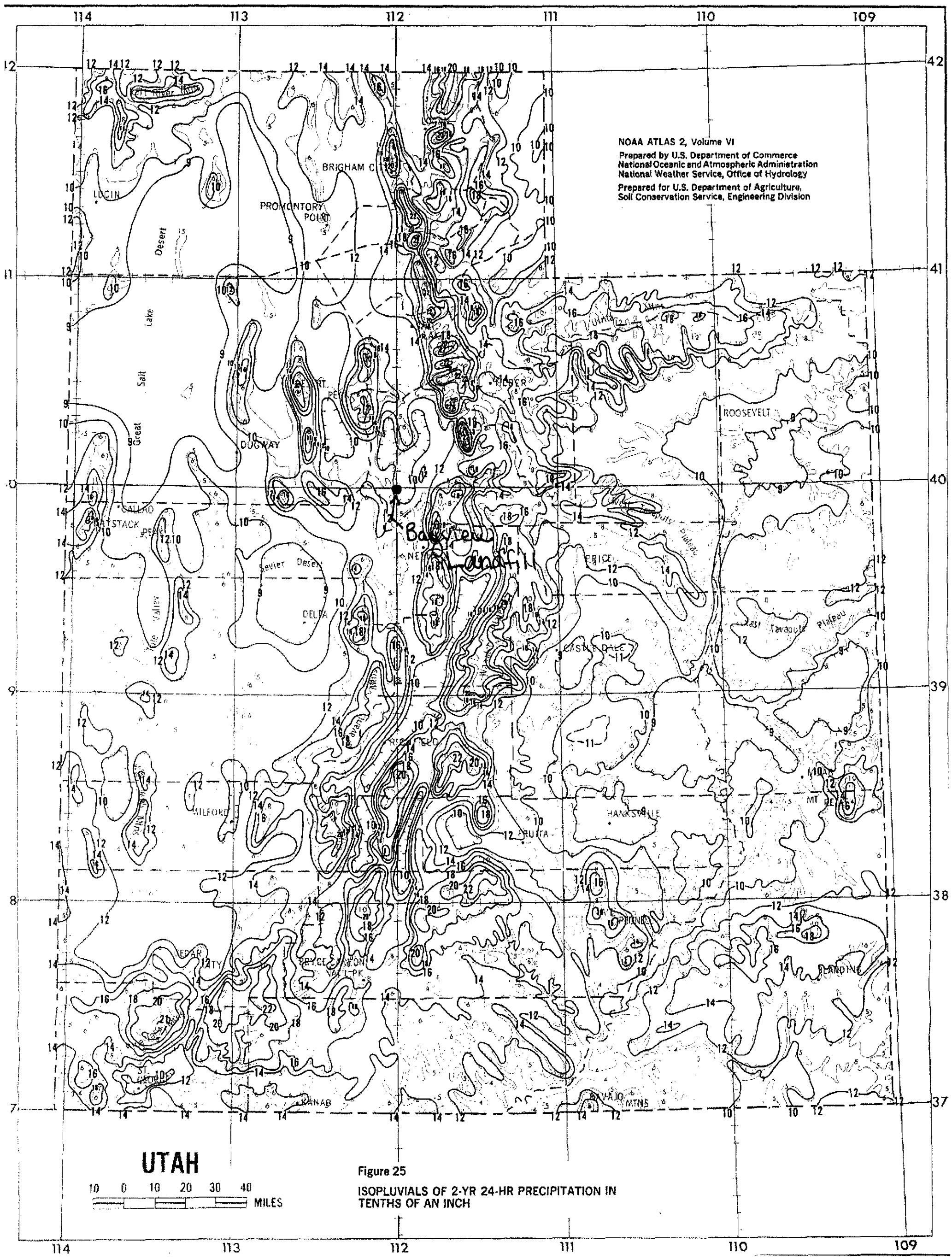

Figure 25

ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

REF. 3
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Region of applicability*	Equation	Corr. coeff.	No. of stations	Mean of computed stn. values (inches)	Standard error of estimate (inches)
Utah south of the Unitas east of Wasatch, and east and south of Boulder and Pine Valley Mountains (1)	$Y_2 = -0.011 + 0.942[(X_1)(X_1/X_2)]$	0.95	86	0.72	0.085
	$Y_{100} = 0.494 + 0.755[(X_3)(X_3/X_4)]$	.90	85	1.96	.290
Most of western Utah (2)	$Y_2 = 0.005 + 0.852[(X_1)(X_1/X_2)]$	.89	65	0.41	.047
	$Y_{100} = 0.322 + 0.789[(X_3)(X_3/X_4)]$	.87	65	1.25	.196
Northeast and northwest corners of Utah (3)	$Y_2 = 0.019 + 0.711[(X_1)(X_1/X_2)] + 0.001Z$	.82	98	0.40	.031
	$Y_{100} = 0.338 + 0.670[(X_3)(X_3/X_4)] + 0.001Z$	.80	79	1.04	.141

* Numbers in parentheses refer to geographic regions shown in figure 18. See text for more complete description.

List of variables

Y_2 = 2-yr 1-hr estimated value
Y_{100} = 100-yr 1-hr estimated value
X_1 = 2-yr 6-hr value from precipitation-frequency maps
X_2 = 2-yr 24-hr value from precipitation-frequency maps
X_3 = 100-yr 6-hr value from precipitation-frequency maps
X_4 = 100-yr 24-hr value from precipitation-frequency maps
Z = point elevation in hundreds of feet

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REF. 3

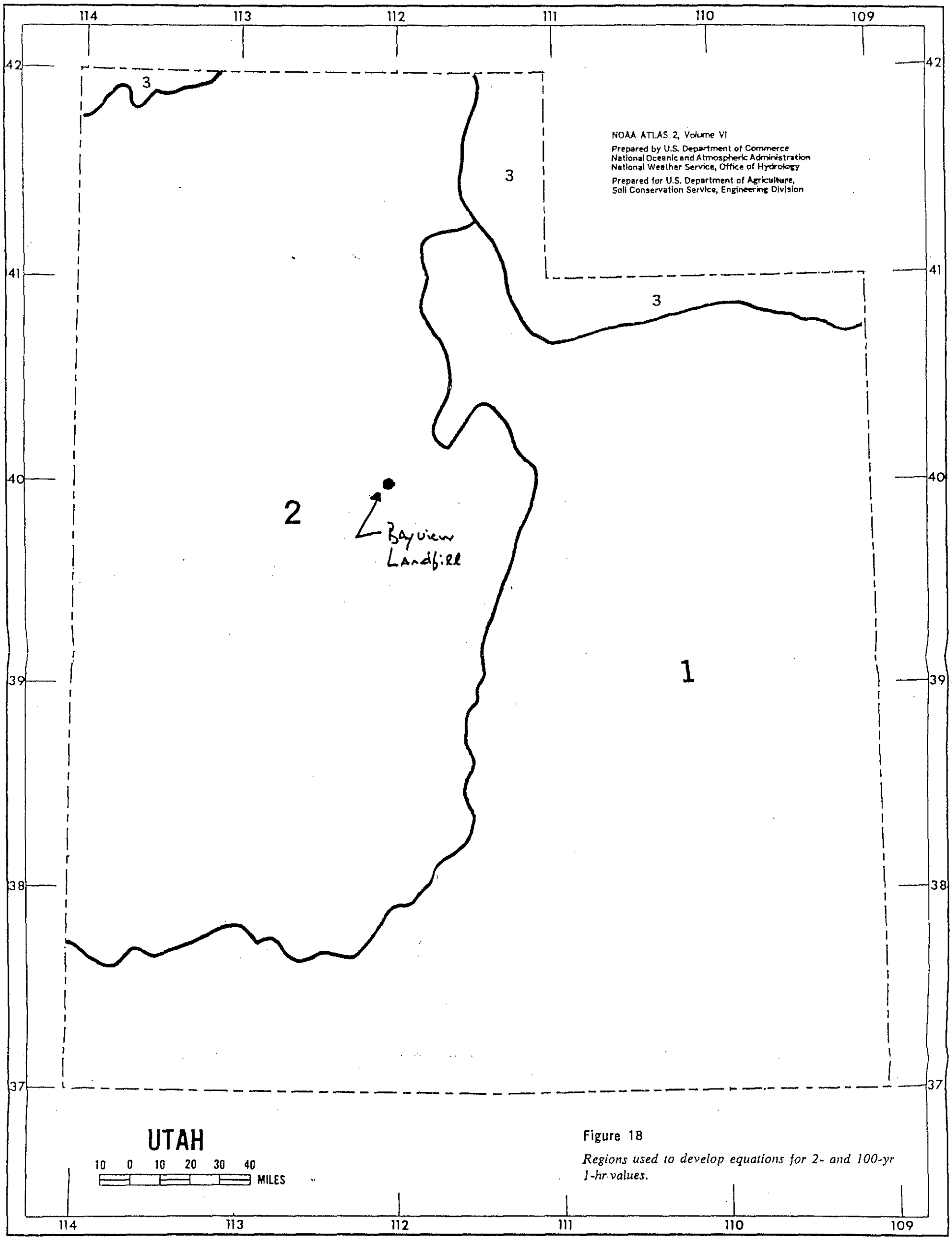

Figure 18

Regions used to develop equations for 2- and 100-yr 1-hr values.

REF. 3
p. 11/21

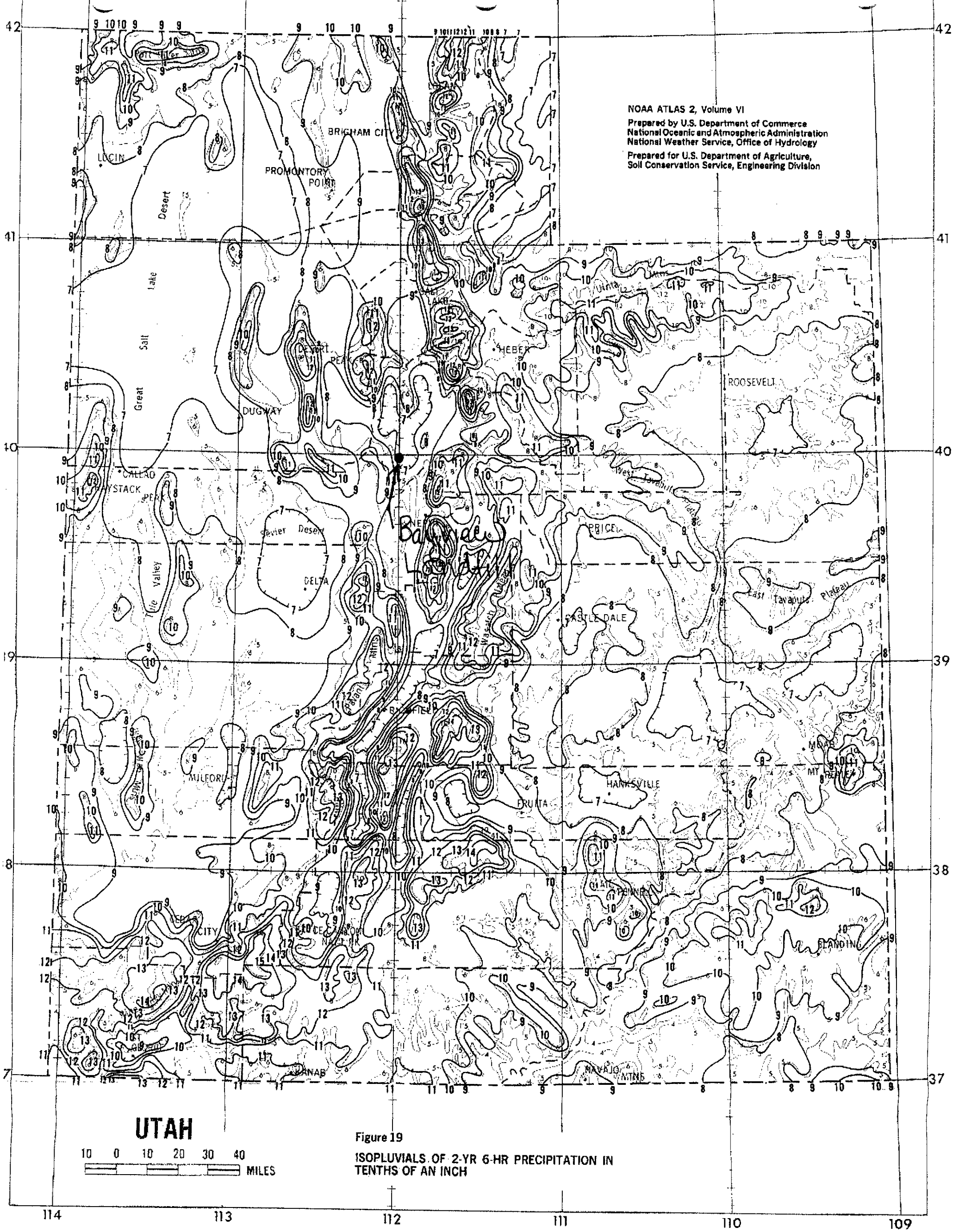

Figure 19

ISOPLUVIALS OF 2-YR 6-HR PRECIPITATION IN TENTHS OF AN INCH

REF. 3
p. 12/21

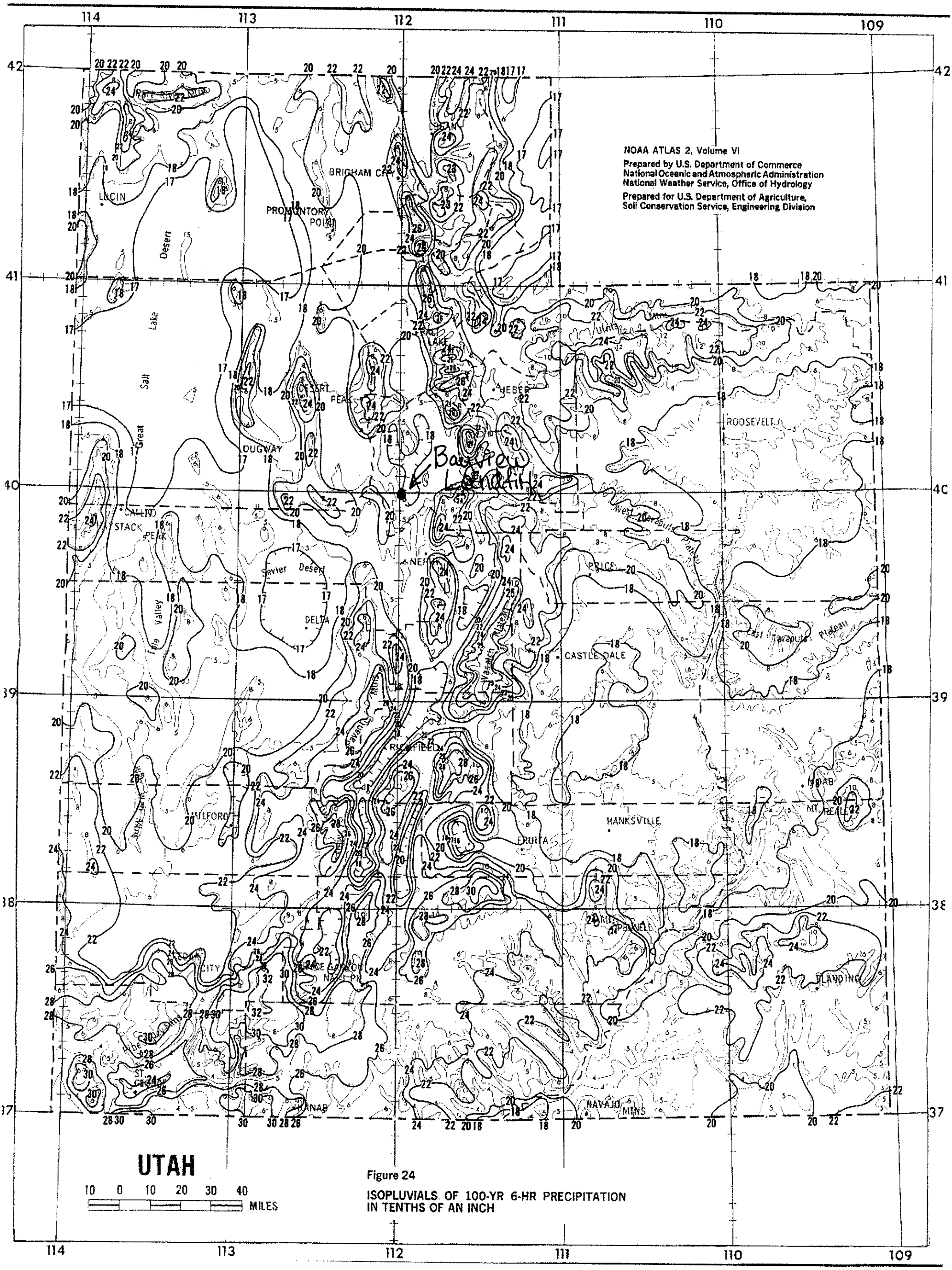

Figure 24

ISOPLUVIALS OF 100-YR 6-HR PRECIPITATION IN TENTHS OF AN INCH

REF. 3
p. 13/21

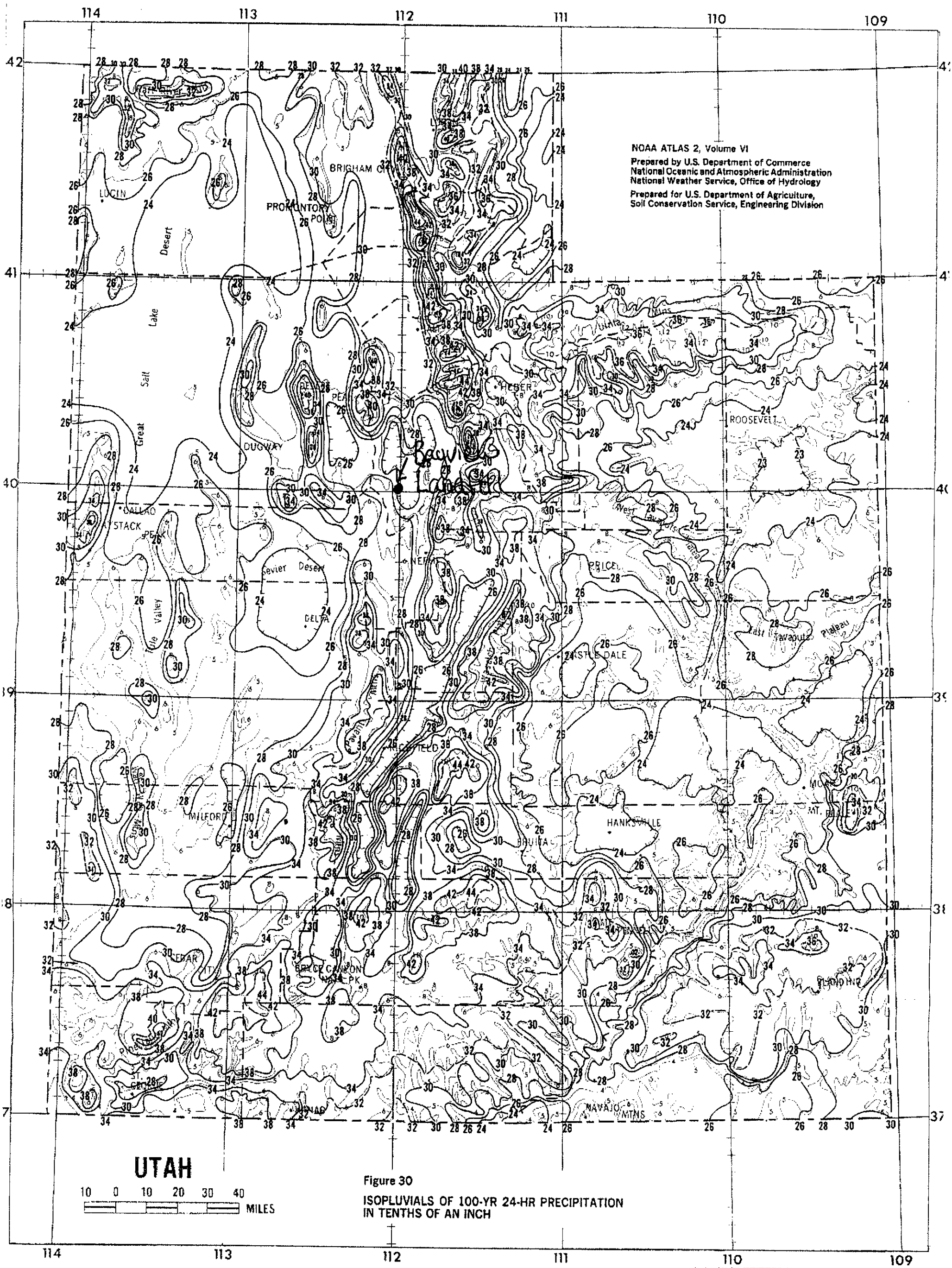

Figure 30

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

REF. 3 pg. 14/21

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HDR Computation

HDR

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Task: Time of Concentration for Cell 2 | Sheet 15 | Of 21

Sheet Flow (overland flow)

Surface Description - Short grass prairie

$n = 0.15$

$L = 300'$

$P_2 = 1''$

$S = 0.05$

$$T_c = \frac{0.007(nL)^{0.8}}{P_2^{0.5}\, S^{0.4}} = \frac{.007(0.15 * 300')^{0.8}}{(1'')^{0.5}(.05)^{0.4}}$$

$T_c = 0.4876$

Shallow concentrated flow (swale flow)

Surface description - short grass prairie

$L_1 = 120'$

$S_1 = 0.05$

$V = 3.6$ ft/s (from REF. 2 using $S = 0.05$ for unpaved soil)

$$T_{c,1} = \frac{L}{3600V} = \frac{120'}{3600(3.6\,ft/s)} = 0.0093$$

$L_2 = 100'$

$S_2 = .25$

$V = 8$ ft/sec (from REF. 2 using $S = .25$ for unpaved soil)

$$T_{c2} = \frac{L}{3600V} = \frac{100'}{3600(3.6\,ft/s)} = 0.0077$$

Channel Slope

$S = 1\%$

$A = 6.75\ ft^2$

$n = .025$

$R = \frac{A}{P} = .7115$ ft

$V = 4.75$ ft/s (from Manning's Equation $V = \frac{1.49}{n} R^{2/3} S^{1/2}$)

HDR Computation

HDR

Project Bayview Landfill		Computed	Date 5/03
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Channel Flow (continued)

$$T_c = \frac{L}{3600V} = \frac{1050\ ft}{3600(4.75\ ft/s)} = .0614$$

$$T_{c,TOTAL} = .4876 + .0093 + .0077 + .0614 = .5660\ hr\left(\frac{60\ min}{1\ hr}\right)$$

$T_c = 33.96$ min (for runoff from Cell 2)

Since the time of concentration for Cell 1 is greater than the time of concentration for Cell 2, the time of concentration to be used is 44.11 min. (for Cell 1).

Based on REF. 3, Figure 6: Precipitation depth versus return period for partial-duration (see page 14), the 25 yr 1-hr storm is estimated to be 1.0 inch.

Based on REF. 3, to obtain estimates for a 25-year 30-min storm, the value of .79 must be applied to a 25-year 1-hour storm. Using linear interpolation, the value that must be applied to a 25-year 1-hour storm to obtain a depth for a 25-year 44-minute storm is 0.89.

∴ depth of a point for 25-year 44-min storm =

$= .89 * 1'' = .89''$

$$i = \frac{0.89''}{44\ min}\left(\frac{60\ min}{1\ hr}\right) = 1.21\ in/hr$$

REF. 3

p.17/21

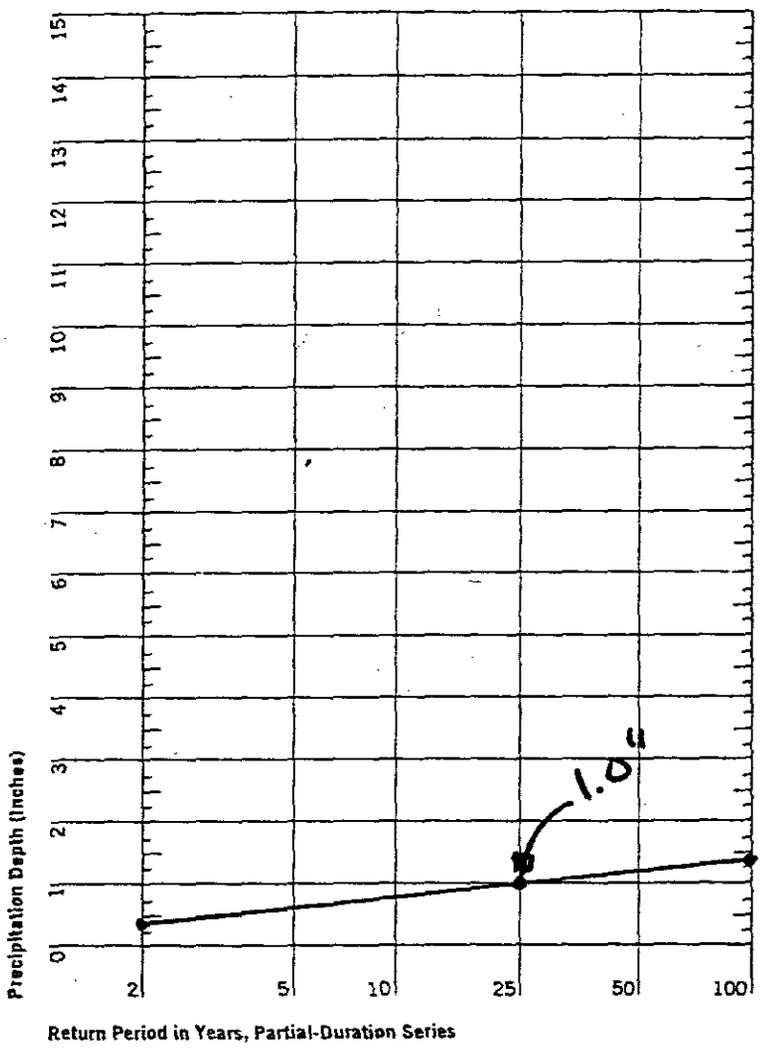

Figure 6. *Precipitation depth versus return period for partial-duration series.*

REF. 3

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Table 1.—Five, 10-, 15- and 30-minute ratios for 2- and 100-year return periods

Region No.	Region	Ratios to 1 Hour: 2-Year Return Period 5 minutes	10	15	30	100-Year Return Period 5 minutes	10	15	30
1	Coastal Northwest	.30	.45	.56	.73	.36	.53	.64	.82
2	Interior Northwest	.35	.53	.64	.81	.37	.56	.67	.85
3	Rocky Mountains-North	.38	.57	.68	.84	.35	.55	.67	.84
4	Front Face and High Plains-North	.39	.58	.69	.85	.37	.56	.69	.87
5	Great Basin	.34	.51	.61	.81	.34	.52	.63	.84
6	Rocky Mountains-South	.35	.54	.65	.83	.32	.50	.62	.81
7	Front Face and High Plains-South	.33	.51	.62	.83	.29	.46	.59	.81
8	Southwest Deserts	.34	.51	.62	.82	.30	.46	.59	.80

The final consideration was comparability to information for locations adjacent to the study area. Taking such information into account accomplished two goals. First, it contributed to the degree of consistency and continuity between this study and other reports. Second, it provided additional insight into the variation of the ratios in this report, providing anchors, so to speak, at the study area boundaries. For areas east of the study region, we compared our results to Frederick et al. (1977) and for California we related our results to Frederick and Miller (1979). In addition, we developed frequency estimates for several stations with short-duration data in surrounding states. Fourteen stations were analyzed for this purpose, 10 in the Plains States and 4 in California. Most of these stations were close enough to be directly comparable to adjacent stations within the study area, while a few were chosen at greater distances from the boundaries to provide some idea of the trend in ratios leading up to the study area.

It was concluded that the ratios in this report were consistent with previous studies. The final ratios are listed in Table 1. A comparison between these ratios and those from NOAA Atlas 2 and Weather Bureau (1953, 1954) is shown in Table 2.

Table 2.—Ratios compared to other reports

Dur. (min)	This Report*	Ratio to 1 Hour: NOAA Atlas 2	Weather Bur. (1953, 1954)*
5	.34	.29	.32
10	.52	.45	.49
15	.64	.57	.59
30	.82	.79	.78

*Averaged over all regions and for all return periods

Note: Comparisons are for illustrative purposes only. Each report covers a different geographic area, and averaging is done without regard to size of region or specific return periods involved.

6. APPLICATION OF RATIOS

The ratios derived in the above analysis are based on stations whose elevations tended to be in the lower sections of each region. To extrapolate these statistics to much higher elevations would be a questionable undertaking, because of the complex effects of slope, funneling, and rain shadows that often occur in these areas. As such, the ratios are not applicable to all elevations within each region, but rather to a general range of elevations. The ranges of applicable elevation, approximately 3,000 to 3,500 ft in most areas, are summarized in table 3. In a few cases, areas are excluded that contain stations included in the analysis. The regional ratios were reviewed in light of this fact, and it was determined that no adjustments were necessary.

Areas of non-applicability, based on elevation and location considerations, are shown in figure 1 as shaded areas. These areas are based primarily on smoothed contour maps of the western states. Due to the generalized nature of the contours, there are isolated sections, primarily at the edge of shaded areas, where the ratios might be applicable. Conversely, there are isolated peaks and high elevations which are not shown as part of any shaded areas, but which may, in fact, be non-applicable areas.

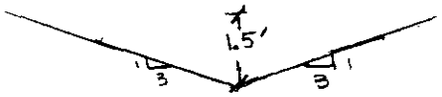
Table 3.—Applicable elevations within regions

Region No.	Generally Applicable elevations (ft)
1	0-2500
2	50-3000 Columbia Basin to 2500-5500 SE
3	2000-5000 N to 4000-7000 S
4	2000-5000 N to 4000-7000 S
5	3500-7000
6	4500-8000 N to 3500-7000 S
7	4000-7500 N to 3500-7000 S
8	3000-6500 mountains to 100-3500 deserts

$Q = CiA$
$= .33(1.21\ in/hr)(18.4\ acres)$
$= 7.37\ ft^3/sec$ (flow in drainage ditch)

This flow is only the portion of the flow that runs off of Cell 1 and 2 that travels in the Northern direction of the ditch. There will be run-off from Cells 1 and 2 that travels in the Southern direction of the ditch, but that flow has not been computed. The flow computed for the Northward direction is a conservative value for the flow heading southward since the south portion has less contributing area than the north portion. There will be less flow in the south portion, so the ditch designed for the flow in the north portion will be acceptable for both directions.

Drainage Ditch Capacity



$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

Q = peak discharge
A = Area
R = Hydraulic radius $\left(\frac{A}{P}\right)$
n = Manning roughness coefficient
S = minimum slope

$A = \frac{1}{2}(1.5')(4.5') + \frac{1}{2}(1.5')(4.5') = 6.75\ ft^2$
$P = \sqrt{22.5} + \sqrt{22.5} = 9.49\ ft$
$R = 6.75\ ft^2 / 9.49\ ft = .7115\ ft$

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Drainage Ditch Capacity (continued)

$S = 0.005$

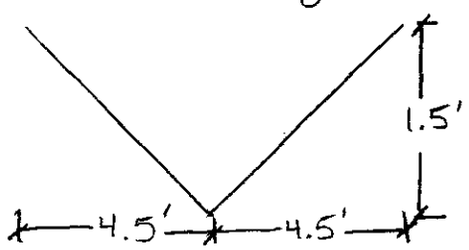
$n = 0.025$ (for straight and uniform Earth that is clean and weathered)

$$Q = \frac{1.49}{0.025}(6.75\,ft^2)(.7115\,ft)^{2/3}(.005)^{1/2}$$

$$\underline{Q = 22.67\ cfs}$$

Since the capacity of the ditch is greater than the amount of flow that will be running off of Cell 1 and Cell 2, than this ditch configuration is adequate.

Drainage Ditch Configuration



*not drawn to scale

REF. 4

pg. 21/21

TABLE 5-6. VALUES OF THE ROUGHNESS COEFFICIENT n (*continued*)

Type of channel and description	Minimum	Normal	Maximum
C. EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140

APPENDIX M

ATTACHMENT 2:
REQUIRED CAPACITY FOR SURFACE WATER DIVERSION DITCH

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill | Computed | Date

Subject | Checked | Date

Task | Sheet 1 | Of 7

Run-off Calculations for Proposed Cell 2

Peak Discharge to Drainage Ditches

$$Q = CiA$$

The area of stage 1 for Cell 2 is 30 acres.

Run-off Coefficient of Drainage Area, C

Based on REF.1, a runoff coefficient of drainage area for bare land is 0.40. This is multiplied by a frequency factor of 1.1 for a recurrence interval of 250 years, so the coefficient of drainage is 0.44.

Rainfall intensity, i

To determine rainfall intensity, time of concentration, t_c, is required

Sheet Flow (overland Flow) (for final contours with no cover) (see pg. 6)

$$T_c = \frac{0.007(nL)^{0.8}}{P_2^{0.5} S^{0.4}} = \frac{0.007(0.025 * 300')^{0.8}}{(1")^{.5}(.05)^{.4}} = .1163 \text{ hr}$$

Shallow concentrated flow (swale flow)

$L = 120'$ $V = 3.6$ ft/s (from REF.2 using $S = .05$ for unpaved soil)

$S = .05$

Job No. | No.

HDR Computation

HDR

Project: Bayview Landfill | Computed | Date

Subject | Checked | Date

Task | Sheet 2 | Of 7

$$T_c = \frac{L}{3600V} = \frac{120'}{3600(3.6\ ft/s)} = 0.0093$$

$L_2 = 100'$
$S_2 = .25$
$V = 8$ ft/sec (from REF. 2 using S=0.25 for unpaved soil)

$$T_c = \frac{L}{3600V} = \frac{100'}{3600(8\ ft/s)} = 0.0035$$

Channel Slope

S=4.6% V=3.4 ft/sec (from REF. 2 using S=4.6% for unpaved soil)

$$T_c = \frac{L}{3600V} = \frac{880'}{3600(3.4\ ft/s)} = .0719$$

S=.005 V=1.15 ft/sec (from REF. 2 using S=.005 for unpaved soil)

$$T_c = \frac{L}{3600V} = \frac{560\ ft}{3600(1.15\ ft/sec)} = .1353$$

S=25% V=8 ft/sec

$$T_c = \frac{80\ ft}{3600(8\ ft/sec)} = 0.0028$$

Job No. | No.

HDR Computation

HDR

Project: Bayview Landfill | Computed | Date

Subject | Checked | Date

Task | Sheet 3 | Of 7

$S = 5\%$ $V = 3.6$ ft/s

$$T_c = \frac{L}{3600\,V} = \frac{1100\text{ ft}}{3600(3.6\text{ ft/s})} = 0.0849$$

$$T_{c,TOTAL} = .1163\text{ hr} + .0093 + .0035 + .0719 + .1353 + .0028 + 0.0849$$

$$= .424\text{ hr}\left(\frac{60\text{ min}}{1\text{ hr}}\right) = 25.44\text{ min}$$

Based on REF. 3, Figure 6: Precipitation depth versus return period for partial-duration (see pg. 14), the 25-yr 1-hr storm is estimated to be 1.0 inch.

Based on REF. 3, to obtain estimates for a 25-year 15-min storm, the value of .57 must be applied to a 25-yr 1-hr storm. Using linear interpolation, the value that must be applied to a 25-year 1-hour storm to obtain a depth for a 25-year 25 min storm is .67.

15 min	.57
25 min	$\boxed{.72}$
30 min	.79

∴ depth of a point for 25-year 25-min storm is .72 * 1' = .72"

$$i = \frac{.72''}{25\text{ min}}\left(\frac{60\text{ min}}{1\text{ hr}}\right) = 1.72\text{ in/hr}$$

Job No. | No.

HDR Computation

HDR

Project Bayview Landfill | Computed | Date

Subject | Checked | Date

Task | Sheet 4 | Of 7

$Q = CiA$
$= .44(1.72 \text{ in/hr})(30 \text{ acres})$
$= 22.70 \text{ cfs}$ (using final contours)

Time of concentration (for initial contours before fill) (see page 7)

Sheet Flow (Overland Flow)

$$T_c = \frac{0.007(nL)^{0.8}}{P_2^{0.5} S^{0.4}} = \frac{0.007(.025 * 230')^{0.8}}{(1")^{.5}(.25)^{0.4}} = .0494 \text{ hr}$$

Shallow concentrated flow (swale flow)

$L = 1120'$ $\quad V = 3 \text{ ft/sec}$ (from REF. 2 using $S = .034$ for unpaved soil)
$S = 0.034$

$$T_c = \frac{L}{3600\,V} = \frac{1120'}{3600(3 \text{ ft/sec})} = .1037 \text{ hr}$$

$$T_{c,TOTAL} = .0494 \text{ hr} + .1037 \text{ hr} = .1531 \text{ hr}\left(\frac{60 \text{ min}}{1 \text{ hr}}\right) = 9.19 \text{ min.}$$
≈ 9 min.

Intensity of Rainfall (i)

Based on REF. 3, to obtain estimates for a 25-year 5 min storm and a 25-year 10 min storm the values of 0.29 and 0.45 must be applied to a 25-year 1-minute storm.

Job No. | No.

HDR Computation

HDR

Project: Bayview Landfill | Computed | Date

Subject | Checked | Date

Task | Sheet 5 | Of 7

Using linear interpolation, the value that must be applied to a 25-year 1-hour storm to obtain a depth for a 25-year 9 min storm is .39.

5 min	.29
9 min	.42
10 min	.45

∴ depth of a point for 25-year 9 min storm is .42 * 1" = .42"

$$i = \frac{.42''}{9\,\text{min}}\left(\frac{60\,\text{min}}{1\,\text{hr}}\right) = 2.79\ \text{in/hr}$$

$$Q = CiA$$
$$= .44(2.79\ \text{in/hr})(30\ \text{acres})$$
$$= 36.78\ \text{cfs}$$

Drainage Ditch Capacity

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

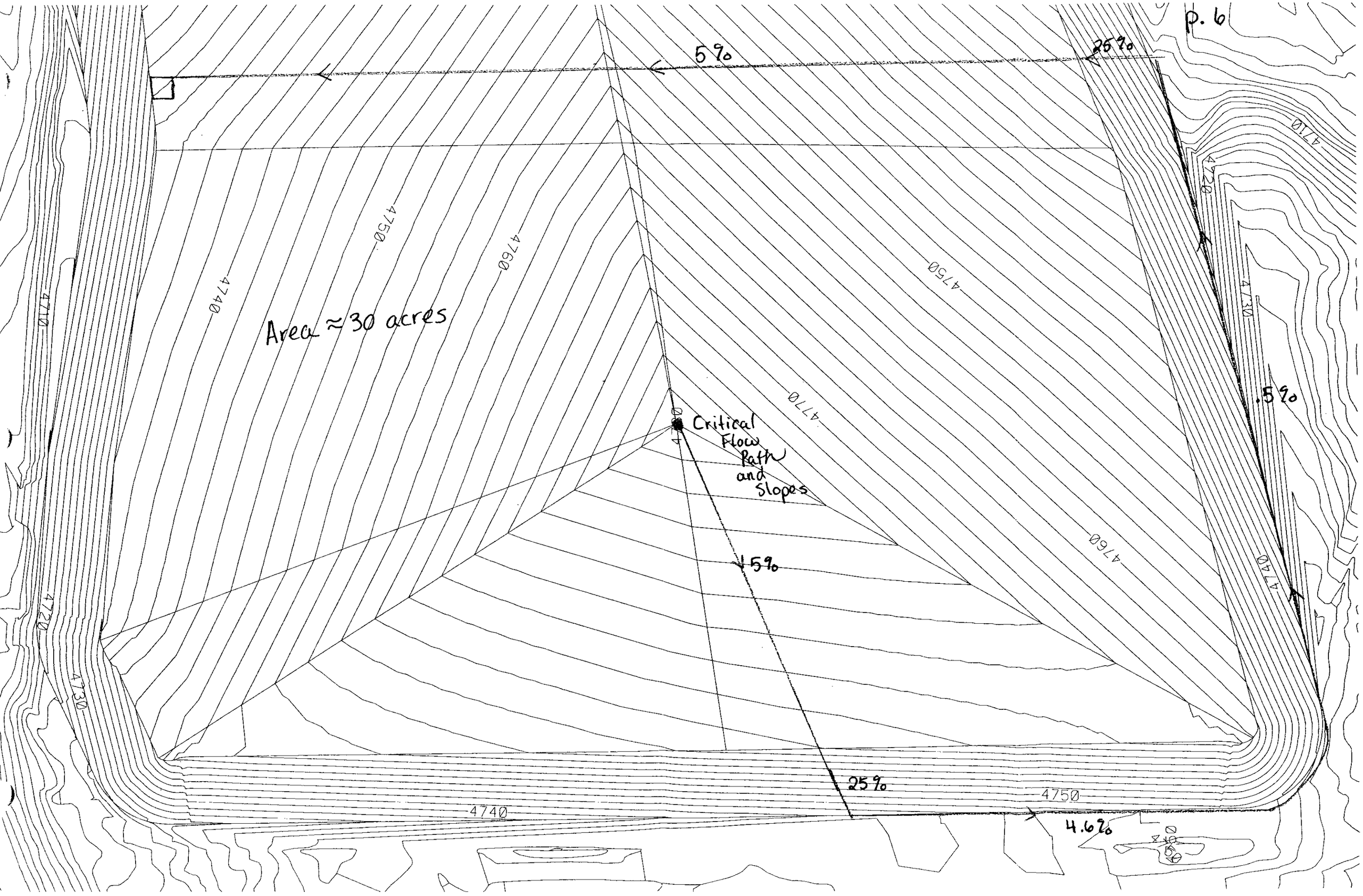
$$A = \tfrac{1}{2}(50')(1') + \tfrac{1}{2}(4')(1') = 27\ ft^2$$

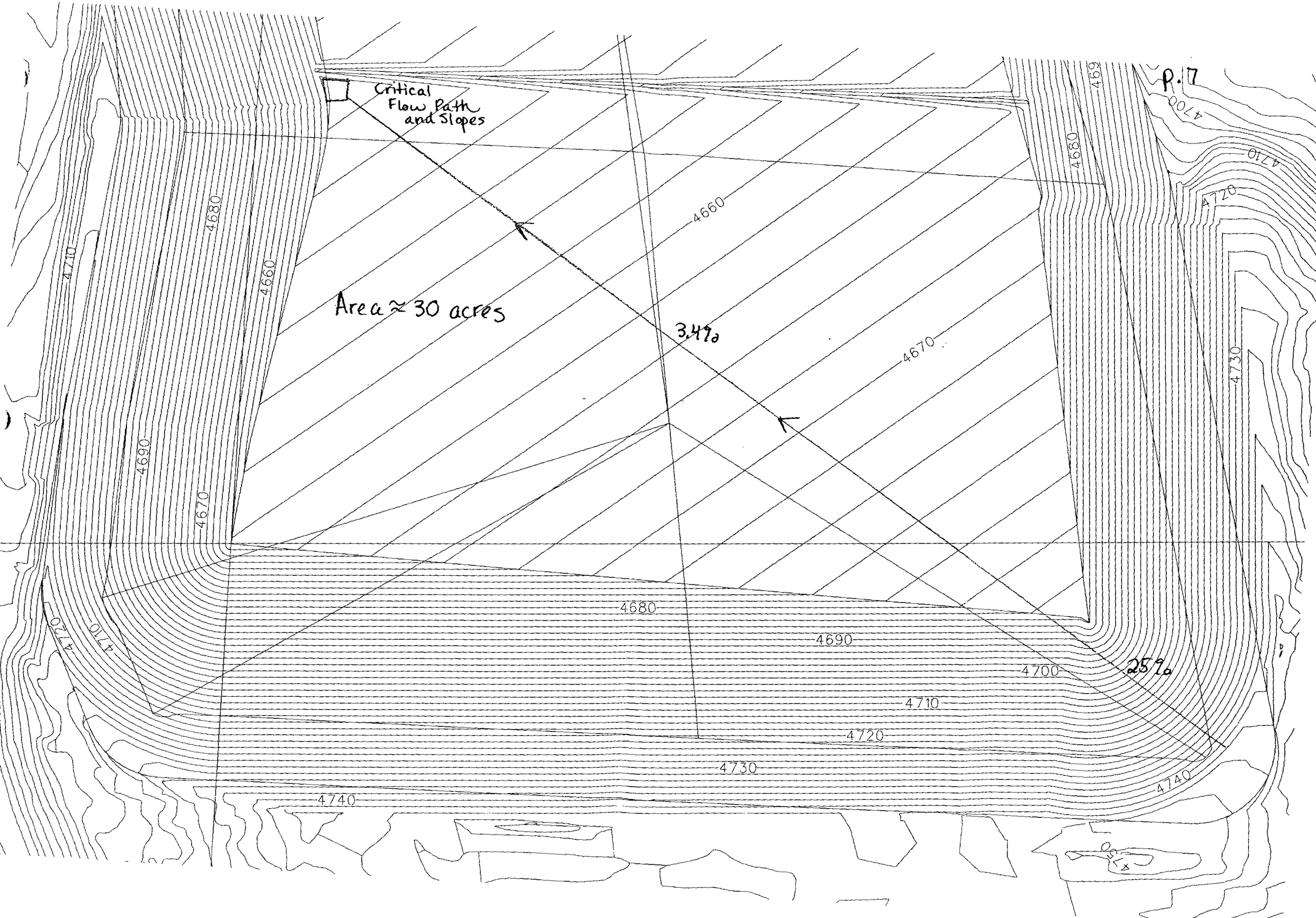
$$P = 50.01\ ft + \sqrt{17\ ft^2} = 54.13\ ft$$

$$R = 27\ ft^2 / 54.13\ ft = .499\ ft$$

$$Q = \frac{1.49}{0.025}(27\ ft^2)(.499\ ft)^{2/3}(.005)^{1/2}$$

$Q = 71.6$ cfs Drainage ditch is adequate


5%
25%
4710
4720
4730
4740
4750
4760
4770
Area ≈ 30 acres
Critical Flow Path and Slopes
.5%
5%
25%
4.6%


P.7
Critical Flow Path and Slopes
Area ≈ 30 acres
3.4%
25%
4660
4670
4680
4690
4700
4710
4720
4730
4740

APPENDIX N

CLOSURE CAP EQUIVALENCY

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

METEORIC WATER INFILTRATION STUDY
SOUTH UTAH VALLEY LANDFILL
(BAYVIEW LANDFILL)
UTAH COUNTY, UTAH

For: HDR

HDR Engineering, Inc.

September 9, 2003

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METEORIC WATER INFILTRATION STUDY
SOUTH UTAH VALLEY LANDFILL
(BAYVIEW LANDFILL)
UTAH COUNTY, UTAH

File No.: 26515.001

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September 9, 2003

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3 General Unsaturated Hydraulic Parameters from Literature
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1 Site Vicinity Map
2 Soil Sample Location Map

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B Site Specific Frost Depth Calculations
C Source Material Investigation Letter and Grain Size Distribution Figure
D Application for Authorization to Use

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1. INTRODUCTION

Bayview Landfill, also called the South Utah Valley Landfill, is located approximately 5 miles north of Elberta, Utah, along State Road 68 (Figure 1). This landfill is a Class I municipal solid waste landfill and began accepting solid waste in 1990. Cell 1 is scheduled for closure during the next year, and the South Utah Valley Solid Waste District wishes to consider modifying their permit to include closure with an evaporative cap. Recent studies have shown that appropriate evaporative caps out-perform standard clay caps in arid environments because they are less prone to desiccation, cracking, and frost damage when compared to traditional thin clay caps. South Utah Valley Solid Waste District would like to take advantage of long-term benefits offered by this type of alternative cap.

The following report describes our assessment of expected long-term meteoric water infiltration or seepage rates through an evaporative cap at Bayview Landfill constructed from on-site soils. Infiltration is defined as precipitation minus surface run-off, evaporation and plant transpiration. The net infiltration rate multiplied by the clay cap area is the net seepage volume that may contribute to formation of leachate. Expected infiltration rates were established by using the HYDRUS-2D saturated/unsaturated flow model (Version 2.0; Simunek and van Genuchten, 1999). Infiltration rates were determined for the standard regulatory prescribed cap and for the proposed site-specific cap materials. The prescriptive cap simulation was constructed using clay and silty clay materials, expected to have the lowest permeabilities. Infiltration processes are rarely saturated, however. Unsaturated soil hydraulic properties are highly non-linear functions of the pressure head (pressure head is also termed 'matric potential' and 'capillary suction'). Soil moisture or saturation and hydraulic conductivity are both a function of pressure head. These three variables interact to control the movement of soil moisture in the vadose or unsaturated zone. To simulate the behavior of a hypothetical prescriptive cap under the climatic conditions at the Bayview Landfill, a bracketing range of unsaturated soil parameters were selected. The resulting prescriptive cap infiltration rates are then compared to the infiltration rates modeled for the actual on-site materials.

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2. MODEL CODE SELECTION

The U.S. Salinity Laboratory's HYDRUS-2D unsaturated flow code was used to predict infiltration through the Bayview Landfill's proposed evaporative cap. This model is a windows based platform for running the public domain SWMS_2D finite element code published by Simunek, Vogel and van Genuchten (1992, 1994).

This model code was chosen because it incorporates the Richard's equations for groundwater flow under conditions of partial saturation and can simulate hydraulic gradients and movement based on soil moisture retention characteristics. The code is widely used in arid regions research. A key factor of concern in arid environments is the upward capillary movement of water towards the drying atmospheric interface caused by soil suction or matric potential under changing conditions of surface soil moisture resulting from infrequent light precipitation events and the intervening relatively long duration desiccation periods. The EPA HELP3 model code developed for evaluation of infiltration into and leakage from landfills (Schroeder et al, 1994) only accounts for gravity drainage of rainfall and is therefore more appropriate for sites in the eastern U.S. where rainfall rates are much higher. In arid climates the HELP model tends to overestimate infiltration rates because it does not account for upward movement of soil moisture toward the land surface during drying intervals (Albright, 1997; Hart and Lassetter, 1999).

The HYDRUS-2D model reacts to heavy precipitation events by limiting surface infiltration to the maximum infiltration capacity of soil based on the unsaturated flow equations; precipitation amounts greater than this maximum rate are assumed to form runoff. The primary water budget processes that determine net infiltration rates occur in near surface materials that are transected by the evapotranspiration zone; the type and thickness of strata below the evapotranspiration depth do not significantly influence percolation rates if they are more transmissive than the near surface materials. The HELP model requires that the evapotranspiration depth be specified *a priori*. The HYDRUS-2D model handles evaporation by using maximum *potential* evaporation at the soil surface. The evaporation depth is implicitly computed by HYDRUS-2D during runtime according

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to the unsaturated flow equation. The user specifies the potential maximum evaporation rate and the simulation code computes movement of water based on saturated and/or unsaturated hydraulic gradients that depend on antecedent moisture conditions.

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3. CLIMATIC CONDITIONS

The HYDRUS-2D model requires specification of daily rainfall and potential evaporation to simulate net infiltration. To obtain worst-case infiltration results, plant cover was excluded from all models prepared for this report, so potential transpiration was not quantified. It is assumed that the addition of plants will reduce infiltration approximately equally for each cap modeled. Potential evaporation at the Bayview Landfill site is a function of wind speed, relative humidity, temperature, precipitation, and insolation (solar energy). Daily precipitation and potential evapotranspiration values were obtained for the Elberta, Utah, weather station site from the Utah Climate Center, University of Utah.

The Utah Climate Center database precipitation values for the Elberta station have an annual average of 10.54 inches for the period of record (1928–1990). Monthly average precipitation amounts for Elberta are shown in Table 1.

For modeling a worst case scenario, the DSHW suggested running the five wettest years on record in sequence. The five wettest years in Elberta were 1983, 1982, 1941, 1967, and 1946, with precipitation rates of 19.34, 17.42, 14.28, 14.04, and 13.84 inches for these years, respectively. Monthly values for each of these years are shown in Table 1.

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4. SOIL HYDRAULIC PROPERTIES

Partial saturation or unsaturated flow hydraulic properties include the effective porosity, the saturated and residual water capacity, the saturated hydraulic conductivity, and the matric potential versus water content curve that is summarized by the van Genuchten soil moisture retention parameters. Effective porosity is the maximum amount of water that fully saturated soil can store. Matric potential is the physical property of a porous medium to attract water as a result of capillary and adsorption processes. The residual capacity of a soil is the virtually irreducible amount of water in soil that has been exposed to desiccating conditions for a long period of time; it is defined as having a matric potential of –15 bar, which is a pressure of about –153 meters of water. The negative pressure is a convention for describing conditions of partial saturation; the pressure is equal to the absolute hydraulic pressure required to drive the water from a sample. The van Genuchten parameters describe the shape of the soil matric potential (capillary suction) curve as a function of volumetric soil moisture. From this is derived the hydraulic conductivity versus soil moisture curve using the equations of Mualem (1976).

4.1 PROPERTIES OF THE IN-PLACE CAP

Unsaturated hydraulic analyses were conducted on samples of potential cap materials collected from the Bayview Landfill site. Four soil samples were collected from representative locations on February 18, 2003. These samples were selected based on the range of observed soil types at the Landfill. The soil sample locations are shown on Figure 2. The samples are described as follows:

Sample ID	Location	Soil Description	General Compaction
BVLF-1	Soil berm	Red-yellow sandy silt (SM)	Uncompacted
BVLF-2	Soil stockpile	Olive-brown silty sand (SM)	Somewhat compacted by equipment during placement
BVLF-3	Soil stockpile	Olive-brown silty sand (SM)	Somewhat compacted by equipment during placement
BVLF-4	In-situ bottom of cell 2	Red-brown silty sand (SP-SM) referred to as "mud stone" or "hardpan"	In-situ compaction

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The saturated hydraulic conductivity for the four samples ranges from 1.3×10^{-3} to 3.8×10^{-6} cm/sec, with the hydraulic conductivity of the olive-brown silty sand (BVL F-2 and -3) ranging from 1.3×10^{-5} to 3.8×10^{-6}. Other parameters are summarized in Table 2. The laboratory report is included in Appendix A.

4.2 PROPERTIES OF THE PRESCRIPTIVE CAP

Unsaturated flow parameters were estimated for the regulatory prescriptive cap assuming the prescriptive cap would be a clay material (see Table 3). Uncertainty regarding exactly which soil texture best approximates the low-permeability portion of the prescriptive cap material led to an approach involving three soil types which bracket the low-permeability portion of the most probable analogue. Three soil types were chosen that exhibited the lowest saturated hydraulic conductivities; these are silty clay, silty clay loam and sandy clay. The hydraulic parameters for these soils range from 5.6×10^{-6} to 3.3×10^{-5}. The low-permeability layer was then covered with a 28-inch sandy loam topsoil to protect the low permeability layer from frost damage. Site specific frost depth information is presented in Appendix B. Soil textures used for modeling are shown in Table 4.

The Solid Waste Rules also specify that the permeability of the prescriptive caps be lower than the permeability of the bottom liner. The bottom liner for Cell 1 consists of an HDPE synthetic liner placed on underlying native soil (a sandy silt to silty sand). The effective permeability of this liner system was calculated using equations developed by J.P. Giroud and R. Bonaparte, 1989. To be conservative, we assumed that the soil under the HDPE liner is a coarse sand, the liner makes good contact with the underlying soil, and that the installation quality was good to excellent (one small, circular hole per acre). We also assumed that up to 1 foot of leachate could be standing on the liner, creating a vertical head. These assumptions were input into Giroud and Bonaparte's equations, and the resulting predicted liner leakage rate is 470 gal/acre/day, or approximately 16 cm/year.

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5. HYDRUS-2D MODEL DESIGN

The HYDRUS-2D finite element model was discretized in the manner of a soil column test, with one-dimensional flow from the atmospheric boundary condition at the top of the column to a free drainage boundary at the bottom of the column. The height of the column was specified to be 215 cm using 50 rows and variable cell sizes from 0.5 to 5 cm. Row height was specified to be 0.5 cm at land surface, at the seepage face, and at each side of a soil texture interface. The uppermost boundary was specified to be an atmospheric boundary with daily time-variable records for rainfall and evaporation potential. Water leaves the model system by gravity drainage from the free drainage boundary when it is fully saturated. The amount of water draining from the drainage boundary was used to quantify the net amount of water infiltrating into the landfill waste.

The model for the prescriptive cap was designed to include a 71 cm (28 inch) thick topsoil layer at the surface, underlain by 45 cm (18 inches) of clay cap material, with the base of the model domain consisting of 94 cm (37.5 inches) of sand to simulate the landfill waste material. A summary of the materials used in the prescriptive cap simulations is shown in Table 5.

The model for the actual cap was designed to include a 5 cm (2 inch) thick topsoil layer consistent with normal surface disturbance, underlain by 81 cm (32 inches) of cap material, with the base of the model consisting of 130 cm (51 inches) of the sand/waste layer. The thickness of the evaporative cap was selected after running several models of various thicknesses to better understand the balance between promoting maximum evaporation (by using of a thinner cap to maintain moisture close to the evaporative surface) and providing sufficient storage for precipitation (by using of a thicker cap that doesn't become saturated and allow breakthrough.)

The initial soil moisture pressure, an important variable influencing short term seepage rates, was specified to be in equilibrium throughout the soil column with a –50 cm matric potential specified at the base of the model domain for all model runs. This pressure is slightly dryer than the subsequent dynamic equilibrium moisture at the base of the model. Net infiltration of rainfall at the land surface during the five wettest year sequence is more accurately quantified by having the

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water content at near-equilibrium levels at the base of the soil column. Model predictions of infiltration rates are sensitive to the initial soil moisture values, but the long-term dynamic equilibrium infiltration rates are not affected by antecedent soil moisture.

Transpiration was not included in the model due to the relatively small percentage that it constitutes relative to evaporation potential and the fact that parameters for soil moisture uptake rates for desert shrubs and grasses are poorly documented. One study reports plant transpiration as contributing three percent of the total evapotranspiration potential in Jean, Nevada, and 32 percent for good grass cover on a landfill in Elko, Nevada (Albright, 1997). Excluding plant transpiration is a conservative choice that tends to increase the predicted net infiltration rates. Similar plant growth is expected on both prescriptive and proposed evaporative caps, so making a comparison between performance of these caps should not be significantly affected by the presence or absence of vegetation.

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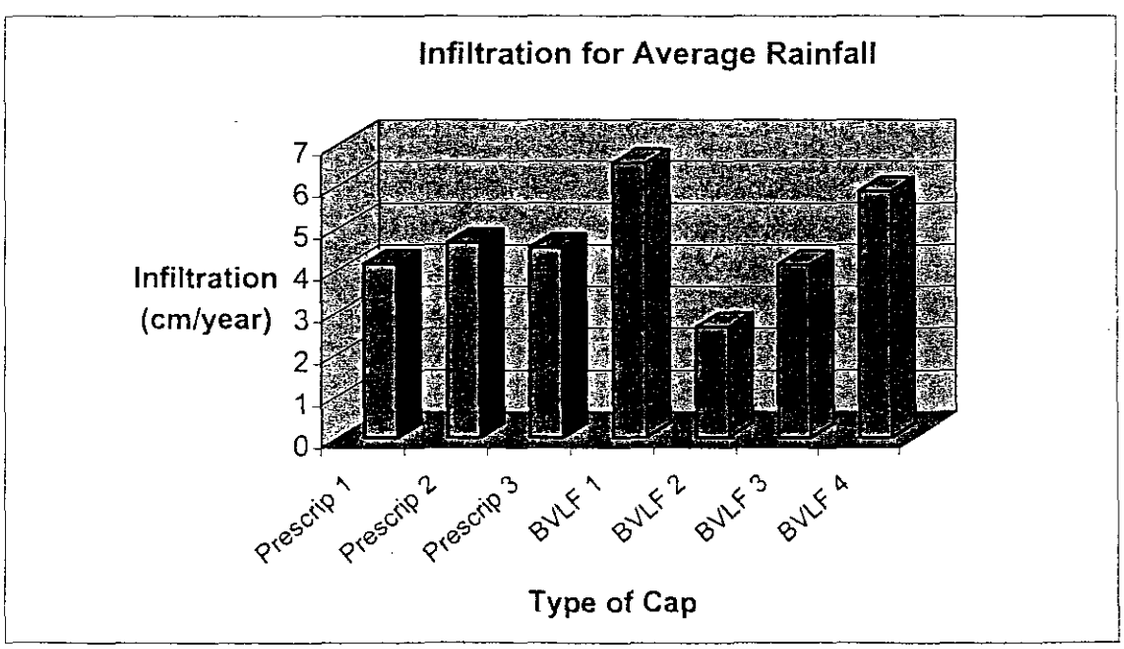
6. HYDRUS-2D INFILTRATION SIMULATIONS

Three prescriptive cap design scenarios were evaluated based upon different soil textures for the 18-inch thick clay cap material. Four actual cap scenarios were evaluated based on measured soil properties. The models were run both for average climatic conditions, and for the five wettest years in sequence (beginning at equilibrium with the average years). Infiltration rates were calculated for both average conditions and each of the five wettest years.

6.1 AVERAGE CLIMATIC CONDITIONS

Under average (normal) climatic conditions observed in nearby Elberta, Utah, the prescriptive caps allow an average of 4.14 to 4.65 cm of infiltration to occur each year. Under the same climatic conditions, evaporative caps constructed of the four potential soils assessed for use at Bayview Landfill allow 2.63 to 6.55 cm of infiltration to occur each year. The olive-brown silty sand material that has been stockpiled at the site (samples BVLF1 and BVLF2) is expected to allow infiltration rates of 2.63 to 4.12 cm/year. These results are shown on Table 5. A graph depicting these results is shown below.



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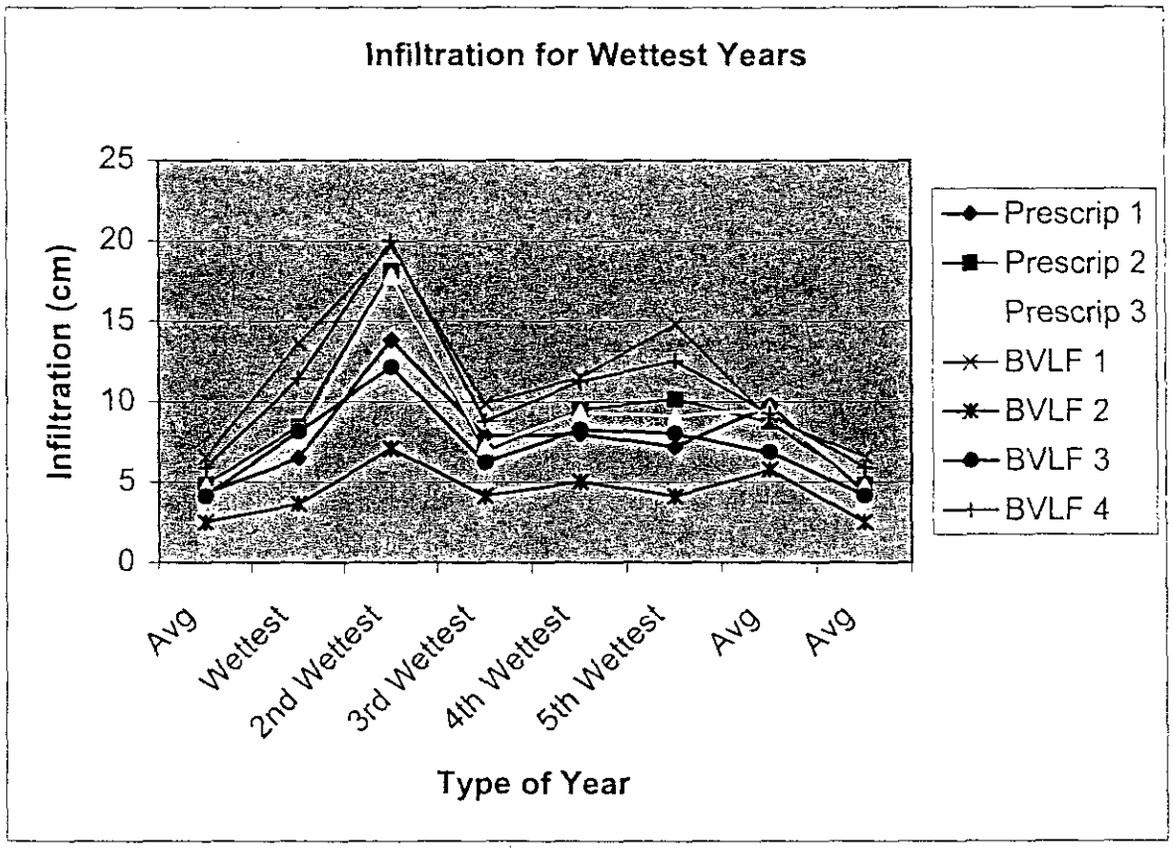
6.2 WETTEST (WORST-CASE) CLIMATIC CONDITIONS

Under an assumed worst-case climatic condition where the five wettest years on record at Elberta, Utah were to occur sequentially, the three modeled prescriptive caps would allow infiltration at rates ranging from 6.49 to 18.12 cm/year. Under the same climatic conditions, evaporative caps constructed of the four potential soils assessed for use at Bayview Landfill allow 3.63 to 20 cm of infiltration per year. The olive-brown silty sand material that has been stockpiled at the site is associated with infiltration rates of 3.63 to 12.17 cm/year. These results are shown on Table 5. A graph depicting these results is shown below.



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7. CONCLUSIONS

Based on unsaturated flow modeling, it appears that a 34-inch evaporative cap, constructed from the olive-brown silty sand material available at Bayview Landfill, will perform as well or better than the hypothetical prescriptive cap under the arid conditions that exist in the area. The proposed evaporative cap performed as well as the prescriptive cap during both the worst case "wet" years, and during normal (dry) years. Both the prescriptive cap and the proposed evaporative cap have much lower predicted infiltration rates (less than 7 cm/year) than the leakage rate of the bottom liner (16 cm/year). Therefore, both caps satisfy the requirement of the Solid Waste Rules that the cap be no more permeable than the liner.

To provide a more detailed description of the proposed capping material and provide quantitative criteria for identifying these materials in the field, Kleinfelder performed a source material investigation in May 2003 (Kleinfelder 2003). A summary of criteria that may be used to identify suitable material (materials that are represented by BVLF-2 and BVF-3) is included in Appendix C.

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8. LIMITATIONS

The unsaturated groundwater model described in this report was used to predict infiltration rates based upon estimates of the regulatory prescriptive cap unsaturated hydraulic parameters and laboratory analyses of the on-site materials. The accuracy of infiltration rate estimates resulting from numerical models is entirely dependant upon the validity of the hydraulic parameters used to construct the model. The simulated infiltration rates are sensitive to the unsaturated flow parameters. These and other subsurface hydraulic parameters generally exhibit spatial heterogeneity. Therefore, simulated infiltration rates are considered to be best estimates and not precise predictions of actual field infiltration rates. No on-site hydraulic testing was performed for this project by Kleinfelder, Inc. Field tests are available which would reduce the level of uncertainty associated with estimating subsurface hydraulic properties.

This study was performed and findings obtained in substantial conformance with the engineering practice that exists within the area at the time of our investigation and includes professional opinions and judgements. We base this report on information derived from data in available literature and our knowledge of and experience in the local area. This report does not provide a warranty as to variable subsurface conditions which may exist and applies only to the specific area that was investigated. In addition, one should recognize that definition and evaluation of subsurface geologic and hydrogeologic conditions is a difficult and inexact art. Geologists and hydrogeologists must occasionally make general judgements leading to conclusions with incomplete knowledge of the geologic history, subsurface conditions and hydraulic characteristics present. No warranty, express or implied, is made.

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9. REFERENCES

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TABLE 1
Average Precipitation and Five Wettest Years on Record (inches)
Elberta, Utah

	Precipitation (inches)					
Month	**Average**	**1983**	**1982**	**1941**	**1967**	**1946**
Jan	.81	1.24	1.12	0.53	1.89	1.04
Feb	.84	2.00	0.33	1.42	0.23	0.11
Mar	.99	2.30	1.12	1.66	0.74	0.88
Apr	1.03	1.32	0.41	1.25	0.88	1.46
May	1.03	1.67	1.66	0.64	2.52	1.68
Jun	0.73	0.89	0.57	1.75	2.44	0
Jul	0.8	0.82	3.67	1.07	2.04	0.72
Aug	0.94	2.11	0.38	0.85	0.15	1.27
Sep	0.72	1.76	5.30	0.54	0.58	0
Oct	1.01	0.57	1.46	2.71	0.39	3.96
Nov	0.86	2.69	0.73	0.46	0.94	1.84
Dec	0.81	1.97	0.67	1.40	1.24	0.88
Sum:	**10.54**	**19.34**	**17.42**	**14.28**	**14.04**	**13.84**

Date from University of Utah, Utah Climate Center, Elberta Station
Period of Record (1/1/1928 to 12/31/90)
Station: Elberta, Utah

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TABLE 2
Unsaturated Hydraulic Parameters for Bayview Landfill Samples

Sample Name	Sample Description	Other	Water Content		Saturated Hydraulic Conductivity	Calculated van Genuchten parameters	
			Saturation	Residual	(cm/sec)	Alpha (1/cm)	n
BVLF-1	Sandy Silt (MH)	Red yellow	0.6671	0.000	4.1×10^{-5}	0.0051	1.35
BVLF-2	Silty Sand (SM)	Olive brown	0.4035	0.000	3.8×10^{-6}	0.0062	1.30
BVLF-3	Silty Sand (SM)	Olive brown	0.3846	0.000	1.3×10^{-5}	0.0071	1.27
BVLF-4	Silty Sand (SM)	Red to brown	0.5395	0.020	1.3×10^{-3}	0.0470	1.36

Note: These values reported by Daniel B. Stephens and Associates, Inc.

TABLE 3
General Unsaturated Hydraulic Parameters from Literature

Soil Type	Water Content		Saturated Hydraulic Conductivity (cm/sec)	van Genuchten parameters	
	Saturation	Residual		Alpha (1/cm)	n
Sand	0.43	0.045	8.3×10^{-3}	0.145	2.68
Loamy sand	0.41	0.057	4.1×10^{-3}	0.124	2.28
Sandy loam	0.41	0.065	1.2×10^{-3}	0.075	1.89
Sandy clay loam	0.39	0.100	3.6×10^{-4}	0.059	1.48
Loam	0.43	0.078	2.9×10^{-4}	0.036	1.56
Sandy clay	**0.36**	**0.070**	**3.3×10^{-5}**	**0.027**	**1.23**
Silty loam	0.45	0.067	1.3×10^{-4}	0.020	1.41
Clay loam	0.41	0.095	7.2×10^{-5}	0.019	1.31
Silt	0.46	0.034	6.9×10^{-5}	0.016	1.37
Silty Clay Loam	**0.43**	**0.089**	**1.9×10^{-5}**	**0.010**	**1.23**
Clay	0.38	0.068	5.6×10^{-5}	0.008	1.09
Silty Clay	**0.36**	**0.070**	**5.6×10^{-6}**	**0.005**	**1.09**

Note: Source: Carsel and Parrish (1988)
Values are averages of hundreds of samples for each soil type.

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TABLE 4
Summary of Hydraulic Properties used for Prescriptive Cap Simulations

Material Description	Soil Type	Water Content		Saturated Hydraulic Conductivity (cm/sec)	van Genuchten parameters	
		Saturation	Residual		Alpha (1/cm)	n
Topsoil	Sandy loam	0.41	0.065	1.2×10^{-3}	0.075	1.89
Clay Cap(1)	Silty Clay	0.36	0.070	5.6×10^{-6}	0.005	1.09
Clay Cap(2)	Silty Clay Loam	0.43	0.089	1.9×10^{-5}	0.010	1.23
Clay Cap(3)	Sandy clay	0.36	0.070	3.3×10^{-5}	0.027	1.23
Fill material	Sand	0.43	0.045	8.3×10^{-3}	0.145	2.68

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TABLE 5
Summary of Model Results

Scenario	Cap design	Annual Infiltration Rate for 5 wettest years (cm/year)	Annual Infiltration Rate for 5 wettest years (inches/year)	Average Annual Infiltration Rate for 5 normal years (cm/year)	Average Annual Infiltration Rate for 5 normal years (inches/year)
Prescriptive Caps					
Presc-1	Sandy Loam (28") Silty Clay cap (18") Sand* (37.5")	6.49 to 13.85	2.56 to 5.45	4.14	1.63
Presc -2	Sandy Loam (28") Silty Clay Loam cap (18") Sand* (37.5")	6.84 to 18.12	2.69 to 7.13	4.65	1.83
Presc -3	Sandy Loam (28") Sandy Clay cap (18") Sand* (37.5")	7.22 to 17.78	2.84 to 7.00	4.53	1.78
Evaporative Cap					
BV-1	Sandy Loam (2") Sample T1-D (32") Sand* (51")	9.9 to 19.65	3.9 to 7.74	6.55	2.58
BV-2	Sandy Loam (2") Sample T2-Da (32") Sand* (51")	3.63 to 7.07	1.43 to 2.78	2.63	1.04
BV-3	Sandy Loam (2") Sample T2-Db (32") Sand* (51")	6.23 to 12.17	2.45 to 4.79	4.12	1.62
BV-4	Sandy Loam (2") Sample T5-D (32") Sand* (51")	8.78 to 19.99	3.46 to 7.87	5.88	2.31

* "Sand" layer simulates the porous waste materials in the landfill.

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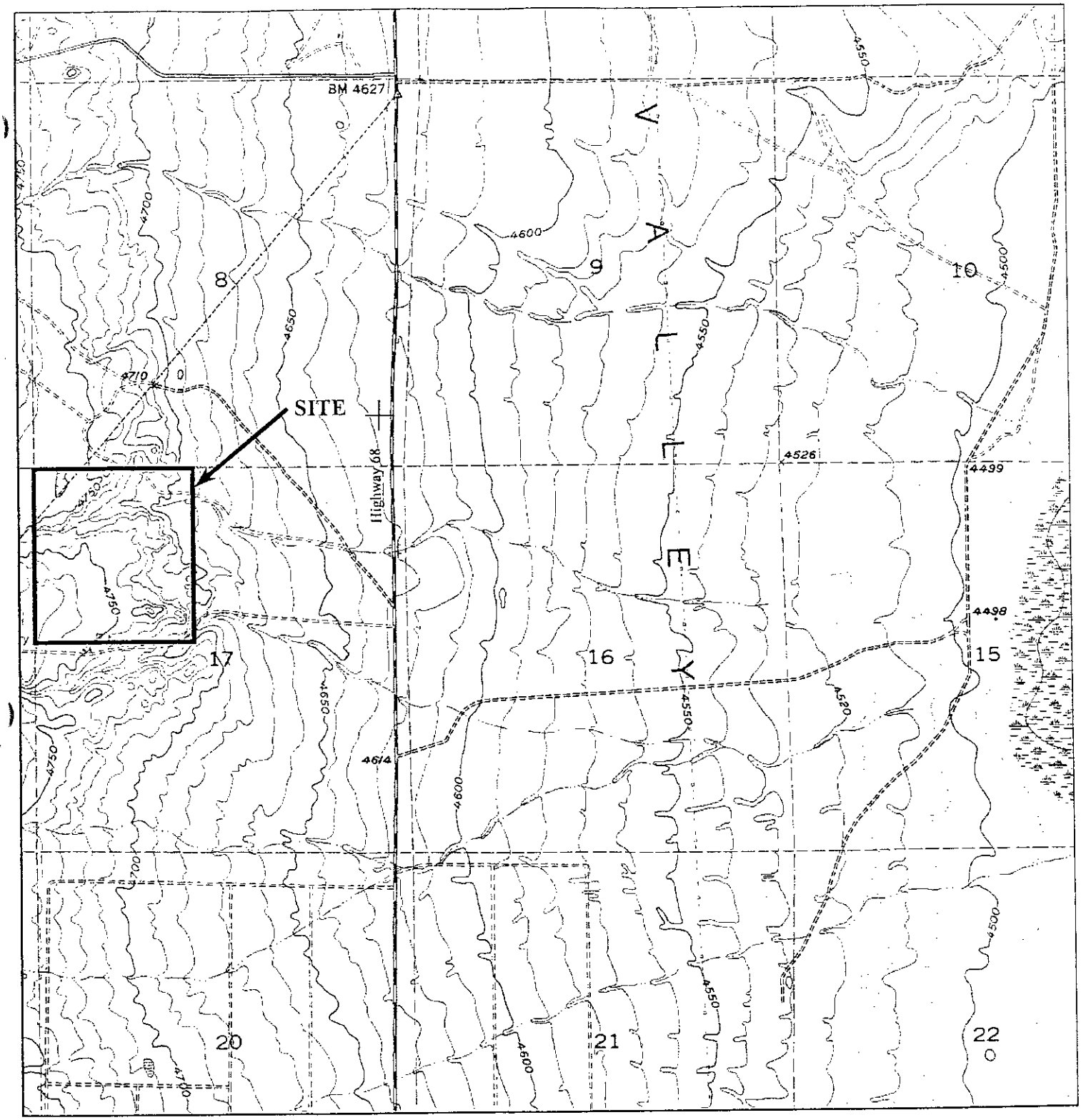


BASE MAP:
GOSHEN VALLEY NORTH, UTAH
U.S.G.S. 7.5 MINUTE QUADRANGLES
PHOTOREVISED 1975

0' 1000' 2000'

SCALE 1:24,000
1" = 2000'
CONTOUR INTERVAL 10 FEET

UTAH

QUADRANGLE LOCATION

SLC3Q102.ppt

KLEINFELDER

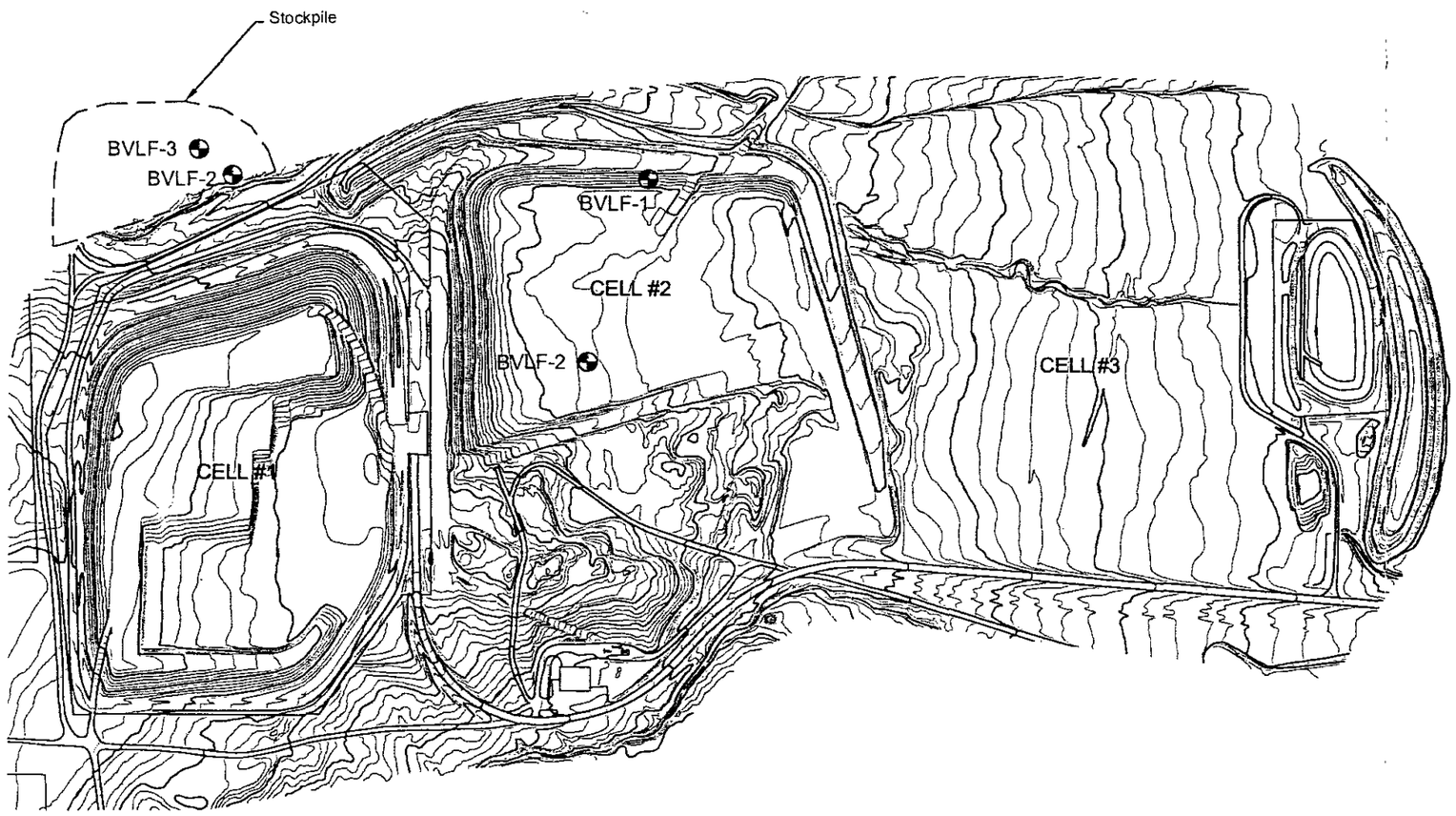
Project Number 26515.001

South Utah Valley Landfill
Approximately 5.6 Miles North of
Elberta, Utah
on Highway 68

SITE LOCATION MAP

FIGURE

1



LEGEND

BVLF-3 Approximate Soil Sample Location

SLC3d155.dwg

N

0 250' 500' 1000'

Approximate Scale: 1" = 500'

KLEINFELDER

Project Number 26515.001

Bayview Meteoric Infiltration Study
Approximately 5.6 Miles North of Elberta
Elberta, Utah

SOIL SAMPLE LOCATION MAP

FIGURE

2

March 13, 2003

Ms. Renee Zollinger
Kleinfelder
2677 East Parley's Way
Salt Lake City, UT 84109-1617
(801) 466-6769

Dear Ms. Zollinger:

Enclosed is the final report for the Kleinfelder (Bayview LF) job #26515.001. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

We are pleased to provide this service to Kleinfelder and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Daniel O'Dowd
Enclosure

Daniel B. Stephens & Associates, Inc.

6020 Academy NE, Suite 100 505-822-9400
Albuquerque, NM 87109 FAX 505-822-8877

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1] (θ, ρ_d, ϕ)	Saturated Hydraulic Conductivity[2]		Moisture Characteristics[3]					Unsaturated Hydraulic Conductivity	Particle Size[4]			Effective Porosity	Particle Density	Air Permeability	1/3, 15 Bar Points and Water Holding Capacity	Atterberg Limits	Proctor Compaction
		CH	FH	HC	PP	TH	WP	RH		DS	WS	H						
BLUF-1	X	X		X	X		X	X	X									
BLUF-2	X	X		X	X		X	X	X									
BLUF-3	X	X		X	X		X	X	X									
BLUF-4	X	X		X	X		X	X	X									

[1] θ = Initial moisture content, ρ_d = Dry bulk density, ϕ = Calculated porosity
[2] CH = Constant head, FH = falling head
[3] HC = Hanging column, PP = Pressure plate, TH = Thermocouple psychrometer, WP = Water activity meter, RH = Relative humidity box
[4] DS = Dry sieve, WS = Wet sieve, H = Hydrometer

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
BLUF-1	4.1E-05	X	
BLUF-2	3.8E-06	X	
BLUF-3	1.3E-05	X	
BLUF-4	1.3E-03	X	

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
BLUF-1	35.0	29.3	0.84	1.13	68.4
BLUF-2	18.6	27.2	1.46	1.74	44.7
BLUF-3	13.4	21.2	1.58	1.79	40.4
BLUF-4	17.1	21.7	1.27	1.49	52.0

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
BLUF-1	0	66.9
	21	65.6
	49	63.4
	150	60.4
	510	43.4
	16623	15.3
	851293	2.5
BLUF-2	0	40.1
	21	39.6
	49	38.0
	150	37.3
	510	25.2
	7445	14.1
	851293	2.7
BLUF-3	0	38.2
	21	37.8
	49	36.3
	150	34.4
	510	24.6
	17541	11.7
	851293	2.5
BLUF-4	0	54.6
	10	48.3
	43	41.7
	80	30.8
	510	18.5
	9892	8.1
	851293	2.9

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
BLUF-1	0.0051	1.3508	0.0000	0.6671
BLUF-2	0.0062	1.2957	0.0000	0.4035
BLUF-3	0.0071	1.2714	0.0000	0.3846
BLUF-4	0.0470	1.3613	0.0200	0.5395

Raw Laboratory Data and Graphical Plots

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Initial Moisture Content Gravimetric (%, g/g)	Initial Moisture Content Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
BLUF-1	35.0	29.3	0.84	1.13	68.4
BLUF-2	18.6	27.2	1.46	1.74	44.7
BLUF-3	13.4	21.2	1.58	1.79	40.4
BLUF-4	17.1	21.7	1.27	1.49	52.0

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-1
Ring Number: NA
Depth: NA

Test Date: 2-Feb-03

Field weight of sample* (g): 98.16
Tare weight, ring (g): 36.57
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 45.63
Sample volume (cm^3): 54.44
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 29.3

Initial Gravimetric Moisture Content (% g/g): 35.0

Dry bulk density (g/cm^3): 0.84

Wet bulk density (g/cm^3): 1.13

Calculated Porosity (% vol): 68.4

Percent Saturation: 42.9

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-2
Ring Number: NA
Depth: NA

Test Date: 2-Feb-03

Field weight of sample* (g): 122.60
Tare weight, ring (g): 34.07
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 74.67
Sample volume (cm^3): 50.99
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 27.2

Initial Gravimetric Moisture Content (% g/g): 18.6

Dry bulk density (g/cm^3): 1.46

Wet bulk density (g/cm^3): 1.74

Calculated Porosity (% vol): 44.7

Percent Saturation: 60.8

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-3
Ring Number: NA
Depth: NA

Test Date: 2-Feb-03

Field weight of sample* (g): 156.11
Tare weight, ring (g): 41.93
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 100.70
Sample volume (cm^3): 63.72
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 21.2

Initial Gravimetric Moisture Content (% g/g): 13.4

Dry bulk density (g/cm^3): 1.58

Wet bulk density (g/cm^3): 1.79

Calculated Porosity (% vol): 40.4

Percent Saturation: 52.4

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-4
Ring Number: NA
Depth: NA

Test Date: 2-Feb-03

Field weight of sample* (g): 128.63
Tare weight, ring (g): 39.39
Tare weight, cap/plate/epoxy (g): 0.00

Dry weight of sample (g): 76.24
Sample volume (cm^3): 59.97
Assumed particle density: 2.65

Initial Volumetric Moisture Content (% vol): 21.7
Initial Gravimetric Moisture Content (% g/g): 17.1
Dry bulk density (g/cm^3): 1.27
Wet bulk density (g/cm^3): 1.49
Calculated Porosity (% vol): 52.0
Percent Saturation: 41.7

Comments:

* Weight including tares

Laboratory analysis by: M. Devine
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Method of Analysis	
		Constant Head	Falling Head
BLUF-1	4.1E-05	X	
BLUF-2	3.8E-06	X	
BLUF-3	1.3E-05	X	
BLUF-4	1.3E-03	X	

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name: Kleinfelder
Job number: WR03.0035.00
Sample number: BLUF-1
Ring number: NA
Depth: NA

Type of water used: TAP
Collection vessel tare (g): 11.81
Sample length (cm): 2.97
Sample diameter (cm): 4.84
Sample x-sectional area (cm^2): 18.36

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
26-Feb-03	12:50:43	18.5	12.8	13.6	1.8	561	4.0E-05	4.1E-05
26-Feb-03	13:00:04							
Test # 2:								
27-Feb-03	08:53:42	18.5	12.8	15.2	3.4	1089	3.9E-05	4.0E-05
27-Feb-03	09:11:51							
Test # 3:								
27-Feb-03	10:45:38	18.5	12.8	14.4	2.6	850	3.9E-05	4.0E-05
27-Feb-03	10:59:48							

Average Ksat (cm/sec): 4.1E-05

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name: Kleinfelder
Job number: WR03.0035.00
Sample number: BLUF-2
Ring number: NA
Depth: NA

Type of water used: TAP
Collection vessel tare (g): 11.81
Sample length (cm): 2.77
Sample diameter (cm): 4.84
Sample x-sectional area (cm^2): 18.42

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
27-Feb-03	08:54:06	18.5	14.6	12.3	0.4	1119	4.1E-06	4.3E-06
27-Feb-03	09:12:45							
Test # 2:								
27-Feb-03	10:45:11	18.5	14.6	13.9	2.1	6055	3.6E-06	3.7E-06
27-Feb-03	12:26:06							
Test # 3:								
28-Feb-03	10:07:39	18.0	14.6	12.2	0.4	1303	3.4E-06	3.5E-06
28-Feb-03	10:29:22							

Average Ksat (cm/sec): 3.8E-06

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name: Kleinfelder
Job number: WR03.0035.00
Sample number: BLUF-3
Ring number: NA
Depth: NA

Type of water used: TAP
Collection vessel tare (g): 10.71
Sample length (cm): 3.41
Sample diameter (cm): 4.88
Sample x-sectional area (cm^2): 18.67

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
27-Feb-03	08:54:12	18.5	13.2	11.7	1.0	1085	1.2E-05	1.3E-05
27-Feb-03	09:12:17							
Test # 2:								
27-Feb-03	10:45:48	18.5	13.2	15.8	5.1	5873	1.2E-05	1.2E-05
27-Feb-03	12:23:41							
Test # 3:								
28-Feb-03	10:05:05	18.0	13.2	11.9	1.2	1265	1.3E-05	1.3E-05
28-Feb-03	10:26:10							

Average Ksat (cm/sec): 1.3E-05

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job name: Kleinfelder
Job number: WR03.0035.00
Sample number: BLUF-4
Ring number: NA
Depth: NA

Type of water used: TAP
Collection vessel tare (g): 11.93
Sample length (cm): 3.22
Sample diameter (cm): 4.87
Sample x-sectional area (cm^2): 18.64

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
27-Feb-03	08:54:23	18.5	6.8	59.7	47.7	939	1.3E-03	1.3E-03
27-Feb-03	09:10:02							
Test # 2:								
27-Feb-03	10:44:50	18.5	6.8	53.6	41.7	807	1.3E-03	1.3E-03
27-Feb-03	10:58:17							
Test # 3:								
28-Feb-03	10:04:07	18.0	6.8	43.0	31.1	655	1.2E-03	1.3E-03
28-Feb-03	10:15:02							

***Average Ksat* (cm/sec):** **1.3E-03**

Comments:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
BLUF-1	0	66.9
	21	65.6
	49	63.4
	150	60.4
	510	43.4
	16623	15.3
	851293	2.5
BLUF-2	0	40.1
	21	39.6
	49	38.0
	150	37.3
	510	25.2
	7445	14.1
	851293	2.7
BLUF-3	0	38.2
	21	37.8
	49	36.3
	150	34.4
	510	24.6
	17541	11.7
	851293	2.5
BLUF-4	0	54.6
	10	48.3
	43	41.7
	80	30.8
	510	18.5
	9892	8.1
	851293	2.9

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r	θ_s
BLUF-1	0.0051	1.3508	0.0000	0.6671
BLUF-2	0.0062	1.2957	0.0000	0.4035
BLUF-3	0.0071	1.2714	0.0000	0.3846
BLUF-4	0.0470	1.3613	0.0200	0.5395

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Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name:	Kleinfelder	*Dry wt. of sample* (g):	45.63
Job Number:	WR03.0035.00	*Tare wt., screen & clamp* (g):	25.32
Sample Number:	BLUF-1	*Tare wt., ring* (g):	36.57
Ring Number:	NA	*Tare wt., epoxy* (g):	0.00
Depth:	NA	*Sample volume* (cm^3):	54.44

Saturated weight at 0 cm tension* (g): 143.92
Volume of water† in saturated sample (cm^3): 36.40
Saturated moisture content (% vol): 66.86
Sample bulk density (g/cm^3): 0.84

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	28-Feb-03 / 14:00	143.92	0.00	66.86
	03-Mar-03 / 12:30	143.25	21.00	65.63
	05-Mar-03 / 15:30	142.04	49.00	63.41
	07-Mar-03 / 15:30	140.38	150.00	60.36
Pressure plate:	10-Mar-03 / 13:00	131.13	509.90	43.37

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-1
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 134.82
Tare weight, jar (g): 113.64
Sample bulk density (g/cm^3): 0.84

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	26-Feb-03 / 13:30	138.68	16622.7	15.28

Dry weight of relative humidity box sample* (g): 65.04
Tare weight (g): 40.93
Sample bulk density (g/cm^3): 0.84

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	03-Mar-03 / 12:30	65.75	851293	2.46

Comments:

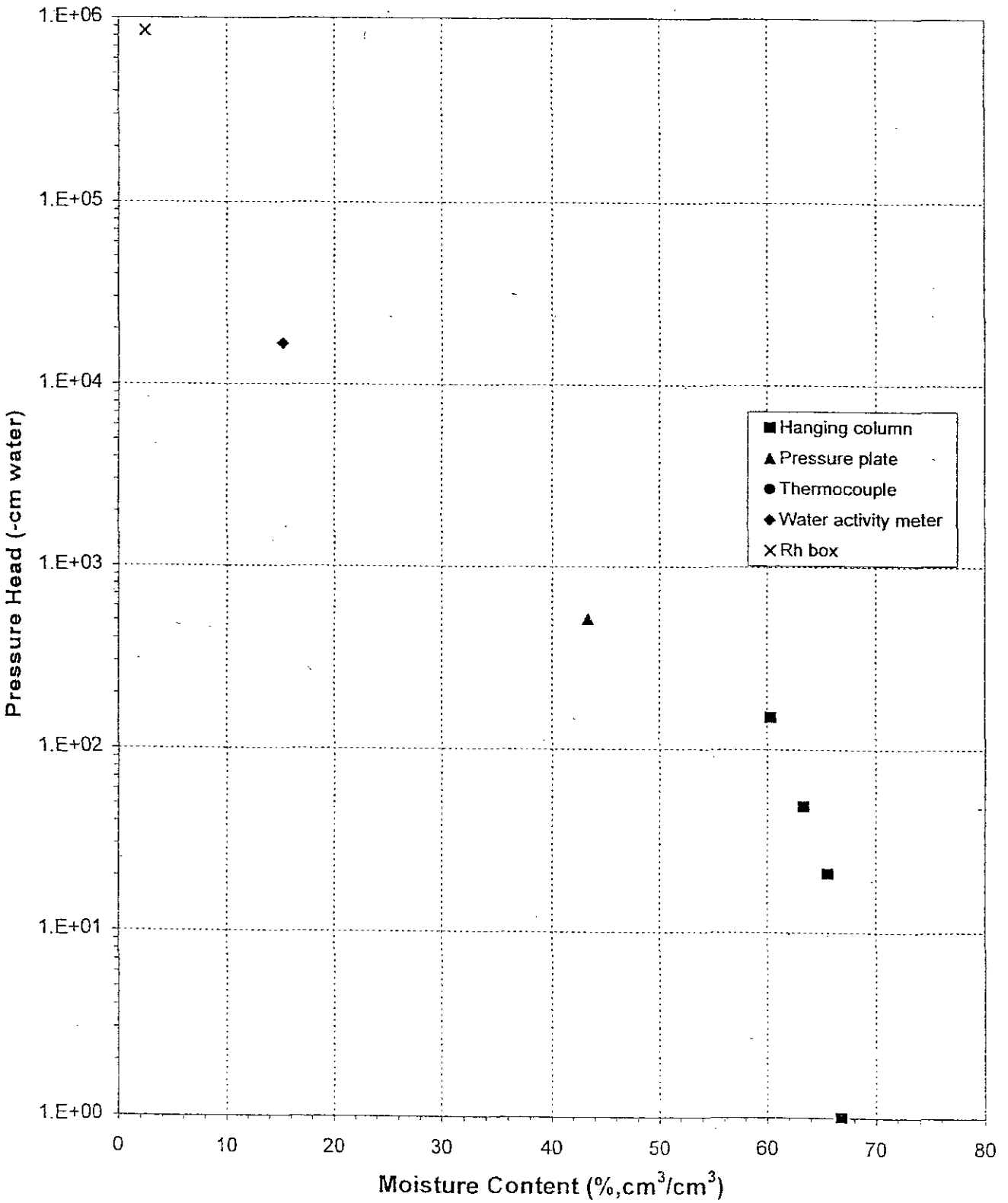
* Weight including tares

† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

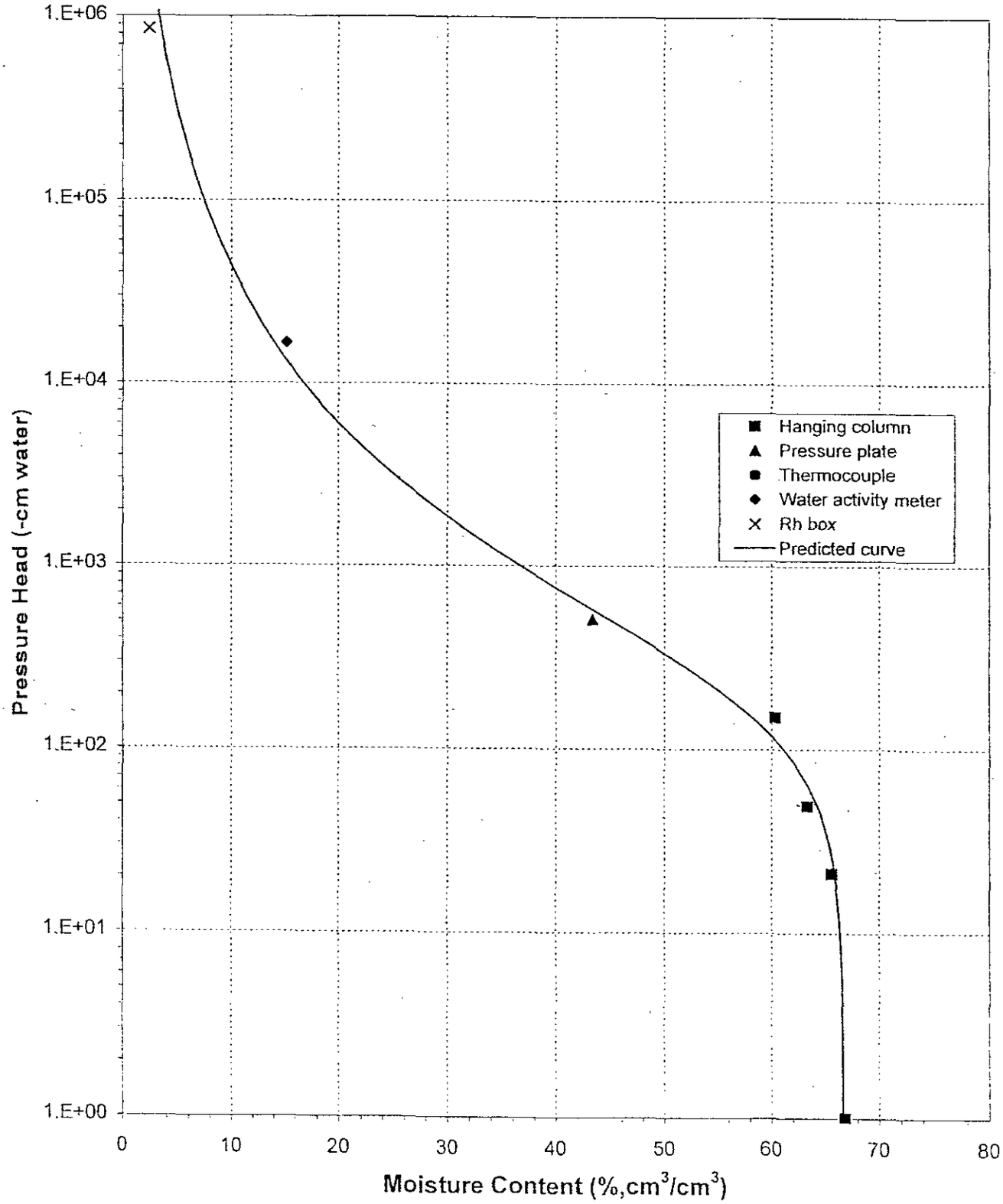
Water Retention Data Points

Sample Number: BLUF-1



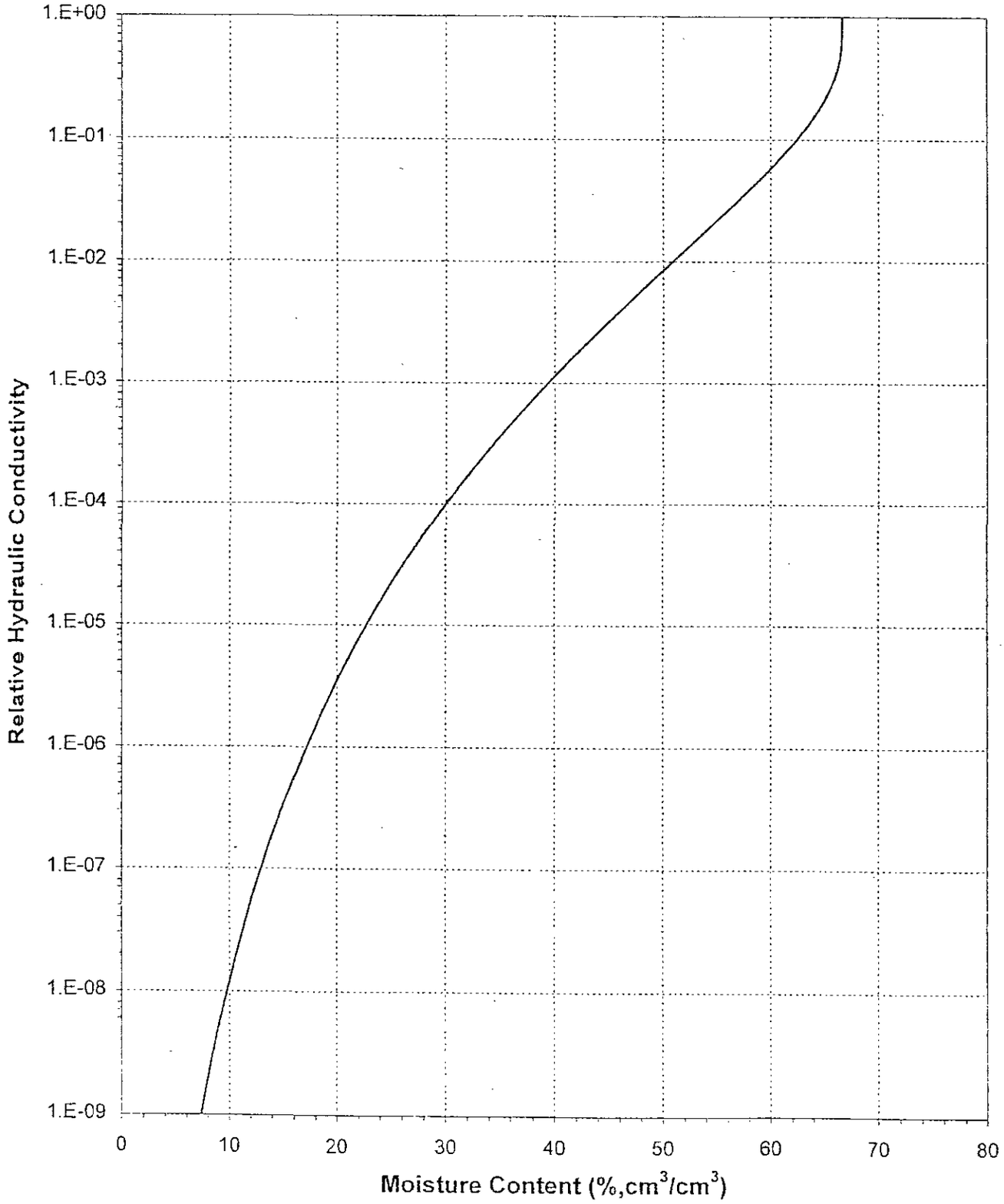
Predicted Water Retention Curve and Data Points

Sample Number: BLUF-1



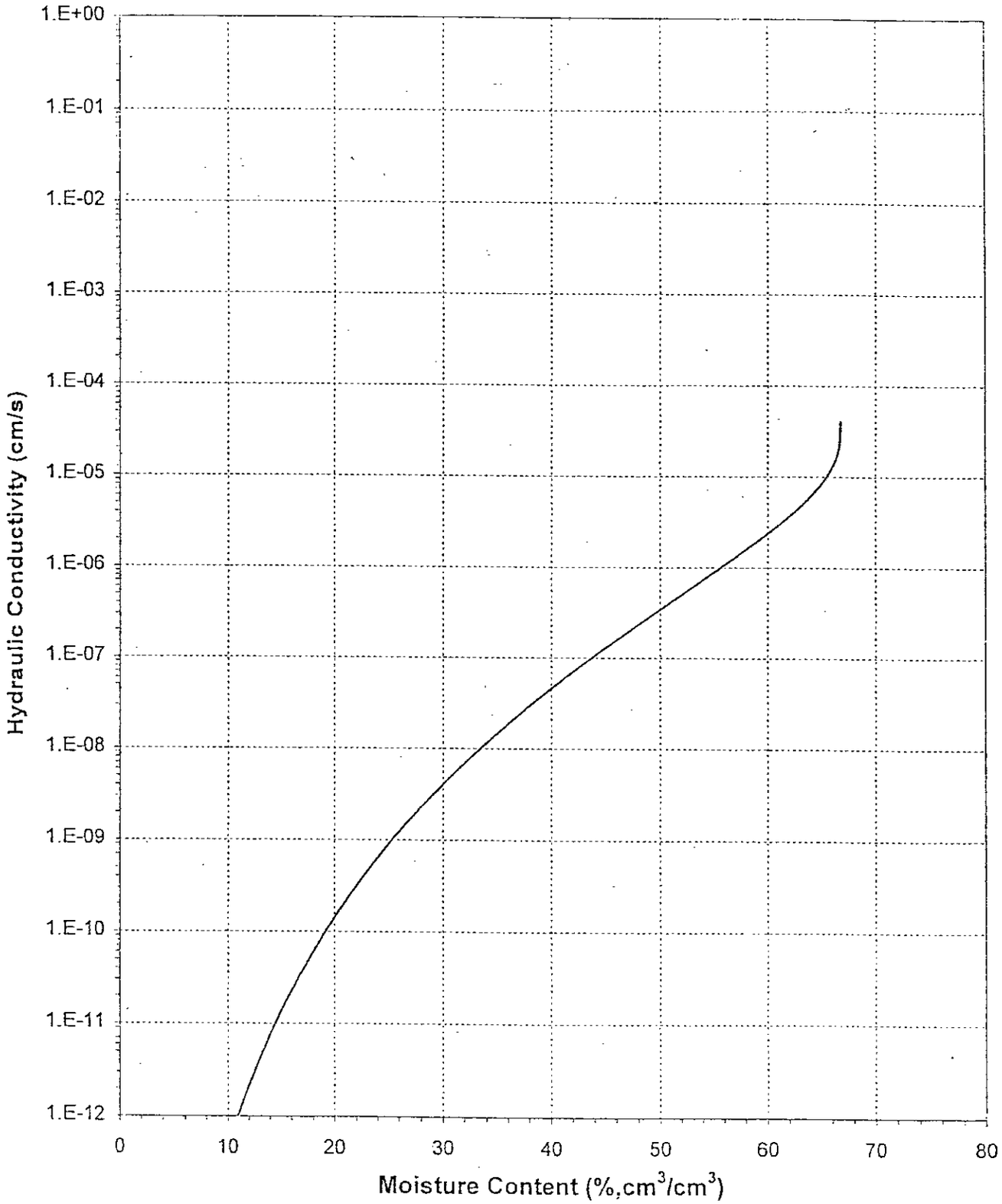
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-1



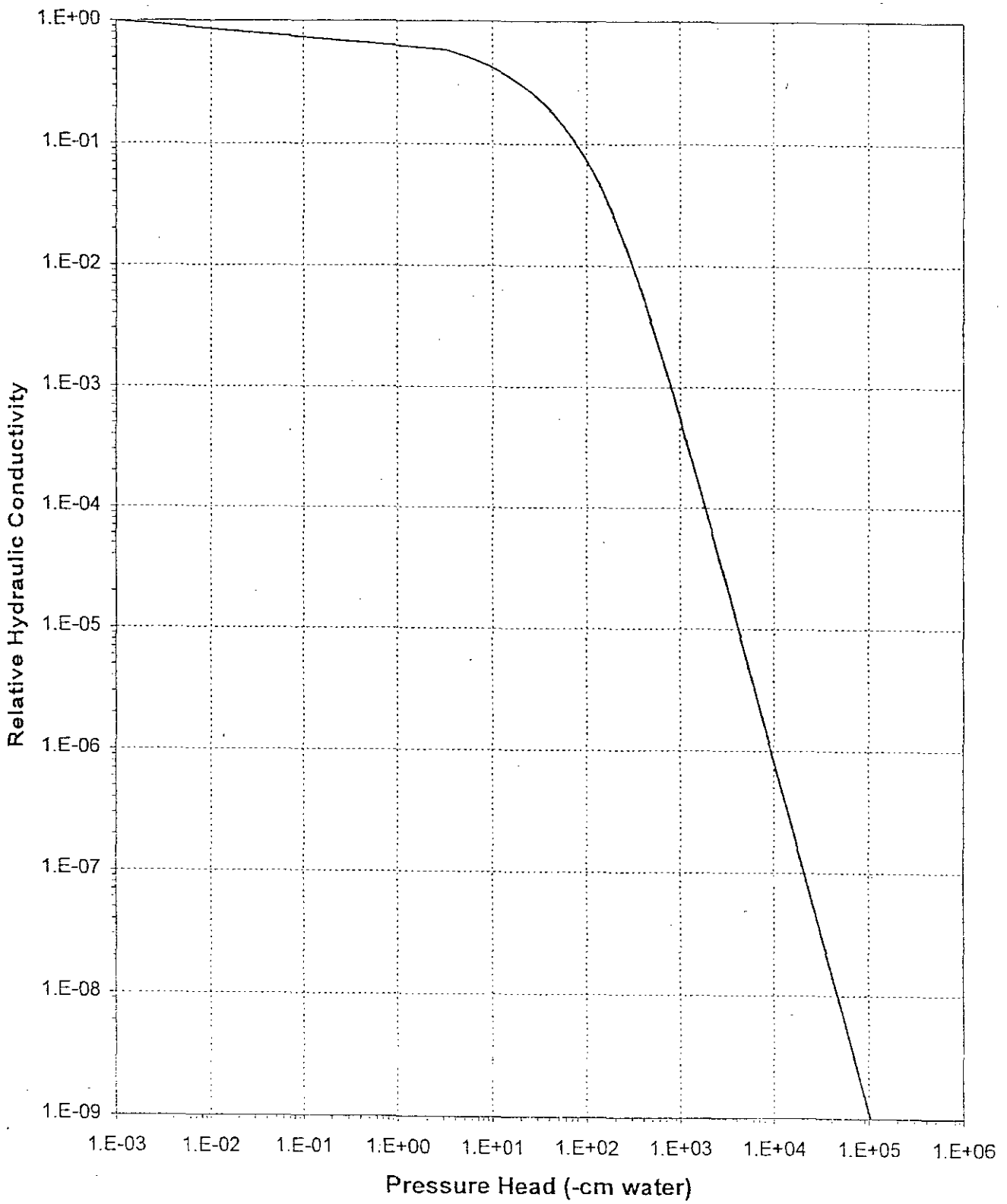
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-1



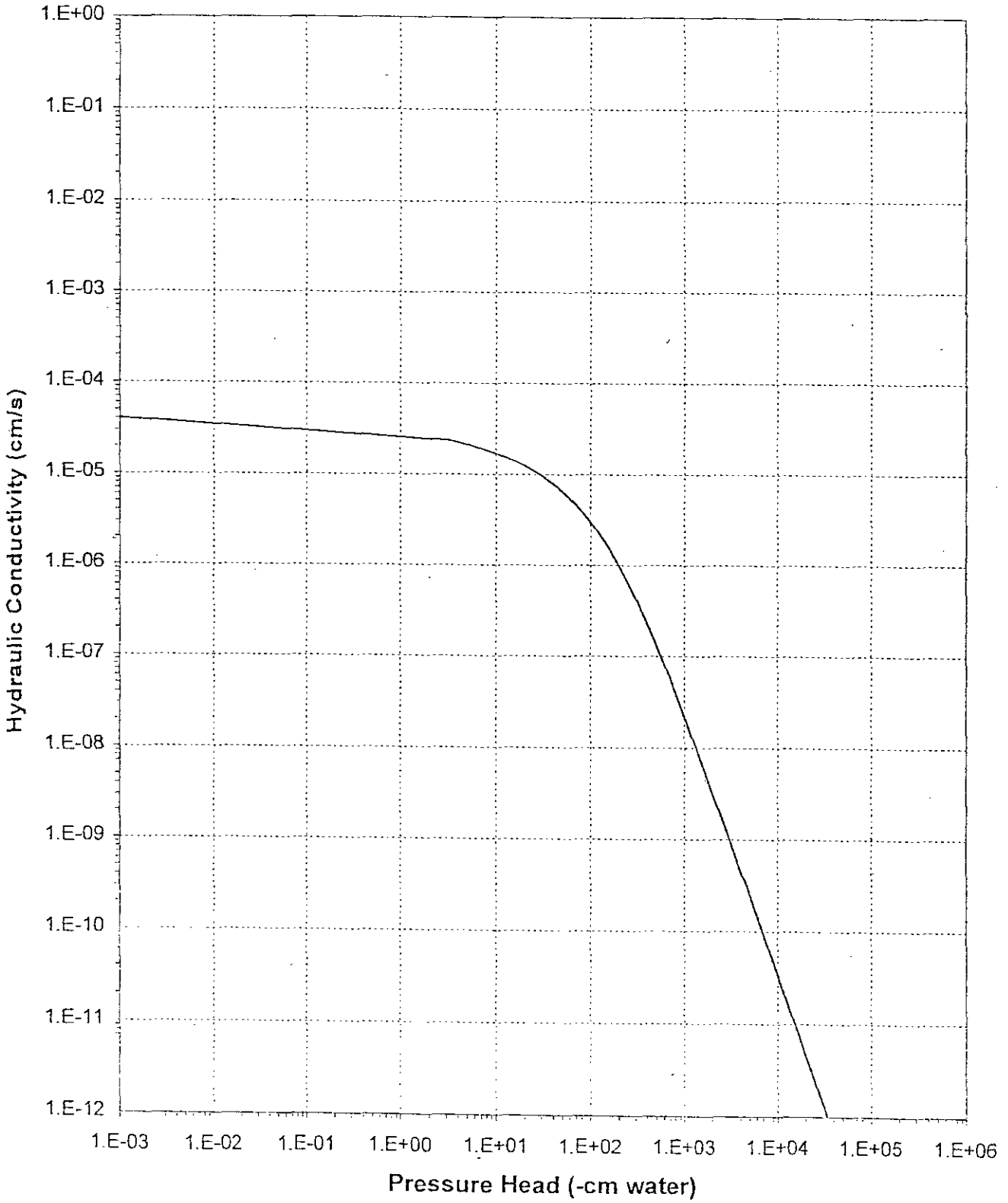
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-1



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-1



Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-2
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 74.67
Tare wt., screen & clamp (g): 25.33
Tare wt., ring (g): 34.07
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 50.99

Saturated weight at 0 cm tension* (g): 154.52
Volume of water† in saturated sample (cm^3): 20.45
Saturated moisture content (% vol): 40.11
Sample bulk density (g/cm^3): 1.46

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	28-Feb-03 / 14:00	154.52	0.00	40.11
	03-Mar-03 / 12:30	154.24	21.00	39.56
	05-Mar-03 / 15:30	153.47	49.00	38.05
	07-Mar-03 / 15:00	153.07	150.00	37.26
Pressure plate:	10-Mar-03 / 13:00	146.94	509.90	25.24

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-2
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 154.86
Tare weight, jar (g): 121.47
Sample bulk density (g/cm^3): 1.46

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	27-Feb-03 / 10:00	158.08	7444.5	14.12

Dry weight of relative humidity box sample* (g): 71.00
Tare weight (g): 42.11
Sample bulk density (g/cm^3): 1.46

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	03-Mar-03 / 12:30	71.53	851293	2.73

Comments:

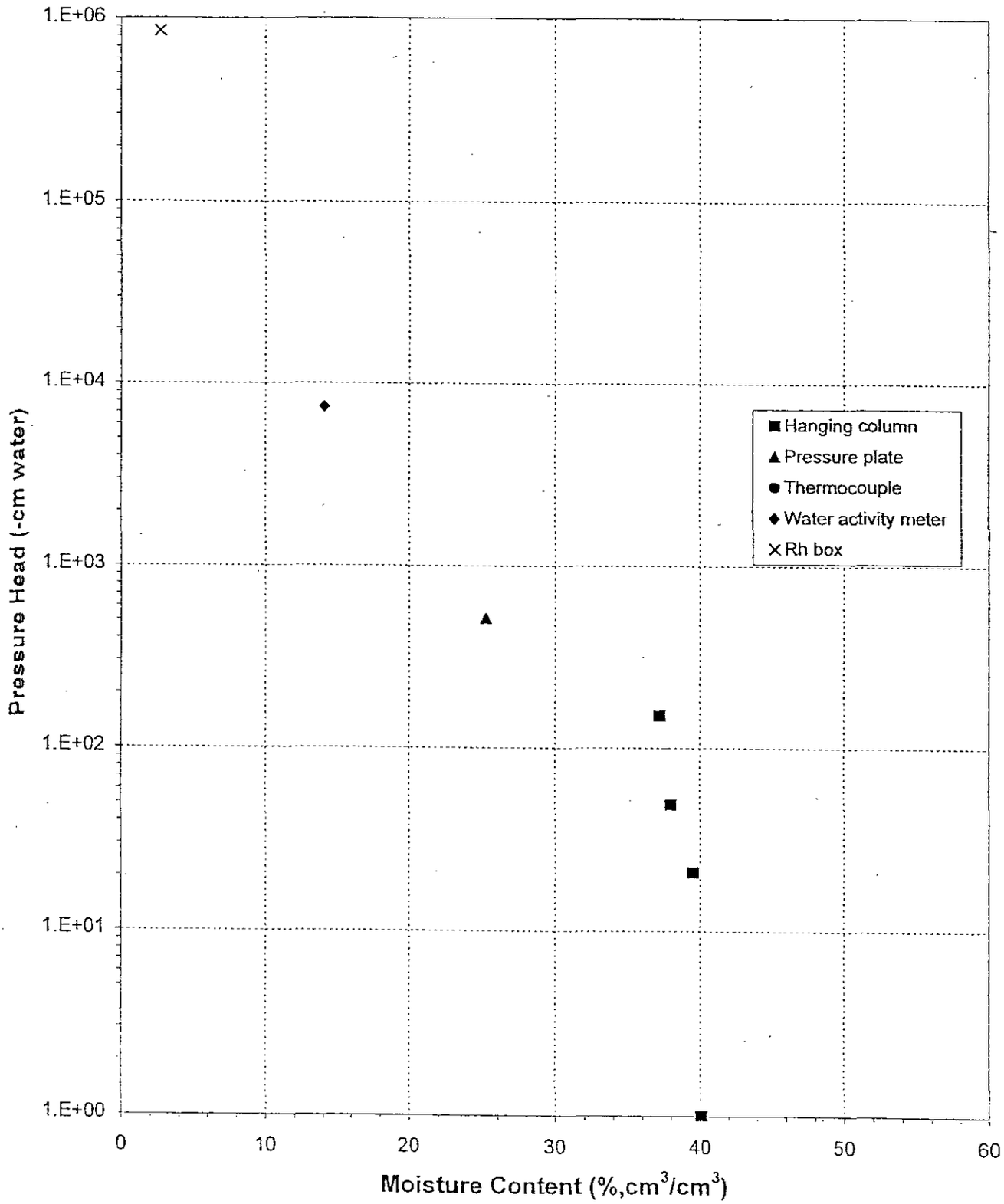
* Weight including tares

† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

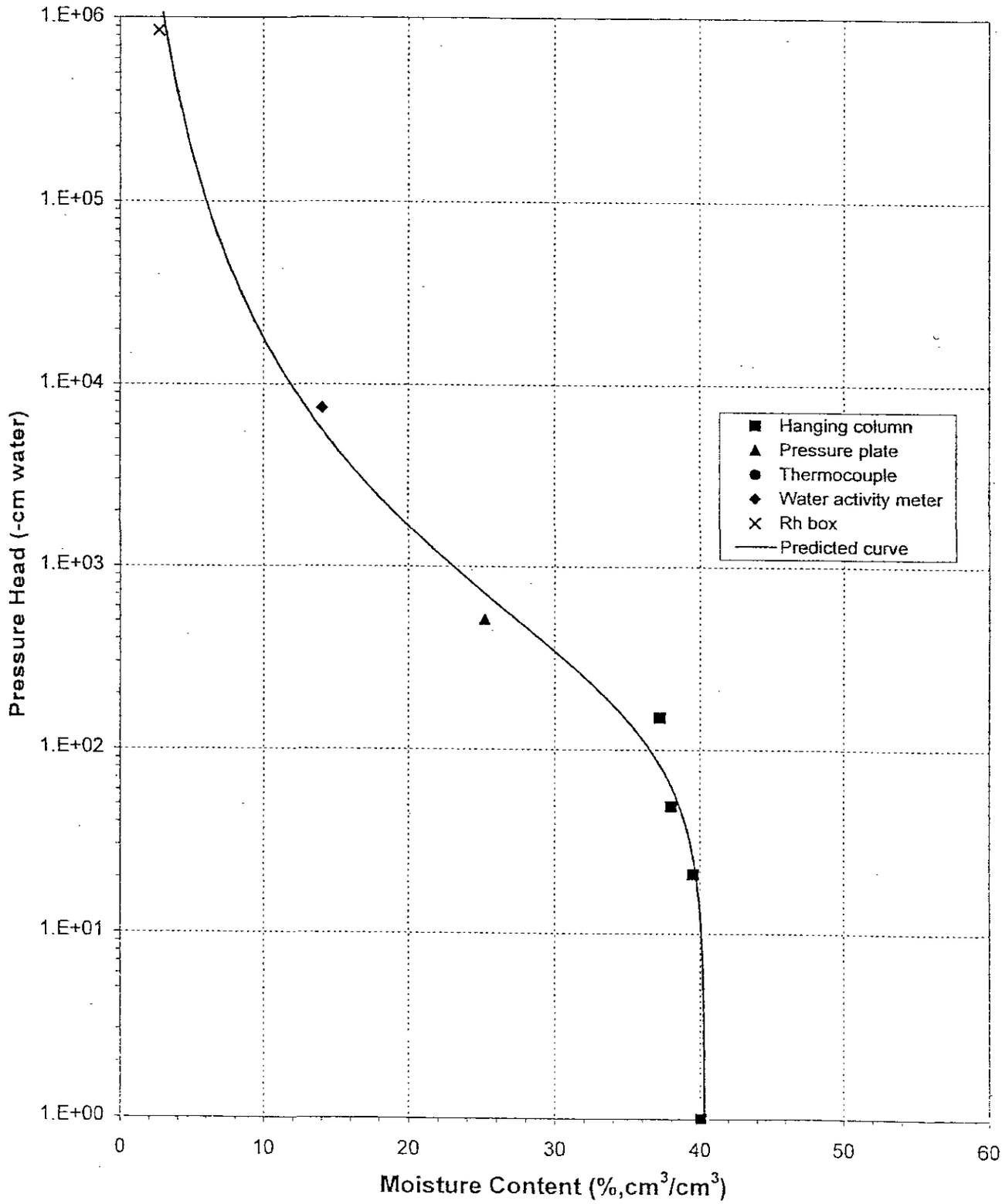
Water Retention Data Points

Sample Number: BLUF-2



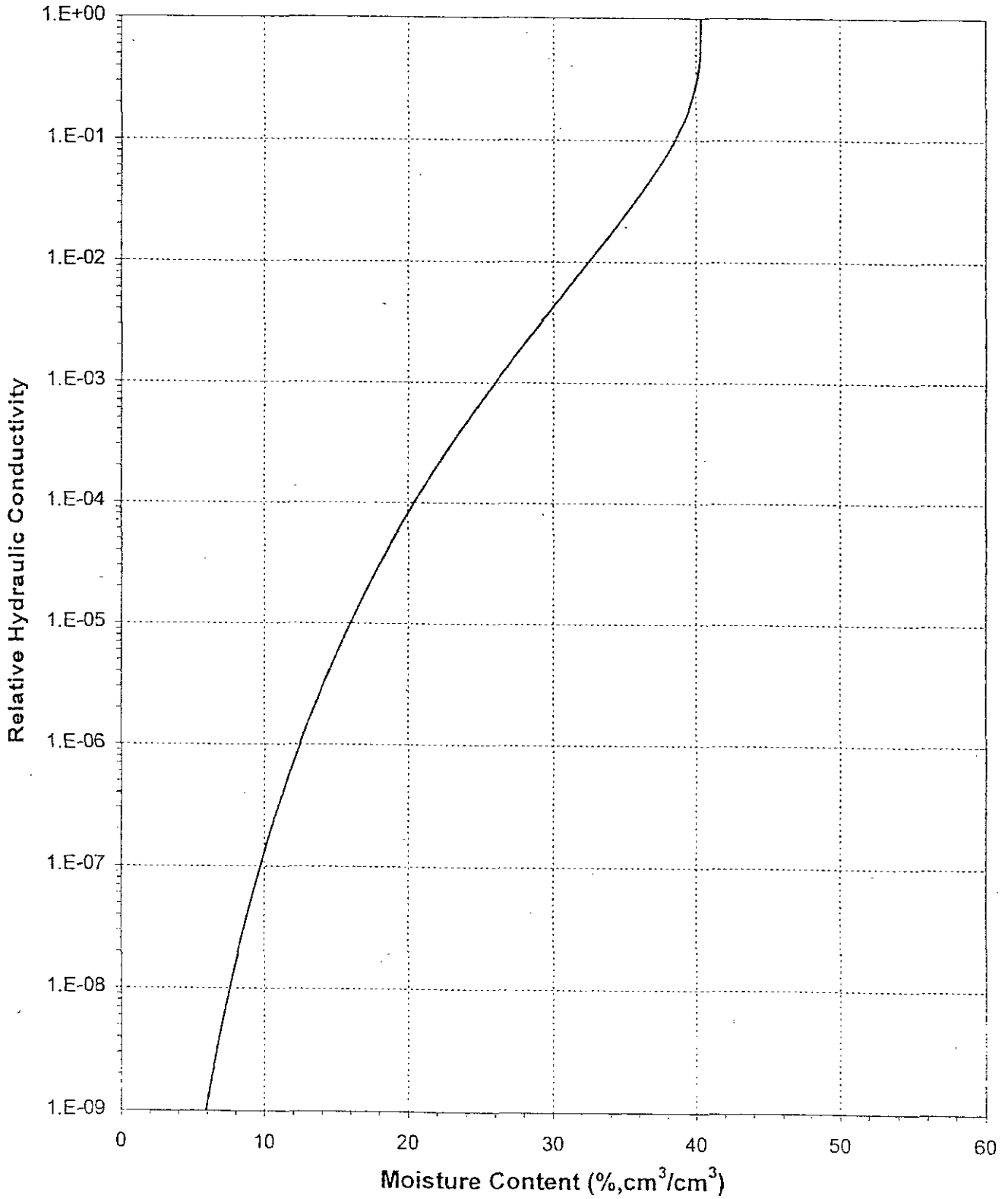
Predicted Water Retention Curve and Data Points

Sample Number: BLUF-2



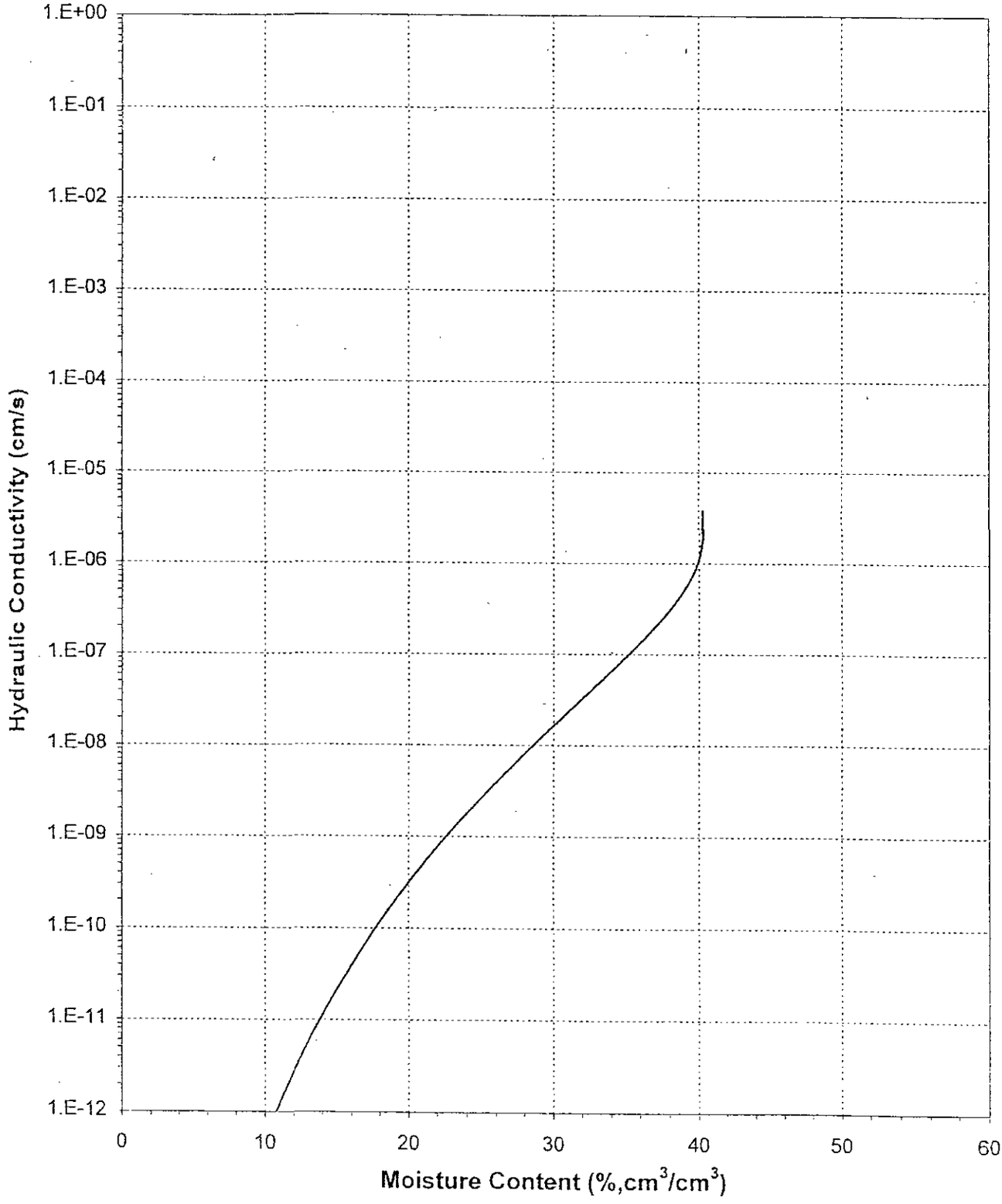
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-2



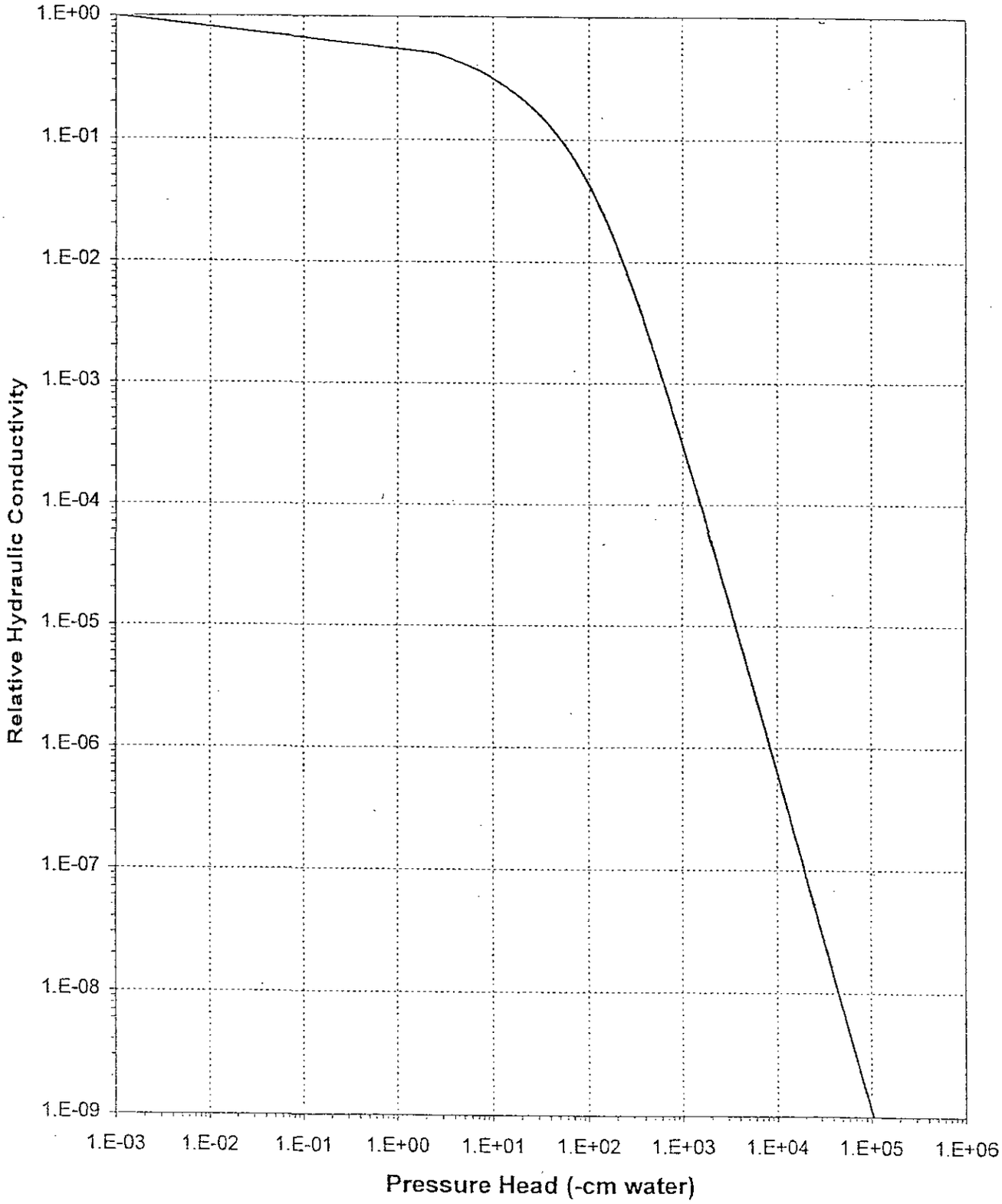
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-2



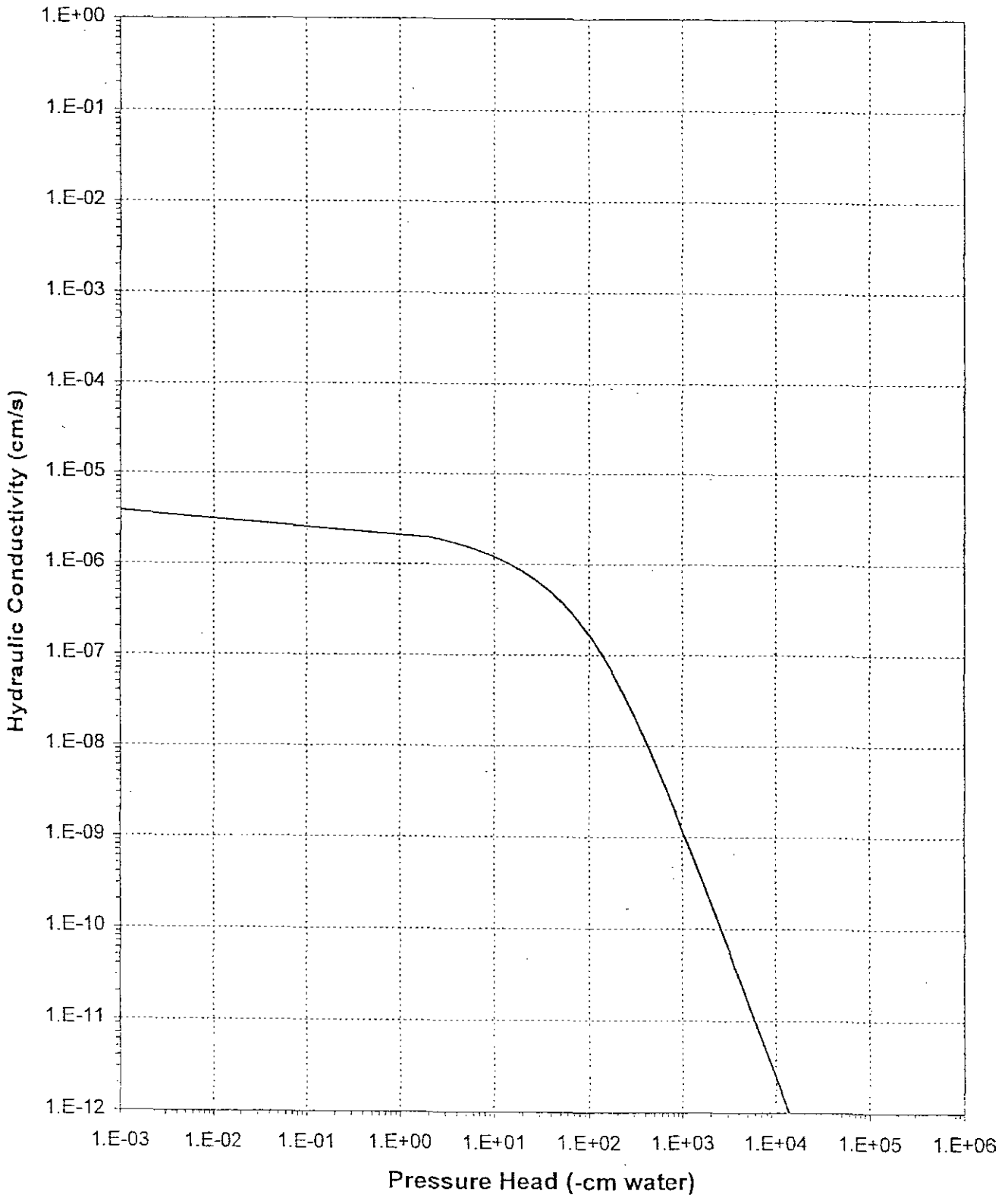
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-2



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-2



Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-3
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 100.70
Tare wt., screen & clamp (g): 25.48
Tare wt., ring (g): 41.93
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 63.72

Saturated weight at 0 cm tension* (g): 192.47
Volume of water† in saturated sample (cm^3): 24.36
Saturated moisture content (% vol): 38.23
Sample bulk density (g/cm^3): 1.58

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	28-Feb-03 / 14:00	192.47	0.00	38.23
	03-Mar-03 / 12:30	192.17	21.00	37.76
	05-Mar-03 / 15:30	191.27	49.00	36.34
	07-Mar-03 / 15:00	190.00	150.00	34.35
Pressure plate:	10-Mar-03 / 13:00	183.80	509.90	24.62

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-3
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 141.82
Tare weight, jar (g): 111.56
Sample bulk density (g/cm^3): 1.58

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	27-Feb-03 / 09:50	144.06	17540.6	11.70

Dry weight of relative humidity box sample* (g): 85.94
Tare weight (g): 40.78
Sample bulk density (g/cm^3): 1.58

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	03-Mar-03 / 12:30	86.67	851293	2.53

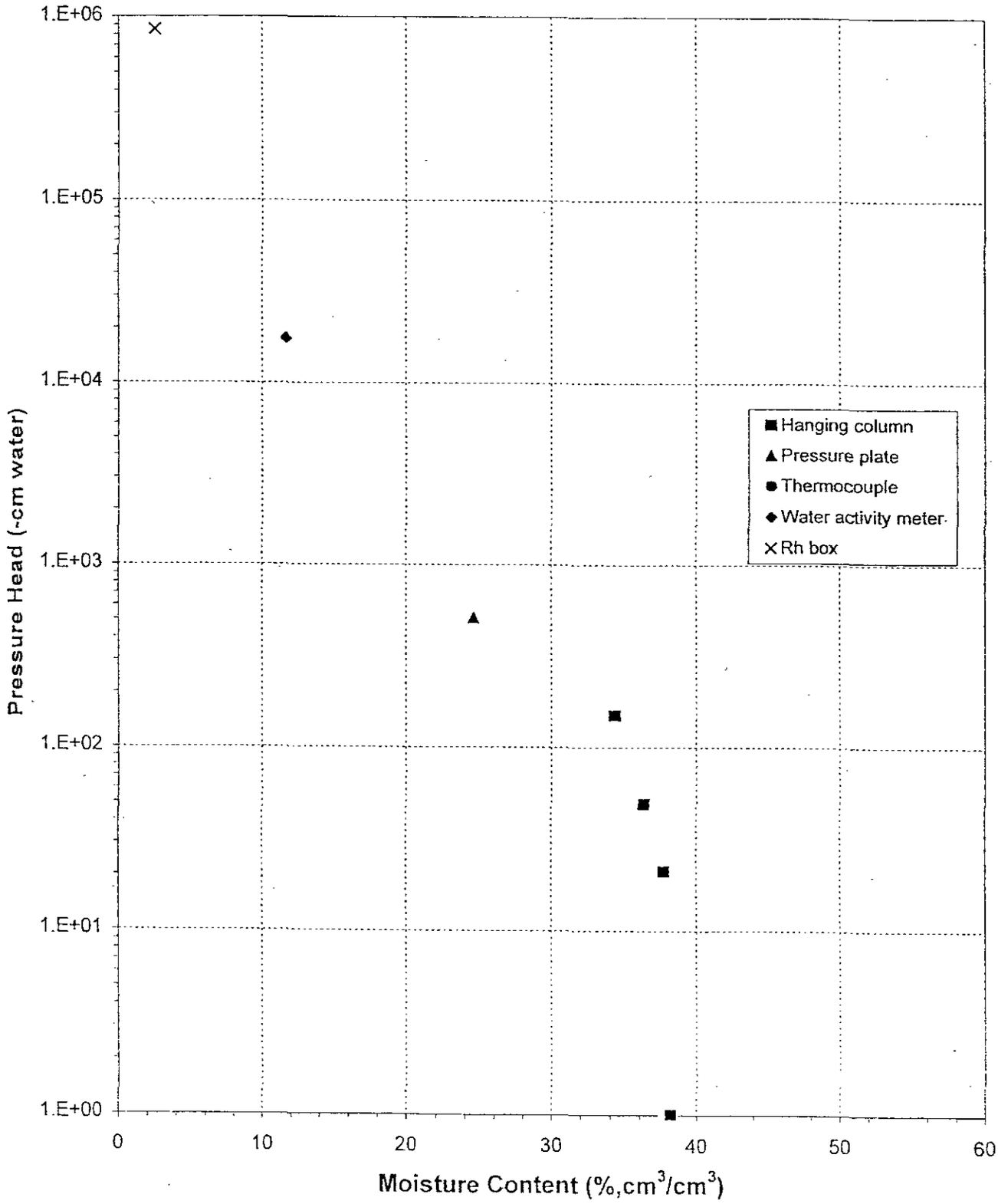
Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

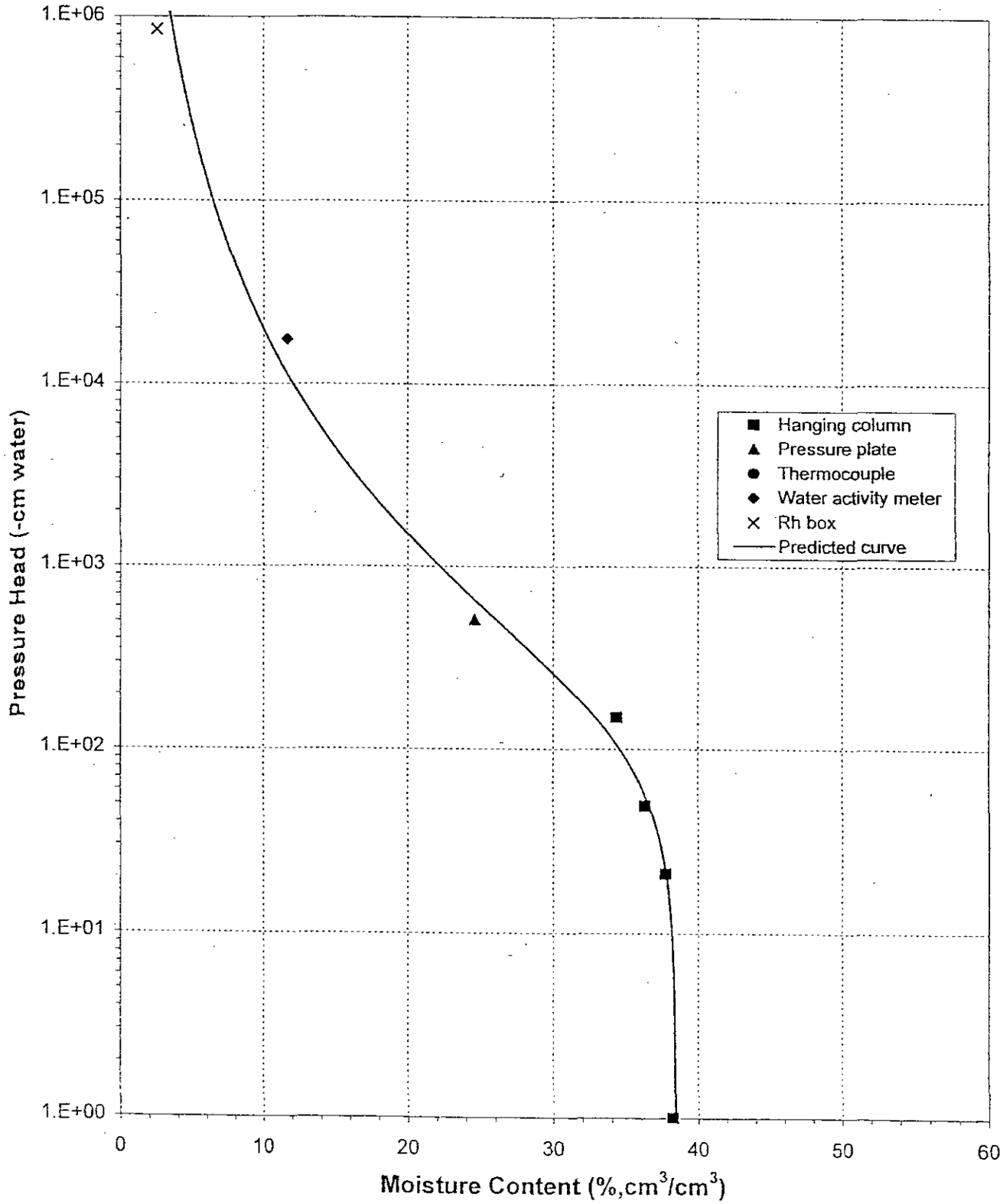
Water Retention Data Points

Sample Number: BLUF-3



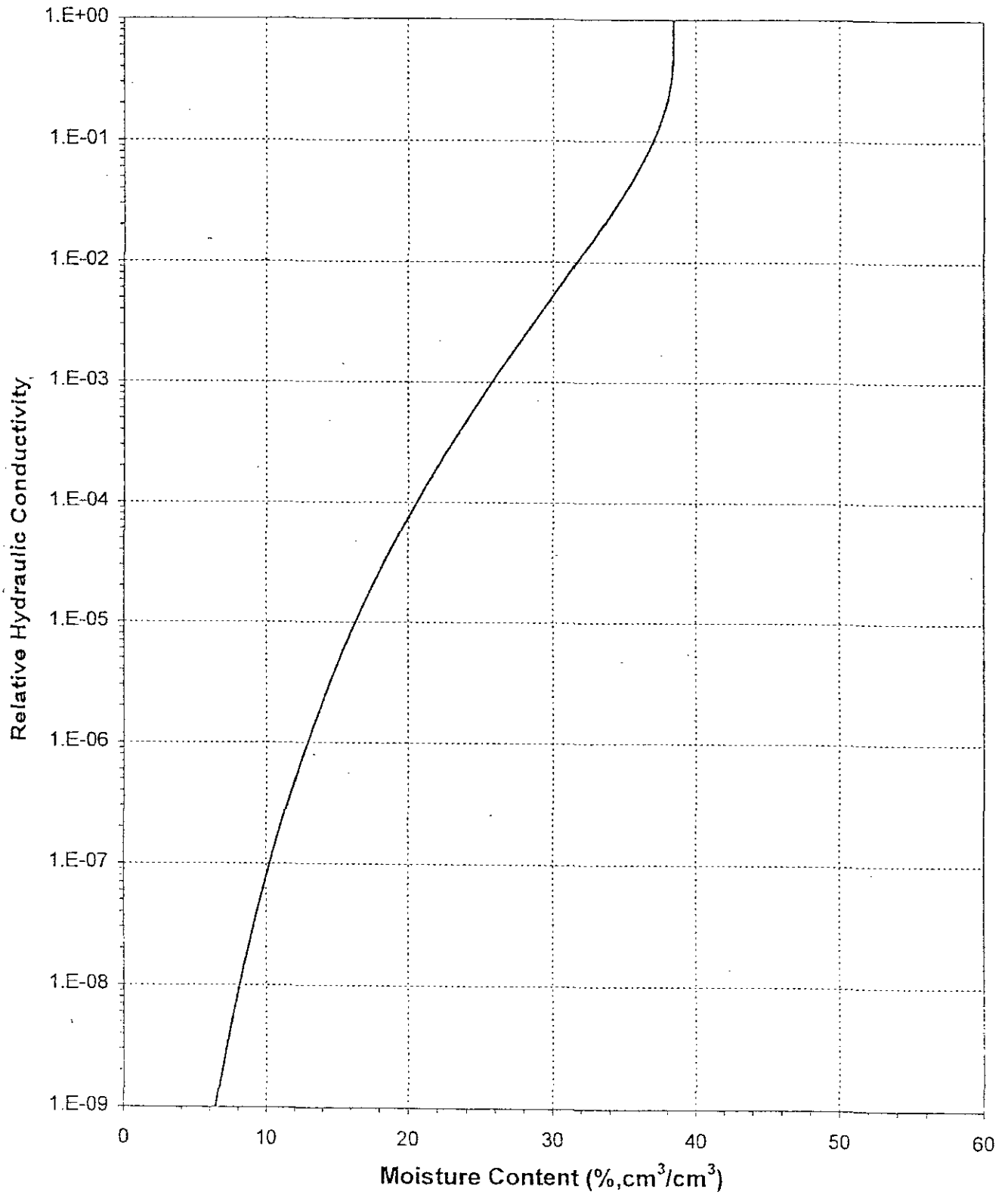
Predicted Water Retention Curve and Data Points

Sample Number: BLUF-3



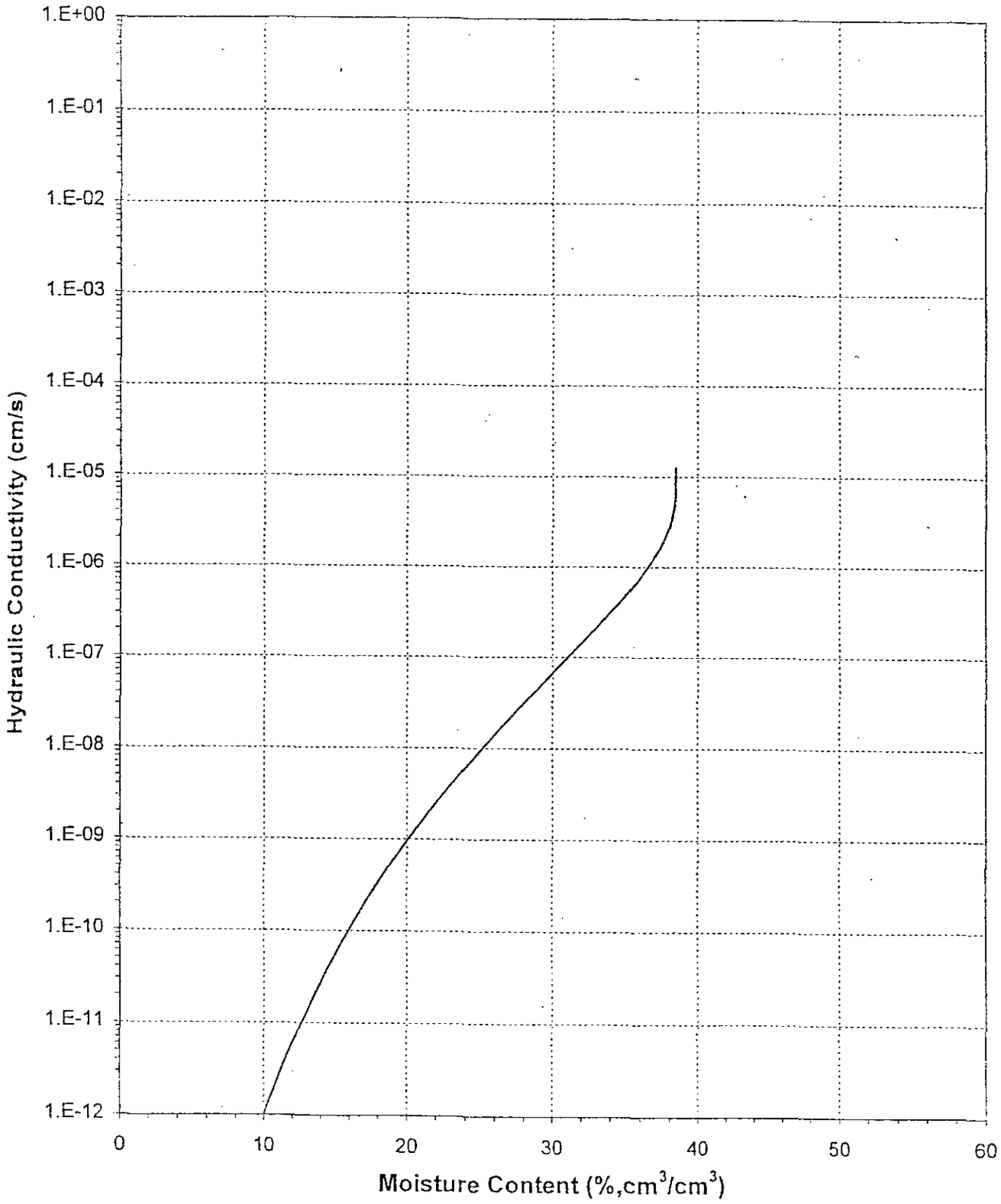
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-3



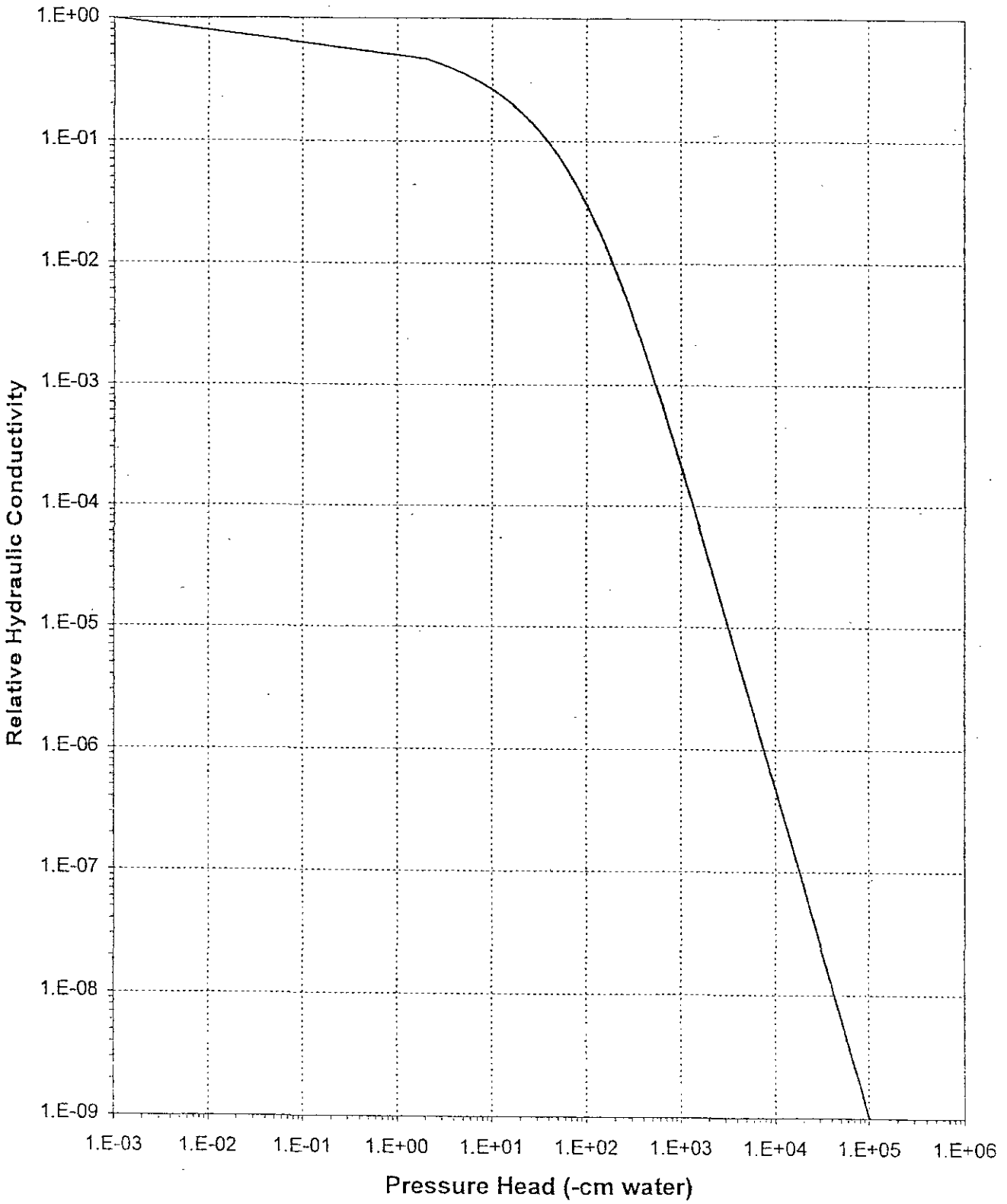
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-3



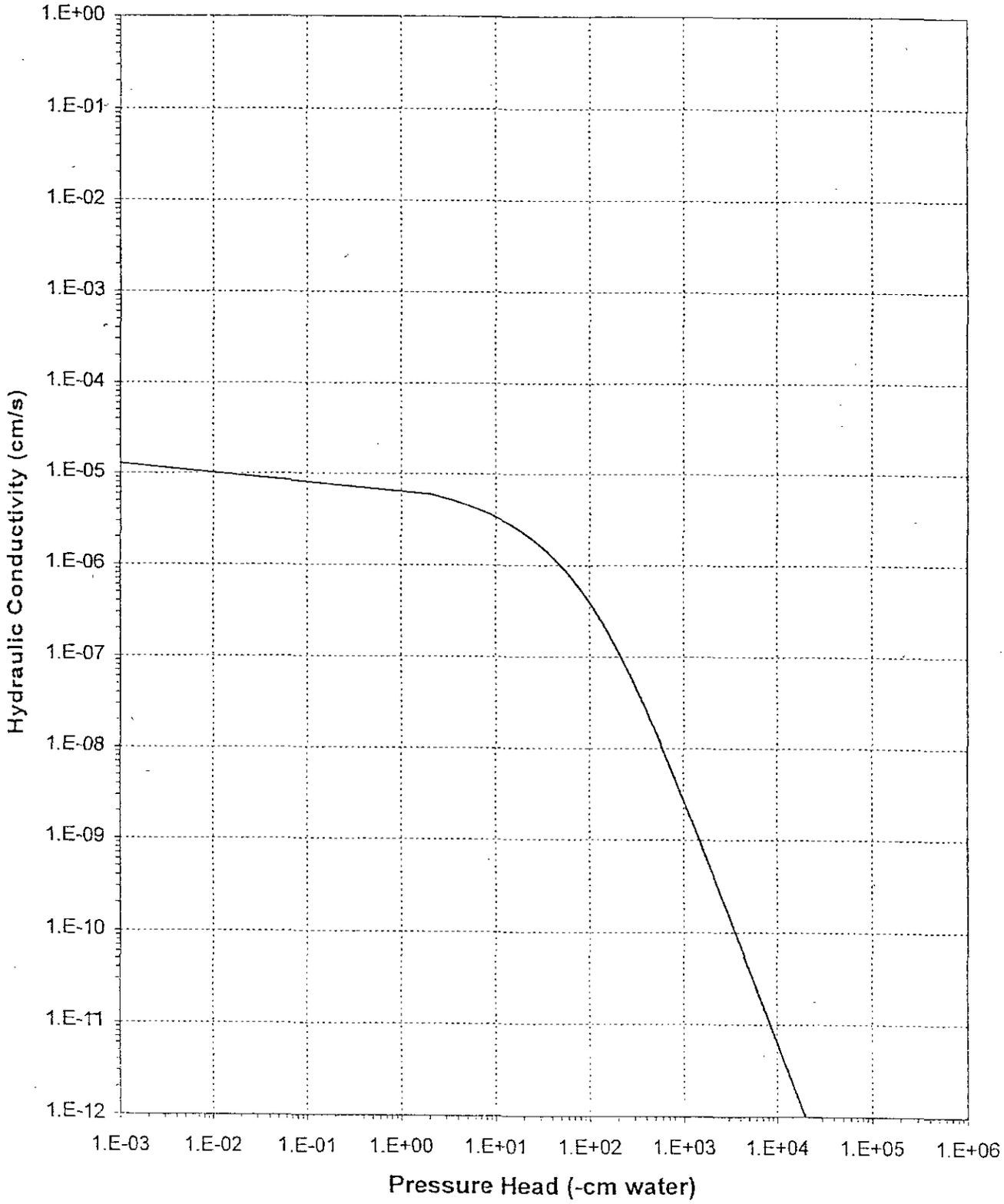
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-3



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-3



Moisture Retention Data

Hanging Column/Pressure Plate/Thermocouple

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-4
Ring Number: NA
Depth: NA

Dry wt. of sample (g): 76.24
Tare wt., screen & clamp (g): 25.84
Tare wt., ring (g): 39.39
Tare wt., epoxy (g): 0.00
Sample volume (cm^3): 59.97

Saturated weight at 0 cm tension* (g): 174.24
Volume of water† in saturated sample (cm^3): 32.77
Saturated moisture content (% vol): 54.64
Sample bulk density (g/cm^3): 1.27

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	28-Feb-03 / 14:00	174.24	0.00	54.64
	03-Mar-03 / 12:30	170.46	10.00	48.34
	05-Mar-03 / 15:30	166.48	43.00	41.70
	07-Mar-03 / 15:00	159.94	80.00	30.80
Pressure plate:	10-Mar-03 / 13:00	152.54	509.90	18.46

Comments:

* Weight including tares
† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

Moisture Retention Data

Water Activity Meter/Relative Humidity Box

(Main Drainage Curve)

Job Name: Kleinfelder
Job Number: WR03.0035.00
Sample Number: BLUF-4
Ring Number: NA
Depth: NA

Dry weight of water activity meter sample* (g): 140.98
Tare weight, jar (g): 116.07
Sample bulk density (g/cm^3): 1.27

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Water Activity Meter:	28-Feb-03 / 10:30	142.56	9892.1	8.06

Dry weight of relative humidity box sample* (g): 71.69
Tare weight (g): 44.95
Sample bulk density (g/cm^3): 1.27

	Date/Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Relative humidity box:	03-Mar-03 / 12:30	72.31	851293	2.93

Comments:

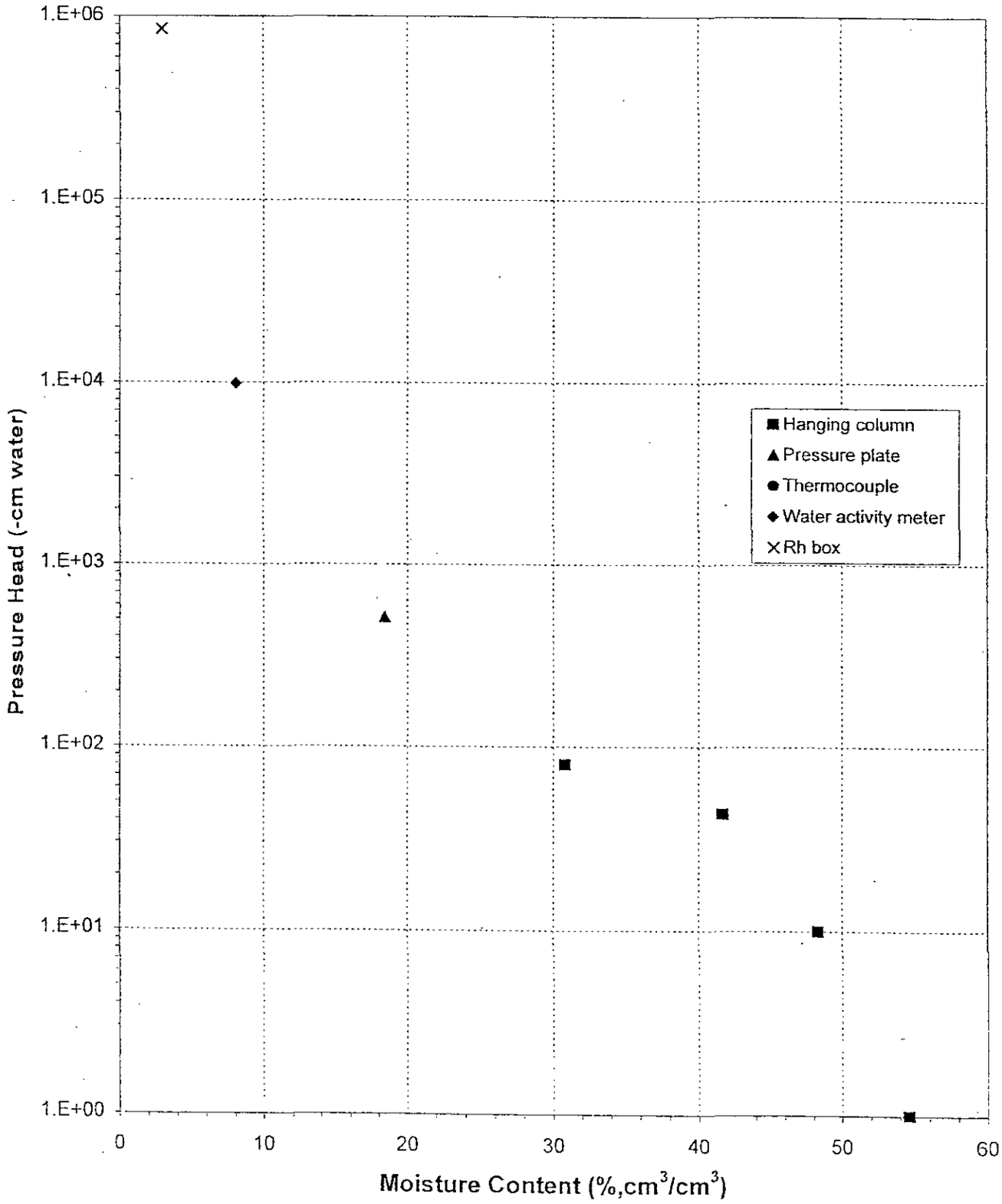
* Weight including tares

† Assumed density of water is 1.0 g/cm^3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: D. O'Dowd

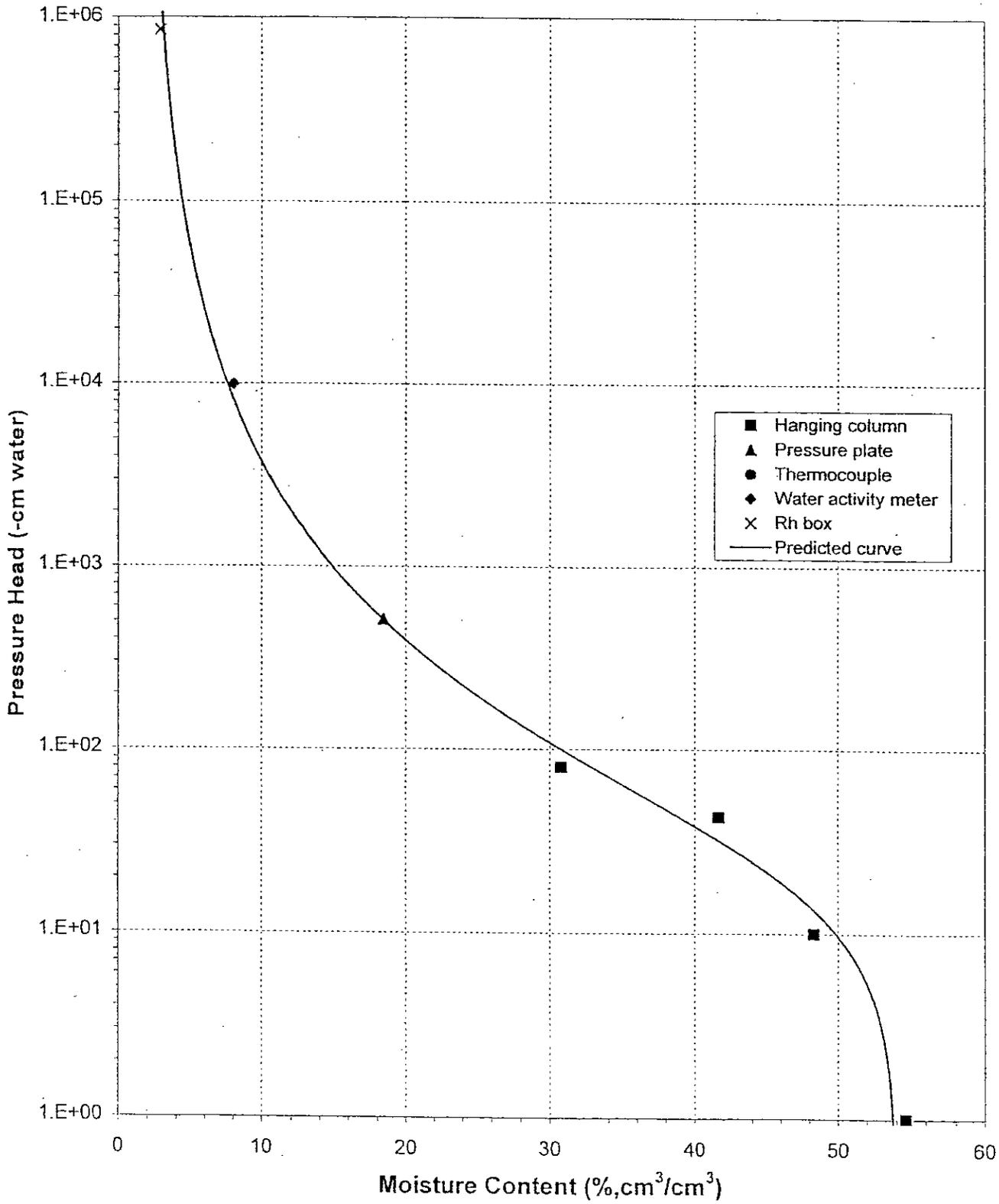
Water Retention Data Points

Sample Number: BLUF-4



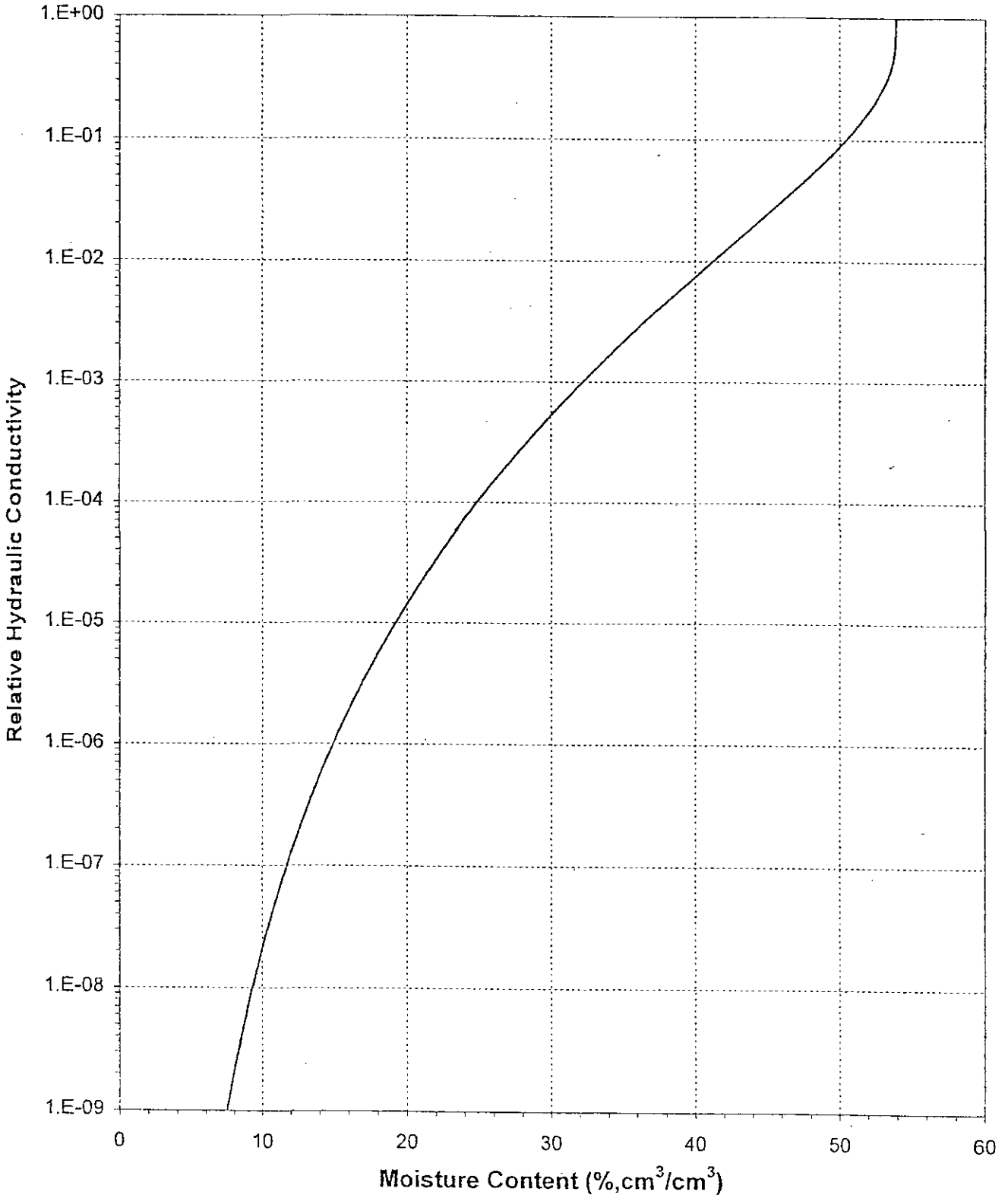
Predicted Water Retention Curve and Data Points

Sample Number: BLUF-4



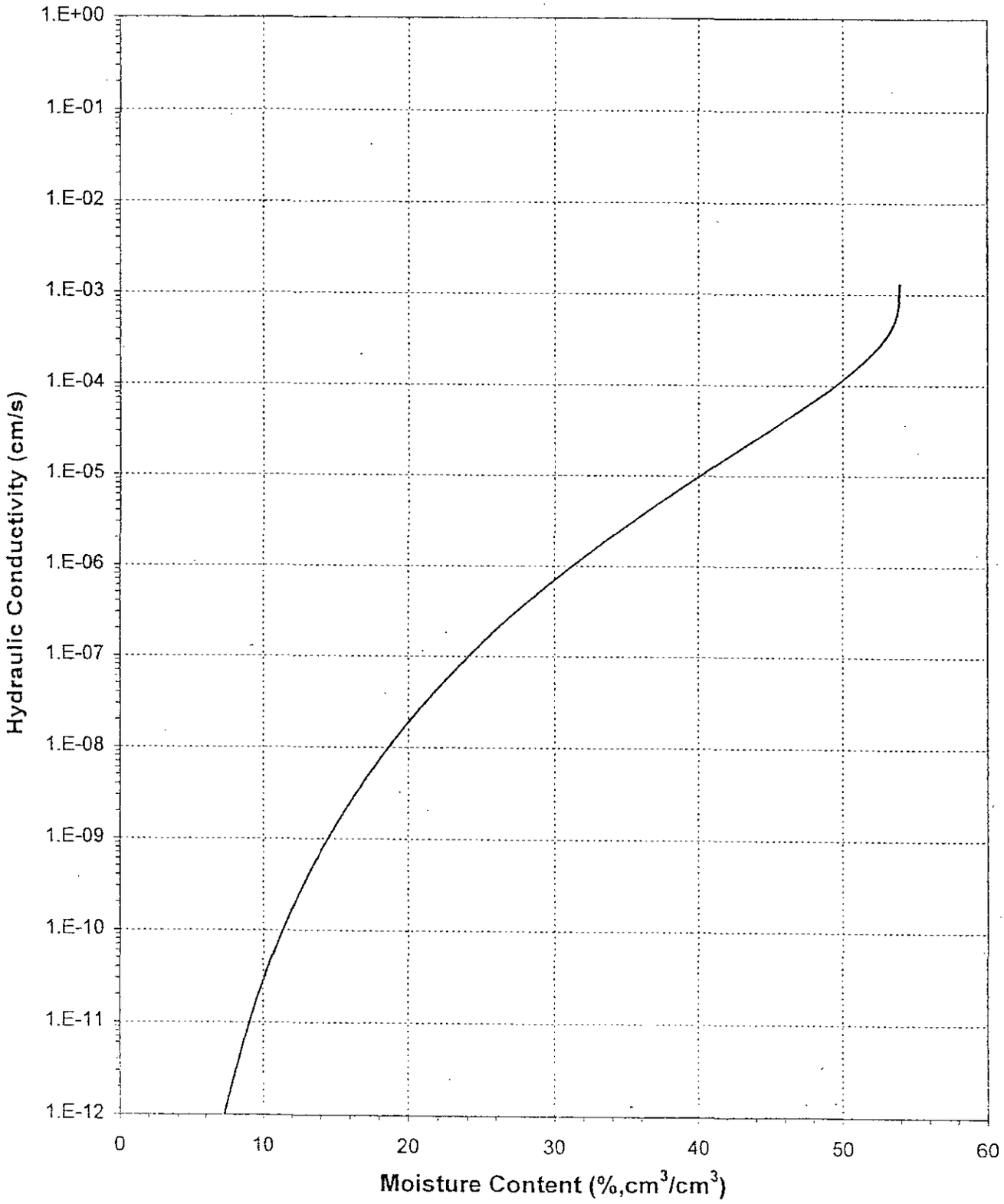
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-4



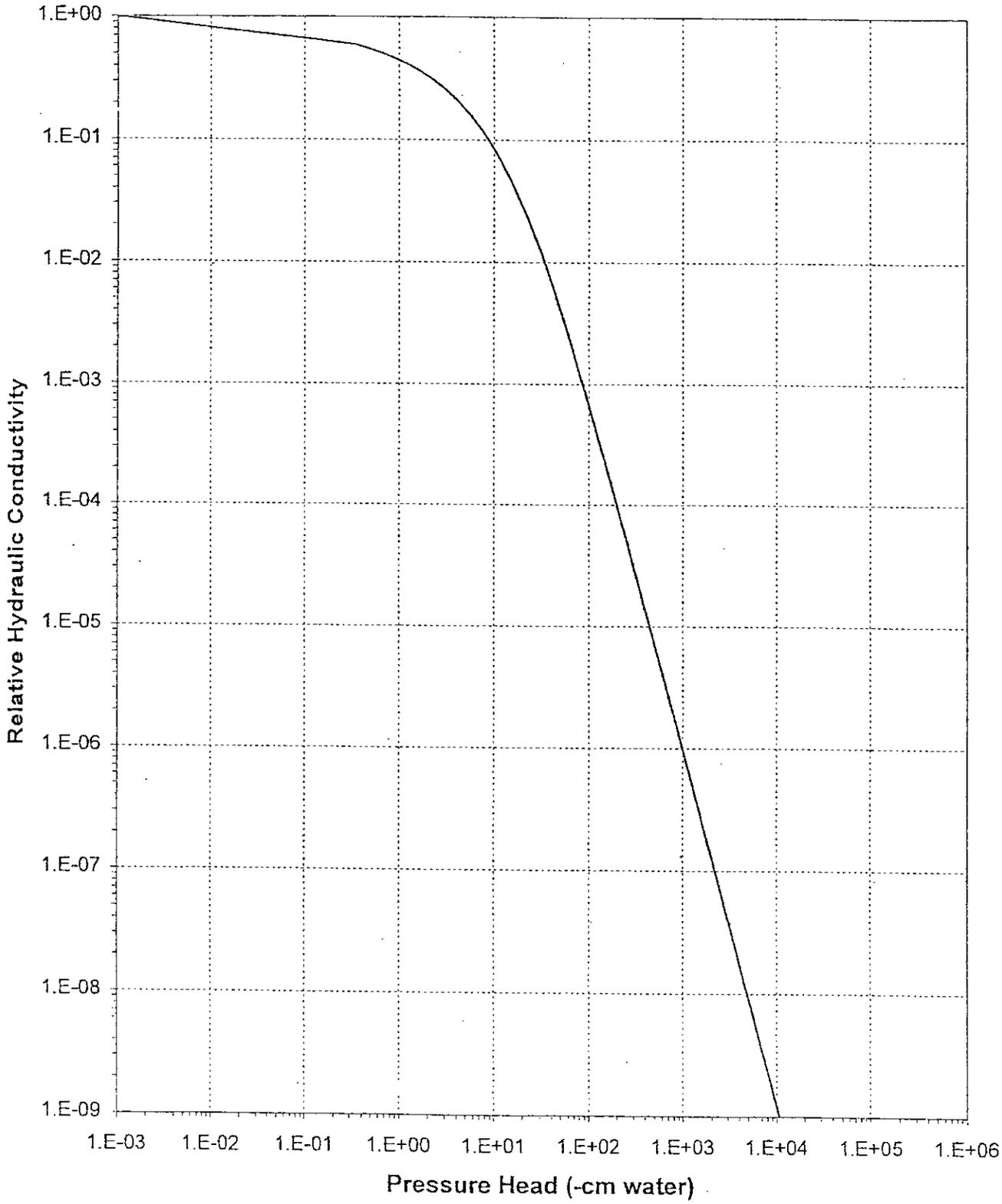
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-4



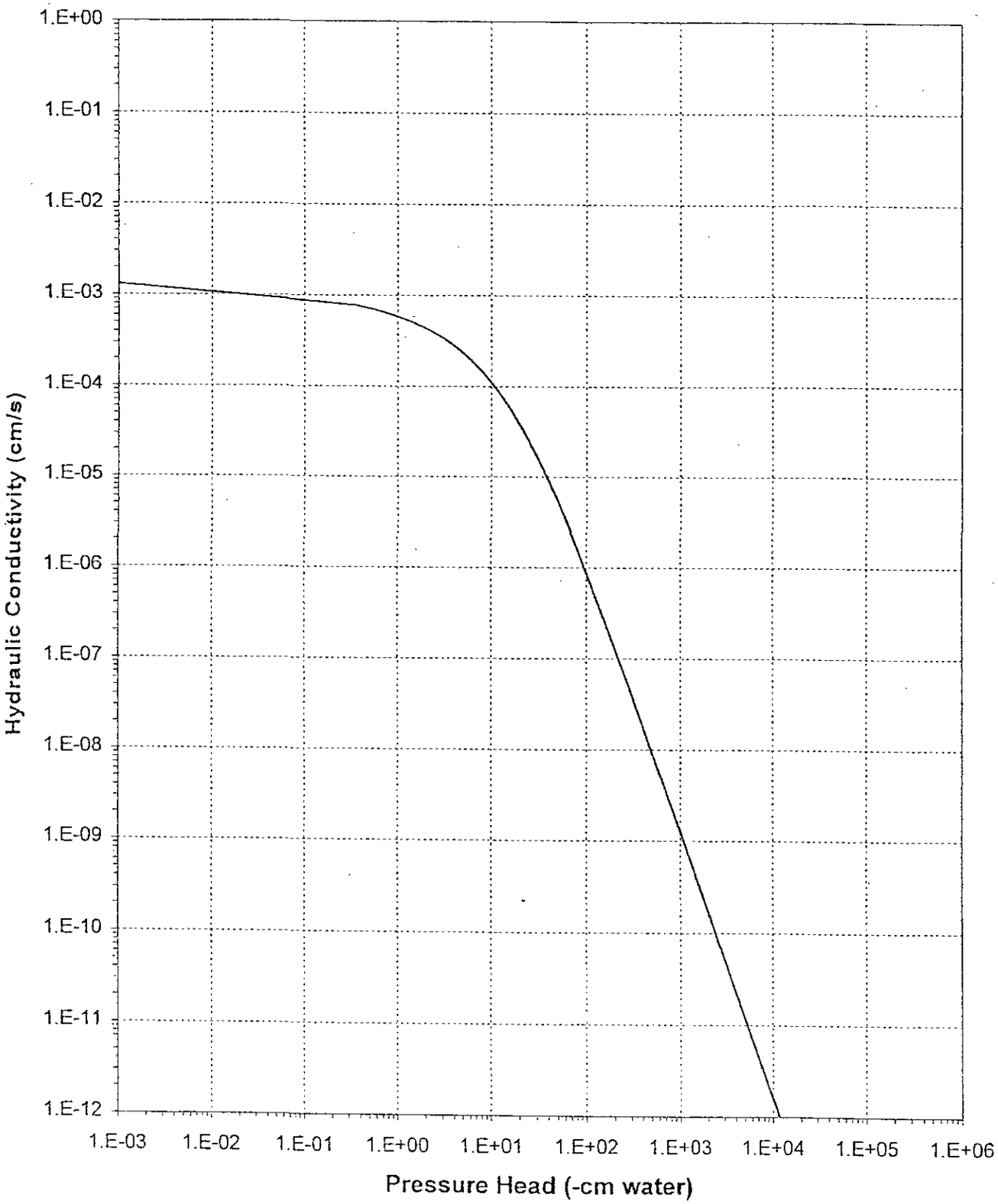
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-4



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-4



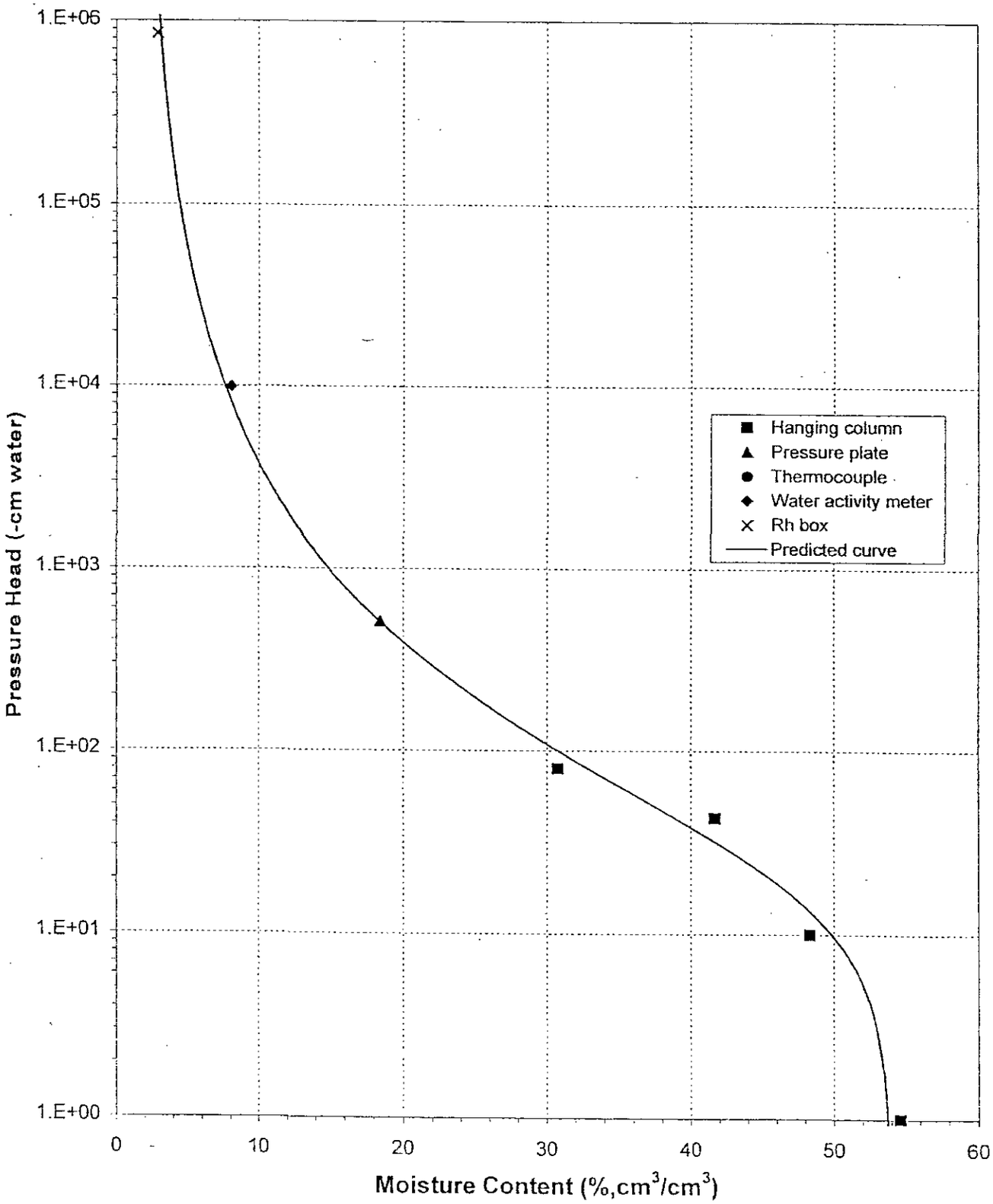
Laboratory Tests and Methods

Methods

Dry Bulk Density:	ASTM D 4531-91
Moisture Content:	ASTM D 2216-92
Calculated Porosity	Klute, A. 1986. Porosty. Chp.18-2.1, pp. 444-445, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Ksat:	
Constant Head:	ASTM D 2434-68 (93)
Hanging Column Method	Klute, A. 1986. Porosty. Chp.26, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Pressure Plate Method	ASTM D 2325-65 (94)
Water Potential Method	Dane, H. Jacob and G. Clark Topp. 2002. Chp.3. pp. 663-665, in J. H. Dane and G. C. Topp (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Relative Humidity Box	Klute, A. 1986. Porosty. Chp.26, in A. Klute (ed.), Methods of Soil Analysis, American Society of Agronomy, Madison, WI
Calc. Kunsat	Soil Sci. Soc. Am. J. 1980 44:892-898

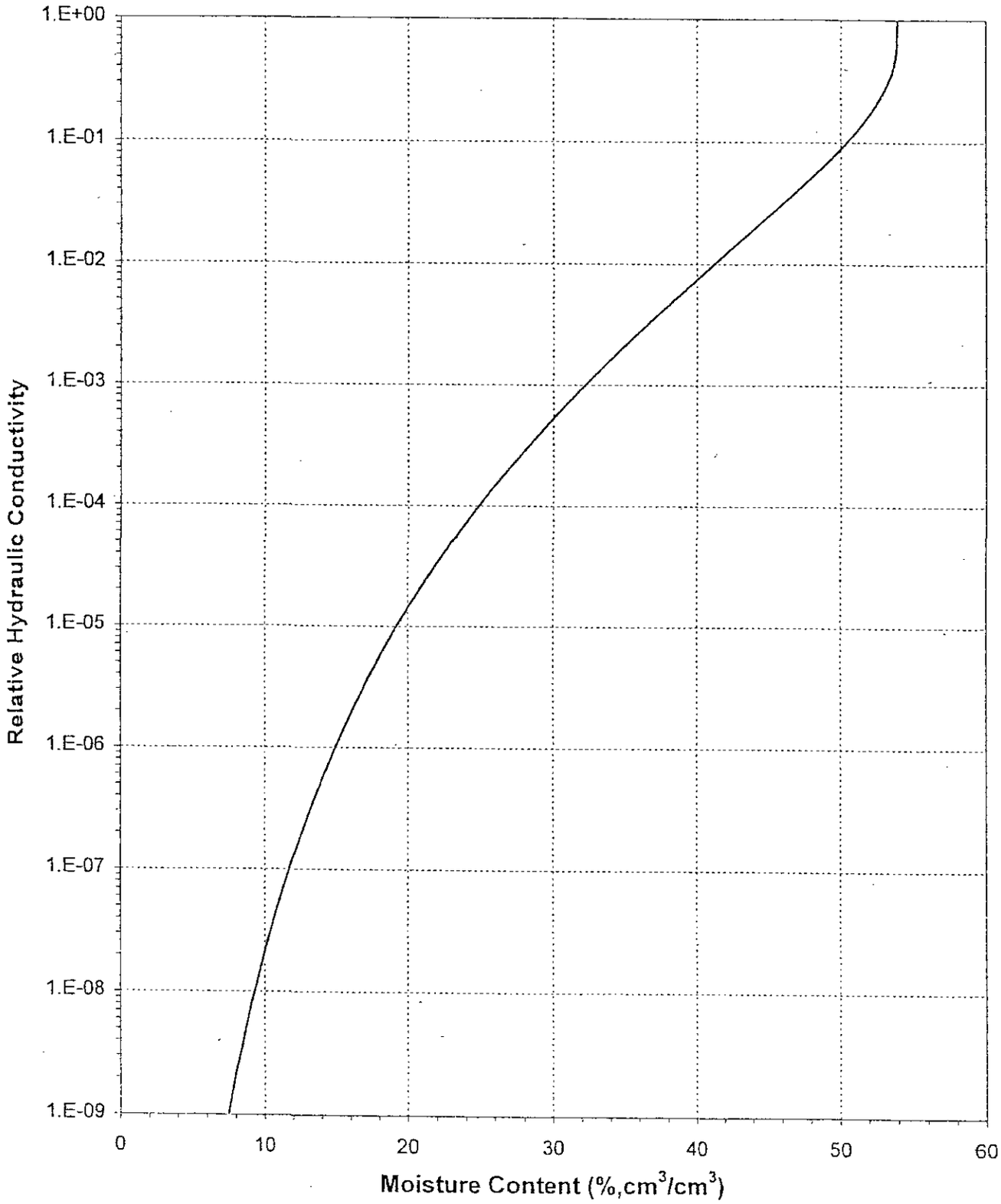
Predicted Water Retention Curve and Data Points

Sample Number: BLUF-4



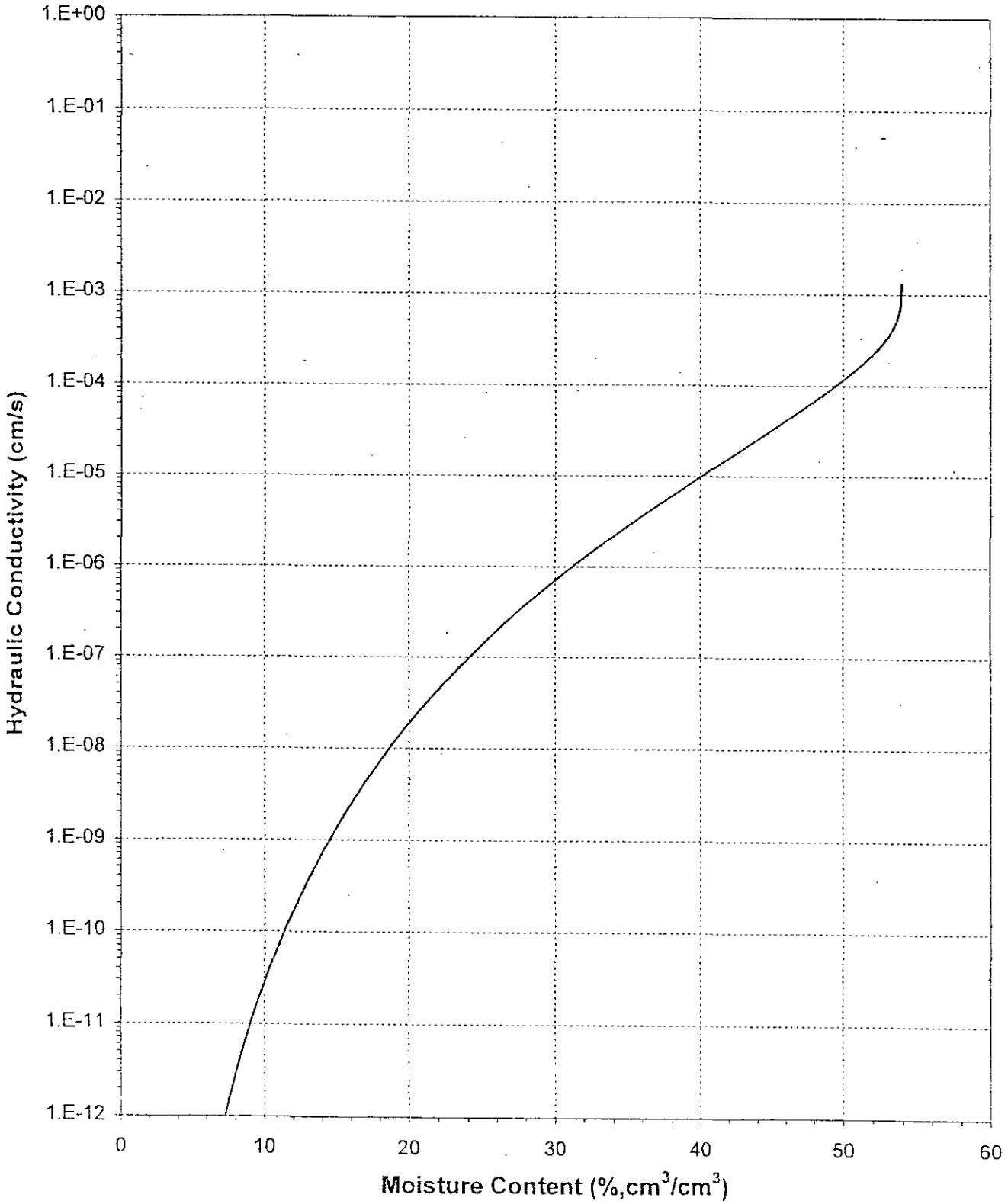
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-4



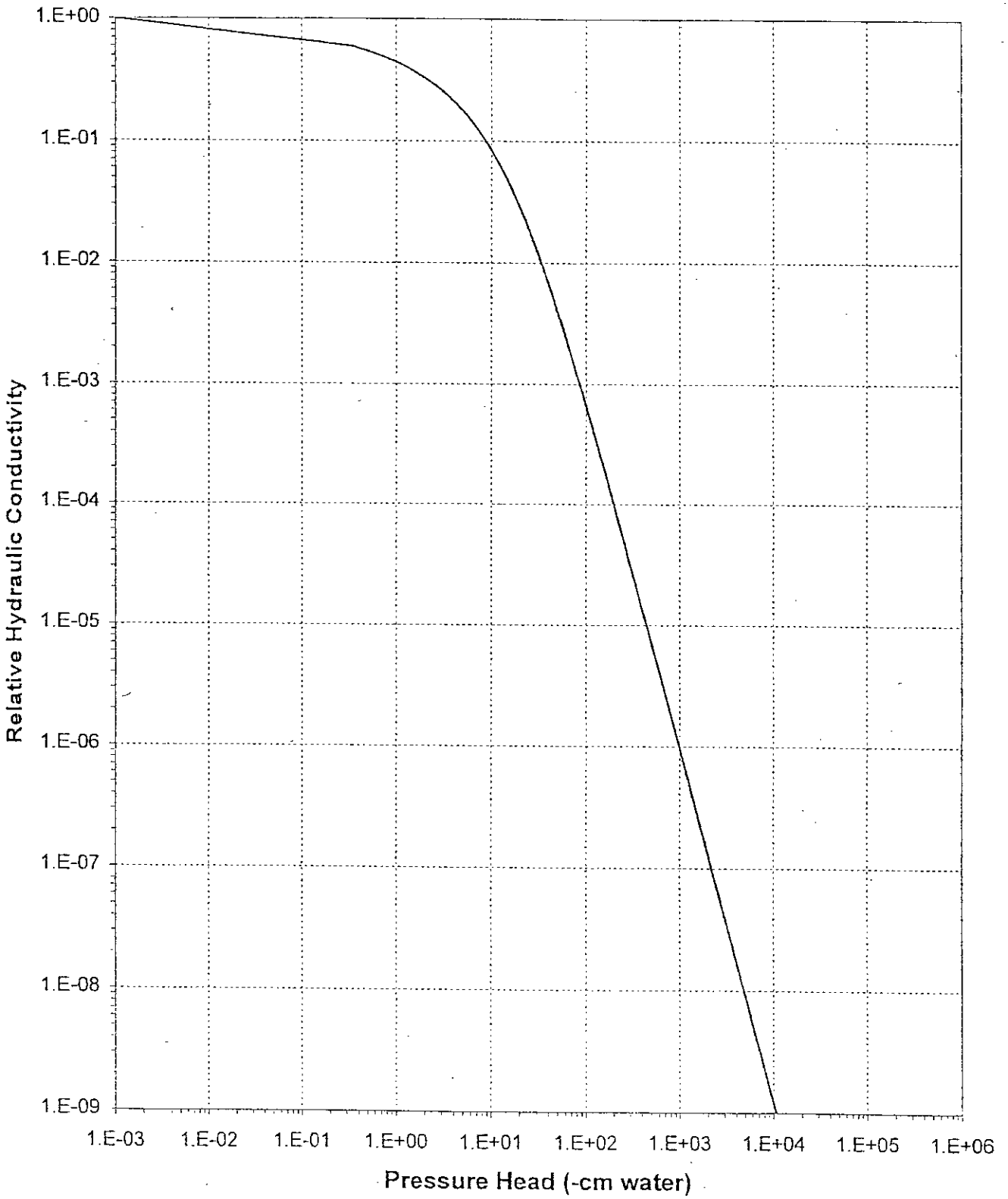
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: BLUF-4



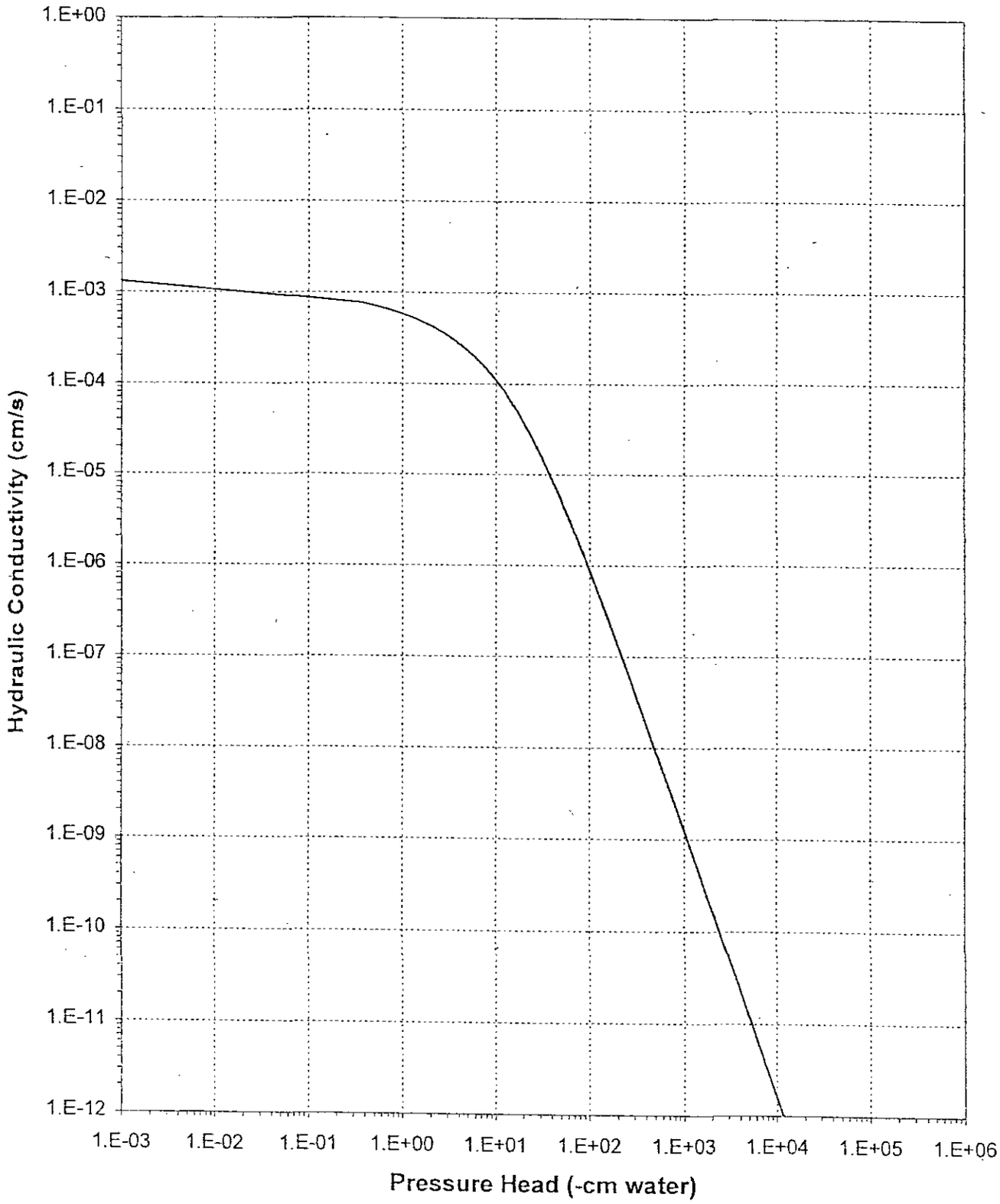
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-4



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: BLUF-4



Bayview Landfill
Frost Depth Calculation

Elberta, Utah NOAA Data
1951 - 1980

Dry Density	94	
Moisture Content	13	
Freezing Index (degree day)	880	
Mean Annual Air Temperature (deg F)	50.3	
Vo (deg F)	24.6	
Vs (deg F)	7.0	=freezing index/length of freezing
Length of Analysis Freezing Period (day)	125	
Latent Heat of Fustion "L" (Bty/ft^3)	1752.3	
Volumetric Heat "C" (Btu/ft/degF)	25.145	
Thermal Conductivity of Soil (Btu/ft^2/hr/degF/in)	0.6	
Alpha (Vo/Vs)	3.5	
Fusion Parameter "mu"	0.10	=C*Vs/L
Correction Coefficient "lambda"	0.62	chart

z = Lambda * ((48*F)/(L/k))^0.5

z = 2.36 feet

z = 28.3 inches

UDOT Map → 20 – 30 inches

Air Freezing Index- USA Method (Base 32^0 Fahrenheit)

State and Station Name	Station Number	Lat. (Deg.-Min.)	Long. (Deg.-Min.)	Elev. (feet)	Mean Annual Temp. (°F)	Air Freezing Index Return Periods (°F-Days) & Associated Probabilities (%)										
						1.1 Year (10%)	1.2 Year (20%)	2 Year (50%)	2.5 Year (60%)	3.3 Year (70%)	5 Year (80%)	10 Year (90%)	20 Year (95%)	25 Year (96%)	50 Year (98%)	100 Year (99%)
Utah																
BRYCE CANYON NP HDQ	421008	N3739	W11210	7915	41.1	606	743	1010	1090	1173	1270	1399	1503	1532	1615	1689
CAPITOL REEF NATL MON	421171	N3817	W11116	5500	53.3	60	100	217	263	317	387	493	590	620	708	791
CEDAR CITY FAA AP	421267	N3742	W11306	5620	50.3	80	125	248	293	345	411	509	596	622	699	771
COTTONWOOD WEIR //	421759	N4037	W11147	4950	53.6	50	80	165	198	235	283	355	420	439	497	551
COVE FORT //	421792	N3836	W11235	5980	47.8	158	231	407	468	537	621	743	847	878	968	1050
DEER CREEK DAM	422057	N4024	W11132	5270	43.5	464	614	936	1039	1150	1281	1464	1614	1658	1783	1895
DESERET	422101	N3917	W11239	4585	49.2	168	249	453	524	605	705	850	976	1014	1123	1223
DESERT EXP RANGE	422116	N3836	W11345	5252	49.0	136	212	416	491	578	686	849	992	1035	1162	1280
DUGWAY	422257	N4011	W11256	4340	51.4	114	178	344	405	475	562	693	807	842	943	1037
ECHO DAM	422385	N4058	W11126	5500	44.9	379	498	753	833	920	1023	1165	1282	1316	1413	1500
ELBERTA	422418	N3957	W11157	4690	50.3	113	177	347	410	482	572	708	828	864	969	1068
EPHRAIM SORENSENS FLD	422578	N3921	W11135	5580	47.0	297	405	650	730	818	923	1071	1195	1231	1335	1428
ESCALANTE	422592	N3746	W11136	5810	49.4	114	173	324	378	440	516	629	728	757	843	923
FAIRFIELD	422696	N4016	W11205	4876	46.6	271	375	614	692	779	883	1032	1156	1192	1297	1392
FARMINGTON USU FLD STA	422726	N4101	W11154	4340	51.2	76	123	253	302	360	432	543	641	671	760	842
FERRON	422798	N3905	W11108	5925	47.7	318	428	670	748	833	935	1077	1195	1229	1328	1416
FILLMORE	422828	N3857	W11219	5160	51.2	79	127	257	306	363	435	544	640	670	756	837
FORT DUCHESNE	422996	N4017	W10952	4990	44.7	627	846	1332	1489	1661	1866	2153	2392	2462	2662	2841
GARFIELD	423097	N4043	W11212	4310	53.0	68	109	223	266	316	379	475	560	586	663	734
GREEN RIVER AVN	423418	N3900	W11010	4070	51.5	180	274	516	603	702	826	1008	1167	1214	1354	1482
HANKSVILLE	423611	N3822	W11043	4308	53.1	122	194	390	463	548	655	817	961	1004	1132	1252
HEBER	423809	N4031	W11125	5580	44.4	414	544	822	910	1005	1117	1273	1401	1438	1543	1638
HIAWATHA	423896	N3929	W11101	7230	45.2	405	521	760	834	914	1007	1134	1238	1268	1354	1429
JENSEN	424342	N4022	W10921	4720	45.4	570	782	1261	1419	1592	1798	2091	2336	2408	2614	2800
KANAB	424508	N3703	W11232	4985	54.6	13	24	59	73	91	115	152	188	199	232	263
LAKETOWN	424856	N4149	W11119	5988	42.0	523	678	1001	1102	1211	1338	1514	1657	1699	1817	1921
LA VERKIN	424968	N3712	W11316	3200	58.6	3	6	20	26	33	44	61	78	83	100	116
LEVAN	425065	N3933	W11152	5300	49.1	175	254	445	511	584	674	804	915	948	1044	1131
LOA	425148	N3824	W11139	7045	43.2	397	513	754	830	911	1005	1136	1242	1273	1360	1438
LOGAN UTAH STATE UNIV	425186	N4145	W11149	4785	48.0	225	322	554	634	722	829	984	1116	1155	1268	1371
MANTI	425402	N3915	W11138	5740	47.6	214	297	485	547	616	698	815	914	943	1026	1101
MEXICAN HAT	425582	N3709	W10952	4270	56.3	15	35	118	159	212	289	422	558	602	740	880
MILFORD WSO //	425654	N3826	W11301	5028	49.1	149	226	420	489	568	666	811	936	974	1084	1185
MOAB 4 NW	425733	N3836	W10936	3965	56.6	36	68	176	222	278	355	478	595	631	743	850

30yr ≈ 88

Footnotes:

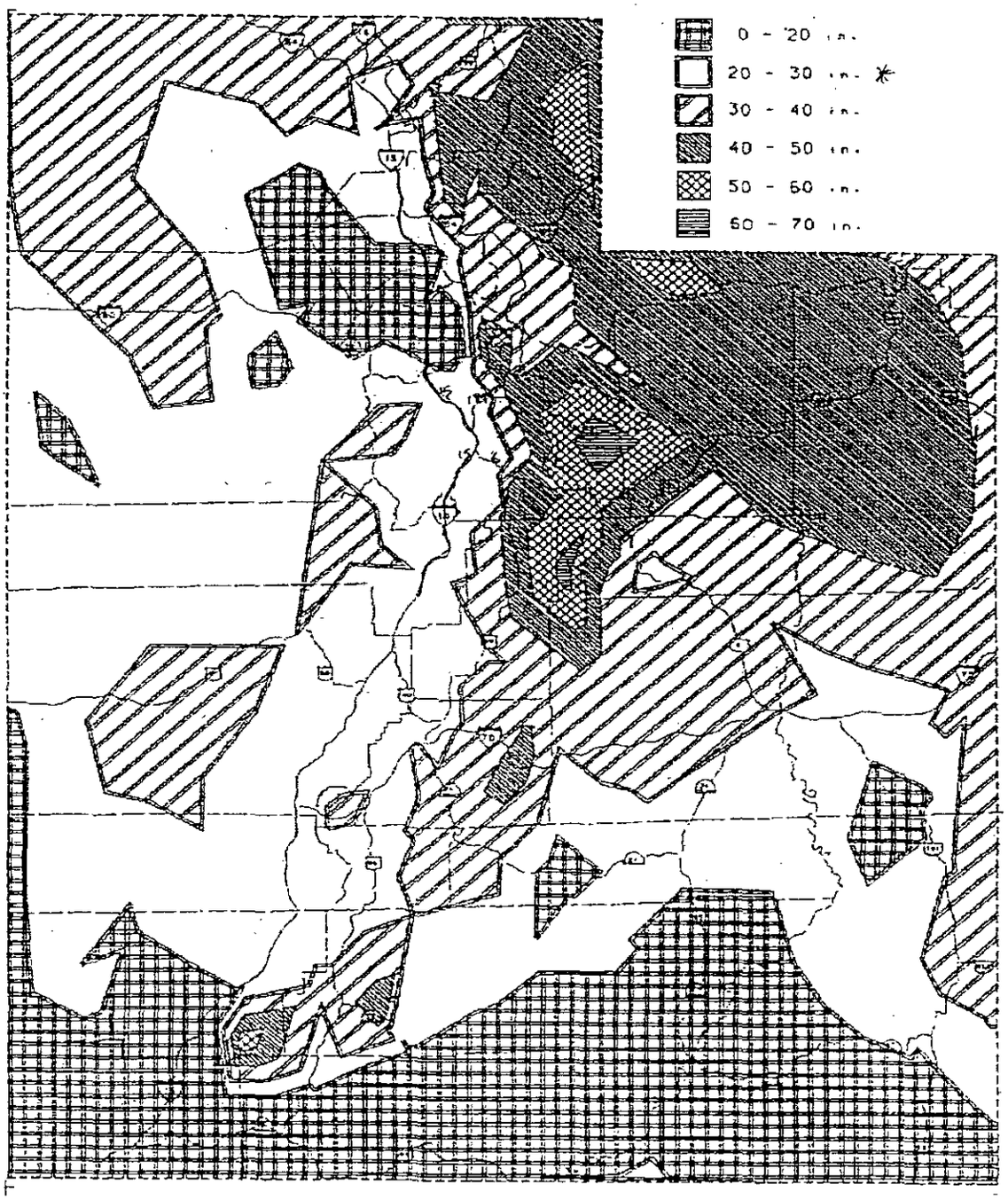
* Probability of occurrence less than indicated probability (Value=0)

** No Freezing Index Values Recorded during 1951-80 period (Value=0)

UDOT Map
from Pavement Design Manual

MAX. FROST PENETRATION DEPTH

Estimated Using Freezing Indices (Corps of Engineers Method)



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An employee owned company

July 31, 2003
File No.: 30268.001

Mr. Terry Warner
HDR Engineering, Inc.
3995 South 700 East, Suite 100
Salt Lake City, UT 84107

Subject: Source Material Investigation
South Utah Valley Landfill (Bayview Landfill)
Utah County, Utah

Dear Mr. Warner:

In conjunction with Kleinfelder's report dated July 1, 2003, we are providing the following information to summarize the findings of our report.

Identification of Suitable Material

Based on laboratory testing and modeling, as presented in Kleinfelder's Meteoric Water Infiltration Study, one of the predominant soils at Bayview Landfill has been identified as an acceptable material for the Cell 1 protective cap. This soil is classified as a silty sand (SM) to sandy silt (ML), and is generally olive brown in color. Based on numerous tests performed on this proposed capping material, this material can generally be characterized by the following grain-sizes:

Sieve Size	Percent Passing
No. 4 (1/4 inch)	95 – 100%
No. 40	70 – 100%
No. 60	60 – 95%
No. 200	30 – 70%

Other materials present at the site differ significantly from this gradation criteria and are generally easy to screen out based on field logging and gradation tests.

Location of Suitable Material

The proposed suitable cap material was found in the stockpile north of Cell 1 and in the floor of the excavation for Cell 2. In the three borings drilled in the stockpile north of Cell 1, we found one 5-foot thick layer in B-3, and a few other pockets of material that did not meet these specifications.

We investigated the materials immediately below the stockpile north of Cell 1 and beneath the dune sand south of Cell 2 and found only some pockets of material suitable for construction of the protective cap layer in those locations.

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Two test pits excavated within Cell 2 contained 6 to 7 feet of the suitable cap material.

We recommend that lenses or pockets encountered within the stockpile or under Cell 2 that do not fall within the gradation criteria identified above be excluded from use in the protective cap layer unless further testing and analysis is performed to evaluate their suitability.

Kleinfelder appreciates this opportunity to assist you. If you have any questions regarding this report please do not hesitate to contact us at (801) 466-6769.

Respectfully,

KLEINFELDER, INC.

Renee Zollinger, P.G.
Senior Geologist

Scott Davis, P.E.
Geotechnical Division Manager

cc: Mike Oden, HDR Engineering
Richard Henry, South Utah Valley Solid Waste District

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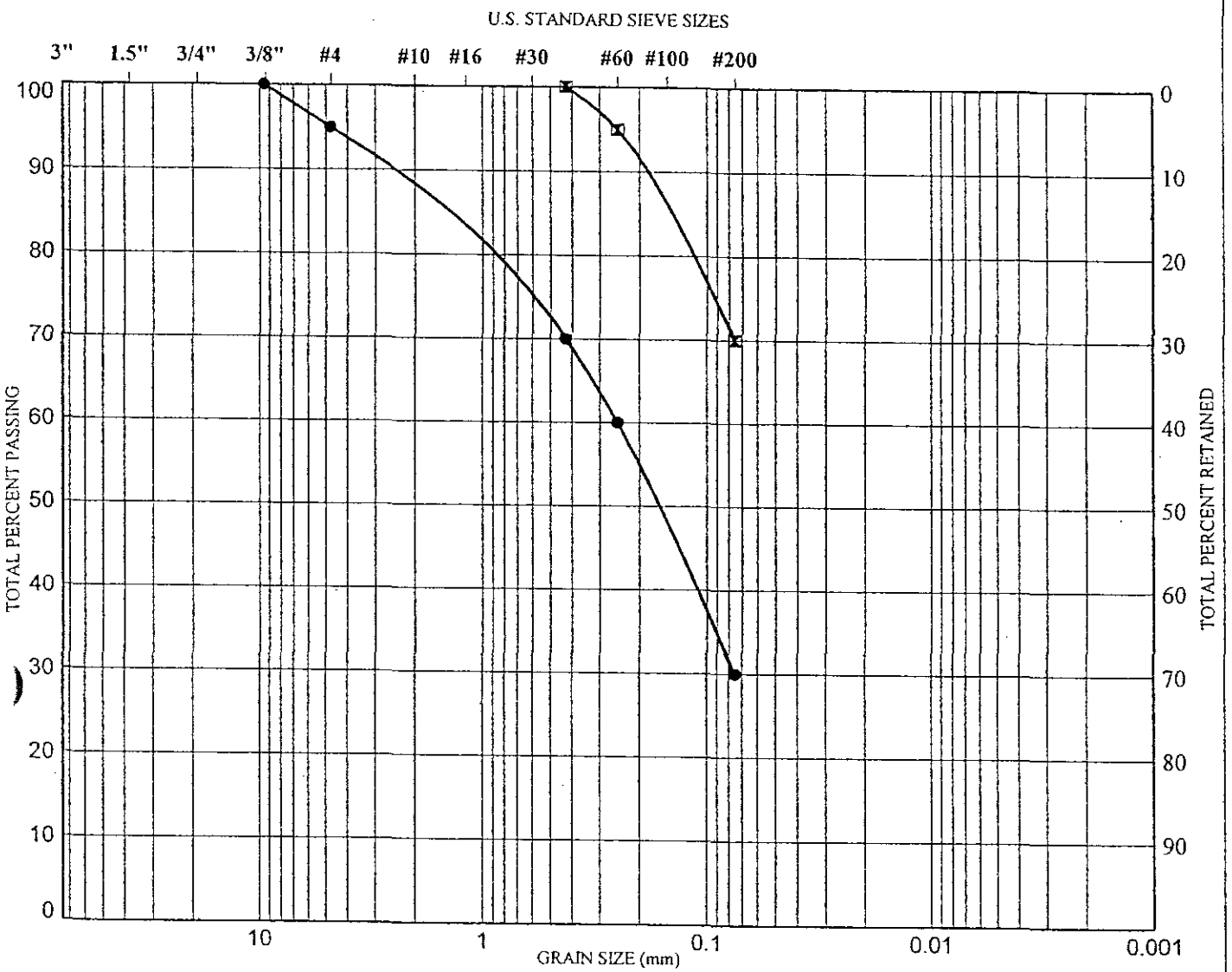
SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●				
⊠				

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PROJECT NO.

GRAIN SIZE DISTRIBUTION

FIGURE

B-1

APPLICATION FOR AUTHORIZATION TO USE

Meteoric Water Infiltration Study
South Utah Valley Landfill (Bayview Landfill)
Utah County, Utah
Report originally prepared for *HDR Engineering, Inc.*

File Number: 26515.001 Report Date: September 9, 2003

KLEINFELDER, INC.
849 West LeVoy Drive, Suite 200
Taylorsville, UT 84123
(801) 261-3336
(801) 261-3306

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APPENDIX N

Attachment N-1

Addendum to Closure Cap Equivalency Report

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February 9, 2004
File No.: 26515.001

FEB 10 2004

Mr. Terry Warner
HDR Engineering, Inc.
3995 South 700 East, Suite 100
Salt Lake City, Utah 84107

Subject: Estimate of Realistic Infiltration Rates
South Utah Valley Landfill (Bayview Landfill)
Utah County, Utah

Dear Terry,

I have reviewed the Utah Division of Solid and Hazardous Waste (DSHW) Request for Additional Information dated November 12, 2003. I also attended a meeting at DSHW with you on December 9, 2003. This letter addresses the questions raised by DSHW in Item No. 3 (2nd bullet) of the Request for Additional Information.

DSHW QUESTION

The DSHW requested that we provide evidence that the proposed evaporative cap will perform as well as an actual cap that Stephen Dwyer tested and found exhibited a leakage rate less than 3 mm/year.

This question is addressed below.

EVIDENCE THAT PROPOSED CAP MEETS PERFORMANCE STANDARD

When the modeling study was performed last year, no performance standard existed for evaporative caps. Under DSHW guidance, our modeling study (Kleinfelder, 2003[1]) showed that the proposed evaporative cap out-performs the prescriptive cap under normal and worst-case weather conditions. However, all modeling was performed on a comparative basis (prescriptive versus evaporative). Our study did not include developing an estimate of "real" infiltration rates under site conditions.

Since we performed the required modeling, DSHW has begun to consider using an infiltration rate of 3 mm/year as a performance standard for evaporative caps. I assume DSHW will enforce this standard under normal weather conditions (possibly including realistic/historical worst case weather), since the standard appears to be based on actual field test cases conducted under real weather patterns, as well as modeling performed using normal climate conditions.

[1] Kleinfelder, 2003. *Meteoric Water Infiltration Study, South Utah Valley Landfill,* September 9, 2003, File No. SLC3R082.

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I have looked at the studies of "real" infiltration rates suggested by DSHW, compared these studies to our modeling study, and have concluded that the proposed evaporative cap at Bayview Landfill will meet the performance standard being considered by DSHW for the following reasons:

1. All studies I reviewed demonstrated that the evaporative caps out-perform prescriptive caps. This information is in agreement with our modeling study, where, under identical worst-case (conservative) assumptions, the proposed evaporative cap allowed less infiltration than the prescriptive cap.

   This result is summarized below.

	Range of Infiltration Rates	
	Normal Climate	**Hypothetical Worst Case Rainfall**
Prescriptive Cap	41.4 to 46.5 mm/yr	138.5 to 181.2 mm/yr
Evaporative Cap	26.3 to 41.2 mm/yr	70.7 to 121.7 mm/yr

2. Field studies performed by Stephen Dwyer (Dwyer, 2000[2]) quoted "real" (observed) prescriptive cap infiltration rates that average 4.82 mm/year compared to "real" evaporative cap infiltration rates that average 0.19 mm/year. The observed (Dwyer) and modeled prescriptive (Kleinfelder) caps should have similar rates, but the rates measured in the field differ from our modeled rates by an order of magnitude because: our model omitted the mitigating effects of plant transpiration; our modeled rates are based on conservative choices for cell size, boundary types, initial saturation, etc., used in "building" the numerical model; our model used hypothetical high rainfall (greater than observed in historical records) to evaluate worst case performance; and our modeled "normal" rainfall is approximately 3 times higher than actual rainfall in the Dwyer study.

   If our conservative assumptions increased the modeled prescriptive cap infiltration rate by an order of magnitude over Dwyer's results, they probably also increased our evaporative cap infiltration rates by an order of magnitude. Therefore, it appears that under more realistic assumptions, our modeled infiltration rates for the evaporative cap would have been around 2 to 4 mm/year.

3. The studies we reviewed consistently demonstrate that, in practice, evaporative caps allow about 10 times less moisture to infiltrate than do prescriptive caps. We made one modeling assumption on our evaporative cap that "overruled" the model's predication for producing that result. We added a 2-inch hypothetical "topsoil" layer to the top of the modeled evaporative cap that allowed excess water storage in an attempt to simulate a loosened ground surface produced by wind erosion. In our experience, adding a loose, organic topsoil significantly

[2] Dwyer, et al., 2000. *Water Balance Data from the Alternative Landfill Cover Demonstration.*

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increases the infiltration rate predicted by the model. Our approach in the modeling study was to add a conservative "worst-case" condition to the evaporative cap and compare it to the prescriptive cap. Even under this worst-case assumption, the evaporative cap allowed less infiltration than the prescriptive cap. In reality, we do not observe a 2-inch, loose, organic topsoil developing in the area around Bayview Landfill and do not expect the cap to develop a permanent layer comparable to the modeled topsoil layer.

Based on the results of the other studies I reviewed, especially Dwyer's work, I believe this hypothetical "topsoil effect" we included produced unrealistically high infiltration rates for the evaporative cap. Removing this topsoil from the model would decrease the modeled infiltration rate significantly, and would result in predicted performance that better matches the observed performance in Dwyer's study.

4. Several studies I reviewed (Mackey, 2002[3]; Forlina, 2003[4]; Zornberg, 2003[5]; and Thompson, 2003[6]), described the composition and texture of evaporative cap material that either met the 3 mm/year performance standard or exceeded the Subtitle C prescriptive cap performance. Accepted cap thicknesses range from 20 to 48 inches and, when specified at all, fines comprised at least 28 to 50 percent of the soil material. These soils and cap thicknesses are very similar to the Bayview Landfill proposed evaporative cap, and were applied in similar climatic settings (Montana, Colorado, and California).

CONCLUSION

For the four reasons discussed above, I believe the proposed evaporative cap at Bayview Landfill will perform better than the prescriptive cap described in the Solid Waste Rules will perform as well as the other evaporative caps being documented in the literatures and will meet the 3 mm/year performance criteria under the same conditions that other evaporative caps meet that criteria.

LIMITATIONS

The conclusions drawn above are based on the study modeling performed by Kleinfelder and the information available in cited literature. These conclusions are subject to limitations on the current accepted understanding of unsaturated flow processes and the limited field tests that have been performed and documented to date. No warranty, express or implied, is made.

---

[3] Mackey, et al., 2003. *RCRA Equivalent Cover Demonstration Project, Rocky Mountain Arsenal.*

[4] Forlina, Ron, 2003. *The Approval Process for an Alternative Final Cover System for the Denver Arapahoe Disposal Site, Colorado.*

[5] Zornberg, Jorge, 2003. *Operating Industries, Inc., Superfund Landfill.*

[6] Thompson, Rick, 2003, *Mr. M. Landfill, Alternative Cover, Fergas County, Montana.*

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I appreciate this opportunity to assist you. Please do not hesitate to call me if you have questions or need additional information.

Sincerely,

KLEINFELDER, INC.

Renee Zollinger, R.G.
Regional Manager

cc. Mike Oden, HDR Engineering, Inc.
Dick Sprague, HDR Engineering, Inc.
Richard Henry, South Utah Valley Landfill

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APPENDIX O

CONSTRUCTION QUALITY ASSURANCE PLAN

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted February 2004

Prepared By:

HDR ENGINEERING, INC.

SUVSWD Bayview
Class I Landfill Permit Modification – Appendix O

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INTRODUCTION

The Construction Quality Assurance Plan (CQAP) will document that the constructed unit meets or exceeds all design criteria contained in the permit, issued by the Utah Department of Environmental Quality (UDEQ). The CQAP describes: 1) observations, inspections, tests and measurements to be performed; 2) roles and responsibilities of various parties in performing Construction Quality Assurance (CQA) and Construction Quality Control (CQC); and 3) documentation, record keeping and certifications.

The procedures described below are tailored to the Bayview Landfill Disposal Site (Site) and are in part excerpted or adopted from EPA/540/R-92/073 Technical Guidance Document, EPA 530-R-93-017 Technical Manual - Solid Waste Disposal Facility Criteria and EPA/600/R-93/182 Technical Guidance Document. The specific site components addressed include:

1) Subgrade;
2) Geotextiles;
3) Geosynthetic Clay Liners;
4) Geomembranes;
5) Leachate Collection System; and
6) Final Cover Systems.

CQA consists of a planned series of observations and tests used to provide quantitative criteria with which to accept the final product. CQC is an ongoing process of measuring and controlling the characteristics of the product in order to meet manufacturer or project specifications.

CQC is a production tool that is employed by the manufacturer of materials and by the contractor installing the materials at the site. CQA, by contrast, is a verification tool employed by the South Utah Valley Solid Waste District (SUVSWD) to ensure that the materials and installation meet project specifications. CQC is performed independently of the CQA. For example, while a geomembrane liner installer will perform CQC testing of field seams, the CQA program will require independent CQA testing of those same seams by a third-party inspector.

1.0 CQA AND CQC TEAM

The CQAP will be implemented under the supervision of a Utah registered professional engineer. The SUVSWD will designate a registered professional engineer to oversee the execution of the CQAP and related field and testing activities. The SUVSWD will also designate a lead individual who will be identified as the CQA officer. The SUVSWD may elect to utilize contract firms for monitoring, observation and testing services.

The CQAP and CQC plan will be implemented through inspection activities that include visual observations, field testing, and evaluation of the test data. Inspection activities will typically be concerned with four separate functions:

- Quality Control (QC) inspection by the manufacturer to provide an in-process measure of the product quality and its conformance with the project plans and specifications. Typically, the manufacturer will be required to provide QC test results to certify that the product conforms to project plans and specifications.

- Construction Quality Control (CQC) inspection by the contractor to provide an in process measure of construction quality and conformance with the project plans and specifications, thereby allowing the contractor to correct the construction process if the quality of the product is not meeting the specifications and plans.

- Construction Quality Assurance (CQA) testing by the SUVSWD (Acceptance Inspection) performed usually through the third-party testing firm to provide a measure of the final product quality and its conformance with project plans and specifications.

- Regulatory Inspection or documentation review, if required, to verify that the final product conforms with all applicable codes and regulations.

The responsibilities of the SUVSWD's CQA officer and the CQA officer's staff vary by physical component being constructed. The personnel will be assigned responsibilities based upon knowledge and competence to perform CQA in a specific area. Prior to starting an activity, the CQA

officers or individuals within the CQA officer's staff will be identified so that the SUVSWD, UDEQ or others can verify that individual's qualifications.

Activities of the CQA officer are essential to document quality of construction. The CQA officer's responsibilities and those of the CQA officer's staff members may include:

- Communicating with the contractor;
- Interpreting and clarifying project drawings and specifications with the designer, SUVSWD and contractor;
- Recommending acceptance or rejection by the SUVSWD of work completed by the construction contractor;
- Submitting blind samples (e.g., duplicates and blanks) for analysis by the contractor's testing staff or one or more independent laboratories, as applicable;
- Notifying SUVSWD of construction quality problems not resolved on-site in a timely manner;
- Observing the testing equipment, personnel, and procedures used by the construction contractor to check for detrimentally significant changes over time;
- Reviewing the construction contractor's quality control recording, maintenance, summary, and interpretations of test data for accuracy and appropriateness; and
- Reporting to the SUVSWD on monitoring results.

The SUVSWD will have the authority to stop work or reject work if problems or deficiencies are encountered.

2.0 INSPECTION, SAMPLING, TESTING

The following is an overview of CQA and CQC activities, by major physical components, to be undertaken before, during or after construction. Reference should be made throughout this discussion to Table O-1 for a more detailed list of major material testing methods and frequency. Table O-1 frequency may be adjusted based upon final material sources, field observations, and results of testing during construction. Additional QC, CQC, and CQA provisions and standards are anticipated to

be included in final construction plans and specifications and for minor system components. Final construction plans and specifications will further delineate sampling strategies, including methods of determining sample locations, frequency of sampling, acceptance and rejection criteria, and methods of implementing corrective measures.

2.1 Subgrade

Final construction plans and specifications along with contractors CQC program will address preparation and compaction of subgrade material to the required bearing strength.

2.2 Geotextiles

Prior to installation, the contractor, material installer, and CQA person will inspect the subgrade to certify its adequacy. During construction, geotextile placement, including coverage and 12-inch minimum overlap and anchorage, will be observed and documented. In addition to field observations, geotextile sampling and testing for tensile strength and AOS may be performed to document that the geotextile meets the design specifications.

2.3 Geosynthetic Clay Liner (GCL)

This section includes the requirements for selection, installation, and protection of geosynthetic clay liner (GCL).

Table O-1: Material Testing Methods and Frequency

Material Tested	Parameter	Test Method	Minimum Testing Frequency
Borrow Source for Protective Cover / Leachate Material	Hydraulic Conductivity	ASTM D2434	4 per material type
	Fines	ASTM D422	1 per 3,000 cubic yards
Granular Layers	% Coarse/Fines (Pipe Bedding Layer surrounding leachate collection pipe only)	ASTM C 136	1 per 1,500 yd^3
	Total Thickness	Measurement	4 per acre
	Soil Placement/Compaction	Visual Observation	Full Coverage
Geomembrane	Material Thickness	ASTM D 1593/D5199	once per roll
	Leaking Seam	Vacuum testing or pressure testing	100% of all field welded seams
	Defect/Punctures	Visual inspection	100% of all seams and liner surface
	Shear	ASTM D 4437	Minimum 500 feet plus twice daily during installation
	Peel	ASTM D 4437	Minimum 500 feet plus twice daily during installation
Piping	Leakage on non-pressure	Low pressure air	All non-slotted sections
	Alignment	Visual Observation	All sections of pipe

Notes: Tests listed are for major components. Additional material standards and CQC/CQA tests will be specified in final design including CQC and CQA for other components of the construction. Storage handling preservation and transport of soil samples will be done in accordance with ASTM D 4220.

2.3.1 Pre-installation

The following must be submitted to the CQA personnel for approval prior to GCL deployment.

- The supplier or GCL manufacturer results for standard tests described in Table O-2.
- Written verification that the GCL meets the properties listed in Table O-2.

- Written certification that the GCL manufacturer has continuously inspected each roll of GCL for the presence of needles and other defects and found GCL to be defect free.
- Written certification from the GCL manufacturer that the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.
- Quality control certificates signed by a responsible party of the GCL manufacturer for each roll delivered to the site. Each certificate will include roll identification numbers and results of all quality control tests. At a minimum, results will be given for tests corresponding to Table O-2. The bentonite and textile suppliers will each certify the respective properties under the Manufacturer's Quality Control. The GCL manufacturer will also perform the bentonite tests described under the Manufacturer's Quality Control and third-party tests.

Table O-2: Standard Tests on GCL Material

{PRIVATE }TEST	ITEM	TYPE OF TEST	STANDARD TEST METHOD	FREQUENCY OF TESTING
Manufacturer's Quality Control	Bentonite[A]	Free Swell[A]	ASTM D 5890	per 50 tons and every truck or railcar
		Fluid Loss[A]	ASTM D 5891	per 50 tons and every truck or railcar
	Geotextile	Grab Tensile Strength[B]	ASTM D 4632	per 200,000 ft^2
		Mass/Unit Area	ASTM D 5261	per 200,000 ft^2
	GCL Product	Grab Tensile Strength[B]	ASTM D 4632	per 200,000 ft^2
		Clay Mass/Unit Area[C]	ASTM D 5993	per 40,000 ft^2
		Permeability[D]	ASTM D 5084	per week for each production line[E]
		Lap Joint Permeability[D][F]	ASTM D 5084	Per each material and lap type
Conformance Testing by 3rd Party Independent Laboratory	GCL Product	Clay Mass/Unit Area[C]	ASTM D 5993	at least 1 test per 100,000 ft^2 and ASTM D 4354 procedure A
		Permeability[D][F]	ASTM D 5084	per 100,000 ft^2
		Direct Shear [F][G]	ASTM D 5321	Per GCL/adjoining material type

Notes:
A - Tests to be performed on bentonite before incorporation into GCL. Free swell shall have a minimum test value of 24 ml. Fluid loss will have a maximum value of 18 ml.
B - For geotextile backed products only. Geotextiles will meet minimum manufacturer's criteria.
C - Minimum test value of 0.8 lb./ft^2 on an oven dry basis (zero percent moisture).
D - 1×10^{-8} m^3/m^2/sec or as required by the permit.
E - Report last 20 permeability values, ending on production data of supplied GCL.
F - Test at confining/consolidating pressures simulating field conditions.
G - Not applicable for slopes of 7H: 1V or flatter. Testing must be on material in hydrated state unless GCL is to include geomembrane on both sides of GCL.

2.3.2 Delivery, Storage, and Handling

Packing and Shipping

The GCL will be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers. The GCL rolls will be marked with the following information:

- Manufacturer's name
- Product Identification
- Roll number
- Roll dimensions
- Roll weight

Storage and Protection

The rolls will be stored on-site by the Contractor until installed. After Contractor mobilization, he will store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage. He will also preserve the integrity and readability of GCL roll labels. Rolls must not be stacked higher than recommended by the manufacturer to preclude thinning of bentonite at contact points.

2.3.3 Installation

The GCL will be handled in a manner to ensure that it is not damaged as recommended by the GCL manufacturer. At a minimum, the following will by complied with:

- On slopes, anchor the GCL securely and deploy it down the slope in a controlled manner.
- Weight the GCL with sandbags or equivalent in the presence of wind.
- Cut GCL with a cutter (hook blade), scissors, or other approved device. Protect adjacent materials from potential damage due to cutting of GCL.
- Prevent damage to underlying layers during placement of GCL.
- During GCL deployment, do not entrap in or beneath GCL, stones, trash, or moisture that could damage GCL.
- Visually examine entire GCL surface. Ensure no potentially harmful foreign objects, such as needles, are present.
- Do not place GCL in the rain or at times of impending rain.
- Do not place GCL in areas of ponded water.

- Replace GCL that is hydrated before placement of overlying geomembrane and cover soil.
- In general, only deploy GCL that can be covered during that day by geomembrane.
- For needle-punched GCLs, add granular bentonite to the overlapped areas at the manufacture's specified rate.
- Avoid dragging GCL on the subgrade.
- Vehicular traffic other than low contact pressure vehicles such as smooth-tired ATV's or golf carts must not be allowed on deployed GCL.
- Installation personnel must not smoke or wear damaging shoes when working on GCL.

Overlaps

The GCL must be overlapped to the manufacturer's recommendations, which will vary according to seam location and climatic conditions. For needle-punched GCLs, apply granular bentonite to overlapped area at a rate required by the manufacturer. At sumps, overlap GCLs at least 1 foot. At the bottom of the collection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams.

In general, horizontal seams and mid-slope anchor trenches are not allowed on side slopes. However, if prohibitive slope lengths cannot otherwise be overcome, the CQA personnel may approve a glue-bonded seam.

Defects and Repairs

Repair all flaws or damaged areas by placing a patch of the same material extending at least 1 foot beyond the flaw or damaged area. Add granular bentonite to the overlapped edges of the patch at the manufacturer's specified rate.

2.4 Geomembranes

Source testing and material quality control testing will be performed prior to material installation. These CQC steps involve manufacture, fabrication, storage at the factory, shipment and storage at the Site of the geomembrane and geotextiles. Manufacturers will be required to

certify thickness, width, length as well as chemical/resin formulation and material properties in accordance with National Sanitation Foundation, Standard 54 (NSF-54). Manufacturers will be required to submit information demonstrating testing of any factory fabricated seams. Information may be required on factory storage and shipment where concerns are identified. At the site, records will be maintained on any material received (especially material received in damaged condition) and on on-site storage and handling practices. Lining materials delivered to the site will be inspected for damage by the installer, unloaded, and stored. Materials will be stored in accordance with the manufacturer's recommendation. The storage will be such that:

- Unloading of rolls at the job site's temporary storage location will be such that no damage to the lining materials occur;
- Pushing, sliding or dragging of rolls of lining materials will not be permitted;
- Temporary storage at the job site will be in an area where standing water cannot accumulate at any time;
- The ground surface will be suitably prepared such that no stones or other rough objects which could damage the lining materials are present;
- Temporary storage of rolls of lining materials in the field will not be so high that crushing of the core or flattening of the rolls occur; and
- Suitable means of securing the rolls will be used such that shifting, abrasion or other adverse movement does not occur.

Prior to installation, the contractor, material installer, and CQA person will inspect the geomembrane to certify its adequacy. During deployment, the CQA personnel, the installer, and possibly the manufacturer's representative will observe the layout, ballasting, seaming and covering. Records will be maintained to verify proper panel layout, weather related impacts (e.g. wind) and material handling. Once deployed, the entire roll or panel will be inspected for blemishes, scratches, and imperfections. The CQA person will spot check material thickness and observe field seaming and seam testing.

Installation of geomembrane liners will be in conformance with a quality assurance/quality control plan. Tests performed to evaluate the integrity of geomembrane seams will be both

"destructive" and "non-destructive." All seams failing the non-destructive or destructive tests will be repaired.

2.4.1 Trial Seams

Trial seams will be done twice daily during installation to demonstrate pre-qualifying experience for personnel, equipment and procedures. Trial seams will be performed on the identical geomembrane material under the same climatic conditions as the actual field production seams will be made. Trial seams will also be made whenever personnel or equipment are changed, and when climatic conditions reflect wide changes in geomembrane temperature or when other conditions occur that could affect seam quality.

2.4.2 Non-Destructive Seam Testing

Non-destructive test methods will be conducted in the field on an in-place geomembrane. These test methods determine the integrity of the geomembrane field seams. All seams will be non-destructively tested. Non-destructive test methods may include vacuum box, or pressurized dual seam tests. Seam sections that fail non-destructive tests will be carefully delineated, patched or re-seamed, and retested. For failing fusion welds, the outer seam lip may be extrusion fillet-welded to the parent sheet or cap stripped over the entire edge. For failing extrusion welds, a cap strip repair will be used. All repaired areas will be non-destructively tested by vacuum box methods. Large patches or re-seamed areas may be subjected to destructive test procedures for quality assurance purposes. The final plans and specifications will describe the degree to which non-destructive and destructive test methods will be used in evaluating failed portions of non-destructive seam tests. For the 60-mil HDPE, double-wedge thermal seams will be pressure tested at a maximum of 30 pounds per square inch (psi) with no more than a 3 psi pressure drop over a 5 minute time period. Tests will occur over a 100 to 1,000 foot distance. Other fusion-welded seams will be tested with a 2.5-psi vacuum box. Other testing will conform to recommendations of the Geosynthetic Research Institute, as applicable.

2.4.3 Destructive Seam Testing

Quality control testing of geomembranes generally includes peel and shear testing of trial weld sections prior to commencing seaming activities and at periodic intervals throughout the day. Additionally, destructive peel and shear field tests are performed on samples from portions of the installed seams. Whenever possible, samples will be taken from within the anchor trench area.

Quality assurance testing will generally require that an independent laboratory perform peel and shear tests of samples from installed seams. The samples will be collected from the anchor trench or in areas of suspect quality. HDPE seams will generally be tested at intervals equivalent to one sample per every 300 to 400 feet of installed seam for extrusion welds, and every 500 feet for fusion-welded seams.

For dual hot wedge seams in HDPE, both the inner and outer seam may be subjected to destructive shear tests at the independent laboratory. Destructive samples of installed seam welds will generally be cut into several pieces and distributed to:

- The installer to perform CQC testing;
- The SUVSWD to retain and appropriately catalog or archive; and
- An independent laboratory for CQA peel and shear testing.

Minimum shear strength based on four out of five samples tested for wedge and extrusion weld seams on the 60-mil HDPE will be 120 pounds per inch in width. Minimum peel strengths for wedge and extrusion weld seams on the 60-mil HDPE will be 78 pounds per inch of width. All failures on the four samples must be film tear bond (FTB).

If the test results for a seam sample do not pass the acceptance/rejection criteria, then samples will be cut from the same field seam on both sides of the rejected sample location. Samples will be collected and tested until the area limits of the low quality seam are defined. Failed seams will be cap-stripped over the length of the rejected seam. All re-seamed or patched areas will be non-destructively tested, and approximately 10 percent of all repairs will be destructively tested.

2.4.4 Geomembrane CQA Observation

The responsibilities of the construction quality assurance (CQA) personnel for the installation of the geomembrane are:

- Observation and documentation of the liner storage area and the liners in storage, and handling of the liner as the panels are positioned on site;
- Observation of seam overlap, seam preparation prior to seaming, and geotextile or GCL underlying the liner;
- Observation of destructive testing conducted on welds prior to seaming;
- Observation of destructive seam sampling, submission of the samples to an independent testing laboratory, and review of results for conformance to specifications;
- Observation of all seams and panels for defects due to manufacturing and/or handling and placement;
- Observation of all pipe penetrations, boots, and welds in the liner; and
- Preparation of reports indicating sampling conducted and sampling results, locations of destructive samples, locations of patches, locations of seams constructed, and any problems encountered during installation. The final panel plan indicating panel layout, seams, test locations and repairs will be provided by the geomembrane installer, as a CQC requirement.

Protective soil cover (including leachate collection media) will be placed over the geomembrane liner as soon as practicable.

2.5 Leachate Collection Systems

The purpose of leachate collection system CQA is to document that the system construction is in accordance with the design plans and specifications. Prior to construction, materials will be inspected to confirm that they meet the construction plans and specifications. These include:

- Protective cover/leachate collection and pipe bedding materials;
- Pipe size, materials, and perforations; and
- Mechanical, electrical, and monitoring equipment (if utilized).

2.5.1 Protective Cover/Leachate Collection and Pipe Bedding Materials

Source quality control testing will be performed on stockpiled materials proposed for use in the protective cover/leachate collection layer to define the material properties. Source testing includes grain size and laboratory hydraulic conductivity in accordance with ASTM D422 and ASTM D2434, respectively.

The Contractor will perform source quality control tests on each principal type or combination of material proposed for use as pipe bedding material to assure compliance with specified requirements.

Production testing of protective cover/leachate collection material and pipe bedding material will be in accordance with Table O-1.

2.5.2 Construction

The leachate collection system foundation will be inspected and surveyed upon its completion to verify that it has proper grading and is free of debris and liquids.

During construction, the following activities, as appropriate, will be observed and documented:

- Protective cover/leachate collection placement including material quality and thickness. Equipment operating on the final layer thickness will be limited to low ground pressures in accordance with the project specifications.
- Pipe installation including location, configuration, grades, joints, and final flushing.
- Pipe bedding placement including protection of underlying liners, thickness, overlap with filter fabrics, and weather conditions. Damage to the underlying geomembrane will be repaired and documented in accordance with the project specifications.

- Geotextile placement including coverage and 12-inch minimum overlap.

In addition to field observations, field and laboratory testing may be performed to document that the materials meet the design specifications. These activities will be documented and should include testing of pipes for leaks, obstructions, and alignments.

The protective cover/leachate collection layer and the pipe bedding material will not be compacted, except as a result of placement methods. No minimum density specification is required.

Upon completion of construction, each component will be inspected to identify any damage that may have occurred during its installation, or during construction of another component (e.g., pipe crushing during placement of Protective Cover/Leachate Collection layer). Any damage that does occur will be repaired; and these corrective measures documented in the CQA records.

Surveying techniques and visual observation will be used to determine total thickness of Protective Cover/Leachate Collection layer.

2.6 Electrical Integrity Survey

After the completion of the liner and protective cover/leachate collection system installation, an electrical integrity survey will be performed to locate potential leaks in the liner. For this test, an electric potential will be applied between the protective cover/leachate collection system and the subgrade beneath the liner components. If a leak is present, current will flow through the liner at the location of the leak. Holes as small as 2 mm can be detected within a few centimeters under two feet of cover. The entire lined area, bottom and sidewall, will be tested using this technique.

This testing method is especially useful in locating leaks or damage that occurs during placement of the protective cover. If any leaks are identified during this process, the protective cover/leachate collection material will be carefully removed, and the leak located and repaired

using standard repair and testing procedures. The results of the electrical survey, including any repair documentation will be included in the Final Certification Report.

A qualified testing firm will be contracted to perform this survey. A detailed plan of operations will be prepared by the testing firm and presented to the CQA officer prior to commencing liner installation.

2.7 Final Cover Systems

A 34-inch evaporative cap constructed from moderately compacted olive-brown silty sand will be used as the final cover system for the Bayview landfill. One compaction test will be performed for each 10,000 square feet of surface area for each lift of the final cover. Compaction of the final cover material will be between 75% and 85% of the maximum dry density with a moisture content dry of optimum.

CQA personnel will also sample the soil to be used for the final cover and perform a grain size distribution analysis in advance of cover placement. If the grain size distribution falls within the range identified on Figure B-1 in the July 31, 2003 letter from Kleinfelder (see Attachment O-2 at the end of this Appendix), then the material will be considered suitable for use in the final cover. A grain size distribution test will be performed for every 5,000 cubic yards of cover material to be placed, and will be performed sufficiently in advance of placement so as to not hinder construction activities. Results of all tests will be recorded on forms similar to those found in Attachment O-1 at the end of Appendix O. Since the material to be used for final cover will be tested in advance for grain size, third-party CQA personnel will be present as needed to test for compaction on each lift at the frequency discussed above and so that cover placement operations are not interrupted.

The required thickness of the protective cover will be verified by survey methods on an established grid system with not less than one verification point per 10,000 square feet of surface.

2.8 Surveying

A SUVSWD surveying crew or an independent crew under the supervision of a registered land surveyor will perform all major construction staking activities. All construction staking will be performed utilizing conventional construction layout practices. Site control will be provided by the permanent site control points already established on site. All site control points are tied into the state plane coordinate system as well as the site project coordinate system. During construction, the survey crew will determine elevation and obtain locations and elevations of as-built features. No stakes will be allowed in the liner, protective cover or final cover systems except as required to document potential erosion of the final cover system as discussed in Section 6.1 of Part II.

Surveys will be used to confirm total thickness of layers during placement of cover materials. Surveying will include enough points to adequately determine the uniformity of the layer thickness. The average distance between survey points will be 100 feet. For multi-lift/multi-layer construction, visual observation and field measurements will be used to confirm layer thickness. Measurements will be performed using surveying, excavated samples or other measuring techniques. At regular intervals, record drawings of the newly constructed features and the areas filled will be prepared. The record drawings will document the final location, size, and elevation of the constructed features within the site. The record drawings will become part of the final construction certification report.

3.0 DOCUMENTATION AND CORRECTIVE ACTION

Ongoing QC, CQC and CQA are designed to minimize deficient work and provide for corrective action prior to completion of an activity. The record-keeping and on-site observation activities are further designed to provide documentation of compliance or non-compliance, and corrective action.

3.1 Corrective Action

For work or physical components that do not satisfy plans and specifications, the general actions may include:

- Removal and replacement; and
- Alternate welding or patching for geosynthetic components.

Along with the final construction plans and specification, the CQC and CQA programs and personnel will identify the deficiency and its extent. They will also ultimately define the form or extent of corrective action required.

If materials are found to deviate from specified standards, they will either be rejected or their suitability demonstrated by additional testing and analysis. A goal of this CQAP is to prevent the inclusion and subsequent removal of defective or inappropriate materials by providing an orderly process of checks prior to final installation.

3.2 Documentation

Documentation will be used to demonstrate the quality of materials and the condition and manner of installation. The overall documentation will include:

- Detailed plans and specifications (final design);
- Contractor shop drawings and material certification reports, with an engineer's review;
- Records of on-site observation, via the CQA officer or the CQA officer's staff;
- Material laboratory test results, both by contractor and independent laboratory;
- On-site test results; and
- Final Certification Report.

The final certification report will include observations, test results, sampling locations, locations of blue tops in the final cover, corrective measures performed, and other information required to certify that the CQAP has been carried out and that construction meets or exceeds the design criteria and specifications in the permit. Example forms for recording observations and data collected during the QA/QC process for cell construction and closure are included as Attachment O-1 at the end of this Appendix. The final report will be submitted to the UDEQ.

APPENDIX O

ATTACHMENT O-1:
EXAMPLE FORMS FOR CELL CONSTRUCTION

CERTIFICATE OF ACCEPTANCE OF SOIL SUBGRADE

Geosynthetic
Installer _____ _____Project: Bayview Landfill
Address _____ Location: Utah County
_____ Owner: South Utah Valley Solid Waste District

I, the Undersigned, the duly authorized representative of _____do hereby accept the soil subgrade surface bounded by_____
_____
_____as an acceptable surface on which to install and shall be responsible for maintaining its integrity and suitability in accordance with the project specifications from this date to the completion of the installation.

Name	Signature	Title	Date

Certificate accepted by CQA Manager:

Name	Signature	Title	Date

Certificate accepted by Owner:

Name	Signature	Title	Date

Geotextile Panel Placement

Panel Number	Roll Number	Date Installed	Overlap Confirmation	
			Side	End

Project Name: Bayview Landfill

GCL Panel Placement

Panel Number	Roll Number	Date Installed	Overlap Confirmation	
			Side	End

Sheet No. ___ of ___

CQA PANEL INSPECTION FORM

PROJECT NAME: **Bayview Landfill**	PANEL NO.
PROJECT NO.:	GEOMEMBRANE TYPE:
CONTRACTOR:	INSTALLER:
DATE PLACED	SUBGRADE CONDITION
WEATHER CONDITIONS	
DEPLOYMENT METHOD:	

SHOW PROJECT NORTH

Panel No.: _____

Date	Defect	Defect Description	Repair Date	Repair Type	Approved By

Panel Length	Technician Comments
Panel Width	
Panel Area	
Roll Number	

Date _____
Page ____ of ____

SMOOTH / TEXTURED GEOMEMBRANE PANEL PLACEMENT SUMMARY

Date	Time	Panel Number	Roll Number	Length (feet)	Width (feet)	Area (SF)	Average Thickness (MILS)	Comments

Sheet No. ___ of ___

CQA SEAM INSPECTION FORM

PROJECT NAME **Bayview Landfill**	SEAM NO.
PROJECT NO.	SEAM LENGTH
CONTRACTOR	COMMENTS
INSTALLER	
WELDING TECH.	
TYPE OF WELDER	WELDING UNIT NO.
DATE WELDED	TIME WELDED

QUALITY ASSURANCE SUMMARY

1. VACUUM BOX TEST

Zone	Length	Date Tested	QC Technicians Initials	Numnber of Defects Found	Date Repairs Made	Date Retested	Date Inspected and Approved

2. AIR PRESSURE TESTING

Start	Start Pressure (psi)	End Time	End Pressure (psi)	Zone	Length (feet)	Pressure Loss (psi)	Approved (Y/N)	If No, Corrective Action	Approved By

LEGEND	
	Zone 1 Air Pressure Zone
	Repair Needed
	Repair Completed
	Repair Tested
	Repair Approved
	Destructive Sample
	Cap Strip Repair

3. SEAM REPAIRS (PATCHES)

Repair No.	Defect Type	Date/NDT Type	Approved By

Panel No. [ ]

Panel No. [ ]

Client SUVSWD

Date

Project Bayview Landfill

Project Location

Project Number

Technician

Sheet: Textured _____ Smooth _____ Mil _____

Density: HDPE _____ VLDPE _____ LLDPE _____

Defect Code:

BO - Burn Out
BS - Boot Skirt
CO - Change of Overlap
CR - Crease
D - Installation Damage
DP - Destructive Sample
EE - Earthwork Equipment
Ext - Extension
FS - Failed Seam
IO - Insufficient Overlap
MD - Manufacturer's Damage
PT - Pressure Test Cut
SI - Soil Irregularity
SL - Slag on Textured
T - Panel Intersection
VL - Vacuum Test Leak
WD - Wind Damage
WR - Wrinkle
WS - Welder Restart
Other - _____

Repair Type:
B - Bead
C - Cap
P - Patch

Geomembrane Repair Log

Repair #	Seam / Panel	Location East/South	Code	Date	Machine #	Time	Type	Size	Tech	Test Date

APPENDIX O

ATTACHMENT O-2:
FINAL COVER GRAIN SIZE DISTRIBUTION
AND
EXAMPLE FORMS FOR FINAL COVER CONSTRUCTION

KLEINFELDER
An employee owned company

July 31, 2003
File No.: 30268.001

Mr. Terry Warner
HDR Engineering, Inc.
3995 South 700 East, Suite 100
Salt Lake City, UT 84107

Subject: Source Material Investigation
South Utah Valley Landfill (Bayview Landfill)
Utah County, Utah

Dear Mr. Warner:

In conjunction with Kleinfelder's report dated July 1, 2003, we are providing the following information to summarize the findings of our report.

Identification of Suitable Material

Based on laboratory testing and modeling, as presented in Kleinfelder's Meteoric Water Infiltration Study, one of the predominant soils at Bayview Landfill has been identified as an acceptable material for the Cell 1 protective cap. This soil is classified as a silty sand (SM) to sandy silt (ML), and is generally olive brown in color. Based on numerous tests performed on this proposed capping material, this material can generally be characterized by the following grain-sizes:

Sieve Size	Percent Passing
No. 4 (1/4 inch)	95 – 100%
No. 40	70 – 100%
No. 60	60 – 95%
No. 200	30 – 70%

Other materials present at the site differ significantly from this gradation criteria and are generally easy to screen out based on field logging and gradation tests.

Location of Suitable Material

The proposed suitable cap material was found in the stockpile north of Cell 1 and in the floor of the excavation for Cell 2. In the three borings drilled in the stockpile north of Cell 1, we found one 5-foot thick layer in B-3, and a few other pockets of material that did not meet these specifications.

We investigated the materials immediately below the stockpile north of Cell 1 and beneath the dune sand south of Cell 2 and found only some pockets of material suitable for construction of the protective cap layer in those locations.

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Salt Lake City, UT 84109-1617 (801) 466-6769 (801) 466-6788 fax

Two test pits excavated within Cell 2 contained 6 to 7 feet of the suitable cap material.

We recommend that lenses or pockets encountered within the stockpile or under Cell 2 that do not fall within the gradation criteria identified above be excluded from use in the protective cap layer unless further testing and analysis is performed to evaluate their suitability.

Kleinfelder appreciates this opportunity to assist you. If you have any questions regarding this report please do not hesitate to contact us at (801) 466-6769.

Respectfully,

KLEINFELDER, INC.

Renee Zollinger, P.G.
Senior Geologist

Scott Davis, P.E.
Geotechnical Division Manager

cc: Mike Oden, HDR Engineering
Richard Henry, South Utah Valley Solid Waste District

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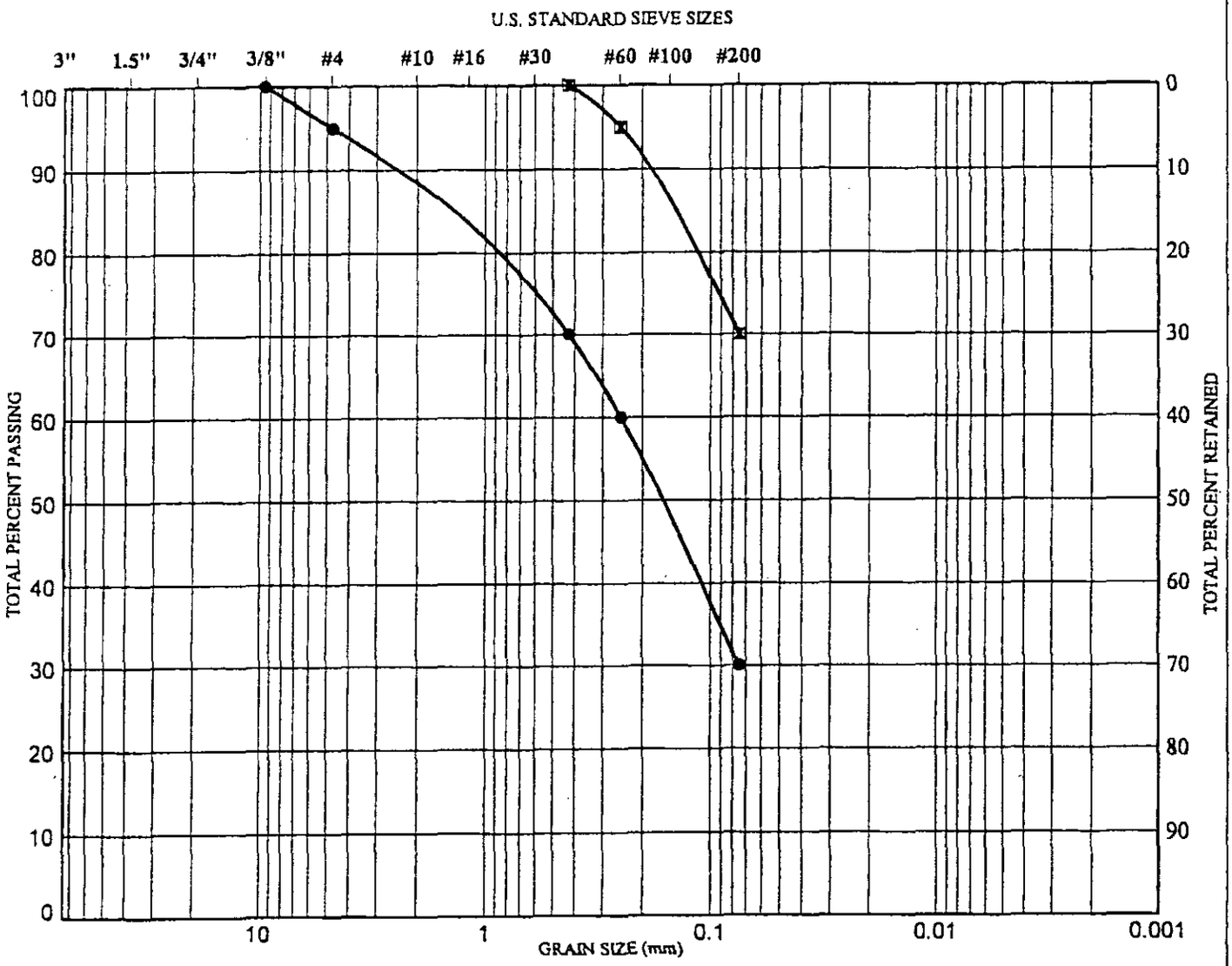
KLEINFELDER 2677 East Bayley's Way, Salt Lake City, UT 84109-1617 (801) 466-6769 (801) 466-6788 fax

SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●				
⊠				

NEW GS/4-E-B RENEE.GPJ

KLEINFELDER

PROJECT NO.

GRAIN SIZE DISTRIBUTION

FIGURE

B-1

Final Cover Material – Grain Size Distribution

Test Location	Depth	Date	Test #	Pass or Fail

Attach copies of grain size distribution tests.

Project Name: Bayview Landfill

Final Cover Placement – Compaction Tests

Test Location	Lift	Date	Compaction %	Pass or Fail

APPENDIX P

CELL 2 GEOSYNTHETIC ANALYSIS

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

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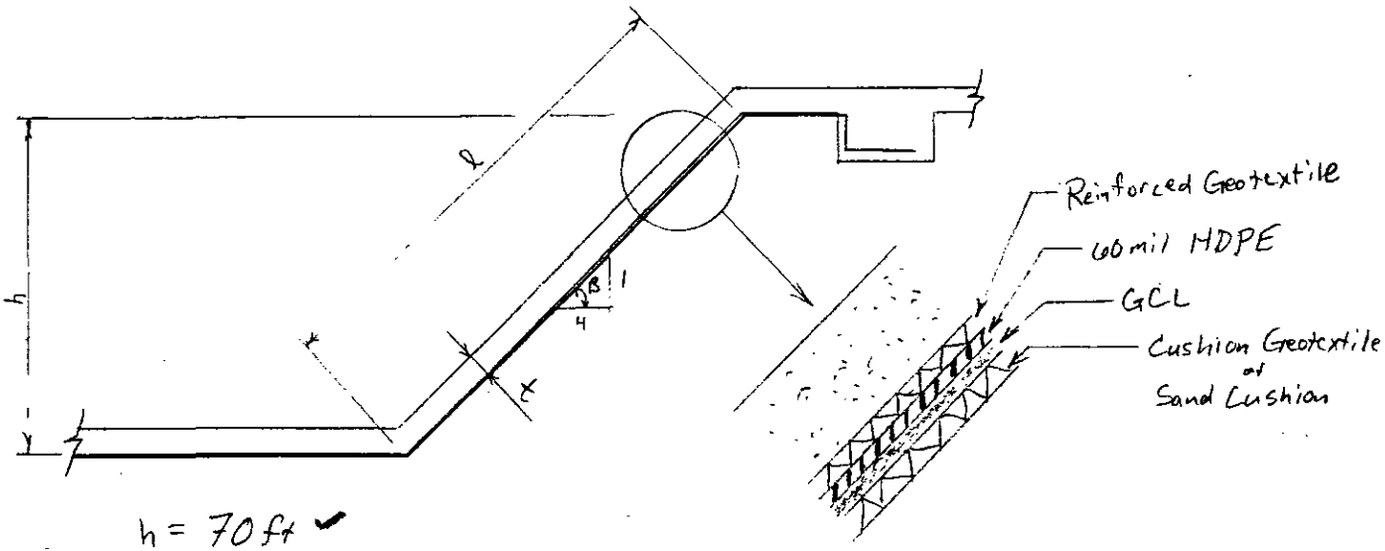
ATTACHMENT P-1
LINER SLOPE STABILITY

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/15/03		
	Subject: Cell 2	Checked: PHP	Date: 7-22-03		
	Task: Slope Stability	Page: 1	of: 7		
	Job #: 3879	No:			

Cell Liner & LCRS

Geometry / Materials



$h = 70\ ft$ ✓
$t = 2\ ft$
$l = h/\sin\beta = 288.6\ ft$

Materials At Interface	Interface Friction, $\delta°$ ②
2' LCRS / Reinforced GT/NW	27° ①
GT / 60 mil Textured HDPE	27°
HDPE / GCL	18° *
GCL / Cushion GT/NW	18° *
GCL / Sand Cushion	N/A > 18°
Cushion GT / Exist Subgrade	27° ①

* Critical Value For Stability Analysis
① Matches July 1996 Permit Value
✓ ② Verify Interface Friction Using Proposed Materials Prior To Construction

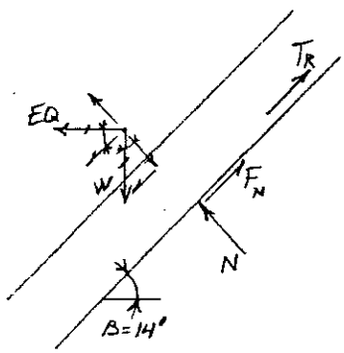
All interface friction values were taken from literature and file of test results.

CONT. →

Cell Liner & LCRS (Cont.)

Static & Pseudo-Static Stability

* Use Infinite Slope Method to Determine Factors of Safety



$W = \gamma t \ell = 0.100(2.0)\ell = 0.200\ell$ (k/ft) ✓

$W\cos\beta = 0.200\ell\cos 14° = 0.194\ell$ (k/ft) ✓

$W\sin\beta = 0.200\ell\sin 14° = 0.049\ell$ (k/ft) ✓

$EQ = W\psi = 0.200\ell\psi$ (k/ft) ✓

$EQ\sin\beta = 0.200\ell\psi\sin 14° = 0.049\ell\psi$ (k/ft) ✓

$EQ\cos\beta = 0.200\ell\psi\cos 14° = 0.194\ell\psi$ (k/ft) ✓

$N = W\cos\beta - EQ\sin\beta = 0.194\ell - 0.049\ell\psi$ (k/ft) ✓

$F_N = N\tan\delta = (0.194\ell - 0.049\ell\psi)\tan\delta$ (k/ft) ✓

✓ STATIC: $FS_{stat} = (F_N + T_R)/W\sin\beta = (0.194\ell\tan\delta + T_R)/0.049\ell$
$(\psi = 0)$

✓ PSEUDO-STATIC: $FS_{p.s} = (F_N + T_R)/(W\sin\beta + EQ\cos\beta)$
$(\psi > 0)$ $= [(0.194\ell - 0.049\ell\psi)\tan\delta + T_R]/(0.049\ell + 0.194\ell\psi)$

* Iterate For T_R & ψ With δ & ℓ From Geometry/Materials Section

CONT. →

Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary

- Stability Calculation by Infinite Slope Method

GEOMETRY

Slope	4.00 Horizontal to 1.00 Vertical	β = 14.036°
Height	70.0 ft	
Length	288.6 ft	

LCRS GEOMETRY/MATERIAL

Thickness	2.0 ft
Unit Weight	0.100 kcf

INTERFACE MATERIALS

Top Material	Geocomposite Clay Liner
Bottom Material	Cushion Geotextile
Minimum Interface Friction	18 °

CALCULATED FACTORS OF SAFETY

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Coefficient, ψ						
	0.00	0.10	0.20	0.30	0.40	0.50	0.60
0.0	1.30	0.91	0.69	0.55	0.45	0.38	0.32
1.0	1.37	0.96	0.73	0.58	0.48	0.40	0.35
2.0	1.44	1.01	0.77	0.61	0.50	0.43	0.37
3.0	1.51	1.06	0.80	0.64	0.53	0.45	0.39
4.0	1.59	1.11	0.84	0.68	0.56	0.47	0.41
5.0	1.66	1.16	0.88	0.71	0.59	0.50	0.43
7.5	1.84	1.29	0.98	0.79	0.66	0.56	0.48
10.0	2.01	1.42	1.08	0.87	0.72	0.62	0.54
12.5	2.19	1.54	1.18	0.95	0.79	0.68	0.59
15.0	2.37	1.67	1.28	1.03	0.86	0.74	0.64

WEIGHTS & FORCES

Weight	57.72 k/ft
Static Driving Force	14.00 k/ft
Static Resisting Force	18.20 k/ft
Earthquake Horizontal Force	57.72 (ψ) k/ft
Earthquake Driving Force	14.00 + 56.00 (ψ) k/ft
Earthquake Resisting Force	18.20 - 4.550 (ψ) k/ft

RESULTS

	Static	Seismic					
$FS_{req'd}$	1.30	1.00	1.00	1.00	1.00	1.00	1.00
ψ	0.00	0.10	0.16	0.20	0.30	0.40	0.50
$T_{Rreq'd}$ (klf)	0.00	1.86	5.70	7.91	13.97	20.02	26.08

Project:	Bayview Landfill	Computed:	NPD	Date:	07/16/03
Subject:	Cell 2 Design	Checked:	PHP	Date:	7-23-03
Task:	Slope Stability	Page:	4	of:	7
Job #:	3879	No:			

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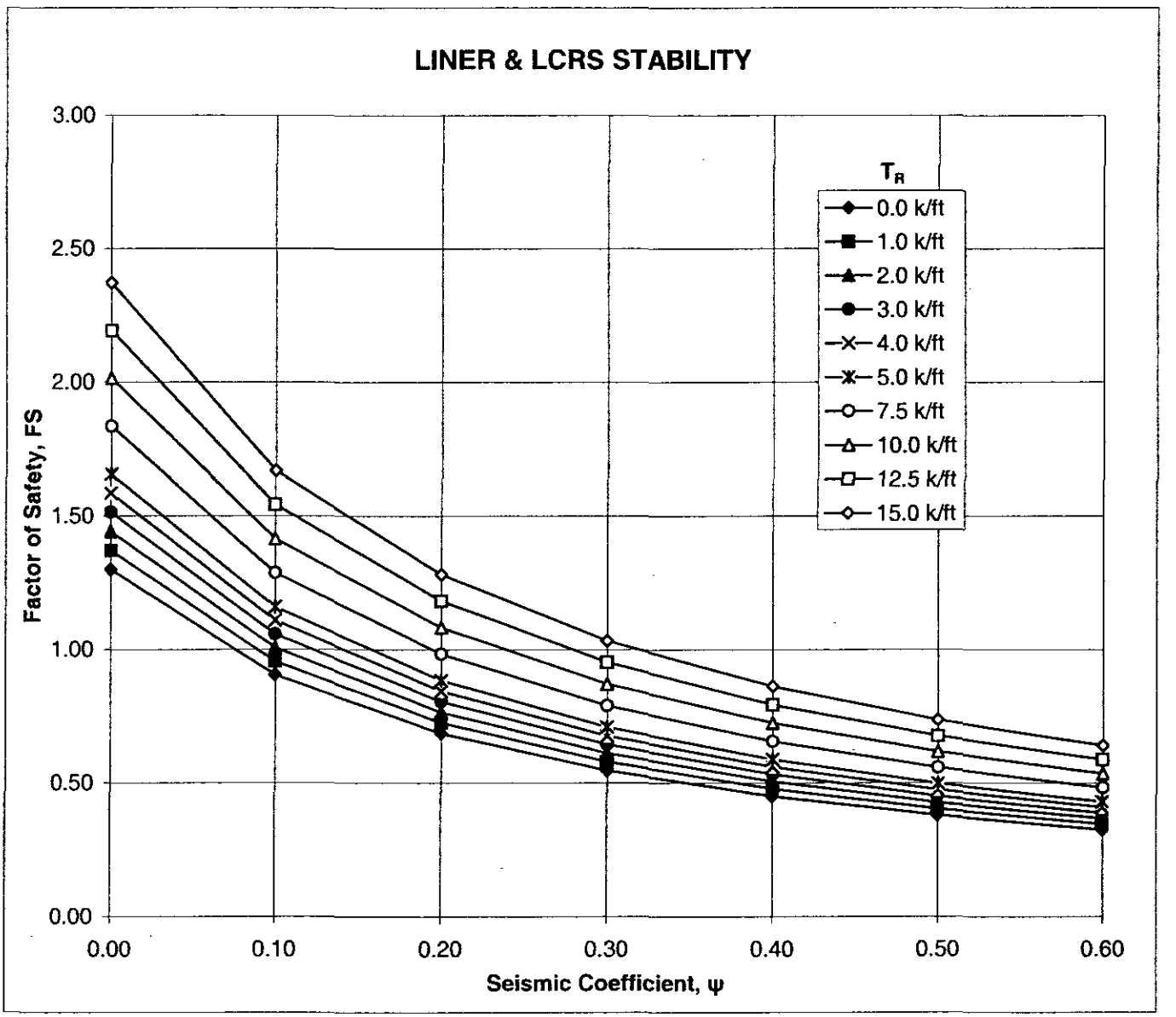
Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary



Project:	Bayview Landfill	Computed:	NPD	Date:	07/16/03
Subject:	Cell 2 Design	Checked:	PHP	Date:	7-23-03
Task:	Slope Stability	Page:	5	of:	7
Job #:	3879	No:			

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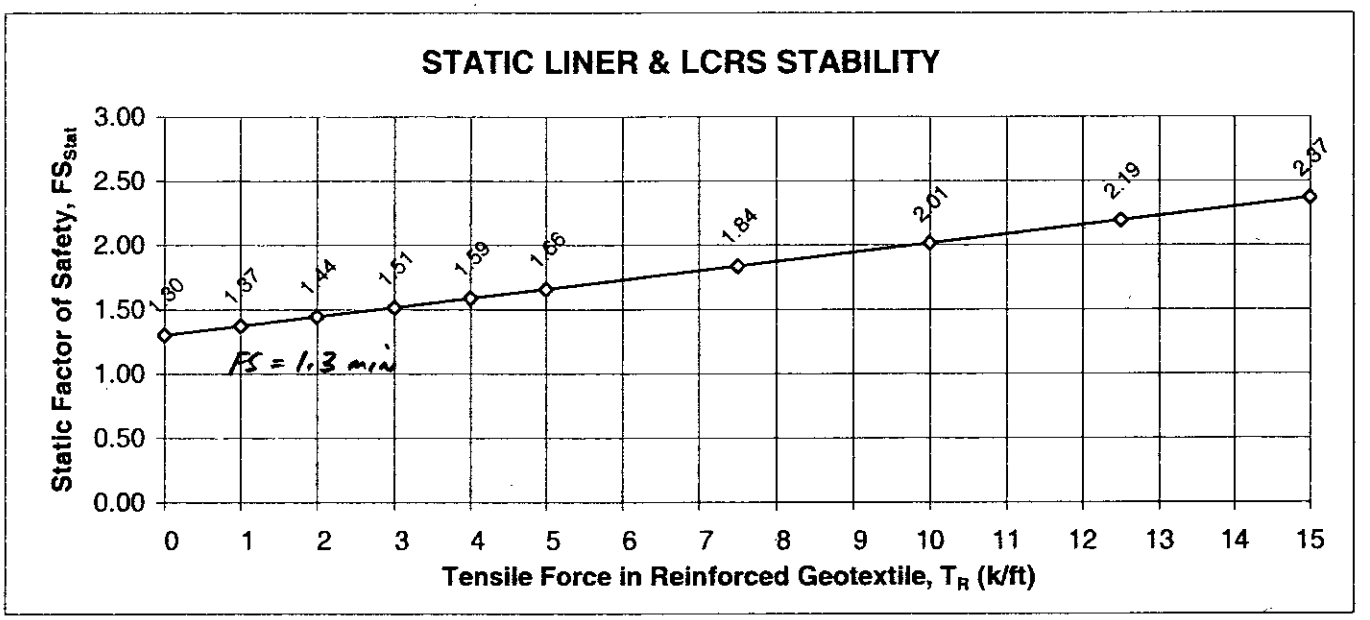
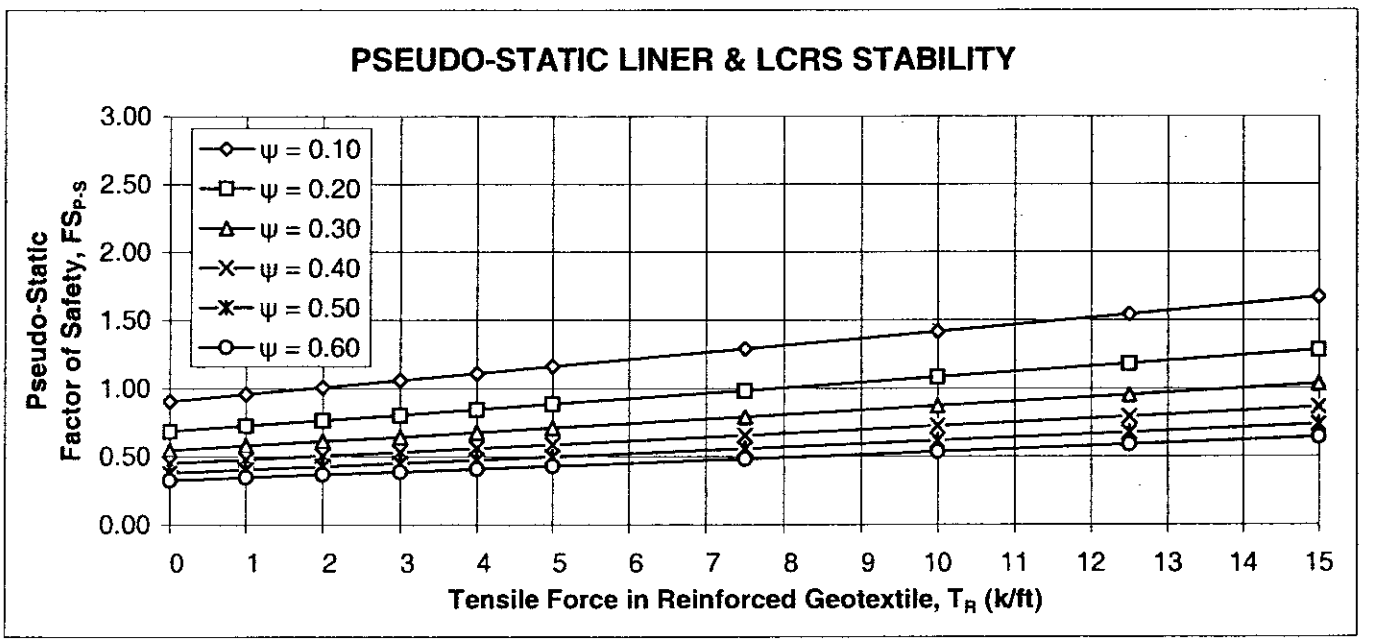
Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary

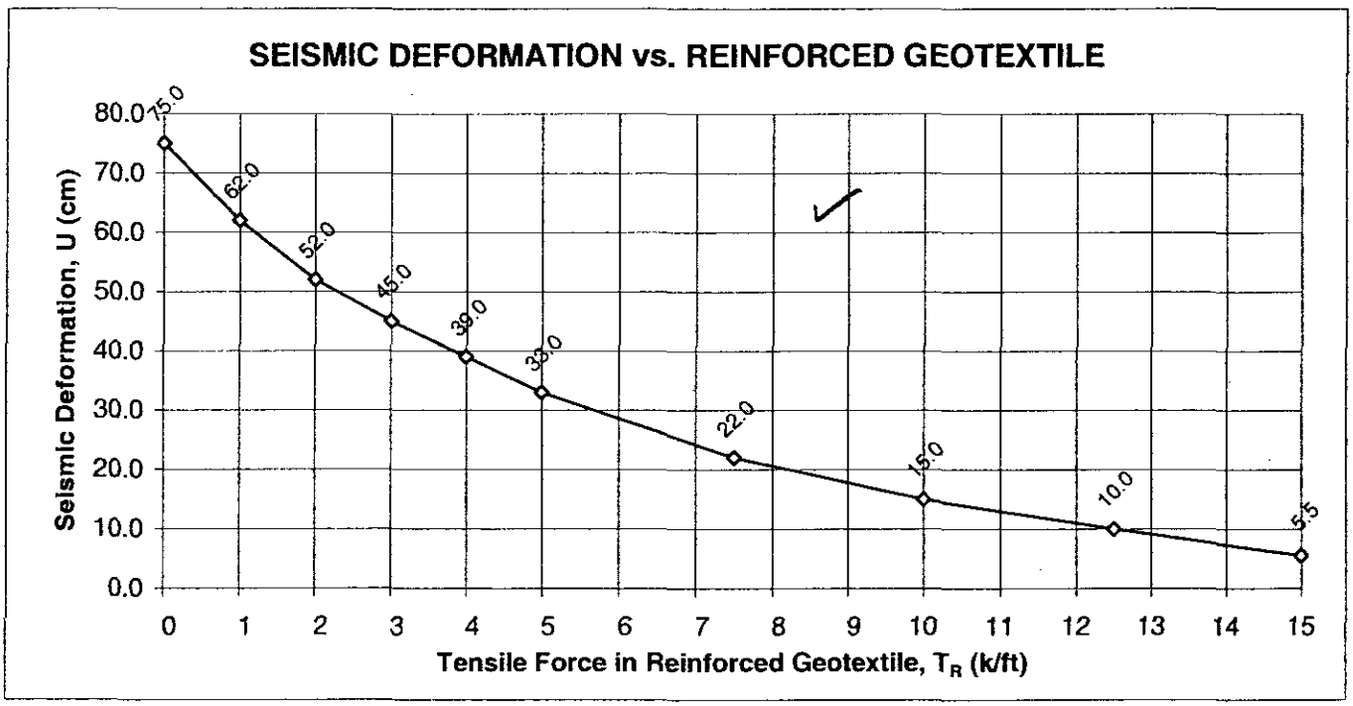




Cell Liner & LCRS (Cont.)

Liner & LCRS Stability Summary

Tensile Force in Reinforced Geotextile, T_R (k/ft)	Seismic Deformation for M ≈ 7.2, U (cm)
0.0	75.0
1.0	62.0
2.0	52.0
3.0	45.0
4.0	39.0
5.0	33.0
7.5	22.0
10.0	15.0
12.5	10.0
15.0	5.5



$T_{req'd}$ = 5.7 k/ft @ u = 30 cm

ψ = 0.16 & FS = 1.0

RESULTS

Static

Required FS = 1.50
Required T_R = 3.00 k/ft

∴ Reinforcing Req'd for Static Stability ✓

Seismic

Required FS = 1.00
Maximum Deformation ≤ 30 cm
Required T_R = 5.70 k/ft ✓
∴ Yield Acceleration = 0.16g

∴ Use Seismic Req'd Reinforcing for Design ✓

Reinforced Geotextile

Long Term Allowable Design Strength (LTADS) Controls:

T_{LTADS} = 5.70 k/ft w/ FS = 1.00 ✓

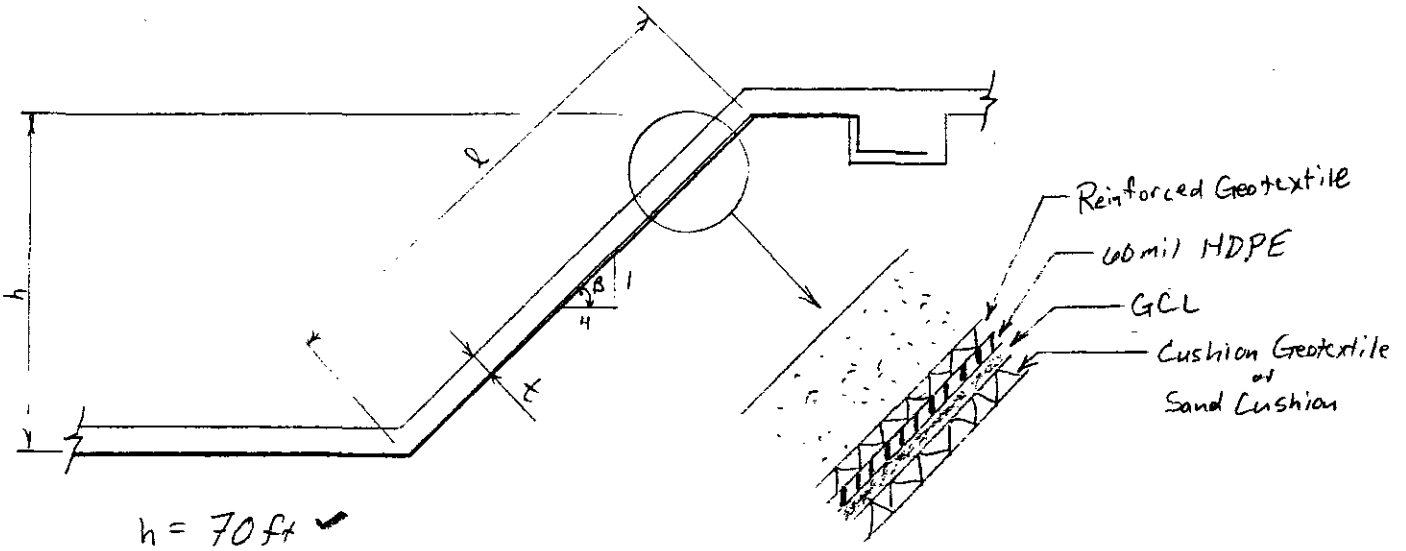
Resulting Static FS = 1.71

ATTACHMENT P-2
LINER SYSTEM STRESSES

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/15/03		
	Subject: Cell 2	Checked: PHP	Date: 7-22-03		
	Task: Slope Stability	Page: 1	of: 5		
	Job #: 3879	No:			

Cell Liner & LCRS System Stresses

Geometry / Materials



$h = 70\ ft$ ✓

$t = 2\ ft$

$l = h/\sin\beta = 288.6\ ft$

Materials At Interface	Interface Friction, $\delta°$ ②
2' LCRS / Reinforced GT/N	27° ①
GT / 60 mil Textured HDPE	27°
HDPE / GCL	18° *
GCL / Cushion GT/NW	18° *
GCL / Sand Cushion	N/A > 18°
Cushion GT / Exist Subgrade	27° ①

* Critical Value For Stability Analysis

① Matches July 1996 Permit Value

✓ ② Verify Interface Friction Using Proposed Materials Prior To Construction

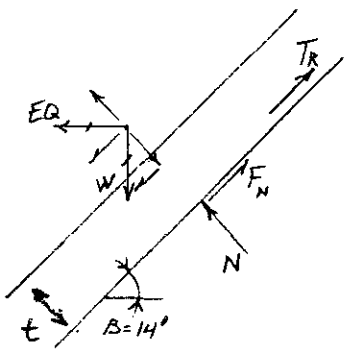
All interface friction values were taken from literature and file of test results.

CONT. →

Cell Liner & LCRS (Cont.)

Static & Pseudo-Static Stability

* Use Infinite Slope Method to Determine Factors of Safety



$W = \gamma t \ell = 0.100(2.0)\ell = 0.200\ell$ (k/ft) ✓

$W\cos\beta = 0.200\ell\cos 14° = 0.194\ell$ (k/ft)

$W\sin\beta = 0.200\ell\sin 14° = 0.049\ell$ (k/ft)

$EQ = W\psi = 0.200\ell\psi$ (k/ft) ✓

$EQ\sin\beta = 0.200\ell\psi\sin 14° = 0.049\ell\psi$ (k/ft) ✓

$EQ\cos\beta = 0.200\ell\psi\cos 14° = 0.194\ell\psi$ (k/ft) ✓

$N = W\cos\beta - EQ\sin\beta = 0.194\ell - 0.049\ell\psi$ (k/ft) ✓

$F_N = N\tan\delta = (0.194\ell - 0.049\ell\psi)\tan\delta$ (k/ft) ✓

STATIC: $FS_{stat} = (F_N + T_R)/W\sin\beta = (0.194\ell\tan\delta + T_R)/0.049\ell$
$(\psi = 0)$

PSEUDO-STATIC: $FS_{PS} = (F_N + T_R)/(W\sin\beta + EQ\cos\beta)$ ✓
$(\psi > 0)$ $= [(0.194\ell - 0.049\ell\psi)\tan\delta + T_R]/(0.049\ell + 0.194\ell\psi)$

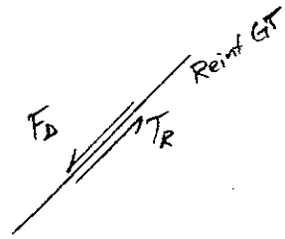
✓

CONT. →

Liner System Stresses (Cont.)

LCRS/Reinforced Geotextile (Woven) Interface ($\delta = 27°$)

Static:



$W = 0.200\,l = 57.72$ k/ft ✓
$N = 0.194\,l = 56.00$ k/ft ✓
$F_D = 0.049\,l = 14.00$ k/ft ✓
$F_N = 0.194\,l \tan\delta = 28.53$ k/ft ✓
$T_R = 5.70$ k/ft ✓

$\Delta F_{stat} = 14.00 - 5.70 = 8.30$ k/ft ✓
∴ Excess Static Stresses From LCRS Transferred Below

OK

Seismic ($\psi = 0.16$):

$W = 0.200\,l = 57.72$ k/ft ✓
$N = 0.194\,l - 0.049\,l\psi = 53.73$ k/ft ✓
$F_D = 0.049\,l + 0.194\,l\psi = 22.96$ k/ft ✓
$F_N = (0.194\,l - 0.049\,l\psi)\tan\delta = 27.39$ k/ft ✓
$T_R = 5.70$ k/ft ✓

$\Delta F_{seis} = 22.96 - 5.70 = 17.26$ k/ft ✓
∴ Excess Seismic Stresses From LCRS Transferred Below

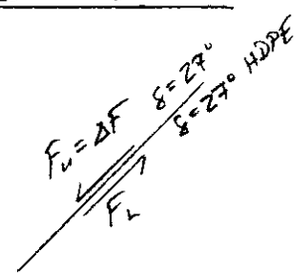
OK.

CONT. →

Liner System Stresses (Cont.)

Reinforced GT / Textured HDPE Interface ($\delta = 27°$)

Static:



$F_u = \Delta F_{stat} = 8.30$ k/ft
$F_L = F_N = 28.53$ k/ft

$F_L \geq F_u$ ∴ No Tension In HDPE OK ✓

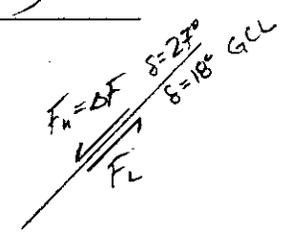
Seismic ($Q = 0.16$):

$F_u = \Delta F_{seis} = 17.26$ k/ft
$F_L = F_N = 27.39$ k/ft

$F_L \geq F_u$ ∴ No Tension In HDPE OK ✓

Textured HDPE / GCL Interface ($\delta = 18°$)

Static:



$F_u = \Delta F_{stat} = 8.30$ k/ft
$F_L = F_N = 0.194\,\ell \tan\delta = 18.20$ k/ft

$F_L \geq F_u$ ∴ No Tension In GCL OK ✓

Seismic ($Q = 0.16$):

$F_u = \Delta F_{seis} = 17.26$ k/ft
$F_L = F_N = (0.194\,\ell - 0.049\,\ell Q) \tan\delta = 17.47$ k/ft

$F_L \cong F_u$ ∴ Nominally Balanced, Which is Consistent With Stability Analysis OK ✓

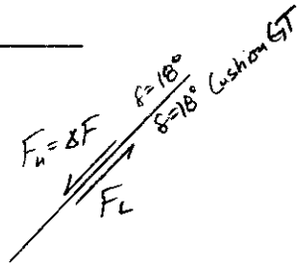
CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/18/03		
	Subject: Cell 2	Checked: PHP	Date: 7-22-03		
	Task: Liner & LCRS	Page: 5	of: 5		
	Job #: 3879	No:			

Liner System Stresses (Cont.)

GCL / Cushion GT Interface ($\delta = 18°$)

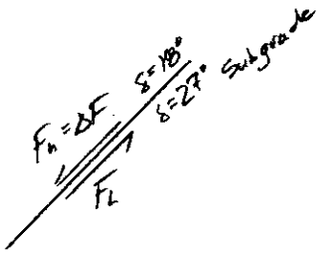
Same As Previous ∴ OK ✓



Cushion GT / Existing Subgrade Interface ($\delta = 27°$)

Static:

$F_u = \Delta F_{stat} = 8.30$ k/ft
$F_L = F_N = 28.53$ k/ft



$F_L \geq F_u$ ∴ No Shear Failure in Subgrade Soils OK ✓

Seismic:

$F_u = \Delta F_{seis} = 17.26$ k/ft
$F_L = F_N = 27.39$ k/ft

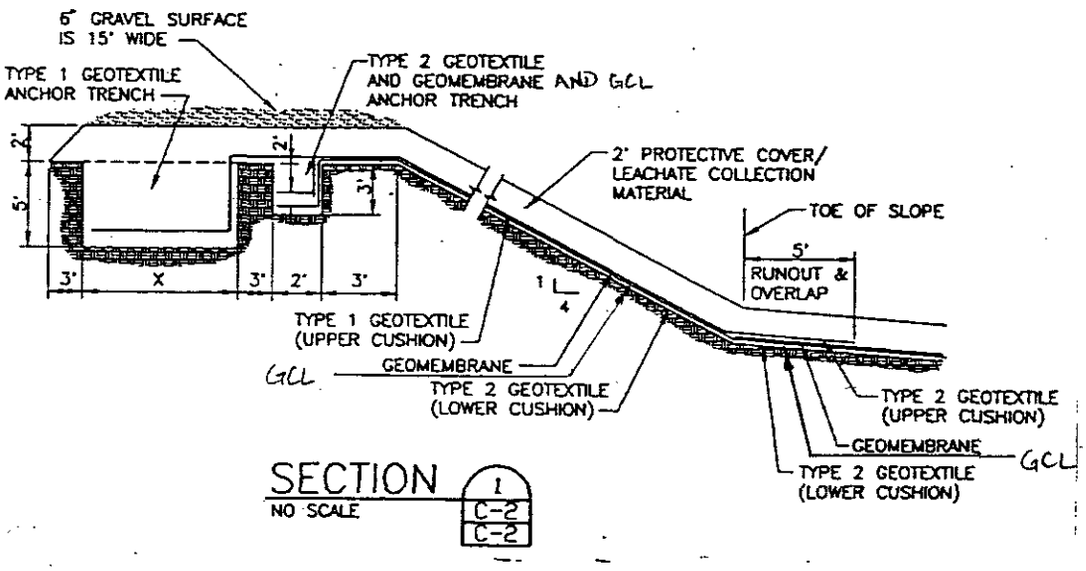
$F_L \geq F_u$ ∴ No Shear Failure in Subgrade Soils OK ✓

ATTACHMENT P-3
ANCHOR TRENCH DESIGN

HDR ONE COMPANY *Many Solutions*™	Project: Bayview Landfill	Computed: NPD	Date: 07/21/03		
	Subject: Cells 2 & 3 Design	Checked: PHP	Date: 7-22-03		
	Task: Liner & LCRS	Page: 1	of: 3		
	Job #: 3879	No:			

Anchor Trench Design

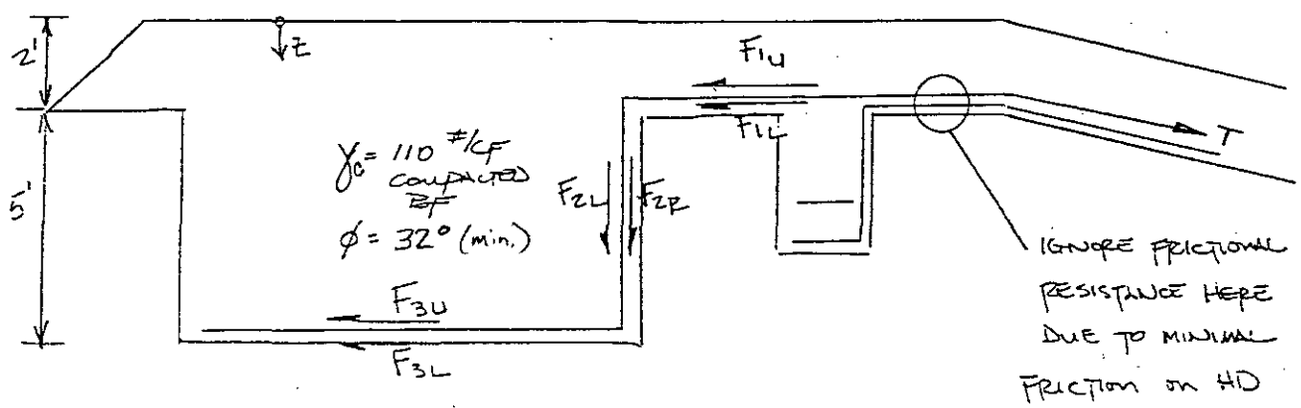
Geometry/Materials



Calculations

(a) FOR TYPE 2 CUSHION GEOTEXTILE & 60 MIL HDPE GEOMEMBRANE, STRESS ANALYSES INDICATE MINIMAL STRESS IN GEOSYNTHETICS. USE MINIMAL ANCHOR TRENCH SHOWN ABOVE

(b) FOR TYPE 1 REINFORCING GEOTEXTILE, SIZE DIMENSION "X", HORIZONTAL RUNOUT, AS ABOVE



CONT. →

HDR ONE COMPANY Many Solutions™	Project: Bayview Landfill	Computed: NPD	Date: 07/21/03		
	Subject: Cell 2	Checked: PHP	Date: 7-23-03		
	Task: Liner & LCRS	Page: 2	of: 3		
	Job #: 3879	No:			

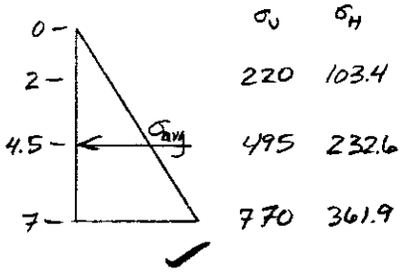
Anchor Trench Design (Cont.)

Calculations (Cont.)

$$FS = \Sigma F / T_{Req'd}$$

$$F_1 = F_{1u} + F_{1L} \quad \& \quad F_{1u} = F_{1L} \text{ (Same Soil \& Friction Both Sides)}$$
$$= 2F_{1u}$$
$$= 2(\gamma)(z)(\tan\delta)(L_1)$$
$$= 2(110)(2)(\tan 27^\circ)(5)/1000$$
$$= 1.12 \text{ k/ft}$$

$$F_2 = F_{2L} + F_{2R}$$
$$= 2F_{2L}$$
$$= 2(\sigma_{Havg})(\tan\delta)(L_2)/1000$$
$$= 2(232.6)(\tan 27^\circ)(5)/1000$$
$$= 1.18 \text{ k/ft}$$



$$\sigma_V = \gamma z \quad (psf)$$
$$\sigma_H = K_o \sigma_V \quad (psf)$$
$$K_o = 1 - \sin\phi$$
$$= 1 - \sin 32^\circ$$
$$= 0.47$$

$$F_3 = F_{3u} + F_{3L}$$
$$= 2F_{3u}$$
$$= 2(\gamma)(z)(\tan\delta)(L_3)/1000$$
$$= 2(110)(7)(\tan 27^\circ)(x)/1000$$
$$= 0.785(x) \text{ k/ft}$$

x	F_3
5 ft	3.925 k/ft
7 ft	5.495 k/ft
10 ft	7.850 k/ft
12 ft	9.420 k/ft

ΣF:

x	ΣF
5 ft	6.2 k/ft
7 ft	7.8 k/ft
10 ft	10.1 k/ft
12 ft	11.7 k/ft

CONT. →

Anchor Trench Design (Cont.)

Calculations (Cont.)

$T_{R_{req'd}} = 5.7$ k/ft

* USE FS = 1.5 FOR SIZING ANCHOR TRENCH - OK

$FS = \Sigma F / T_{R_{req'd}}$

$\therefore \Sigma F_{req'd} = FS(T_{R_{req'd}})$
$= 1.5(5.7)$
$= 8.55$ k/ft

10 ft Anchor Trench: $\Sigma F = 10.1$ k/ft $> \Sigma F_{req'd}$ OK

Use 10 ft Wide Anchor Trench

ATTACHMENT P-4
HDPE GEOMEMBRANE PUNCTURE RESISTANCE

HDR | ONE COMPANY *Many Solutions*™

Project: Bayview Landfill Cell 2	Computed: GMS	Date: 7/17/2003	
Subject: Liner System	Checked: PWP	Date: 7-23-03	
Task: HDPE Geomembrane Puncture Resistance	Page: 1	of: 6	
~~Job #~~	No:		

CELL COMPONENT: LEACHATE COLLECTION / REMOVAL SYSTEM

.1 CONSIDERATION: PUNCTURE OF HDPE GEOMEMBRANE FROM GRANULAR LCRS MATERIALS

.2 REFERENCES: (a) Narejo, Koerner, and Wilson-Fahmy, Experimental Puncture Behavior of HDPE Geomembranes Without, Then With, Various Protection Materials. GRI Report 10

(b) Koerner, Designing with Geosynthetics, 3rd. ed.

.3

REQ'D. MATL PROP	VALUE	TEST	METHOD
Aggregate Max Size		Sieve	ASTM C136/D422
Puncture Resistance		Hydrostatic	ASTM D5514

.4 ANALYSIS PROCEDURE:

(1) DETERMINE MAX STRESS @ AGG : GM INTERFACE

(2) DETERMINE AGGREGATE M.S.A.

(3) DETERMINE GEOTEXTILE MASS/AREA.

- FROM NOMOGRAPH OF REF (a)

WHERE: CH (CONE HEIGHT) & MSA, UNITS ARE INCHES

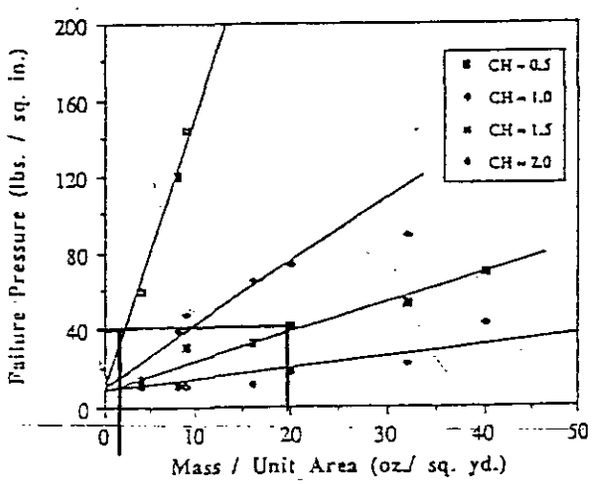
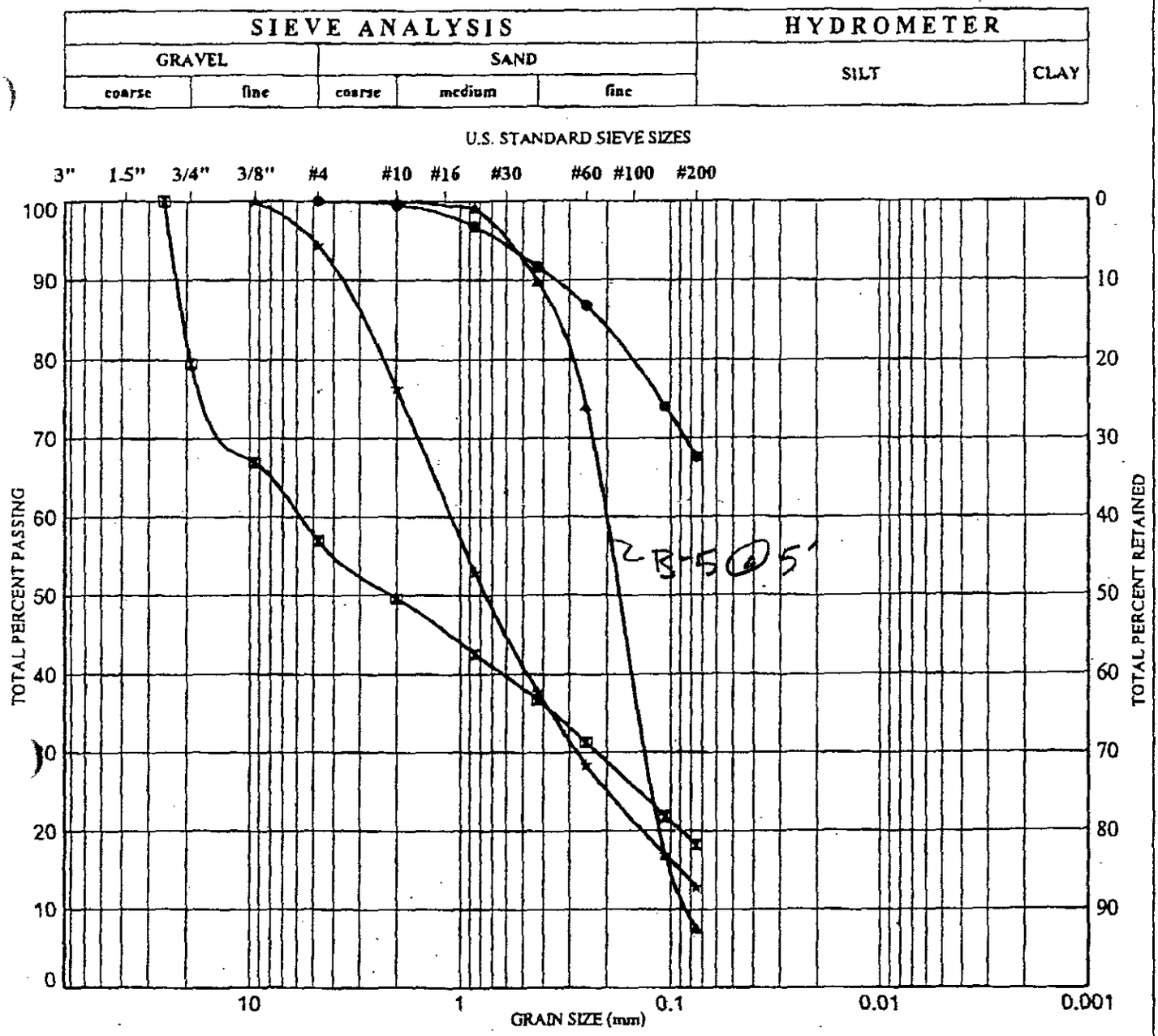


Figure 9(a) - Effect of Nonwoven Needle Punched Geotextile Mass / Unit Area on HPTC Behavior of 60 mil HDPE Geomembranes



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-4	22.0	Sandy SILT	ML
⊠	B-4	35.0	Silty GRAVEL with sand	GM
▲	B-5	5.0	Poorly graded SAND with silt	SP-SM
★	B-5	25.0	Silty SAND	SM

KLEINFELDER

PROJECT NO. 30268.001

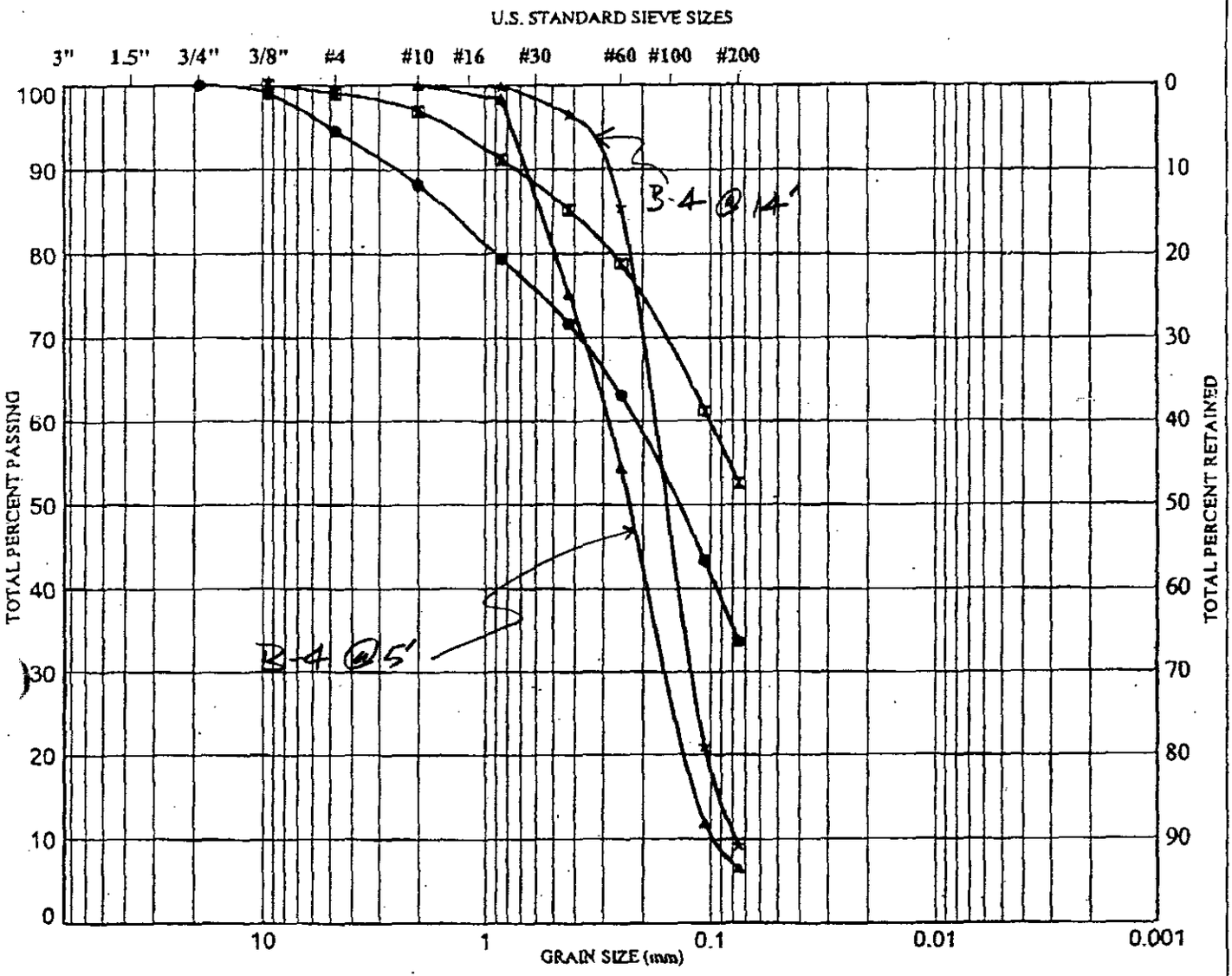
South Utah Valley Landfill
Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE
B-7

Page 3 of 6

SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-3	42.0	Silty SAND	SM
⊠	B-3	47.0	Sandy SILT	ML
▲	B-4	5.0	Poorly graded SAND with silt	SP-SM
★	B-4	14.0	Poorly graded SAND with silt	SP-SM

Dune Sand
LCRS

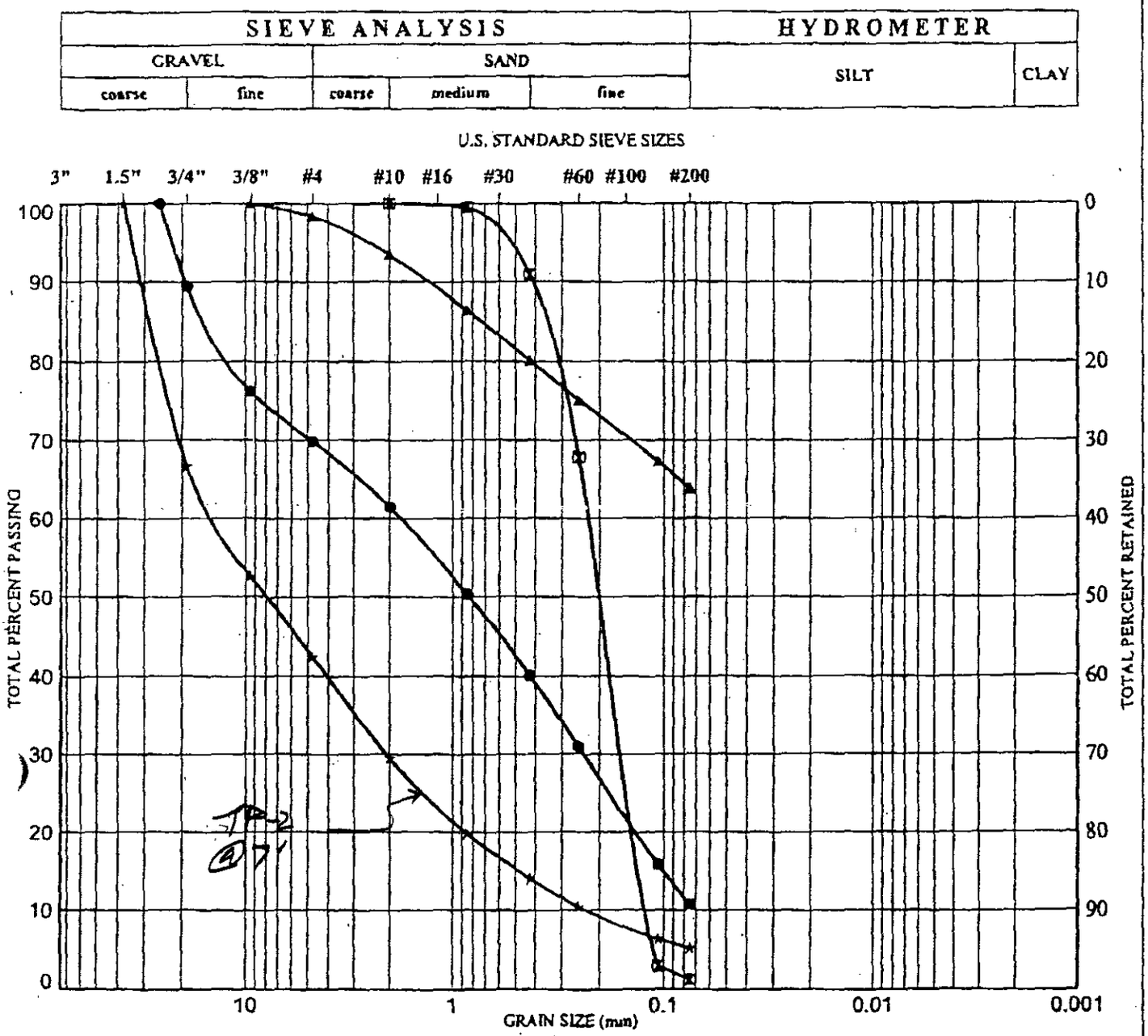
KLEINFELDER

PROJECT NO. 30268.001

South Utah Valley Landfill
Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE B-6



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	BVLF-4	0.0	Well graded SAND with silt and gravel	SW-SM
⊠	BVLF-5	0.0	Poorly graded SAND	SP
▲	TP-1	0.0	Sandy SILT	ML
★	TP-2	7.0	Well graded GRAVEL with sand	GW

KLEINFELDER

PROJECT NO. 30268.001

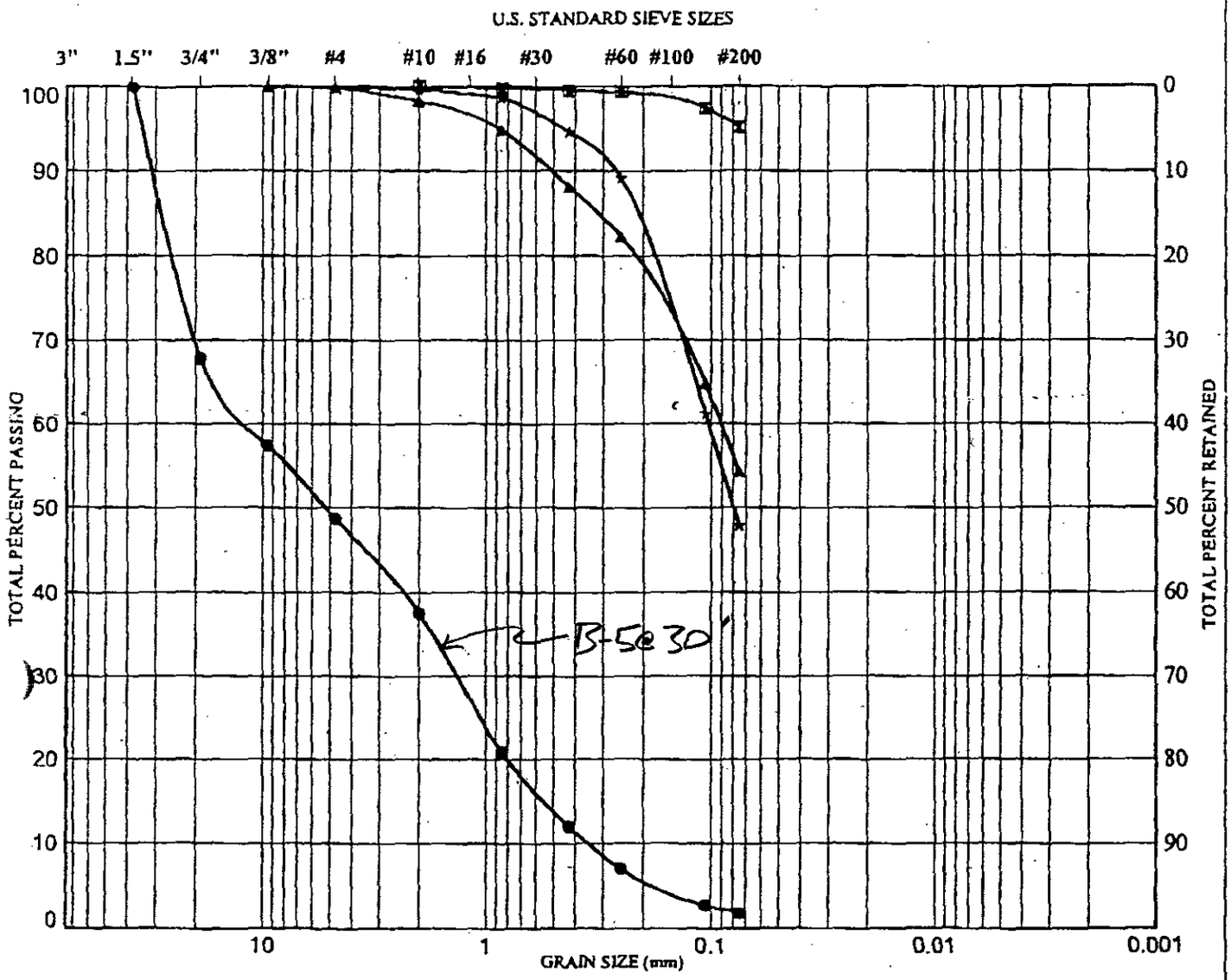
South Utah Valley Landfill
Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE
B-9

Page 5 of 6

SIEVE ANALYSIS					HYDROMETER	
GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B- 5	30.0	Well graded GRAVEL with sand	GW
⊠	BVLF- 1	0.0	SILT	ML
▲	BVLF- 2	0.0	Sandy SILT	ML
★	BVLF- 3	0.0	Silty SAND	SM

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Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE

B-8

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Project: Bayview Landfill Cell 2	Computed: GMS	Date: 7/18/2003	
Subject: Liner System	Checked: PHP	Date: 7-24-03	
Task: HDPE Geomembrane Puncture	Page: 60	of: 60	
~~Job #~~: Resistance	No:		

5. Analysis

A) Determine max stress @ Agg. : GM interface

- From waste height : 4780 FT
  - 4666 FT
  - 114 FT ✓

$$\sigma_c = \frac{(114') * 50\ PCF}{144\ in^2} = 39.6\ psi \text{ say } 40\ psi$$ ✓

- From vehicle operations at top of LCRS ①:

CAT 826C Compactor 12.3 psi (CAT Lit) ✓
D8N Dozer 14.6 psi (CAT LIT)

① Stresses will decrease (dissipate) through 2' LCRS.

Use worst case $\sigma_c = 40$ psi - OK

B) Determine Agg. MSA

July 1, 2003
Kleinfelder
Source material Invest.
South Utah Valley Landfill

For LCRS = #4 sieve = 0.2 IN (Gradations pages 2 & 3)
For Native Subgrade = 1 1/2 IN (Gradations pages 4 & 5)

C) Determine required geotextile mass/area from nomograph page 1

For upper geotextile between LCRS & HDPE use geotextile with 3 oz/sy min. ←

For Lower geotextile between HDPE and Subgrade use geotextile with 20 oz/sy min ←

ATTACHMENT P-5
GEOTEXTILE PERMEABILITY AND FILTRATION

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Project: Bayview Landfill Cell 2	Computed: GMS	Date: 7/24/2003	
Subject: Leachate Collection System	Checked: PHP	Date: 7-24-03	
~~Task:~~ LCRS - Geotextile	Page: 1	of: 6	
Job #:	No:		

.1 CONSIDERATION: RETENTION / FILTRATION / PERMEABILITY BETWEEN SOIL : GEOTEXTILES.

.2 REFERENCES: (a) Luettich, Giroud, and Bachus, "Geotextile Filter Design Guide," PROCEEDINGS, 5th GRI Seminar, 1991.

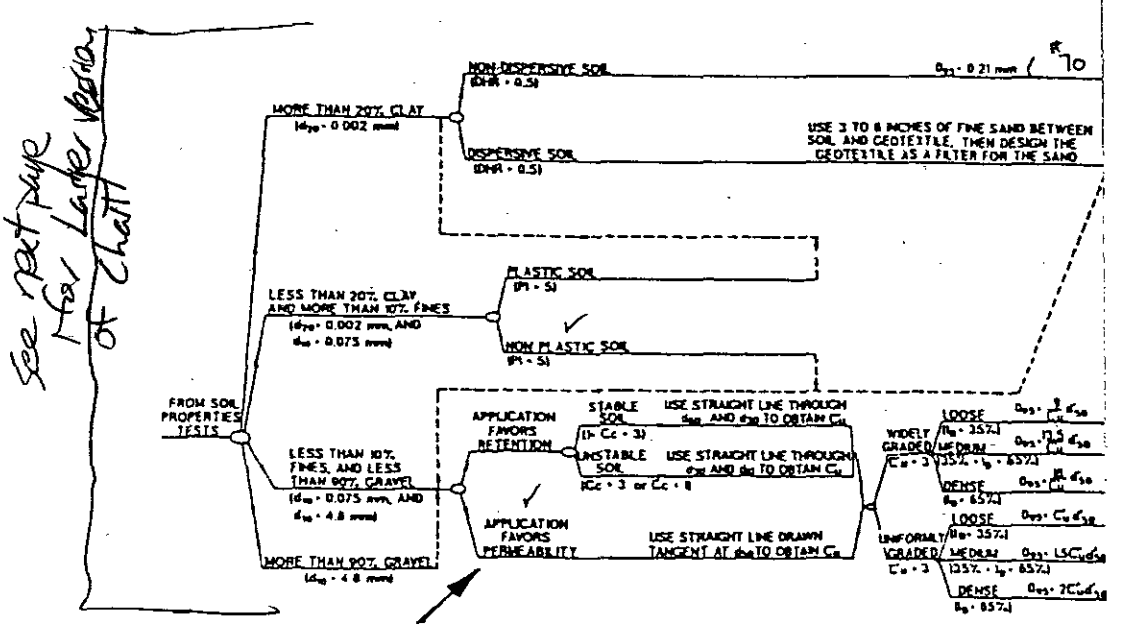
.3

REQ'D. MATL PROP.	VALUE	TEST	METHOD
SOILS			
gradation	ATTACHED	sieve / hydro	ASTM C136/D422
Atterberg Limits	NON PLASTIC	LL, PI	ASTM D4318
dispersion	NA FOR SM/SP	hydrometer	ASTM D422
Geotextile			
Apparent Opening Size, O_{95}	TBD	sieve	ASTM D4751
Thickness, t_{gt}		—	ASTM D5199
Permittivity, ψ_{gt}		permeability	ASTM D5493

.4 ANALYSIS PROCEDURE:

(1) OBTAIN PHYSICAL PROPERTIES OF SOILS

(2) EVALUATE RETENTION / FILTRATION CRITERIA

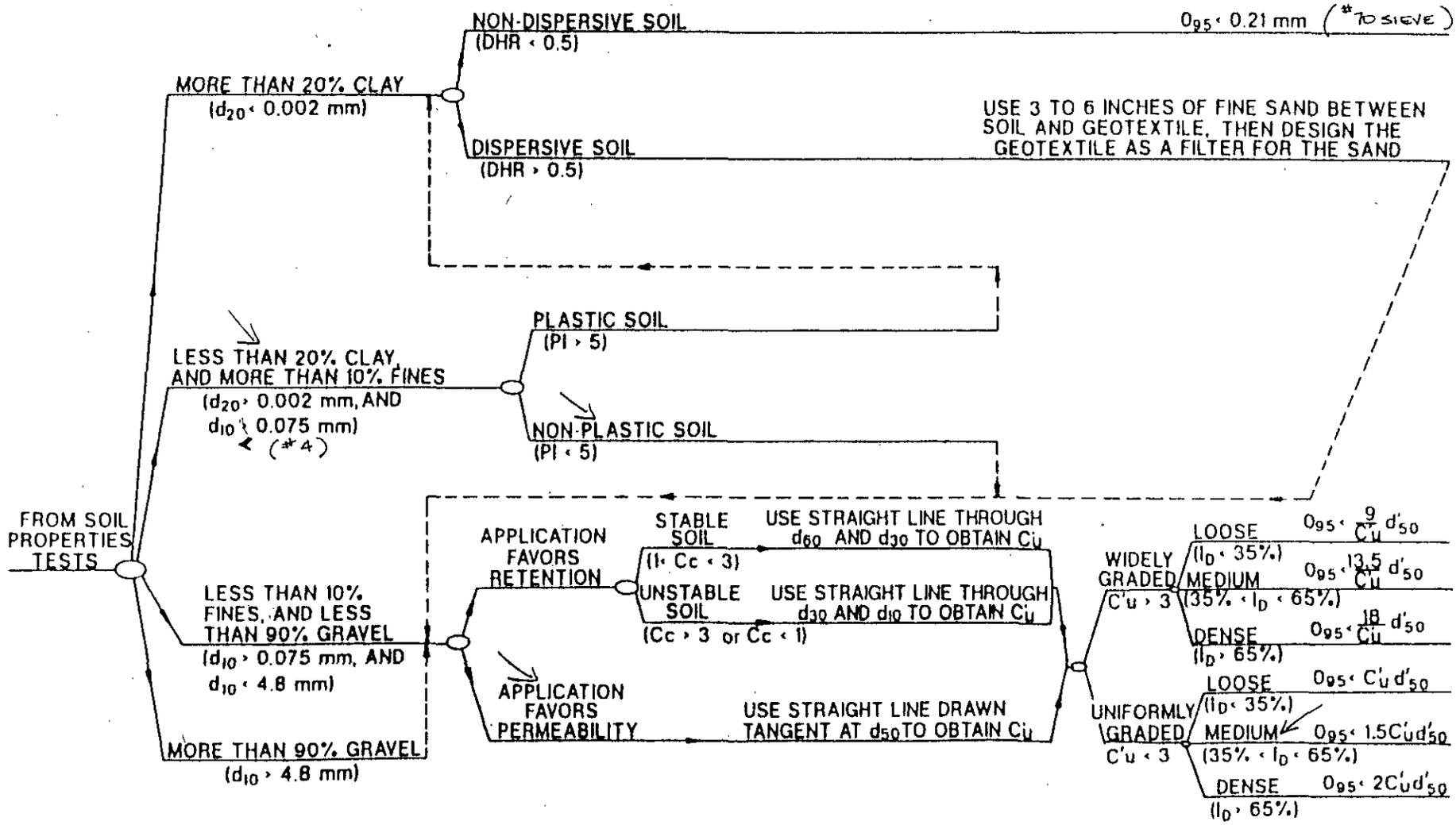


(3) EVALUATE GEOTEXTILE PERMEABILITY / PERMITTIVITY

$$k_{gt} = i_s k_s$$

(i_s = 1.5 FOR LANDFILLS)

CHART 1
SOIL RETENTION CRITERIA
FOR STEADY-STATE FLOW CONDITIONS



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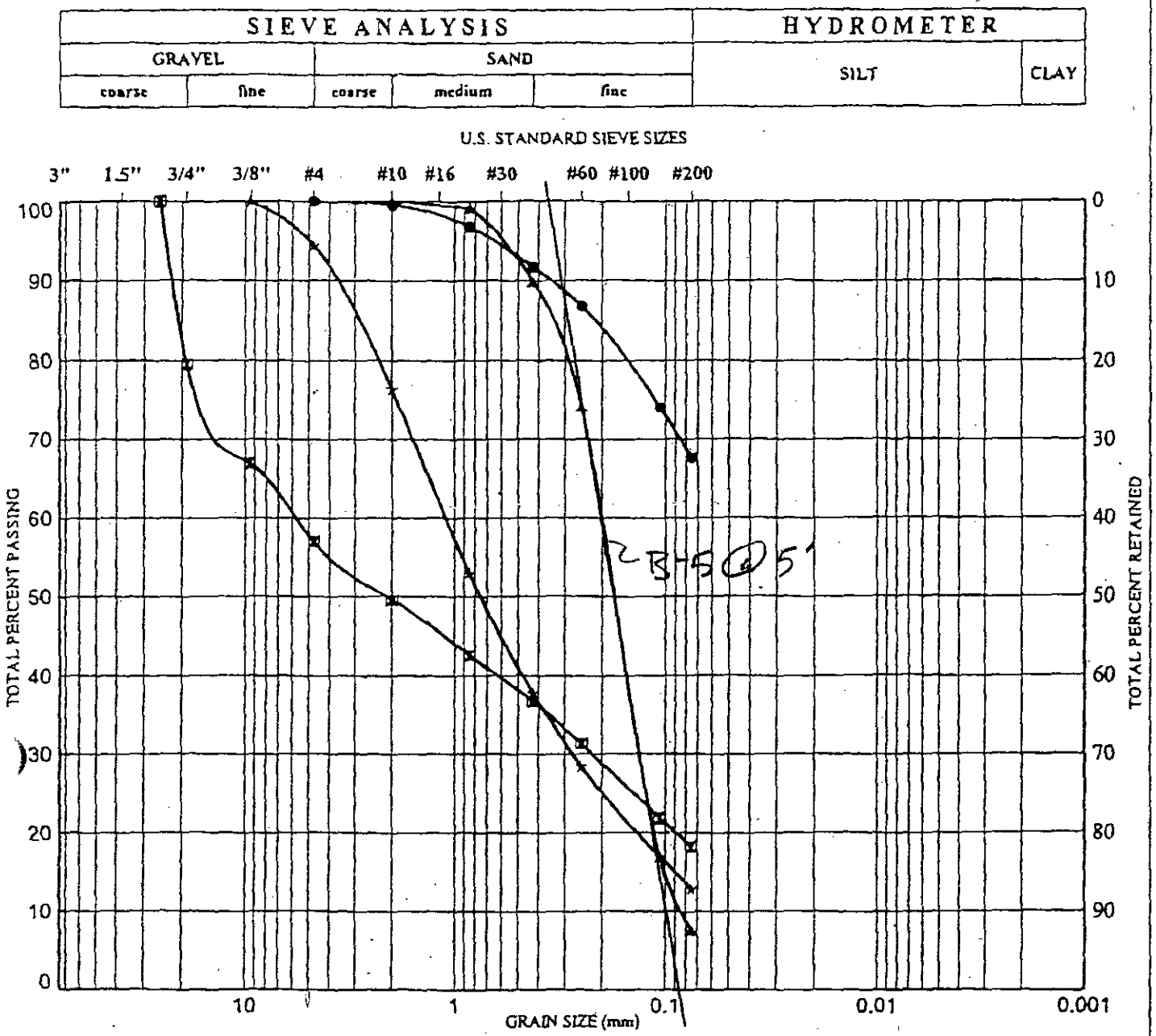

Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-4	22.0	Sandy SILT	ML
⊠	B-4	35.0	Silty GRAVEL with sand	GM
▲	B-5	5.0	Poorly graded SAND with silt	SP-SM
★	B-5	25.0	Silty SAND	SM

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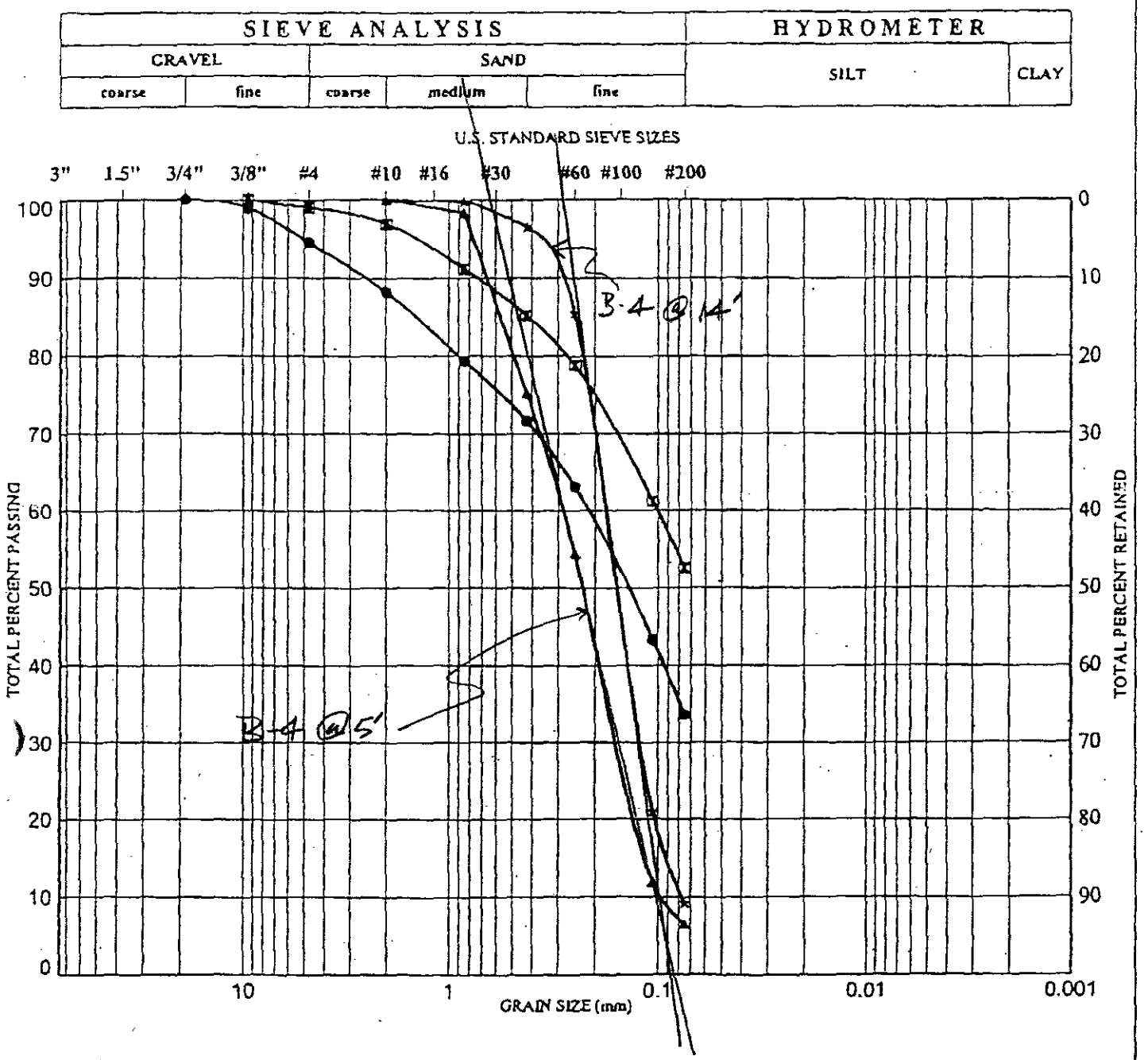
GRAIN SIZE DISTRIBUTION

FIGURE
B-7



Symbol	Sample	Depth (ft)	USCS Soil Description	USCS Classification
●	B-3	42.0	Silty SAND	SM
⊠	B-3	47.0	Sandy SILT	ML
▲	B-4	5.0	Poorly graded SAND with silt	SP-SM
★	B-4	14.0	Poorly graded SAND with silt	SP-SM

Dune Sand
LCRS

KLEINFELDER

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Utah County, Utah

GRAIN SIZE DISTRIBUTION

FIGURE
B-6

.5 Analysis

Evaluate retention / Filtration Criteria

see Flowchart, pg. 1

Less than 20% clay (Based on USCS classification)
More than 10% fines (Gradations pages 3+4)
Non plastic (From test results + USCS classification)

Application favors permeability – straight line tangent @ d_{50}

$C_u' = \sqrt{d'_{100}/d'_0}$ (d_{100}, d_0 thru of d_{50})

→ Material Info from Kleinfelder, July 1, 2003 Report. see Attach E of Appd. J

Material (sample)	d'_{100}	d'_{50}	d'_0	C_u'	$O_{95} \leq 1.5 C_u' d'_{50}$
B-5 @ 5'	0.35	0.18	0.085	✓2.0 <3.0	0.54 ✓
B-4 @ 5'	0.64	0.23	0.084	✓2.8 <3.0	0.97 ✓
B-4 @ 14'	0.28	0.17	0.083	✓1.8 <3.0	0.46 ← Controls ✓

$C_u' < 3$ = Uniformly graded

For med. density (Dumped, no compaction)

$O_{95} < 1.5 C_u' d_{50}$

Use $O_{95} \leq 0.46$ mm $\leq$ #70 AOS (0.212 mm) ✓ ←

Evaluate geotextile permeability / Permitivity

Determine permeability ($K_s = 1.4 \times 10^{-3}$ cm/sec, Kleinfelder Report, App. J, Attach. E)

$K_{gt} = 1.5 K_s$
$= 1.5 (1.4 \times 10^{-3}$ cm/sec$) = 0.0021$ cm/sec ✓

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Determine Permittivity

$$\psi = \frac{K_g t}{t}$$

$t = 100$ MIL Typical for #70 AOS nonwoven
$= 0.1$ IN $= 0.04$ cm

$$= \frac{0.0021 \text{ cm/sec}}{0.04 \text{ cm}} = 0.05 \text{ 1/sec} = 0.05 \text{ sec}^{-1}$$

Typical #70 AOS nonwoven geotextiles have $\psi = 0.5 \text{ sec}^{-1}$ or greater

Use $\psi \geq 0.5 \text{ sec}^{-1}$ ←

Other physical properties per AASHTO M288 ←

Class A subsurface drainage application for type 2 cushion geotextile

High survivability seperaration application for type 1 reinf. geotextile

ATTACHMENT P-6
PIPING STRENGTH/DEFLECTION

.1 CONSIDERATION: LCRS PIPING STRENGTH/DEFLECTION

.2 REFERENCES:
(a) EPA SW-870, LINING OF WASTE IMPOUNDMENT AND DISPOSAL FACILITIES
(b) MOSER, BURIED PIPE DESIGN.
(c) KOERNER, DESIGNING WITH GEOSYNTHETICS
(d) ASTM D-2412, "EXTERNAL LOADING CHARACTERISTICS OF PLASTIC PIPE BY PARALLEL-PLATE LOADING."

.3

REQ'D. MATL PROP.	VALUE	TEST	METHOD
Pipe Stiffness, F/Δy	SCH 80	Comp.	ASTM D-2412
Backfill Soil Modulus, E'	1000 psi	—	REF b,c
Backfill Lat Pressure, $K\mu$	0.165		REF a,b

.4 ANALYSIS PROCEDURE:

(1) COMPUTE WASTE & BACKFILL STRESSES ON PIPE (REF a)

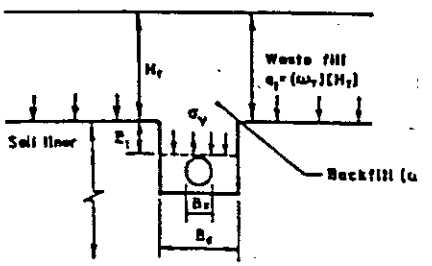
For TRENCH CONDITION:

$$\sigma_v = B_d \omega C_D + q_f C_{w.s.}$$

Where: $C_D = \dfrac{\left[1 - e^{-2K\mu(z/B_d)}\right]}{2K\mu}$

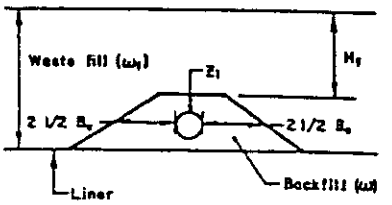
$C_{w.s.} = e^{-2K\mu(z/B_d)}$

$K\mu = 0.165$ for gran. bf



For PROJECTING CONDITION:

$$\sigma_v = (\omega_f)(H_f) + \omega z_1$$



For PERFORATED PIPE:

$$\sigma_{v(des)} = \frac{A_{pipe}}{A_{pipe} - ZA_{perf}} \sigma_v$$

(2) OBTAIN / COMPUTE PIPE STIFFNESS (REFS b & d)

- FROM SPECS OR MANUFACTURER'S LIT/RESULTS
- FROM PIPE MATERIALS & DIMENSIONS:

$$PS = 6.7 \frac{EI}{r^3} \qquad \text{(REF d, APP X2)}$$

$$= 0.559E\left(\frac{t}{r}\right)^3$$

WHERE: E = modulus of elas, $\#/in^2$
I = moment of inertia/in, in^3
$= t_{wall}^3 / 12$
r = mean radius, in
$= (B_c - t_{wall})/2$

- FROM SDR:

$$PS = \frac{4.47E}{(DR-1)^3} \qquad \text{(REF b, pg 174)}$$

WHERE: $E = 400{,}000\ \#/in^2$ for PVC
$DR = B_c / t_{wall}$

(3) COMPUTE DEFLECTION w/ MODIFIED IOWA EQN (REFS b, d)

$$\Delta y_{in} = \frac{D \cdot K \cdot W_c}{0.149PS + 0.061E'} \qquad \text{(REF d, APP X1.)}$$

FOR $D = 1.5$, $K = 0.10$ (TYP VALUES, REF c), $W_c = \sigma_v \cdot B_c$, SUBSTITUTE

$$\frac{\Delta y}{B_c} = \frac{1.005\,\sigma_v}{PS + 0.41E'}$$

WHERE: E' = modulus of soil reaction:

TABLE 3.4 Average Values of Modulus of Soil Reaction, E' (For Initial Flexible Pipe Deflection)

Soil type-pipe bedding material (Unified Classification System*)	E' for degree of compaction of bedding, lb/in²			
	Dumped	Slight, < 85% proctor, < 40% relative density	Moderate, 85%–95% proctor, 40%–70% relative density	High, > 95% proctor, > 70% relative density
Fine-grained soils (LL > 50)† Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; Otherwise use $E' = 0$			
Fine-grained soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1000
Fine-grained soils (LL < 50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles Coarse-grained soils with fines GM, GC, SM, SC contains more than 12% fines	100	400	1000	2000
Coarse-grained soils with little or no fines GW, GP, SW, SP‡ contains less than 12% fines	200	1000	2000	3000
Crushed rock	1000	3000	3000	3000
Accuracy in terms of percentage deflection§	± 2	± 2	± 1	± 0.5

(4) COMPARE VS. $\left(\frac{\Delta y}{B_c}\right)_{ALLOW}$

$$\left(\frac{\Delta y}{B_c}\right)_{ALLOW} = 7.5\ \%$$

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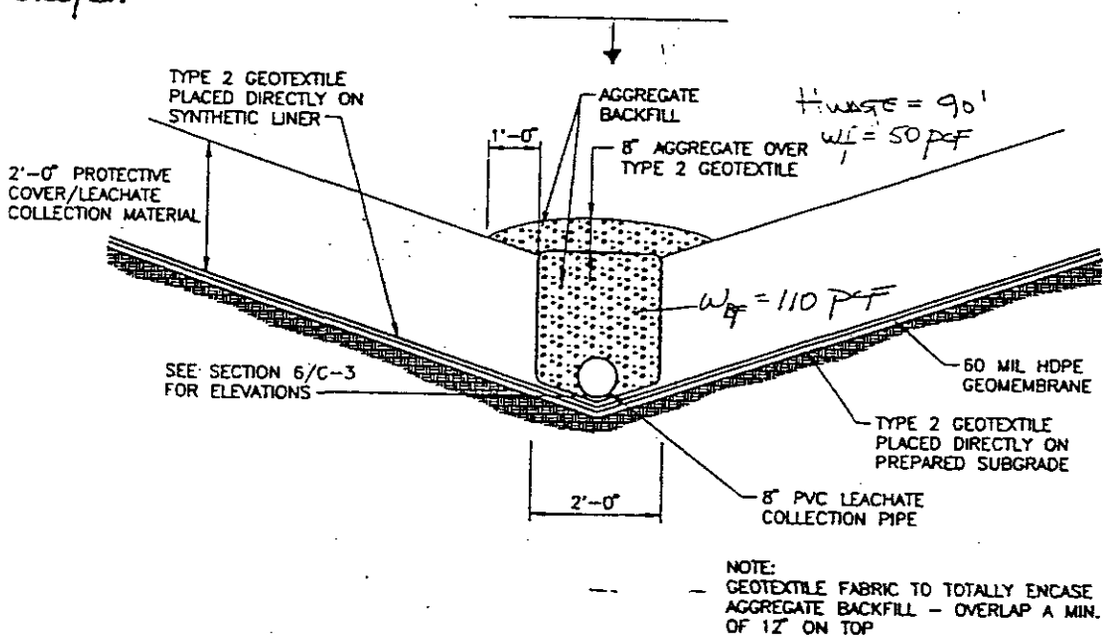
.5 SKETCH



.6 Calculations

A) Calculate backfill + waste stresses on pipe

$z = 2'$, ie at bottom of Agg. backfill

$B_d = 2'$

$$C_D = \frac{1-e^{(-2)(0.165)(2/2)}}{2(0.165)} = 0.85$$

$$C_{us} = e^{-2(0.165)(2/2)} = 0.72$$

$$\sigma = B_d w_{BF} C_D + H_w (w_f) C_{us}$$

$$= (2'(110\text{ pcf})(0.85) + (114)(50\text{ pcf})(0.72)$$

187 4104

$$= 4291 \text{ psf}$$

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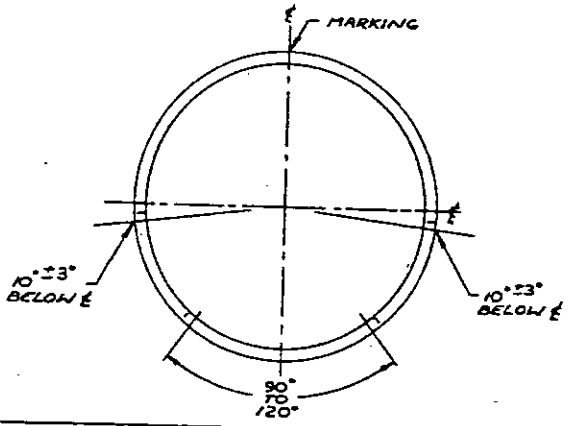
ADJUST FOR PIPE PERFORATIONS

TABLE 5 Perforations[A]



Nominal Diameter, in.	Minimum Rows of Perforations	Hole Size[A]		Hole Spacing[A]	
		mm	in.	mm	in.
4	2	4.8 to 9.7	3/16 to 3/8	82.55 ± 6.35	3 1/4 ± 1/4
6	4	4.8 to 9.7	3/16 to 3/8	82.55 ± 6.35	3 1/4 ± 1/4
8	4	4.8 to 9.7	3/16 to 3/8	82.55 ± 6.35	3 1/4 ± 1/4

[A] Combination of hole size and spacing of holes shall provide a minimum inlet area greater than 0.2200 in.²/ft of pipe (that is, 3/16-in. holes at 3-in. center would permit a 0.2206-in.² area).

$$\sigma_{V(des)} = \frac{A_{pipe}}{A_{pipe} - \Sigma A_{perf.}} \sigma_V$$

$A_{pipe} \Rightarrow$ 8 IN ID = 9.00 OD for schedule 80

$= (\pi d)(L) = 28.3 \ in^2/FT$

$$\sigma_{V(des)} = \frac{28.3 \ in^2/FT}{(28.3 - 0.22) \ IN^2/FT} (4291 \ PSF)$$

$\sigma_{V(des)} = 4325$ PSF, 30 PSI

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B) Pipe stiffness

For Schedule 80 PVC 8" ID

Wall $t = 0.5''$

$OD = B_c = 9.00''$

$E = 400{,}000$ psi for PVC

$I = t_{wall}^3 \div 12 = (0.50\ IN)^3 \div 12 = 0.010\ IN^3$

$r = (B_c - t_{wall}) \div 2 = (9.00 - 0.50) \div 2 = 4.25\ IN$

$$PS = \frac{6.7\ EI}{r^3}$$

$$= \frac{(6.7)(400{,}000\ \#/IN^2)(0.010\ IN^3)}{(4.25\ IN)^3} = 349\ psi$$

C) Compute Deflection

Crushed rock dumped (loose) $E = 1{,}000$ psi

$$\frac{\Delta Y}{B_c} = \frac{1.005\ \sigma_v}{PS + 0.41E}$$

$$= \frac{1.005\ (30\ psi)}{349\ psi + (0.41)(1000)} * 100\%$$

$= 4.0\%$ < 7.5 OK

Use Schedule 80 PVC

ATTACHMENT P-7
PIPE STRENGTH CALCULATIONS
FOR HDPE PIPE

Pipe Strength Calculations for HDPE Pipe
Bayview Landfill

The Driscopipe Manual Procedure was used for calculating wall crushing and wall buckling.

The first item to be determined is the landfill cross-section.

Landfill Cross Section
36" Cover Soil
1560" Waste
24" Protective Cover Soil

The associated depths and estimated densities for each layer are shown in Table 1. The composition of the waste is four parts waste and 1 part soil. The density of the waste was estimated to be 1300 lb/yd^3 and the density of the soil was estimated to be 115 lb/ft^3. Therefore, the composite density was calculated to be 61.52 lb/ft^3.

TABLE 1
LANDFILL CROSS SECTION

ITEM	DEPTH (in)		DENSITY (pcf)	DEPTH DENSITY
SOIL	36	@	115	345
WASTE	1560	@	61.52	7997.6
PROTECTIVE COVER	24	@	115	230
P_T (psi)				60

The external pressure, P_T, is determined by summing the product of the density and the depth for each layer in the cross-section.

Wall Crushing

$$S_A = \frac{SDR - 1}{2} P_T$$

Where:

S_A = actual compressive stress in psi
SDR = standard dimension ratio
P_T = external pressure

After wall crushing is calculated for a specific *SDR* of HDPE pipe, the compressive yield strength of Driscopipe, 1,500 psi, is divided by S_A. If this safety factor exceeds two, then that particular SDR passes the test for Wall Crushing. The calculations for Wall Crushing of various SDRs are shown in Table 2.

TABLE 2
WALL CRUSHING

SDR	P_T (psi)	SA (psi)	DRISCO COMPR. STR.	PASS or FAIL
11	60	300	1,500	PASS
17	60	480	1,500	PASS
19	60	540	1,500	PASS
21	60	600	1,500	PASS
32.5	60	945	1,500	FAIL

Wall Buckling

The hydrostatic, critical collapse differential pressure, P_C, in psi is first calculated.

$$P_C = \frac{2.32E}{SDR^3}$$

Where:

E = stress and time dependent tensile modulus of elasticity in psi

The modulus is found using the calculated S_A, enter Chart 25 (See Page Ref-11) and find modulus, E. P_C can then be calculated by the above equation. P_{cb} or critical buckling pressure can then be calculated by the following equation.

$$P_{cb} = 0.8\sqrt{E'P_C}$$

Where:

P_{cb} = critical buckling soil pressure at the top of pipe in psi
P_c = hydrostatic, critical collapse differential pressure in psi
E' = 3,000 psi for crushed rock which is slightly compacted (page Ref-10).
(Note: There is little data available at this time for E' at depths greater than 50 feet. However, available literature has indicated the value of E' to be greater than 3,000 psi; therefore, a value of 3,000 has been selected).

The computations for the critical collapse differential pressure, P_C, and the critical buckling soil pressure, P_{cb}, for various *SDR*s are given in Table 3. The pipe will withstand buckling if the external pressure, P_T, is less than the critical buckling soil pressure, P_{cb} (See Ref-11).

TABLE 3
WALL BUCKLING (E' = 3,000 psi)

SDR	SA (psi)	E (psi)	P_c (psi)	E' (psi)	P_{cb} (psi)	PASS / FAIL
11	300	25,000	44	3,000	289	PASS
17	480	20,000	9	3,000	135	PASS
19	540	18,000	6	3,000	108	PASS
21	600	17,000	4	3,000	90	PASS

Ring Deflection

The following equation was used for the calculation of ring deflection.

$$\Delta x = \frac{D_L K W_c r^3}{EI + 0.061 E' r^3}$$

Where:

- D_L = deflection lag factor = 1.0 for prism load
- K = bedding constant = 0.1
- W_c = Marston's load per unit length of pipe (lb/linear inch)
- r = mean radius of pipe (in)
- E = Modulus of pipe material (psi)
- I = Moment of inertia of the pipe wall per unit length (in^3) which is given by the pipe thickness divided by 12 = $t^3/12$
- E' = Modulus of soil reaction (psi) = 3,000 psi

The calculations for ring deflection are shown in Table 4 for various SDRs.
If the calculated deflection is less than the maximum allowed, the pipe passes the ring deflection criteria for the given *SDR*.

TABLE 4
RING DEFLECTION (6" DIAMETER, E' = 3,000 psi)

SDR	MAX ALLOW DEFLEC	DL	K	P_T	OD	WC	T	R	R^3	E	I	E'	DX	ID	MAX	PASS / FAIL
11	2.7%	1	0.1	60	6.625	397.50	0.602	3.01	27.3	25,000	0.018	3,000	0.199	5.421	0.179	FAIL
17	4.2%	1	0.1	60	6.625	397.50	0.390	3.12	30.3	20,000	0.005	3,000	0.213	5.845	0.278	PASS
19	4.7%	1	0.1	60	6.625	397.50	0.349	3.14	30.9	18,000	0.004	3,000	0.215	5.927	0.311	PASS
21	5.2%	1	0.1	60	6.625	397.50	0.315	3.16	31.4	17,000	0.003	3,000	0.216	5.995	0.345	PASS

RING DEFLECTION (18" DIAMETER, E' = 3,000 psi)

SDR	MAX ALLOW DEFLEC	DL	K	P_T	OD	WC	T	R	R^3	E	I	E'	DX	ID	MAX	PASS / FAIL
11	2.7%	1	0.1	60	18	1080.00	1.636	8.18	547.7	25,000	0.365	3,000	0.541	14.728	0.486	FAIL
17	4.2%	1	0.1	60	18	1080.00	1.059	8.47	607.8	20,000	0.099	3,000	0.580	15.882	0.756	PASS
19	4.7%	1	0.1	60	18	1080.00	0.947	8.53	619.9	18,000	0.071	3,000	0.584	16.106	0.846	PASS
21	5.2%	1	0.1	60	18	1080.00	0.857	8.57	629.8	17,000	0.052	3,000	0.586	16.286	0.936	PASS

WHERE:
PT = EXTERNAL PRESSURE (psi)
OD = OUTSIDE DIAMETER (in)
T = THICKNESS (in)
DX = CALCULATED DEFLECTION (in)
ID = INSIDE DIAMETER (in)
MAX = MAXIMUM DEFLECTION (in)
R = MEAN RADIUS (in)

APPENDIX Q

CONCEPTUAL GAS EXTRACTION SYSTEM

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted October 2003

Prepared By:

HDR ENGINEERING, INC.

SUVSWD Bayview
Class I Landfill Permit Modification – Appendix Q

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1.0 BACKGROUND 1
2.0 GAS GENERATION 1
3.0 GAS COLLECTION SYSTEM DESIGN 2
4.0 PIPE SIZING 4

Figures

Figure Q-1: Cell 1 Gas Collection System Layout

1.0 BACKGROUND

Regulations require that landfills that produce over 50 Mg of non-methane organic compounds (NMOC) must have a landfill gas collection and control system installed. It is not anticipated that Cell 1 of the Bayview landfill will exceed this benchmark even when it is filled to capacity. (See calculation Q-1 at the end of this appendix.) However, the District desires to install the gas collection wells before placement of final cover in order to minimize the disturbance of the final cover in the future. At some future time, SUVSWD will collect the landfill gas with an active system utilizing a blower to create a negative pressure, or vacuum, in the landfill cell and extract the gas that is produced. The collected gas would then be combusted in a candlestick-type flare.

2.0 GAS GENERATION

Landfill gas generation is estimated for the landfill using the Scholl Canyon model. This model is a first order, single stage model that assumes that the gas production rate from a given mass of waste is at its peak upon initial waste placement, after a negligible lag time during which anaerobic conditions are established in the landfill. Therefore, peak gas generation from the landfill cell would occur at closure. Gas production is then assumed to decrease exponentially as the organic matter in the landfill decomposes. The following equation summarizes the model.

$$Q_{lfg} = 2L_O R\left(e^{-kc} - e^{-kt}\right) \qquad \text{Equation 2}$$

Where:

	Qlfg	= landfill gas generation rate at time t, [m3/yr]
	L_o	= potential methane generation capacity of the refuse, [m3/Mg]
	R	= average annual refuse acceptance rate during active life, [Mg/yr]
	k	= methane generation constant, [1/yr]
	c	= time since landfill closure, [yrs], (c=0 for an active landfill)
	t	= time since initial refuse placement, [yr]

Using this equation, the landfill gas generation rate is 7,272,828 cubic meters / year, which equates to approximately 488 cubic feet / minute (cfm). (Since Cell 1 is not closed, c = 0, and e-kc = 1.0.) The EPA's guidance document EPA-450/3-90-011a, Air Emissions from Municipal Solid Waste Landfills – Background Information for Proposed Standards and Guidelines suggests a conservative value of 100 for L_o and 0.04 for the k value for these calculations. A k value of 0.03 was used instead to account for the much drier climate at the Bayview Landfill site.

Calculation Q-2 is included at the end of this appendix. As a check, gas generation was calculated on a yearly basis for the waste received during that year. A first order decay rate was used to calculate gas generation from the waste for subsequent years. The gas generation for each year is then added to predict the total gas generated from all waste received. This calculation (Q-3) is included at the end of this appendix and predicts a peak flow of 494 cubic feet per minute (cfm), which is reasonably close to the amount of 488 cfm predicted in calculation Q-2.

3.0 GAS COLLECTION SYSTEM DESIGN

The first step to designing a gas collection system is determining the type of wells to be used to collect the landfill gas. Since the entire area of Cell 1 (approximately 33 acres) is near final grade, it was determined that the Cell 1 area would have vertical wells drilled through the waste.

The vertical well radius of influence (ROI) was calculated using techniques outlined in the EPA guidance document referenced above. The following equation is used to determine the radius of influence.

$$R_a = \left(\frac{Q_w \times DesignCap}{\pi L \rho_{refuse} Q_{gen} E_a} \right)^{1/2} \qquad \text{Equation 1}$$

Where:

	R_a	= Radius of Influence, [m]
	Q_w	= Gas flow rate / well, [m3/yr)
	L	= Landfill Depth, [m]
	P_{ref}	= Refuse Density, [Mg/m3]
	Q_{gen}	= Peak generation rate, [m3/yr]
	E_a	= Fractional collection efficiency
	DesignCap	= Design Capacity [Mg}

Using this equation, the ROI was determined to be 139 feet. This calculation (Equation 1 on Q-2), with assumptions, is provided at the end of this appendix. This radius determines the extraction well spacing. An effective landfill gas collection system will cover the entire area of Cell 1.

Using the calculated ROI, vertical wells were laid out as shown in Figure Q-1. The well radius was reduced along the side slopes to account for the more shallow depths encountered. This increases the well density along the side slopes. The size of the perforations along the well casing in the side slope wells may also be varied to achieve greater collection efficiency.

Flare location is the next issue to be resolved. The flare location is currently proposed to be in the vicinity of the existing leachate drain line in the northeast corner of Cell 1. This location will be convenient in the event that it is decided to use the same flare for Cell 2 when all or portions of it are closed. Additional blowers may be required to transmit landfill gas to the flare from Cell 2. This will be evaluated during subsequent design phases. See Figure 2 (Part IV) for the location of Cell 2 in relation to Cell 1.

Following well layout, the gas collection header was designed. The main design criteria for the header is to maintain a minimum 5% slope to promote positive drainage of gas condensate over the lifetime of the site. This slope takes into account the gradual settlement of the landfill over time. Utilizing the existing leachate collection system to manage gas condensate was another key concern. The header loops around Cell 1 and connects to the gas flare station.

Additional condensate sumps will be necessary at low points along the header. As mentioned, whenever possible, the condensate will be routed into the leachate collection system. However, some dedicated condensate sumps will be necessary in order to maintain a minimum of 5% slope on all gas collection lines.

Each well is designed to be connected to a gas collection node by a system of entrenched laterals. These small diameter laterals extend from the wellhead for several individual wells and are collected at a node for ease of monitoring and calibration. These nodes are then connected by a larger diameter sub-header to the main gas header system. Each lateral is also designed with a minimum 5% slope to promote condensate drainage. Whenever possible, each lateral should also be installed with a minimum two foot cover. It may be necessary during construction for some laterals to be installed with less than two feet of cover to maintain the 5% slope criteria. Figure Q-1 shows the proposed lateral/sub-header/header layout for the landfill.

All laterals, sub headers, and headers will be constructed of high-density polyethylene (HDPE) pipe. Gas collection wells will be constructed of either HDPE or PVC pipes. Pipes were sized to maintain a minimum head drop across the system to allow the blower to extract gas from the entire collection system. Should part of the collection system be disconnected for maintenance, the blower will still have the capacity to collect gas from the remainder of the system. A blower with a capacity to produce 60-inches of water column vacuum is proposed for the site.

4.0 PIPE SIZING

When sizing the pipes for the gas system, the furthest point from the flare was chosen as the starting point. The cumulative flow from the starting point to the flare (in both directions) was used to size the header pipeline. The size of the header varies between sub-headers in order to handle the additional flow of gas at that location in the system. Then, the flow from each node was used to size each sub-header pipeline.

A form of the Mueller equation was used to calculate the pressure drop in each section of pipe:

$$\Delta P = L\left(\frac{G\ (60F)}{2971\left(d^{2.725}\right)}\right)^{\frac{1}{.575}}$$

where:
- ΔP = Change in Pressure
- L = length of pipe (feet)
- G = specific gravity (air = 1)
- F = gas flow rate (ft3/hr)
- d = pipe internal diameter (inches)

All pipes were designed to have a cumulative pressure drop of less than 30-inches, leaving 30-inches of vacuum at the farthest pipe location to extract gas from the cell. In the event that a pipe in the system malfunctions, the blower will still be able to collect gas from the majority of the system until repairs can be made.

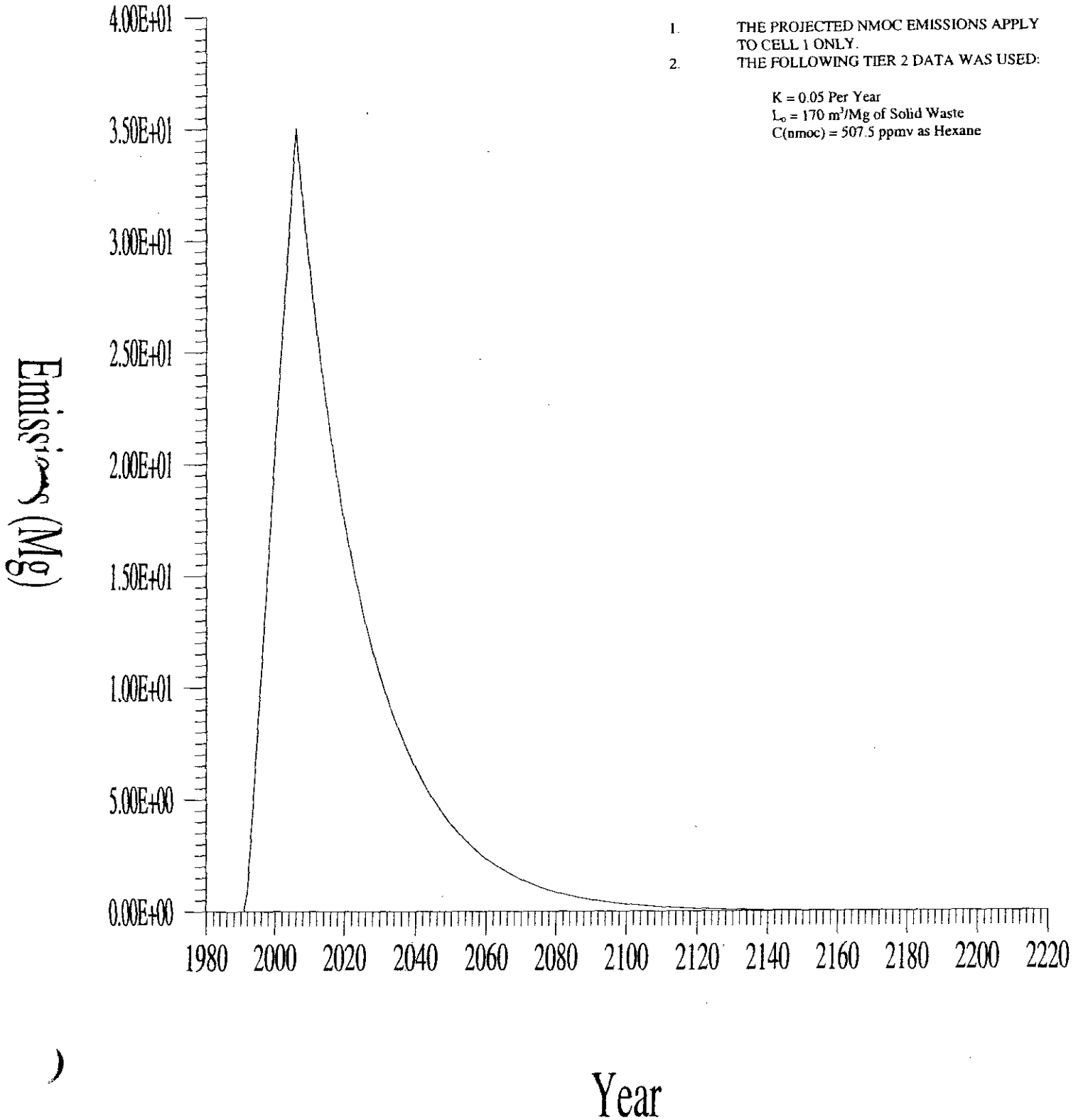
Q-1

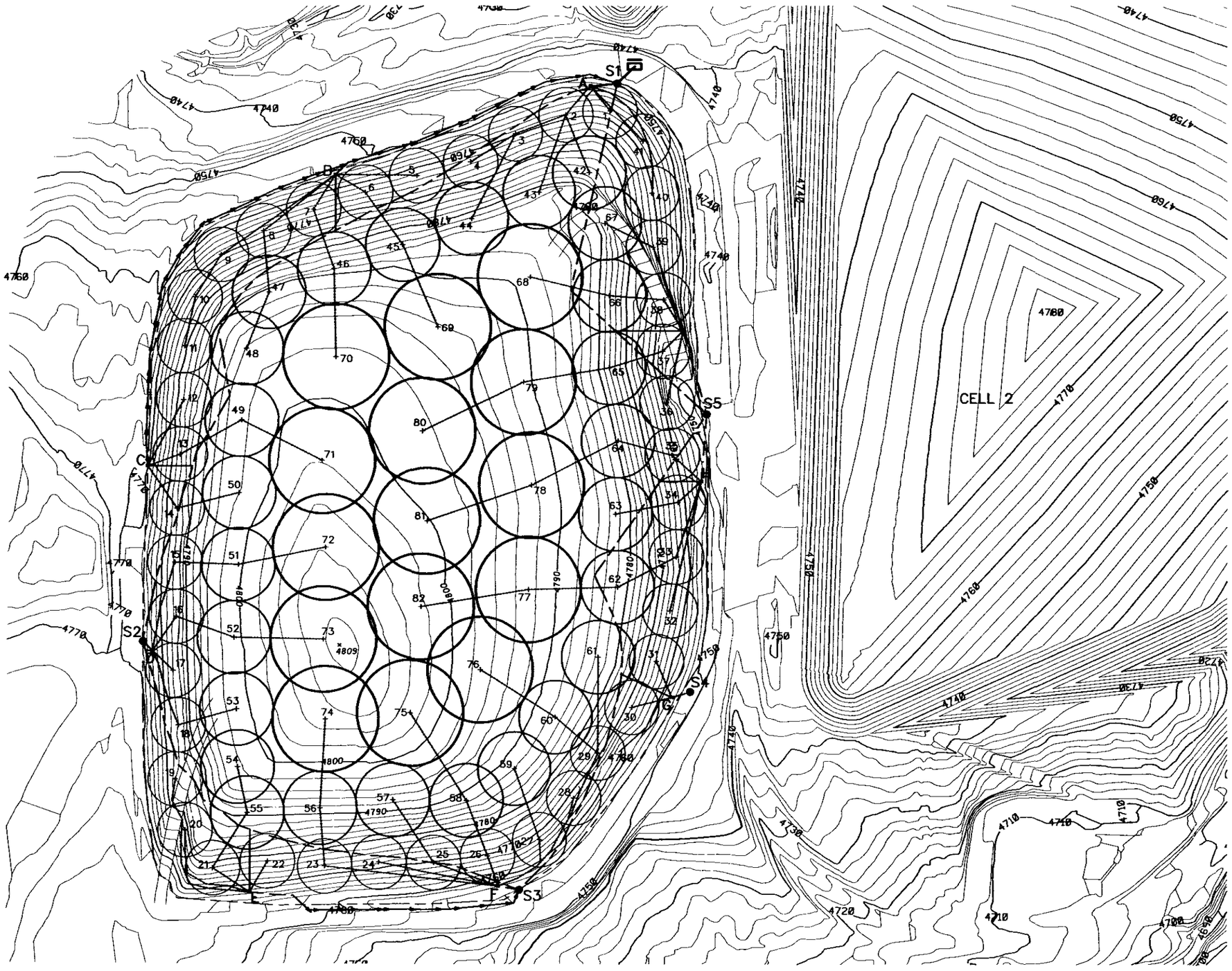
Projected NMOC Emissions

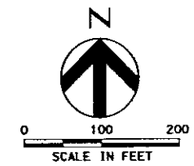
NOTES:

1. THE PROJECTED NMOC EMISSIONS APPLY TO CELL 1 ONLY.
2. THE FOLLOWING TIER 2 DATA WAS USED:

   K = 0.05 Per Year
   L_o = 170 m^3/Mg of Solid Waste
   C(nmoc) = 507.5 ppmv as Hexane







LEGEND

- HEADER
- CELL BOUNDARY
- LATERAL
- FLOW OUTSIDE CELL BOUNDARY
- SUBHEADER
- CONDENSATE LINE
- WELL WITH 130' ROI
- WELL WITH 72' ROI
- WELL WITH 50' ROI
- FLARE LOCATION
- S5 — CONDENSATE SUMP
- NODE

NOTES:

1. ROI - RADIUS OF INFLUENCE
2. CONTOURS SHOWN FOR CELLS 1 AND 2 ARE PROPOSED FINAL ELEVATIONS

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Revision No.	Description	Date	Drwn.	Chkd.	Resp. Engr	Proj Mgr

Project Manager: M. ODEN	
Architect	I&C/Process
Civil	Mechanical
Electrical	Structural
Designed: K. GREEN	Drawn By: K. GREEN

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL
PERMIT MODIFICATION

CELL 1 - GAS COLLECTION SYSTEM LAYOUT

Date	Project No.	Figure No.	Issue
AUGUST, 2003	03879-143	Q-1	0

Scale: AS SHOWN

Job No.	3608	Calc No.	Q-2

Computation

HDR

Object	Bayview Landfill Cell 1 Gas Collection Design	Computed	kdf
System	Landfill Gas Collection System	Date	6/26/2003
Component	Vertical Well Spacing	Reviewed	
Task	Radius of Influence Calculation	Date	

Purpose

Solve for the gas well radius of influence using equations provided in EPA's document, *Air Emissions from Municipal Solid Waste Landfills - Background Information for Proposed Standards and Guidelines.*

Find

Description	Variable	Units
Radius of Influence	R_a	feet

Given

Description	Value	Source
Design Capacity	1,659,232	[tons], client supplied
Avg. Annual Acceptance, R	100,350	[Mg/yr], client supplied
Methane Gen. Potential, L_o	100	[m^3/Mg], test values
Gas Generation Constant, k	0.03	[1/yr], test values

Solution

Description	Value	Comment
Radius of Influence	139	feet

Assumptions

Waste in Place Density	1300	*lbs/cy, client supplied value*
Gas Flow Rate	0.04	m^3/min/ m of landfill depth, *EPA Gas Background Document*
Landfill age at closure	15	years, *client supplied value*
Collection Efficiency	100%	*assumed for purposes of this calculation*
Landfill Depth, L	1	*[m], unit convention for flow/meter*

Equations

$$R_a = \left(\frac{Q_w \times DesignCap}{\pi L \rho_{refuse} Q_{gen} E_a} \right)^{1/2}$$

Equation 1

Source: EPA Gas Background Doc.

Where: R_a = Radius of Influence, [m]
Q_w = Gas flow rate / well, [m^3/yr)
L = Landfill Depth, [m]
ρ_{ref} = Refuse Density, [Mg/m^3]
Q_{gen} = Peak generation rate, [m^3/yr]
E_a = Fractional collection efficiency
DesignCap = Design Capacity [Mg}

$$Q_{gen} = 2 L_o R \left(1 - e^{-kt}\right)$$

Equation 2

Source: EPA Gas Background Doc.

Where: Q_{gen} = Peak generation rate [m^3/yr]
L_o = Methane generation potential [m^3/Mg refuse]
R = Average annual acceptance rate [Mg/yr]
k = Gas generation rate constant [1/yr]
t = landfill age at closure, [yr]

Job No.	3608	Calc No.	Q-2

Computation

HDR

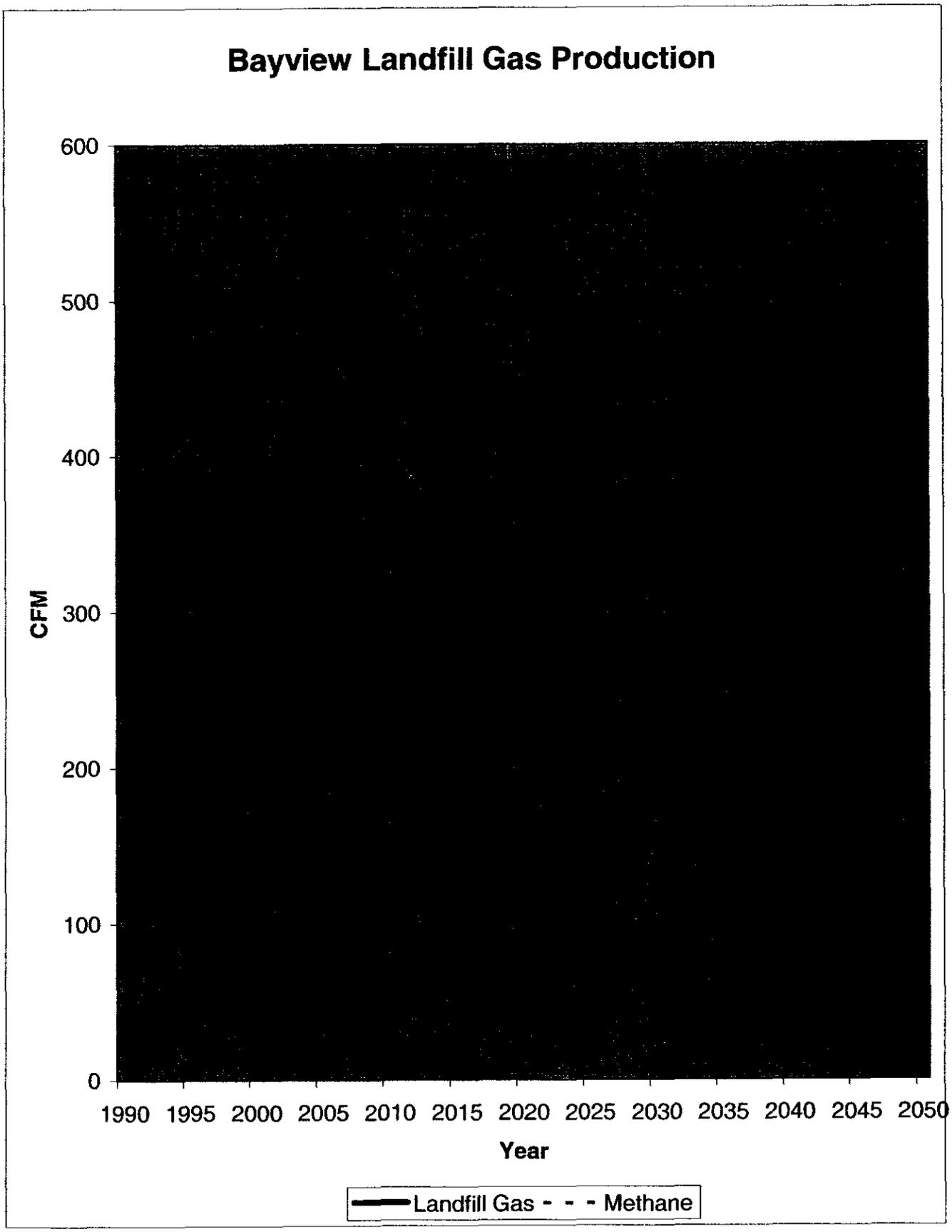
Project	Bayview Landfill Cell 1 Gas Collection Design	Computed	kdf
System	Landfill Gas Collection System	Date	6/26/2003
Component	Vertical Well Spacing	Reviewed	
Task	Radius of Influence Calculation	Date	

Calculation

Description	Equation	Comment	Value	Units
Gas Flow Rate				
Assume Value	from EPA Gas Document		0.04	m^3/min-m
Convert to yearly	525,600 min/yr		21,024	m^3/yr-m
Design Capacity				
Design Capacity	Given Value		1,659,232	tons
Convert to Mg	1 ton = .9072 Mg		1,505,255	Mg
Refuse Density	Given value		1,300	lbs/cy
Convert to Mg/m^3	1 lb/cy = .000593 Mg/m^3		0.771	
Peak Generation Rate				
Determine peak rate	Equation 2 above		7,272,828	m^3/yr
Convert to cfm	1 ft^3/min = 14,895 m^3/yr		488	cfm
Radius of Influence				
Solve for R_a	Equation 1 above		42.4	m
Convert to feet	1 m = 3.28 ft		**139**	ft

Bayview Landfill
Gas Generation Estimates

	Year	Tons Received	Cumulative Tons	Megagrams Received	Cumulative Megagrams	Landfill Gas Produced (cfm)	Methane Produced (cfm)
0	1990	32,713	32,713	29,677	29,677	11.6	5.8
1	1991	82,841	115,554	75,153	104,831	21.4	10.7
2	1992	92,045	207,599	83,503	188,334	72.1	36.1
3	1993	96,899	304,498	87,907	276,241	104.4	52.2
4	1994	106,641	411,139	96,745	372,985	139.1	69.6
5	1995	105,746	516,885	95,933	468,918	172.6	86.3
6	1996	108,305	625,190	98,254	567,172	205.9	102.9
7	1997	119,391	744,581	108,312	675,484	242.2	121.1
8	1998	126,661	871,242	114,907	790,391	280.0	140.0
9	1999	124,286	995,528	112,752	903,143	315.8	157.9
10	2000	127,031	1,122,559	115,243	1,018,386	351.5	175.8
11	2001	126,664	1,249,223	114,910	1,133,295	386.1	193.1
12	2002	130,790	1,380,013	118,653	1,251,948	421.1	210.6
13	2003	136,584	1,516,597	123,909	1,375,857	457.1	228.6
14	2004	142,635	1,659,232	129,398	1,505,255	494.2	247.1
15	2005	0	1,659,232	0	1,505,255	479.6	239.8
16	2006	0	1,659,232	0	1,505,255	465.5	232.7
17	2007	0	1,659,232	0	1,505,255	451.7	225.9
18	2008	0	1,659,232	0	1,505,255	438.4	219.2
19	2009	0	1,659,232	0	1,505,255	425.4	212.7
20	2010	0	1,659,232	0	1,505,255	412.8	206.4
21	2011	0	1,659,232	0	1,505,255	400.6	200.3
22	2012	0	1,659,232	0	1,505,255	388.8	194.4
23	2013	0	1,659,232	0	1,505,255	377.3	188.6
24	2014	0	1,659,232	0	1,505,255	366.1	183.1
25	2015	0	1,659,232	0	1,505,255	355.3	177.7
26	2016	0	1,659,232	0	1,505,255	344.8	172.4
27	2017	0	1,659,232	0	1,505,255	334.6	167.3
28	2018	0	1,659,232	0	1,505,255	324.7	162.4
29	2019	0	1,659,232	0	1,505,255	315.1	157.6
30	2020	0	1,659,232	0	1,505,255	305.8	152.9


Bayview Landfill Gas Production
600
500
400
300
200
100
0
CFM
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
Year
Landfill Gas
Methane

APPENDIX R

TEMPORARY COMPOST OPERATIONS PLAN

SUVSWD Bayview
Class I Landfill Permit Modification

Prepared By:

HDR ENGINEERING, INC.

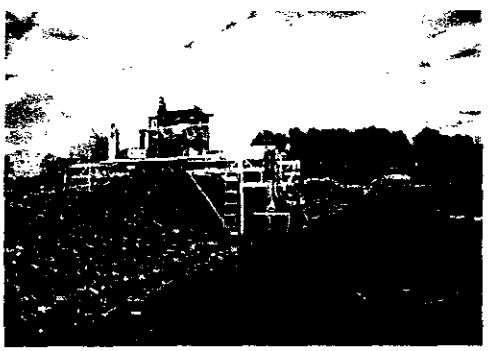
This document was originally

submitted in July 2003.

South Utah Valley Solid Waste District
Temporary Composting Facility
Bayview Landfill Site

Plan of Operations
Pursuant to R315-302-(2)
Utah Department of Environmental Quality

July 2003



Prepared for:
South Utah Valley Solid Waste District
2450 West 400 South
Springville, Utah 84663

Prepared by:
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HDR

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FIGURE 1 BAYVIEW LANDFILL TEMPORARY COMPOSTING PLAN

APPENDIX A OPERATING PLAN FOR BAYVIEW LANDFILL

A. PURPOSE OF PLAN

This Plan of Operations describes the methods for managing and operating the SUVSWD Temporary Composting Facility at the Bayview Landfill. This Plan of Operations is required for compliance with Utah Department of Environmental Quality (UDEQ) Solid and Hazardous Waste Division Regulation R315-312-2, Recycling and Composting Requirements. Based on guidance from the UDEQ, a portion of this rule, referencing Regulation R315-302-2, is not applicable because all of the storm water runoff and infiltration from the Temporary Composting Facility is contained within the Subtitle D liner system of the existing, permitted Bayview Landfill.

This Plan of Operations presents a description of composting equipment, input material, and procedures utilized at the temporary composting facility. The plan also addresses equipment monitoring, composting schedules, odor and vectors control, and special precautions. The Temporary Composting Facility is to be located directly on the top of Bayview Landfill Cell 1, as shown in Figure 1. The composting operations will take place entirely on at least 12 inches of interim cover soil with approximately 50 feet of municipal solid waste below that. This operating plan has many similarities to the Plan of Operations for Bayview Landfill Cell 1; therefore, a copy of the Bayview Landfill Cell 1 Plan of Operations is attached as Appendix A, for reference.

B. ON-SITE PERSONNEL

The composting facility will be open 44 hours per week – Monday through Friday and one-half day on Saturday. The employees operating the Temporary Composting Facility will be the compost foreman, one composting equipment operator, and one other full-time temporary employee during the summer. The compost foreman will be responsible for the training of all employees in safety and fire protection practices. He will also be responsible for the training of employees in the inspection and identification of unauthorized wastes. There will be other on-site employees at the Bayview Landfill as described in Appendix A, Section 4.2, Landfill Personnel. Landfill Personnel will assist as needed to maintain the site, including any regrading or repair of the compost operating surface. Communication and coordination between landfill and composting operations will be necessary to achieve uninterrupted operations of each facility, and will be the joint responsibility of the compost foreman and the landfill foreman.

C. PLANS AND SPECIFICATIONS

The temporary composting operation does not require fence construction, since the landfill site is completely surrounded with fencing equipped with locking gates. Plans and specifications for the temporary composting facility have not yet been created; however, plans and specifications for Bayview Landfill Cell 1, where the composting facility is located, can be found on file at Utah Department of Environmental Quality (UDEQ) Department of Solid and

Hazardous Waste (DSHW). The grade already established in the operating area is reflected on Figure 1. Basic drainage patterns are also reflected.

D. WINDROW PROCESS

The proposed composting operation will utilize a windrow process. Windrow processing is a method of controlled, aerobic decomposition of organic material. A carefully controlled windrow process balances oxygen, water, and carbon and nitrogen (C:N) in the feedstocks to support beneficial microorganisms. The biological activity raises the temperature of the compost windrow to kill pathogens, seeds and spores. Compost operators must manage windrows to maintain conditions that meet compost disinfection standards and biosolids disinfection standards if the biosolids are included in the feedstock. A typical windrow process consists of the following elements.

1. Feedstock receiving, grinding, blending, and misting (if necessary for dust control)
2. Windrow formation, turning, watering, and monitoring
3. Addition of biosolids to biologically active windrows (optional)
4. Active windrow management to achieve disinfection standards
5. Static pile curing and stabilization
6. Product screening, and possible recycling of larger material, called "overs"
7. Product blending, coloring, and bagging (optional)
8. End product storage, sales, and distribution of bulk product, bagged product, or both

Grinding of yard waste and waste wood will take place at either the (closed) Spanish Forks Landfill or the Springville Transfer Station using an existing tub grinder. Yard waste will be debagged before it is ground so there will be little or no plastic material in the waste. There is a magnet after the grinding operation in order to pull out all of the ferrous material (nails, wire, etc.) Spotters at the grinding area will visually inspect several randomly selected loads per day to watch for unacceptable material; therefore, the ground material will be free of unacceptable wastes and contamination when it arrives at the composting facility.

E. EQUIPMENT

Equipment utilized in the windrow process at this composting facility is as follows.

- Windrow Turner - Scarab 1994- Model #18-450; VIN#0200SB, 2800 tons per hour
- Deck Screen - Roadrunner 1998- Model # CC514; 250 cubic yards per hour
- Front-end Loader – John Deere 2003- Model # TC544; VIN # DWTC54H586370; 1200 cubic yards per hour
- Water Truck- 4000 gallon tank; 200 gpm pump.

F. WINDROW CONSTRUCTION

Windrows will be formed initially using the front-end loader. They will be turned periodically using the windrow turner. This model of windrow turner forms windrows that are approximately 18-feet wide, 7-feet tall, and have a 4 ft wide top. The cross-sectional area of the windrows will be approximately 77 square feet. The length of the windrows will vary, depending on the quantity of feedstock processed and processing time. Windrows will be arranged no closer than 10 ft apart.

G. INPUT MATERIALS

The materials that will be used in the composting operation are yard waste (brush, grass, leaves), wood waste. Other non-hazardous organic waste materials such as agricultural waste and food processing waste may be added in the future. Biosolids from the Provo Wastewater Treatment Plant or other sources may also be included as a feedstock.

A balance of carbon and nitrogen is required to support proper biological activity to achieve good product without causing unacceptable odors during processing. A mix ratio by volume of between 1:2 and 1:5 biosolids to other organic high carbon materials such as wood and yard waste is needed to achieve a proper balance of carbon to nitrogen of at least 30:1 by weight. The method of measuring and proportioning input materials will be by a visual volume estimate (per bucket load).

The Class B biosolids hauled from the Provo Wastewater Treatment Plant will be anaerobically digested, dewatered using polymers and centrifuges, and will contain approximately 21% to 23% solids for a total of approximately 1450 dry tons of biosolids per year and a total of approximately 8000 wet cubic yards per year or 6000 wet tons per year. If biosolids from any other source are accepted for processing, the estimated quantity and composition will be reported to the UDEQ DSHW prior to the acceptance of the material for composting.

Yard waste, wood waste, and other similar high-carbon material will be solicited in quantities as appropriate to provide enough available carbon to maintain a high enough C:N ratio to support proper decomposition without nuisance conditions. Any excess wood will be used directly for erosion control and top dressing on the landfill, will be composted, or will be removed from the site and sold.

Water used to add moisture will be provided from a storage tank on-site, which stores groundwater from the culinary well, also on-site. The culinary well is tested periodically as required by the WQD. Maintaining proper moisture in the windrows is important to support microbiological decomposition. When water is needed in the windrows, on-site staff will spray the windrows using a water truck, filled from the groundwater storage tank.

microbiological decomposition. When water is needed in the windrows, on-site staff will spray the windrows using a water truck, filled from the groundwater storage tank.

H. GROUNDWATER MONITORING

Groundwater monitoring wells are currently located up gradient and down gradient of the composting facility in order to monitor the water quality before and after it enters the composting area. No groundwater monitoring of the composting area is required, but the groundwater monitoring wells will reflect any landfill liner leakage of leachate from the compost operation on top of the landfill cell, as well as the waste disposed in it.

I. SPECIAL PRECAUTIONS

Rain will not be a hindrance to composting because composting requires the addition of moisture due to the fact that the process is exothermic. Heat generated by microbiological activity causes evaporation of water on a continual basis. Therefore, it will be necessary to add water. The heat of decomposition will mitigate the effects of snow and freezing weather on the material while it is being processed on-site. An operator will be available at all times when feedstocks are being delivered to monitor for unacceptable materials, and to take any action to maintain active, aerobic composting in cold weather, such as adjustments in feedstock ratios, frequency of turning or watering.

Windrows and curing piles will be crowned to shed rainfall. The site is graded at approximately 2% toward the east to direct runoff away from the operational area to the perimeter drainage ditches and ultimately to the leachate evaporation pond. Biosolids will not be stockpiled on-site for more than 24 hours. Generally, they will be incorporated into active windrows immediately upon delivery to the site.

J. COMPOST MONITORING

As required by federal regulations for Class A pathogen reduction of biosolids using the windrow composting method, the biosolids must maintain a minimum temperature of 55 degrees Celsius or higher for a period of at least 15 days. During the time the compost is maintained at a temperature of at least 55 degrees Celsius, the windrow must be turned a minimum of 5 times. As required for Class B pathogen reduction using the windrow composting method, the biosolids must maintain a minimum temperature of 40 degrees Celsius or higher for a period of at least 5 days. During at least 4 hours during that 5-day period, the temperature in the compost must exceed 55 degrees Celsius. It is anticipated that the complete composting cycle will entail approximately 45 to 60 days in the windrow process and an additional 30 days in the curing process. It is the intention of the SUVSWD to produce compost that meets standards for Class A biosolids disinfection when biosolids are included in the feedstock.

To meet the requirements for Class A pathogen reduction, the temperature in the pile will be measured and recorded daily. Daily logs will be kept including the quantity and type of material processed. Moisture content may also be measured at a frequency necessary to support proper operations. Moisture can be checked just by feeling the material, or by a meter. An oxygen meter may also be used as needed to ensure that piles are not becoming anaerobic.

K. DRAINAGE AND STORM WATER RUNOFF

There is no need for an impervious pad or additional impervious material to prevent stormwater from contaminating surface water or groundwater. The storm water from the composting facility is completely contained on the Subtitle D liner and in the leachate collection system of Cell 1 of the Bayview Landfill. All storm water from the composting area drains to one of two low spots in the perimeter ditch, soaks into the waste in place, and is collected in the leachate collection system above the liner in Cell 1 of the Landfill. It is transferred by gravity piping to the existing leachate evaporation pond, which has successfully evaporated all leachate during its 12 years of operation. Figure 1 illustrates site drainage patterns and perimeter ditches inside the lined area.

L. FINISHED COMPOST USE/DISPOSAL

Finished compost and excess wood mulch will either be hauled off-site to be sold, or used on-site at the landfill for side-slope stabilization and to support vegetation as an amendment to native soils.

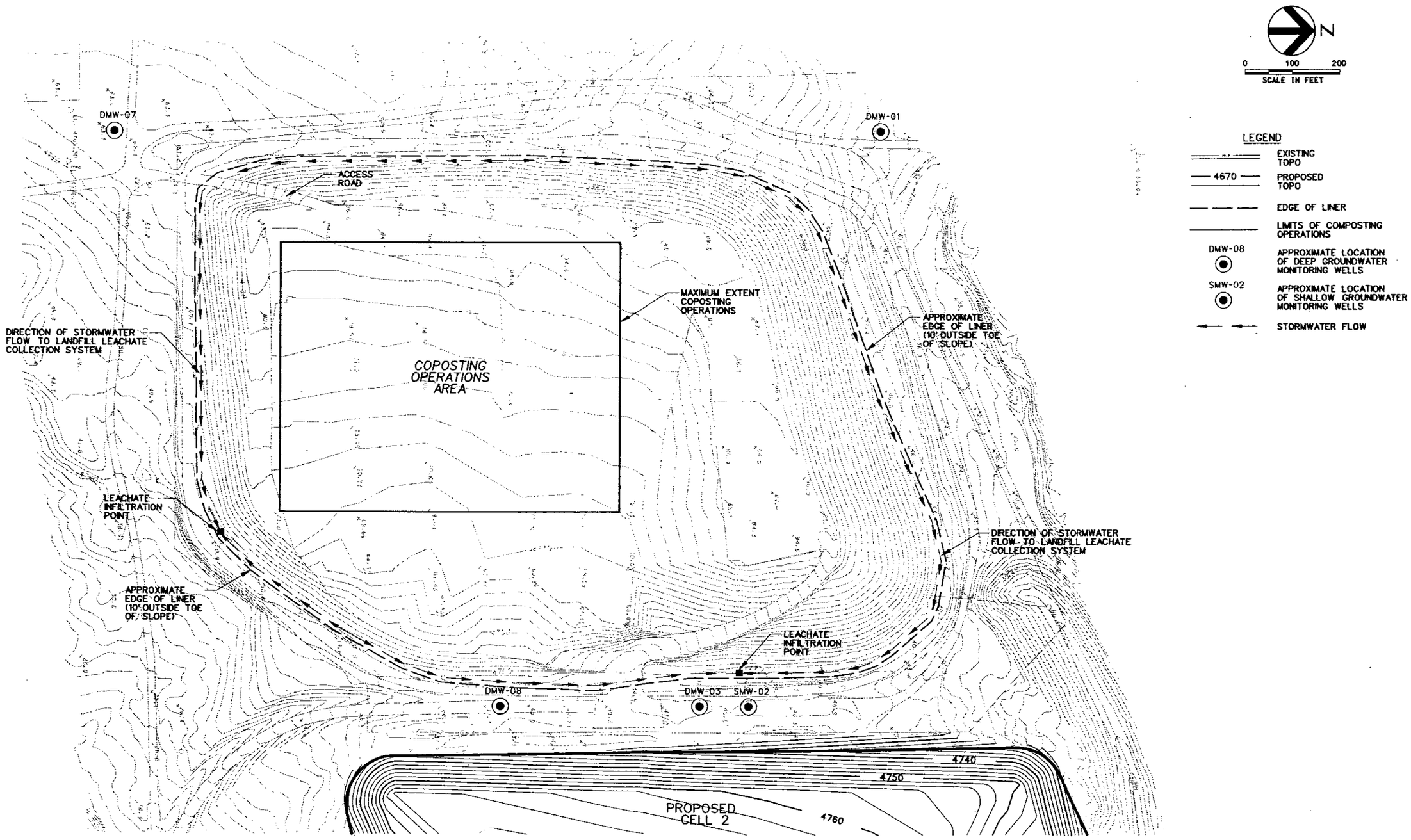
M. SAFETY

Safety training for personnel will be provided routinely and will be the responsibility of the landfill foreman. Training will consist of how to prevent, control, and report fires; and proper use of equipment. See Appendix A, Section 4.2.1, Emergency Response Actions, and Section 4.6, Contingency and Corrective Action Plans, for explosion, fire, and emergency response plans. The foreman will also enforce safety rules and policies and will investigate and report all accidents.

Lockout / tagout procedures will be followed for maintenance and cleaning of onsite equipment. Smoking and public access will be prohibited. Personal protective equipment will be provided to all on-site employees. This includes gloves, eye protection, and ear protection. All on-site employees will be required to wear steel-toed shoes and long pants. Dust masks will be available if needed.

Material Safety Data Sheets will be maintained on-site for all applicable materials used. Employees will have access to these sheets.

Emergency phone numbers will be posted in the landfill office. First Aid kits and fire extinguishers will be available in the office and on or near heavy equipment, as appropriate.



HDR

HDR Engineering, Inc.
17111 Preston Road
Suite 200
Dallas, Texas 75248

Revision No.	Description	Date	Drwn.	Chkd.	Resp. Engr.	Proj. Mgr.

Project Manager: M. ODEN	
Architect	I&C/Process
Civil: R. FISHER	Mechanical
Electrical	Structural
Designed: A. MILLER	Drawn By: J.ZEPEDA

SOUTH UTAH VALLEY SOLID WASTE DISTRICT

BAYVIEW LANDFILL PERMIT MODIFICATION

CELL 2
BAYVIEW LANDFILL COMPOSTING OPERATIONS PLAN

Date	Project No.	Figure No.	Issue
JULY, 2003	03289-143	1	0
Scale: AS SHOWN			

APPENDIX A

SECTION 4
OPERATIONS PLAN

4.1 INTRODUCTION

The purpose of this Operations Plan is to assist the Landfill Foreman and Landfill Operating Personnel in conducting day-to-day operations in a manner that is consistent with the various permit requirements, and with the design of the Bayview Landfill Cell 1. Section 4.2 describes the emergency response procedures applicable to the landfill, the permit conditions applicable to the landfill, the designed facilities at the landfill, and equipment and personnel requirements for proper operation of the landfill. Section 4.3 provides a schedule for construction of new landfill facilities at the site. Section 4.4 describes the procedures for handling wastes received at the landfill. Section 4.5 provides a schedule for conducting inspections, monitoring, and reporting for the landfill facilities. Section 4.6 provides contingency plans and corrective action programs to be implemented if emergency conditions (e.g., fire or explosion) exist, or if data indicate that containment systems have failed. Section 4.7 discusses alternative waste handling and disposal during inclement weather. Section 4.8 describes the maintenance of landfill monitoring equipment. Section 4.9 describes routine and non-routine procedures to be implemented to control disease vectors. Section 4.10 addresses waste screening to exclude regulated hazardous wastes. Section 4.11 provides a discussion of the current and planned recycling and diversion of solid wastes at the landfill.

4.2 EMERGENCY RESPONSE AND BACKGROUND INFORMATION

4.2.1 Emergency Response Actions

Landfill emergencies include: injury, dismemberment, or death of personnel; and fire, explosion, or other catastrophic events. Because of its remote location, the landfill maintains its own fire protection equipment, and personnel are trained in the operation of this equipment. Also because of its remote location, injured personnel will be transported to medical facilities in District vehicles if their condition allows movement. The Landfill Foreman, or his designee, may request that ambulance and paramedical personnel meet the transporting vehicle enroute to the medical facility.

For other emergencies, the following list provides the phone number to access emergency services. This list shall be posted directly adjacent to each phone on the facility site within a colorless, protective plastic cover.

Fire and Rescue . . . . . **911** . . . . . .(801)375-3601

Hospital **911**

Utah Valley Regional Medical Center . . . . . (801) 371-7001

Mountain View . . . . . (801) 465-7190

County Fire Marshall . . . . . (801) 370-8885

Sheriff . . . . . (801) 375-3601

District Office . . . . . (801) 489-3027

In the event of any emergency, the following personnel shall be notified:

Name	Position/Title	Phone (Work/Home)
Dale Stephenson	District Manager	(801) 489-3027/377-2123
Craig Hoffman	Landfill Foreman	(801) 376-0197/798-9348
Jerry Mitchell	Transfer Station Foreman	(801) 489-3027/374-1020
Dorothy Morse	Executive Secretary	(801) 489-3027/375-8202

4.2.2 Permit Requirements

The Bayview Landfill is subject to both State of Utah and local Utah County requirements controlling day-to-day operations at the landfill. The state and local requirements are discussed below.

State Requirements

On October 9, 1991, the U.S. Environmental Protection Agency (EPA) published revisions to the Criteria for Classification of Solid Waste Disposal Facilities. These regulations were developed in response to requirements of Subtitle D of the 1984 Hazardous and Solid Wastes Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) of 1976. The Subtitle D regulations set forth minimum federal criteria for municipal solid waste landfills, including facility design and operational requirements. The Subtitle D regulations became effective on October 9, 1993.

Subtitle D establishes a framework for federal, state, and local government cooperation in controlling the management of non-hazardous solid wastes. The federal government's role within this framework is to establish the regulatory direction by providing minimum nationwide standards for protection of human health and the environment, and by providing technical assistance to states for planning and developing their own environmentally sound waste management practices. However, the actual planning, direct implementation, and enforcement of solid waste programs remains a state and local role under the Subtitle D framework.

On ~~February 1, 1994,~~July 15, 1993, the Utah Department of Environmental Quality (UDEQ) issued final Administrative Rules implementing Subtitle D at the state level. These rules, entitled Solid Waste Permitting and Management Rules (R315-301 through ~~315~~320), have been reviewed by EPA, and the UDEQ has received authorization from EPA to implement and enforce the solid waste management program.

The UDEQ rules require that each landfill develop and comply with its approved Operations Plan. The rules further specify certain operational requirements, including: excluding hazardous and bulk liquid wastes; controlling access; controlling disease vectors; controlling air discharges and explosive gases; controlling run-on, run-off, and surface water discharges; and maintaining records. This Operations Plan has been developed to include the requirements of the UDEQ rules.

Utah County Requirements

During the process of permitting the Bayview Landfill site, the Utah County Board of Adjustment enumerated 26 criteria that the landfill must meet to remain in compliance with the Board's Conditional Use Permit. These permit conditions include the following. (Note: These permit conditions are quoted directly from the Conditional Use Permit and are provided here to make the landfill operators aware of the District's obligations under the Conditional Use Permit.)

1. Compacted or baled garbage will be placed in trenches and covered at the end of each day.

2. The waste shall be buried away from the gravel pit area.

3. A fence shall be installed surrounding each trench area at least eight (8) feet in height and higher if found inadequate to control blowing papers.

4. After an area has been filled, it will be contoured, mulched, and reseeded as indicated by the State Agronomist and the State Extension Service.

5. There will be a watchman on site during normal working hours.

6. The gate will be closed any time it is unattended; and it must be locked. (This is the main gate, not that around a particular area being filled.)

7. A new access road from the state highway into the deposit area will be provided as required by the Department of Transportation.

8. The size of the garbage trucks shall meet the requirements of the Utah Department of Transportation and Utah Highway Patrol.

9. Provo City will cooperate with the State Highway Department and local residents to prevent inordinate damage to the road during periods when the road is saturated and subject to destruction; and comply with all state and local ordinances conforming to same.

10. All garbage would be collected and compacted at a location other than the landfill site and transported in covered trucks by Provo City.

11. No burning is to be allowed at the disposal site.

12. The trenching shall be done in such a manner as to protect the drainage channels in the area as required by the State Department of Environmental Health.

13. No hazardous wastes shall be deposited in the area.

14. All reasonable caution and prudence be exercised to not dispose of any waste during any unreasonable weather conditions.

15. All requirements in the "Code of Solid Waste Disposal Regulations" be met.

16. Any terms of the lease held by Mr. Jacobs be protected and that Provo City cooperate with him during lambing season to minimize the impact on his operation.

17. No public dumping.

18. Landfill to be used only by Provo City and if other cities are to use the landfill, approval from the Board of Adjustment would be necessary.

19. Personnel will police the grounds outside the fence, and keep litter and garbage picked up.

20. Rodent control must be in effect at all times as state law provides.

21. Water samples will be taken by the Department of Environmental Health from any wells within 1500' of the disposal site prior to any dumping to determine the water quality. Samples would be taken every six months or more often as determined by the Department of Environmental Health.

22. The area used to begin the operation of filling must be selected to minimize the impact on people in the surrounding area.

23. In constructing the road or roads required by the Department of Transportation to get access to the landfill; Provo City shall minimize the amount of disruption to the environment of the area.

24. That Provo City maintain a buffer zone of at least 100' from existing state roads, homes and premises in dumping their compacted garbage.

25. Upon noncompliance with any of these provisions Utah County may revoke said right to the landfill.

26. Provo City will provide an annual report to the Board of Adjustment for their review, as to the progress in the engineering of the landfill.

These conditions should be considered the minimum criteria that the landfill operations must meet to remain in compliance with the Conditional Use Permit.

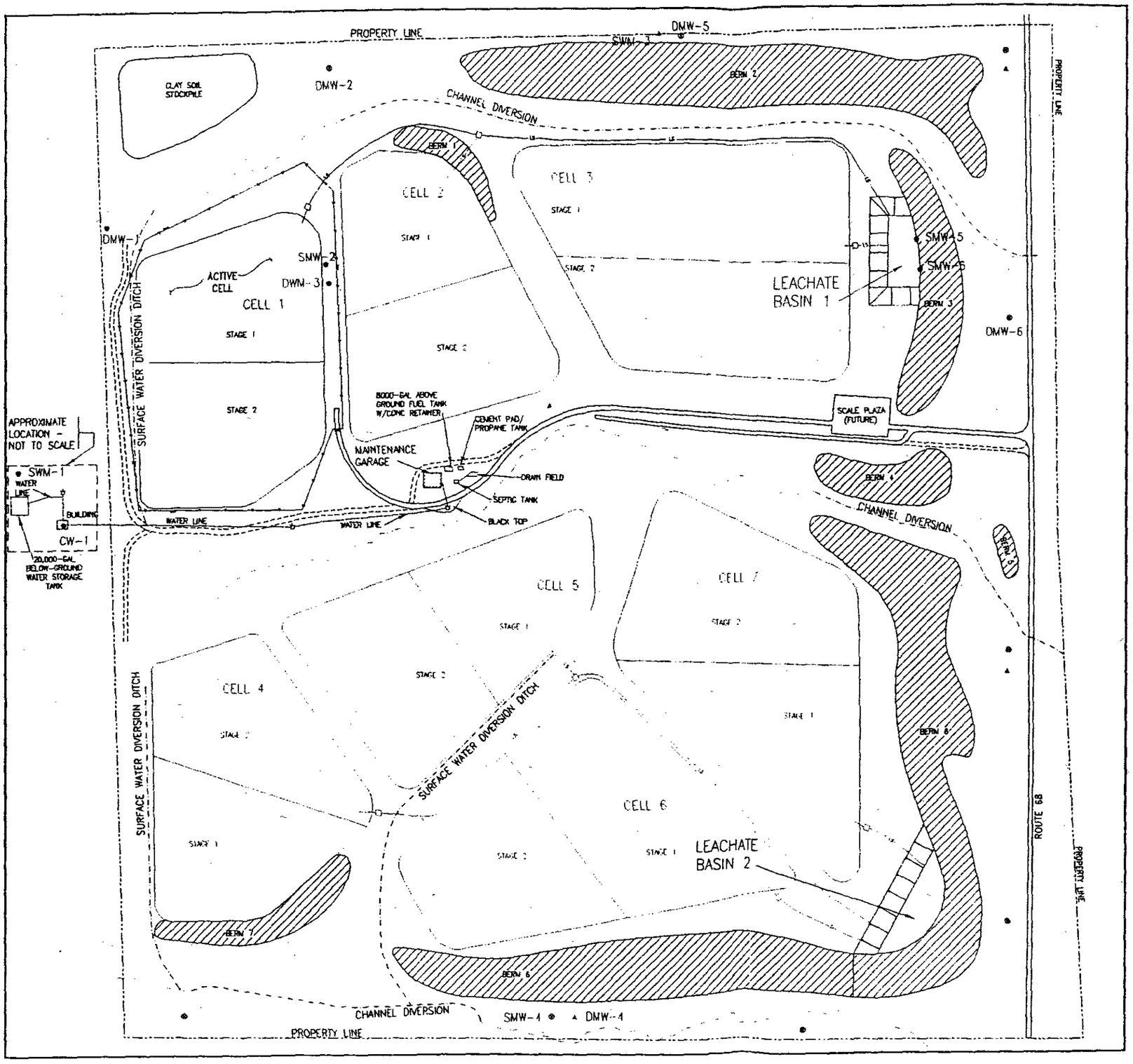
4.2.3 Landfill Facilities

At the time of this permit application, the Bayview Landfill consists of one 22-acre half landfill cell, one stormwater/leachate evaporation pond, five screening berms, one maintenance building, and appurtenant roads, fences, and culinary and monitoring wells; a second half landfill cell has been largely excavated. The excavated soils have been used either as daily cover in the first half cell, or in construction of the screening berms. Figure 1 provides a layout of the existing facilities at the Bayview Landfill. Each of these facilities was anticipated in the Landfill Master Plan (HDR, 1988) developed for the site, and is described in the following paragraphs. The landfill is also currently equipped with various earthmoving and landfill operations equipment. The types and numbers of pieces of equipment necessary for proper operation of the landfill are described on page 22.

Fixed Landfill Facilities

Landfill Cell 1 — Stage 1 is the first half of planned Landfill Cell 1; soil excavated from future Landfill Cell 1 — Stage 2 is used as daily cover in Stage 1 and to further construct screening berms. Stage 1 has been constructed with a liner and leachate collection system. The liner consists of a 40-mil high density polyethylene (HDPE) geomembrane sandwiched between two layers of 12-ounce polypropylene geotextile. At the time of its construction, the liner system was covered with a 2-foot layer of protective soil cover. The liner system and its protective soil cover are critical elements in the landfill cell leachate containment system; operators should take all possible precautions to protect the liner system. Damage to the protective soil cover should be inspected, and damage to the liner system should be reported to the District Manager for appropriate action.

The leachate collection system consists of 2 feet of permeable screened soil on the floor of the landfill cell and a leachate collection trench that is fitted with granular fill and a pipe. The granular fill is surrounded with filter fabric (geotextile). The leachate collected within this system flows by gravity through an underground pipe to a valve and sampling station outside of the landfill cell. From the sampling station, leachate flows through an underground pipe by



EXPLANATION

- PROPERTY LINE
- LEACHATE GRAVITY SEWER
- STRUCTURES
- MONITORING WELL, PERCHED WATER TABLE
- MONITORING WELL, SHALLOW PLEISTOCENE AQUIFER
- MONITORING WELL, APPROXIMATE LOCATION
- LEACHATE COLLECTION MANHOLE STRUCTURE
- BERM
- CHAIN LINK FENCE
- SLOPE INDICATOR
- UNIMPROVED ROAD
- WATER LINE (APPROXIMATE LOCATION)
- FIRE HYDRANT
- STREAM
- CHANNEL DIVERSION

N

0 600' 1200'

SCALE: 1" = 600'

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215 Union Boulevard
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BAYVIEW LANDFILL
SOUTH UTAH VALLEY
SOLID WASTE DISTRICT

FIGURE 1

LAYOUT OF EXISTING
LANDFILL FACILITIES

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gravity to the stormwater/leachate evaporation pond. The cleanout stations on the pipeline should be inspected on a regular basis to verify integrity.

The stormwater/leachate evaporation pond has been constructed with a liner and a protective cover system. The liner system consists of a 60-mil HDPE geomembrane sandwiched between two layers of 12-ounce polypropylene geotextile. The liner system was covered with a 6-inch concrete pad on the bottom and part way over a 40-mil HDPE geomembrane on the sideslopes. The concrete pad extends approximately 3 feet (measured vertically) up the sideslopes, and a concrete access road has been constructed to provide equipment access into the bottom of the pond. The concrete pad is intended to allow landfill operators to enter the pond to remove accumulated sediments as required. The concrete bottom and access road should be inspected on a regular basis to verify integrity of the concrete. Similarly, the 40-mil HDPE protective liner should be inspected on a regular basis to verify its integrity. Damage to either the concrete or HDPE protective cover materials should be reported to the District Manager for appropriate action.

The screening berms have been constructed to provide a visual barrier between State Highway 68 and the active landfill facilities. These screening berms also provide a partial visual barrier between properties north and south of the site and the active landfill facilities. The District constructed these berms to lessen the visual impact of the landfill facilities on the passersby, not as a condition of a permit.

The maintenance building consists of three equipment maintenance bays, a combined office/break room, and restroom facilities. This building is locked when landfill operations personnel are not on-site. The building is supplied with culinary water from the culinary well located in Section 18.

Twelve wells were constructed around the landfill property to provide stations for monitoring groundwater underlying the site. Six of these wells were constructed to intercept the regional groundwater at a depth of approximately 250 feet below ground surface. The remaining six wells were constructed as "wet/dry" wells screened in the seasonal water table aquifer at a depth

of approximately 70 feet below ground surface. These shallow wells are intended to provide early warning of leachate movement, if it should occur.

The site is surrounded by a 3-foot high welded wire fence to control access to the facilities when landfill operations personnel are not present. The main access to the site is equipped with double-wide, locking gates. These gates are locked during nonworking hours. In addition, the stormwater/leachate evaporation pond is surrounded by a 6-foot high chain link fence and two double-wide, locking gates. The stormwater/leachate evaporation pond gates are locked unless landfill operations personnel are inside the fenced enclosure. Finally, the active landfill cell is provided with a 8-foot high chain link fence and four pairs of double-wide, locking gates. Thus, the two active areas of the landfill site are provided with access control fencing separate from, and in addition to, the property boundary fence.

Landfill Equipment

The following equipment is maintained for use at the Bayview Landfill:

Equipment	Quantity	Size	Make/Model
Compactor, Landfill Blade	2	56,000 lb.	Cat 826C
Scraper	1	22 yd.	Cat 623E
Dozer	1		Cat D8N
Water Truck	1	3,000 gal.	Ford
Pickup Truck	1		Ford 250
Fire Truck	1		Mack Pumper

This equipment is sufficiently sized for operation of the Bayview Landfill. All equipment, with the exception of the pickup truck and fire truck, is required to have an OSHA-approved safety cab, a fire extinguisher, a first aid kit, and a backup alarm. Additional equipment may be purchased as existing equipment approaches the end of its useful life, or as operating conditions require.

Landfill Personnel

The following persons are responsible or available for on-site operations at the Bayview Landfill:

- **District Manager.** The District Manager is responsible for: planning, design, and construction of the landfill facilities; overall operation of the solid waste management system, including the landfill; and production of annual environmental and financial reports. The District Manager reports to the District's Board of Directors. The Landfill Foreman reports directly to the District Manager.

- **Landfill Foreman.** The Landfill Foreman is responsible for all day-to-day operations at the Bayview Landfill. He is responsible for: acceptance and placement of wastes at the landfill; routine inspection of the facilities for compliance with permit requirements; and coordination with the Transfer Station Foreman. The Landfill Foreman is a certified Manager of Landfill Operations with at least 10 years of professional experience related to landfill operations and earthwork. The Equipment Operator(s), Spotter/Laborer(s), and any visitors report directly to the Landfill Foreman.

- **Equipment Operators (3).** The Equipment Operator is responsible for: safe operation and daily maintenance of equipment; visual inspection of waste loads for unauthorized or hazardous wastes; and daily operations on the working face of the landfill. The Equipment Operators, with the exception of apprentices, have at least 2 years of professional experience related to landfill operations or earth work. The Equipment Operators receive training on landfill operations within 2 years of employment. (Note: As of the date of this permit application, the three operators each have more than 15 years of experience in landfill operation, and all have completed the 12-lesson SWANA course entitled "Training Sanitary Landfill Personnel.") The Landfill Foreman may designate the Equipment Operator to act in his behalf in the foreman's absence.

- **Spotter/Laborer (1).** The Spotter/Laborer is responsible for: directing traffic to the working face; control of litter and dust generated from the landfilling operations; assistance to the Equipment Operators; and any other tasks assigned by the Landfill Foreman.

4.3 SCHEDULE OF FACILITIES CONSTRUCTION

Landfill Cell 1 — Stage 1, the first landfill half cell, was excavated in 1988, and the soils excavated from this half cell were used to construct portions of the screening berms on the eastern and northern boundaries of the site. The geomembrane lining system for this half cell

was installed during the Fall of 1989. The specifications for the excavation and geomembrane lining system are included in Appendix C. Essentially, the construction consisted of: excavating the native soils, compacting the exposed soils to 95% of optimum density (Standard Proctor), installing a geotextile to cushion the overlying geomembrane from underlying soils, installing a 40-mil HDPE geomembrane liner, installing a geotextile to absorb sideslope tensile stresses and to transmit leachate, and placing the protective soil cover. Provo City Corporation and design personnel (HDR Engineering, Inc.) provided construction quality assurance observation during the installation of the geosynthetics and during the placement of protective cover soils.

Bayview Landfill accepted its first solid wastes for disposal on February 4, 1991. Since that time, soils excavated from Landfill Cell 1 — Stage 2 have been used for daily cover in Stage 1, and for further construction of the screening berms. At the time of this permit application, Stage 2 is approaching its planned excavation grades. The District anticipates that design and construction of Stage 2 will occur during the Fall of 1994 and Spring of 1995, respectively.

As a general rule for future landfill cells, the new landfill cell should be planned to be available no less than 3 months prior to the completion of filling in the operational cell. This will allow for construction delays due to weather, construction contractor difficulties, or other unanticipated delays. The design, permit review, and contractor negotiations should be planned to require approximately 1 year.

4.4 SOLID WASTE HANDLING

4.4.1 Waste Acceptance

All solid wastes entering the Bayview Landfill originate at the Springville Transfer Station or the City of Goshen Transfer Station. All wastes entering these transfer station facilities are pre-screened for unacceptable materials by transfer station personnel prior to compaction of the wastes. Operations at the transfer stations are not included in this landfill Operations Plan.

Private hauler and citizen self-hauled wastes are not accepted at the landfill.

4.4.2 Waste Disposal

Transfer trailers entering the site will be directed by landfill operations personnel to the working face where the driver will be instructed to discharge the load. Landfill operations personnel will push the solid waste up the working face using a compactor. The waste will be placed in lifts with the loose thickness of solid wastes 12 to 24 inches in thickness. After the waste has been placed in loose lifts, the operator will run the compactor over all portions of the lift at least two times parallel with the slope (up slope), and at least one time across the slope. There may be times in operating the landfill when pushing uphill may be impractical or poor practice (i.e., when the first lift of waste is placed on protective cover soil.) Equipment operators will also maintain the working face so that it is as small as practical to allow for efficient unloading of transfer trucks, and placement and compaction of solid wastes.

~~During the unloading and placement of solid wastes, the equipment operator will observe the wastes for unacceptable materials. The operator will remove any unacceptable materials from the working face prior to compaction.~~

4.4.3 Placement of Cover Soils

Cover soils will be placed over solid wastes to minimize the potential for nuisance conditions, fire, and disease vector contact with solid wastes. Nuisance conditions include: odor generation and air discharges; blowing of plastic and paper wastes; and other conditions that impair the use of adjoining properties.

Daily cover will be placed to minimize the nuisance, fire, and disease vector potential attributable to each day's waste placement. Intermediate cover will be placed to reduce the production of leachate and contact stormwater within the landfill cell.

At the end of each working day, the landfill operations personnel will cover all solid wastes received during that day. The cover will consist of a minimum of 6 inches of soil borrowed from other portions of the landfill site.

Whenever a portion of the landfill cell will remain in an inactive conditions for an extended period, landfill operations personnel will place an intermediate cover over the inactive portion. The intermediate cover will reduce the potential for wind- and water-induced erosion of the cover. The intermediate cover will consist of an additional 6 inches of soil.

4.5 INSPECTIONS, MONITORING, AND REPORTING

4.5.1 Inspections

The Landfill Foreman is responsible for conducting and recording ~~in a logbook~~ routine inspections of landfill facilities. The schedule for conducting routine inspections is provided in Table 2. Forms for recording routine inspections are presented in Appendix I.

The District Manager is responsible for verifying the completeness of the inspection records on a quarterly basis.

4.5.2 Groundwater Monitoring

Detection Monitoring

The District has completed a 2-year program to determine the background water quality in each of the 12 monitoring wells constructed at the landfill site. The 2-year program consisted of bimonthly sampling of each well. During the first year, the District sampled each well every other month; during the second year, the District also sampled every other month, skipping one month so that each calendar month was sampled during the 2-year program. The results of the 2-year program will be used as a baseline for each well, and subsequent groundwater monitoring results for each well will be compared to this baseline data.

The District will conduct groundwater sampling on a semi-annual basis; this sampling program began beginning with the first half of 1993. The District Manager and the Landfill Foreman will coordinate the monitoring events, schedule the timing of groundwater sampling, sample or arrange for sampling of the wells, arrange for analysis of the groundwater samples, and arrange

Table 2

Recommended Frequency of Inspection of Landfill Facilities

Landfill Facility	Inspection	Frequency
Landfill Cell	Daily and intermediate cover integrity.	Daily
	Stormwater and leachate collection (ponding).	Daily
	Run-on/run-off control integrity.	Daily
	Cell perimeter fence integrity.	Daily
Stormwater/Leachate Pond	Perimeter fence integrity.	Daily
	Water depth.	Weekly
	Liner system integrity.	Weekly
	Water volume.	Quarterly
Other Appurtenances	Entrance/main gate integrity.	Daily
	Perimeter fence integrity.	Weekly
	Monitoring well integrity.	Monthly
	Equipment maintenance.	Monthly
	Site road integrity.	Quarterly
	Berm integrity.	Quarterly

for interpretation of the analytical results. The groundwater samples will be analyzed for the constituents listed in UDEQ rules (R315-308-4) for detection monitoring.

The semi-annual detection monitoring samples will be compared to the baseline data and to ongoing averages for each well. Student's t tests will be used to determine if the data are statistically different from either the baseline data or from ongoing average data for each well. If statistically significant increases are detected in the Detection Monitoring Program, the District will begin an Assessment Monitoring Program, as required by UDEQ rules.

Assessment Monitoring

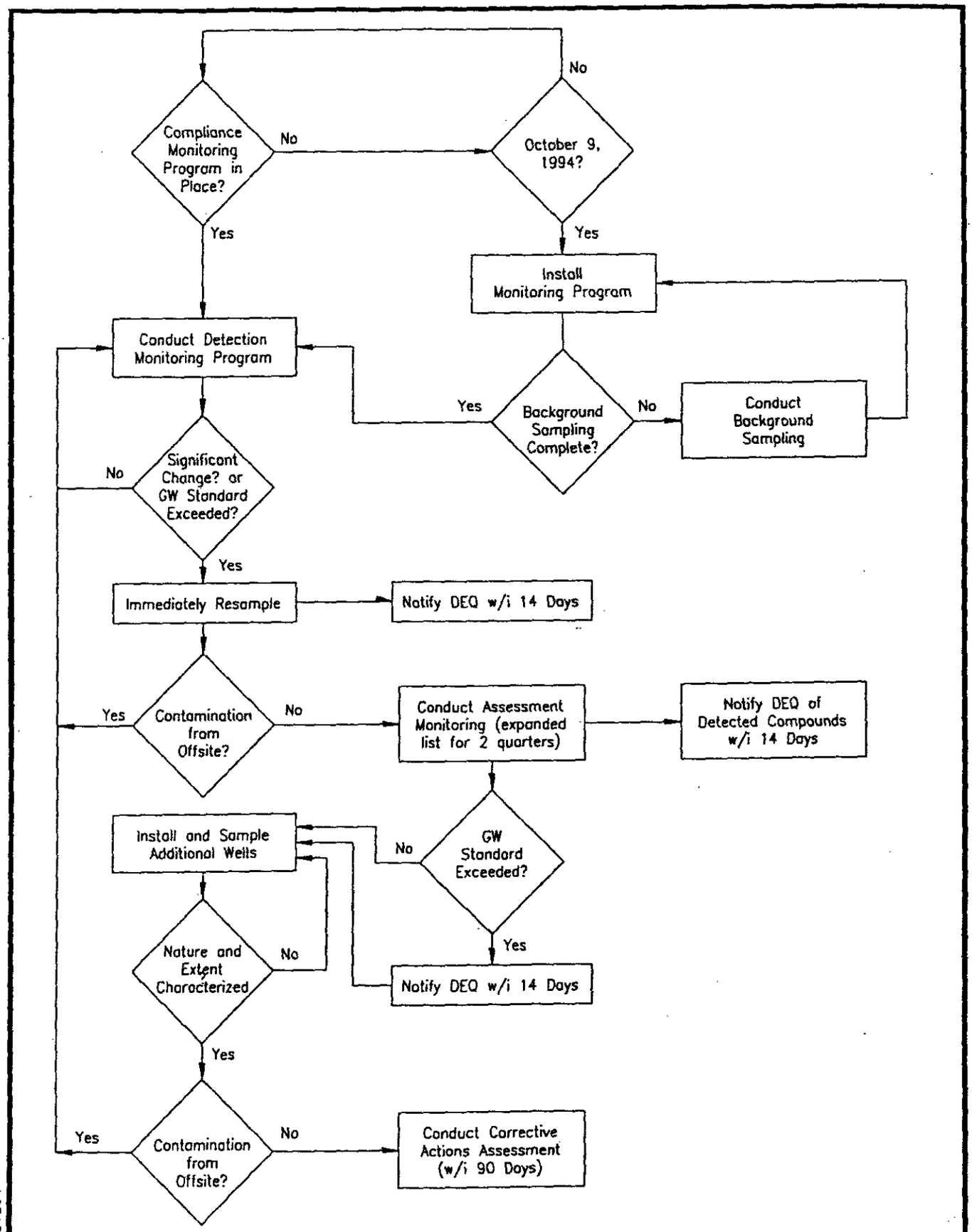
If a statistically significant increase in groundwater contaminants is detected as part of the Detection Monitoring Program, the District will initiate the following actions:

- Notify UDEQ in writing, within 14 days of obtaining laboratory results. The notification will include identification of the constituents that have shown a statistically significant increase.
- Enter the laboratory results into the operating record for the landfill.
- Immediately resample the groundwater in all wells, or a subset of the wells as specified by the Executive Secretary, for all constituents listed in R315-308-4. Determine whether a statistically significant change has, in fact, occurred such that the groundwater protection has been compromised.
- Notify DEQ within 7 days of receipt of the results of the resampling if a statistically significant change has, in fact, occurred.

Figure 2 summarizes the requirements imposed on the District by UDEQ regulations to define the nature and extent of groundwater contamination, and to take corrective action if the source of the groundwater contamination is the landfill.

4.5.3 Landfill Gas Monitoring

The District has begun a landfill gas monitoring program by conducting an initial surface survey for combustible gases, and by purchasing a combustible gas indicator (CGI). During the initial



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BAYVIEW LANDFILL
SOUTH UTAH VALLEY SOLID WASTE DISTRICT

UTAH REQUIREMENTS
GROUNDWATER MONITORING

FIGURE 2

UTAH SOLID WASTE
R315-308

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survey, no measurable combustible gases were detected on the site, and landfill gas monitoring stations were established for future monitoring events.

The District will conduct combustible gas monitoring at the established stations on a quarterly basis. The District Manager and the Landfill Foreman coordinate the monitoring events with groundwater monitoring events, and will arrange for interpretation of the monitoring results if combustible gasses are detected at any station.

If concentrations of combustible gasses exceed the standard set in UDEQ Rules, the District will implement the requirements imposed on the District by UDEQ regulations in effect at the time of the permit or revisions of the permit.

4.6 CONTINGENCY AND CORRECTIVE ACTION PLANS

The following sections describe the contingency and corrective action plans that will be implemented if fire, explosion, failure of run-off/run-on structures, release of explosive gases, or contamination of groundwater occurs.

4.6.1 Fire

No burning of wastes is planned in the active landfill cell area. Limited burning may be planned, permitted, and accomplished during clearing of new landfill cell construction areas, and perimeter fence and drainage channel maintenance. No other burning activities are planned at the Bayview Landfill.

Two other types of fires must be planned for at the landfill: fires in loaded vehicles, and fires in disposed wastes. Each of these is discussed below. The preferred method of fighting fires in the Bayview Landfill will consist of smothering the fire with soil. Water will contribute to the formation of leachate, and should only be used as a last resort if the fire cannot be smothered.

Loaded Vehicle Fires

In the event that a transport vehicle enters the landfill site carrying a burning or smoldering load of waste, landfill operating personnel will take the following actions:

- Direct the vehicle to a designated section of the landfill away from the working face. Direct the driver to deposit his load and to clear the area as quickly as possible.
- Immediately cover the burning waste with soil using sufficient soil to completely smother the fire. Allow the waste to cool for several days, or longer if necessary.
- If necessary, spray equipment and the transfer vehicle with water to cool the equipment while working the fire. This should not be necessary if the equipment is pushing or dumping soil on the burning wastes in front of the advancing equipment.
- If landfill operations personnel cannot control the fire, the County Fire Marshall should be contacted.
- Notify the UDEQ immediately and provide written documentation within 14 days of the fire.

Working Face/Below Cover Fire

In the event of a working face fire or a fire below cover, landfill operations personnel will take the following actions:

- Evacuate all non-essential personnel from the area of the fire. Non-essential personnel would include transfer truck drivers, laborers/spotters, and visitors.
- Isolate the burning material from other wastes to the extent possible. Use compactor blades and dozers to move the burning materials away from other wastes; this may not be possible if the fire is below cover soil.
- Immediately cover the burning waste with soil using sufficient soil to completely smother the fire. Allow the waste to cool for several days, or longer if necessary.

- If necessary, spray equipment and the transfer vehicle with water to cool the equipment while working the fire. This should not be necessary if the equipment is pushing or dumping soil on the burning wastes in front of the advancing equipment.

- If landfill operations personnel cannot control the fire, the County Fire Marshall should be contacted.

- Notify the UDEQ immediately and provide written documentation within 14 days of the fire.

4.6.2 Explosion

In the event that an explosion should occur at the landfill or in any structure associated with the landfill, landfill operations personnel will take the following actions:

- Immediately evacuate the area surrounding the explosion, including any adjacent buildings. Shut down and abandon any equipment near the explosion that is hot and may provide an ignition source for additional explosions.

- Account for all personnel. Contact the County Fire Marshall and the emergency dispatcher (911). Contact the District Manager.

- Restrict the explosion area to any entry until the area is cleared by emergency response personnel.

- Notify the UDEQ immediately and provide written documentation within 14 days of the explosion.

4.6.3 Failure of Run-Off/Run-On Structures

Failure of run-off structures may allow release of contaminated water into the environment; failure of run-on structures may allow stormwater to mingle with and become leachate. Neither of these effects is desirable.

Failure of Run-Off Structures

In the event that a failure of run-off structures is discovered during routine or non-routine inspections, landfill operations personnel will take the following actions:

- As soon as practical, suspend acceptance of wastes at the landfill, if necessary, and inform the transfer stations of this suspension.
- Use landfill compactor and dozer equipment to construct temporary berms to contain the run-off. Divert the flow of run-off water away from surface water drainage channels.
- Resume landfilling operations as soon as possible after the run-off is contained. Inspect the temporary berms as frequently as possible, but not less frequently than once every 2 hours.
- Assess the impact of the release of run-off as soon as practicable following the event. Assess the need for permanent improvements in the temporary berms, or other run-off control structures, as soon as practicable following control of the run-off.
- Notify the UDEQ immediately and provide written documentation within 14 days of the release event.

Failure of Run-On Structures

Failure of run-on control structures may temporarily overload the leachate collection system, but is generally less serious than failure of run-off control structures. In the event that failure of run-on control structures is discovered during routine or non-routine inspections, landfill operations personnel will take the following actions:

- Immediately mobilize landfill compactor or dozer equipment to construct temporary berms, swales, or other structures to temporarily divert surface water run-on from the active landfill cell. Assess the need to suspend acceptance of waste.
- Assess the need for permanent run-on control structures as soon as practicable.
- Notify the UDEQ immediately and provide written documentation within 14 days of the failure event.

4.6.4 Release of Explosive Gases

It is unlikely that a release of explosive gas will occur from the lined Bayview Landfill cells. However, it is possible that landfill gas concentrations will exceed the regulatory requirements in one or more gas monitoring locations. For purposes of this contingency plan, a release is defined as detection of more than 25% lower explosive limit (LEL) in a landfill building, or more than 100% LEL at the property boundary. If a release of explosive gases is detected, landfill operations personnel will take the following actions:

- Immediately suspend landfilling operations and determine if landfill personnel or structures are threatened. If so, personnel will be evacuated immediately, and building doors will be opened to allow gases to escape. Notify the transfer stations of the suspension of operations.
- As soon as possible, determine if off-site buildings or other structures are threatened. If so, immediately notify the County Fire Marshall.
- Monitor the release area, and all other landfill gas monitoring locations, until the emergency condition has been eliminated.
- Determine temporary corrective actions as soon as possible, and permanent corrective actions as soon as practicable, following detection of the release.
- Notify the UDEQ immediately and provide written documentation within 14 days of the release event.

4.6.5 Groundwater Contamination

Contingency and corrective actions following the detection of groundwater contamination are described in Figure 1.

4.7 ALTERNATIVE WASTE HANDLING PROCEDURES

Landfill operations have been adapted for wet weather by constructing an all-weather, asphalt-paved roadway from the site entrance to the active cell. The site soils, including those used as daily cover, consist primarily of sands and gravels. In the semi-arid climate of the Bayview Landfill site, experience has shown that precipitation has little effect on the operation of the

landfill, especially given the nature of the cover soils. The District does not believe that alternate waste handling plans are necessary for this site with respect to wet weather operations.

All reasonable caution and prudence will be exercised to not dispose of wastes during any unreasonable weather conditions. If unforeseen weather conditions occur, the District Manager, or his designee, shall be informed and shall coordinate any changes in operations. The District Manager will consider the system-wide requirements (including transfer station requirements) in determining what changes, if any, need to be made in operations at the landfill.

4.8 MONITORING EQUIPMENT MAINTENANCE

4.8.1 General

The inspection schedule for groundwater monitoring wells and landfill gas monitoring stations is presented in Section 4.5.2. This section describes the more detailed inspection and maintenance of these landfill structures.

4.8.2 Groundwater Monitoring Wells

All groundwater monitoring wells will be thoroughly inspected during each sampling event. The detailed inspection will note signs of deterioration or failure of the protective steel casing, the concrete pad and bollards, and the polyvinyl chloride (PVC) well casing and screen. If damage is discovered, the nature of the problem will be recorded and reported to the District Manager who will make a decision to repair, replace, or abandon the well. This decision will be documented in the operating record for the landfill, and the required actions will be completed prior to the next scheduled monitoring event.

The monitoring well locations will be maintained on a routine basis. Weeds will be removed at least every 6 months, approximately 2 weeks prior to each scheduled sampling event. During the weed removal, landfill personnel will note any obvious indications that the well has been damaged to allow the Landfill Foreman and the District Manager to assess the situation. Bollards and well casing materials will be inspected during each sampling event to determine whether painting or other routine maintenance is required.

4.8.3 Gas Monitoring Locations

Gas monitoring locations will be maintained on a routine basis. Weeds will be removed from the vicinity of each monitoring location at least every 3 months, approximately 2 weeks prior to each scheduled sampling event.

4.9 DISEASE VECTOR CONTROL

For landfills in Utah, disease vectors essentially consist of rodents and birds. This section describes the methods that the Bayview Landfill personnel will use to control rodents and birds.

4.9.1 Rodent Control

The primary method of rodent control is to eliminate conditions favorable for the reproduction of rodents through proper compaction of wastes and proper placement of daily cover. If landfill personnel observe the presence of rodents, more frequent application of cover soils will be considered.

If the primary method of rodent control does not produce satisfactory results, poisoning may be employed by the District. A poison control program must include the following conditions:

- Poison traps must be set by experienced, professional exterminators.
- Poison traps may only be set within areas with controlled access. This means that the trapped area must be within the security fencing for the active landfill cell, and that the security gates must be locked for the duration of the poisoning program whenever landfill personnel are not on-site.
- Occupational Health and Safety Administration (OSHA) warning signs of acceptable color and size must be permanently fixed to the outside of the access gate and fencing, at spacings not to exceed 150 feet, for the duration of the poisoning program. A minimum of one sign per side of the fence is required.
- Landfill personnel must conduct a daily inspection of each poison trap, and notify the professional exterminator if disruptions of any traps are noted.

- The professional exterminator must conduct periodic inspections of the poison traps.

- Written documentation of the poisoning program must be maintained at the maintenance building. The documentation must include: the number and exact location(s) of the poison traps; the name of the poison(s) (including both chemical and brand name, and a listing of ingredients); the quantity of poison contained in each trap; and the medically accepted antidotes or treatments for the poison(s).

- The professional exterminator must submit monthly reports to the District Manager documenting the status of the poisoning program. The reports shall include the number and location of traps, the quantities of poison(s) used during the past month, and any changes in the program instituted during the past month.

- Poison supplies shall be stored on-site in a separate, locked, and properly labelled enclosure. Access to the poison shall be restricted to the professional exterminator and the Landfill Foreman, or his designee.

4.9.2 Bird Control

As with rodent control, the primary method of controlling birds is to control the conditions favorable to their existence. The following methods can be used as needed:

- Minimizing the size of the working face. This is the most effective method of controlling birds since it reduces the area available for feeding. More frequent cover and higher degrees of compaction of the wastes may also serve to minimize the opportunities for feeding.

- Minimizing the accumulation of water in depressions, ponds, or other features near the active working face. The lack of water makes a landfill a less attractive feeding area for birds.

- Use of noise or other frightening techniques. These techniques offer short-term reductions in the numbers of birds feeding at a landfill.

If the primary methods do not produce satisfactory results, a destructive method of control may need to be implemented. Destructive methods may cause harm or death to some birds, and authorization must be obtained from local officials prior to implementing a destructive program.

4.10 WASTE SCREENING

The primary location for screening of wastes will be the transfer stations. All transfer station personnel will receive periodic training in detecting wastes that are prohibited for disposal at the landfill. This training will consist of an initial training and annual refresher training. These personnel will conduct routine inspections and random load inspections as specified in the operations plan for the transfer stations.

The landfill equipment operators will also receive periodic training in detecting prohibited wastes. This training will consist of an initial training and annual refresher training; however, the landfill operational personnel will provide secondary waste screening only.

4.11 RECYCLING

The primary location for recycling will be the transfer stations. These locations are best suited for separating recyclable materials, and separation will be difficult or impossible after the wastes have been compacted and loaded into over-the-road trucks. The landfill operations personnel may segregate tires, large and bulky wooden wastes, and similar materials upon receipt at the landfill; however, this recycling activity is considered secondary to recycling at the transfer stations.

APPENDIX S

LANDFILL OPERATIONS PLAN

SUVSWD Bayview
Class I Landfill Permit Modification

Submitted February 2004

Prepared By:

HDR ENGINEERING, INC.

SUVSWD Bayview
Class I Landfill Permit Modification – Appendix S

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1.0 INTRODUCTION

The purpose of this Operations Plan is to assist the Landfill Foreman and Landfill Operating Personnel in conducting day-to-day operations in a manner that is consistent with the various permit requirements, and with the design of the Bayview Landfill. Section 2 describes the emergency response procedures applicable to the landfill, the permit conditions applicable to the landfill, the designed facilities at the landfill, and equipment and personnel requirements for proper operation of the landfill. Section 3 provides a discussion of landfill facilities at the site. Section 4 describes the procedures for handling wastes received at the landfill. Section 5 provides a schedule for conducting inspections, monitoring, and reporting for the landfill facilities. Section 6 provides contingency plans and corrective action programs to be implemented if emergency conditions (e.g., fire or explosion) exist, or if data indicate that containment systems have failed. Section 7 discusses alternative waste handling and disposal during inclement weather. Section 8 describes the maintenance of landfill monitoring equipment. Section 9 describes routine and non-routine procedures to be implemented to control disease vectors. Section 10 addresses waste screening to exclude regulated hazardous wastes. Sections 11 and 12 provide a discussion of the current and planned recycling and diversion of solid wastes at the landfill.

2.0 EMERGENCY RESPONSE AND BACKGROUND INFORMATION

2.1 Emergency Response Actions

Landfill emergencies include: injury, dismemberment, or death of personnel; and fire, explosion, or other catastrophic events. Because of its remote location, the landfill maintains its own fire protection equipment, and personnel are trained in the operation of this equipment. Also because of its remote location, injured personnel will be transported to medical facilities in District vehicles if their condition allows movement. The Landfill Foreman, or his designee, may request that ambulance and paramedical personnel meet the transporting vehicle enroute to the medical facility.

For other emergencies, the following list provides the phone number to access emergency services. This list will be posted directly adjacent to each phone on the facility site within a colorless, protective plastic cover.

Fire and Rescue ..... 911 ..... (801)375-3601

Hospital 911

Utah Valley Regional Medical Center ..... (801) 371-7001

Mountain View ..... (801) 465-7190

County Fire Marshall ..... (801) 370-8885

Sheriff ..... (801) 375-3601

District Office ..... (801) 489-3027

In the event of any emergency, the following personnel will be notified:

Name	Position/Title	Work Phone
Richard Henry	District Manager	(801)489-3027
Scott Aitken	Landfill Foreman	(801)376-0197
Mark Loveless	Transfer Station Foreman	(801)489-3027
Dorothy Morse	Executive Secretary	(801)489-3027

2.2 Permit Requirements

The Bayview Landfill is subject to both State of Utah and local Utah County requirements controlling day-to-day operations at the landfill. The state and local requirements are discussed below.

2.2.1 State Requirements

On October 9, 1991, the U.S. Environmental Protection Agency (EPA) published revisions to the Criteria for Classification of Solid Waste Disposal Facilities. These regulations were developed

in response to requirements of Subtitle D of the 1984 Hazardous and Solid Wastes Amendments (HSWA) to the Resource Conservation and Recovery Act (RCRA) of 1976. The Subtitle D regulations set forth minimum federal criteria for municipal solid waste landfills, including facility design and operational requirements. The Subtitle D regulations became effective on October 9, 1993.

Subtitle D establishes a framework for federal, state, and local government cooperation in controlling the management of non-hazardous solid wastes. The federal government's role within this framework is to establish the regulatory direction by providing minimum nationwide standards for protection of human health and the environment, and by providing technical assistance to states for planning and developing their own environmentally sound waste management practices. However, the actual planning, direct implementation, and enforcement of solid waste programs remains a state and local role under the Subtitle D framework.

On July 15, 1993, the Utah Department of Environmental Quality (UDEQ) issued final Administrative Rules implementing Subtitle D at the state level. These rules, entitled Solid Waste Permitting and Management, Rules (8315-301 through 320), have been reviewed by EPA, and the UDEQ has received authorization from EPA to implement and enforce the solid waste management program.

The UDEQ rules require that each landfill develop and comply with its approved Operations Plan. The rules further specify certain operational requirements including: excluding hazardous and bulk liquid wastes; controlling access; controlling disease vectors; controlling air discharges and explosive gases; controlling run-on, run-off, and surface water discharges; and maintaining records. This Operations Plan has been developed to include the requirements of the UDEQ rules.

2.2.2 Utah County Requirements

During the process of permitting the Bayview Landfill site, the Utah County Board of Adjustment enumerated 26 criteria that the landfill must meet to remain in compliance with the

Board's Conditional Use Permit. These permit conditions include the following. (Note: These permit conditions are quoted directly from the Conditional Use Permit and are provided here to make the landfill operators aware of the District's obligations under the Conditional Use Permit.)

1. Compacted or baled garbage will be placed in trenches and covered at the end of each day.
2. The waste will be buried away from the gravel pit area.
3. A fence will be installed surrounding each trench area at least eight (8) feet in height and higher if found inadequate to control blowing papers.
4. After an area has been filled, it will be contoured, mulched, and reseeded as indicated by the State Agronomist and the State Extension Service.
5. There will be a watchman on site during normal working hours.
6. The gate will be closed any time it is unattended and it must be locked. (This is the main gate, not that around a particular area being filled.)
7. A new access road from the state highway into the deposit area will be provided as required by the Department of Transportation.
8. The size of the garbage trucks will meet the requirements of the Utah Department of Transportation and Utah Highway Patrol.
9. Provo City will cooperate with the State Highway Department and local residents to prevent inordinate damage to the road during periods when the road is saturated and subject to destruction, and comply with all state and local ordinances conforming to the same.
10. All garbage will be collected and compacted at a location other than the landfill site and transported in covered trucks by Provo City.
11. No burning is to be allowed at the disposal site.
12. The trenching will be done in such a manner as to protect the drainage channels in the area as required by the State Department of Environmental Health.
13. No hazardous wastes will be deposited in the area.
14. All reasonable caution and prudence be exercised to not dispose of any waste during any unreasonable weather conditions.
15. All requirements in the "Code of Solid Waste Disposal Regulations" will be met.

16. Any terms of the lease held by Mr. Jacobs are protected and that Provo City cooperates with him during lambing season to minimize the impact on his operation.
17. No public dumping.
18. Landfill to be used only by Provo City, and if other cities were to use the landfill, approval from the Board of Adjustment would be necessary.
19. Personnel will police the grounds outside the fence, and keep litter and garbage picked up.
20. Rodent control must be in effect at all times as state law provides.
21. Water samples will be taken by the Department of Environmental Health from any wells within 1500' of the disposal site prior to any dumping to determine the water quality. Samples would be taken every six months or more often as determined by the Department of Environmental Health.
22. The area used to begin the operation of filling must be selected to minimize the impact on people in the surrounding area.
23. In constructing the road or roads required by the Department of Transportation to get access to the landfill, Provo City will minimize the amount of disruption to the environment of the area.
24. That Provo City maintain a buffer zone of at least 100' from existing state roads, homes and premises in dumping their compacted garbage.
25. Upon noncompliance with any of these provisions Utah County will revoke said right to the landfill.
26. Provo City will provide an annual report to the Board of Adjustment for their review as to the progress in the engineering of the landfill.

These conditions will be considered the minimum criteria that the landfill operations must meet to remain in compliance with the Conditional Use Permit.

2.3 Landfill Facilities

At the time of this permit application renewal, the Bayview Landfill consists of one 33-acre landfill cell almost at final grade, one stormwater/leachate evaporation pond, five screening berms,

one maintenance building, and appurtenant roads, fences, and culinary and monitoring wells. In addition, an 82-acre cell is currently under design and will be constructed in 15-acre increments or stages. Figure 5 in Part IV provides a layout of the existing facilities at the Bayview Landfill. Each of these facilities was anticipated in the Landfill Master Plan (HDR, 1988) developed for the site, and is described in the following paragraphs. The landfill is also currently equipped with various earthmoving and landfill operations equipment. The types and numbers of pieces of equipment necessary for proper operation of the landfill are described below.

2.3.1 Fixed Landfill Facilities

Cell 1 Stage 1 and Stage 2 have been constructed with a liner and leachate collection system. The liner consists of a 40-mil and 60-mil high density polyethylene (HDPE) geomembrane, respectively, sandwiched between two layers of 12-ounce polypropylene geotextile. At the time of its construction, the liner system was covered with a 2-foot layer of protective soil cover. The liner system and its protective soil cover are critical elements in the landfill leachate containment system; therefore, operators will take all possible precautions to protect the liner system. Damage to the protective soil cover will be inspected, and damage to the liner system will be reported to the District Manager for appropriate action.

Cell 2 will also be constructed with a liner and leachate collection system. The liner will consist of a geosynthetic clay liner (GCL), and a 60-mil high-density polyethylene (HDPE) geomembrane sandwiched between two layers of geotextile. The liner system will be covered by 2 feet of protective cover/leachate collection material.

For Cell 2, the leachate collection system will consist of 2 feet of permeable screened soil on the floor of the landfill cell and a leachate collection trench that is fitted with granular fill and a pipe. The granular fill is surrounded with filter fabric (geotextile). The leachate collected within this system flows by gravity to a sump at the low end of the cell and pumped to the surface, where it then flows by gravity to the on-site leachate sewer line and ultimately to the evaporation pond. The cleanout stations on the pipeline will be inspected on a regular basis to verify integrity.

The stormwater/leachate evaporation pond has been constructed with a liner and a protective cover system. The liner system consists of a 60-mil HDPE geomembrane sandwiched between two layers of 12-ounce polypropylene geotextile. The liner system was covered with a 6-inch concrete pad on the bottom and a 40-mil HDPE geomembrane on the side slopes. The concrete pad extends approximately 3 feet (measured vertically) up the side slopes, and a concrete access road has been constructed to provide equipment access into the bottom of the pond. The concrete pad is intended to allow landfill operators to enter the pond to remove accumulated sediments as required. The concrete bottom and access road will be inspected on a regular basis to verify the integrity of the concrete. Similarly, the 40-mil HDPE protective liner will be inspected on a regular basis to verify its integrity. Damage to either the concrete or HDPE protective cover materials will be reported to the District Manager for appropriate action.

The screening berms have been constructed to provide a visual barrier between State Highway 68 and the active landfill facilities. These screening berms also provide a partial visual barrier between properties north and south of the site and the active landfill facilities. The District constructed these berms to lessen the visual impact of the landfill facilities on the passersby, not as a condition of a permit.

The maintenance building consists of three equipment maintenance bays, a combined office/break room, and restroom facilities. This building is locked when landfill operations personnel are not on-site. The building is supplied with culinary water from the culinary well located in Section 18.

Fourteen wells have been constructed around the landfill property to provide stations for monitoring groundwater underlying the site. Eight of these wells were constructed to intercept the regional groundwater at a depth of approximately 250 feet below ground surface. The remaining six wells were constructed as "wet/dry" wells screened in the seasonal water table aquifer at a depth of approximately 70 feet below ground surface. These shallow wells are intended to provide early warning of leachate movement, if it should occur.

A 6-foot high chain link fence surrounds the site to control access to the facilities when landfill operations personnel are not present. The main access to the site is equipped with doublewide, locking gates. These gates are locked during nonworking hours. In addition, the stormwater/leachate evaporation pond is surrounded by a 6-foot high chain link fence and two doublewide, locking gates. The stormwater/leachate evaporation pond gates are locked unless landfill operations personnel are inside the fenced enclosure.

2.3.2 Landfill Equipment

The following equipment is maintained for use at the Bayview Landfill:

Equipment	Quantity	Size	Make/Model
Compactor, Landfill Blade	2	56,000 lb.	Cat 826C
Scraper	1	22 cu. yd.	Cat 623E
Dozer	1		Cat D8N
Water Truck	1	3,000 gal.	Ford
Pickup Truck	1		Ford 250
Fire Truck	1		Mack Pumper

This equipment is sufficiently sized for operation of the Bayview Landfill. All equipment, with the exception of the pickup truck and fire truck, is required to have an OSHA-approved safety cab, a fire extinguisher, a first aid kit, and a backup alarm. Additional equipment may be purchased as existing equipment approaches the end of its useful life, or as operating conditions require.

2.3.3 Landfill Personnel

The following persons are responsible or available for on-site operations at the Bayview Landfill:

- **District Manager.** The District Manager is responsible for: planning, design, and construction of the landfill facilities; overall operation of the solid waste management system, including the landfill; and production of annual environmental and financial reports. The District Manager reports to the District's Board of Directors. The Landfill Foreman reports directly to the District Manager.
- **Landfill Foreman.** The Landfill Foreman is responsible for all day-to-day operations at the Bayview Landfill. He is responsible for: acceptance and placement of wastes at the landfill; routine inspection of the facilities for compliance with permit requirements; and coordination with the Transfer Station Foreman. The Landfill Foreman is a certified Manager of Landfill Operations with at least 10 years of professional experience related to landfill operations and earthwork. The Equipment Operator(s), Spotter/Laborer(s), and any visitors report directly to the Landfill Foreman.
- **Equipment Operators.** The Equipment Operator is responsible for: safe operation and daily maintenance of equipment; visual inspection of waste loads for unauthorized or hazardous wastes; and daily operations on the working face of the landfill. The Equipment Operators, with the exception of apprentices, typically have 2 years of professional experience related to landfill operations or earth work. As of July 2003, two of the operators have in excess of two years experience and a third is nearing completion of two years. The current apprentice operator has about one year of experience. Equipment Operators receive training on landfill operations within 2 years of employment. The Landfill Foreman may designate the Equipment Operator to act in his behalf in the foreman's absence.
- **Spotter/Laborer.** The Spotter/Laborer is responsible for: directing traffic to the working face; control of litter and dust generated from the landfilling operations; assistance to the Equipment Operators; and any other tasks assigned by the Landfill Foreman.

3.0 SCHEDULE OF FACILITIES CONSTRUCTION

Landfill Cell 1 - Stage 1, the first landfill half-cell, was excavated in 1988. The soils excavated from this half-cell were used to construct portions of the screening berms on the eastern and northern boundaries of the site. The geomembrane lining system for this half-cell was installed during the fall of 1989. Essentially, the construction consisted of: excavating the native soils, compacting the exposed soils to 95% of optimum density (Standard Proctor), installing a geotextile to cushion the overlying geomembrane from underlying soils, installing a 40-mil HDPE geomembrane liner, installing a geotextile to absorb side slope tensile stresses and to transmit leachate, and placing the protective soil cover. Provo City Corporation and design personnel (HDR Engineering, Inc.) provided construction quality assurance observation during the installation of the geosynthetics and during the placement of protective cover soils.

Stage 2 of Cell 1 was similarly constructed except that a 60-mil geomembrane was used. Cell 1 is nearing final waste grades, and closure is expected to occur in 2005.

Stage 1 of Cell 2 is anticipated to be constructed in early 2004 and is expected to last approximately 5 years. Soil excavation to be used as daily cover is ongoing in Cell 2, and select material will be used as final cover on Cell 1. A portion of this select material has already been stockpiled on-site.

As a general rule, landfill cells will be planned to be available no less than 3 months prior to the completion of filling in the operational cell. This will allow for construction delays due to weather, construction contractor difficulties, or other unanticipated delays. The design, permit review, and contractor negotiations will be planned to require approximately 1 year.

4.0 SOLID WASTE HANDLING

4.1 Waste Acceptance

All solid wastes entering the Bayview Landfill originate at the Springville Transfer Station or the City of Goshen Transfer Station. All wastes entering these transfer station facilities are pre-

screened for unacceptable materials by transfer station personnel prior to compaction of the wastes. Operations at the transfer stations are not included in this landfill Operations Plan.

Private hauler and citizen self-hauled wastes are not accepted at the landfill.

4.2 Waste Disposal

Transfer trailers entering the site will be directed by landfill operations personnel to the working face, where the driver will be instructed to discharge the load. Landfill operations personnel will push the solid waste up the working face using a compactor. The waste will be placed in lifts with a loose thickness of 2 - 3 feet. After the waste has been placed in loose lifts, the operator will run the compactor over all portions of the lift at least two times parallel with the slope (up slope), and at least one time across the slope. There may be times in operating the landfill when pushing uphill may be impractical or poor practice (i.e., when the first lift of waste is placed on protective cover soil.) Equipment operators will also maintain the working face so that it is as small as practical to allow for efficient unloading of transfer trucks, and placement and compaction of solid wastes.

4.3 Placement of Cover Soils

Cover soils will be placed over solid wastes to minimize the potential for nuisance conditions, fire, and disease vector contact with solid wastes. Nuisance conditions include: odor generation and air discharges; blowing of plastic and paper wastes; and other conditions that impair the use of adjoining properties.

At the end of each working day, the landfill operations personnel will cover all solid wastes received during that day with daily cover. The daily cover will consist of a minimum of 6 inches of soil excavated from other portions of the landfill site. Daily cover will be placed to minimize the nuisance, fire, and disease vector potential attributable to each day's waste placement.

Whenever a portion of the landfill cell will remain in an inactive condition for an extended period, landfill operations personnel will place an intermediate cover over the inactive portion.

The intermediate cover will reduce the potential for wind- and water-induced erosion of the cover, and reduce the production of leachate and contact stormwater within the landfill cell. The intermediate cover will consist of an additional 6-inches of soil.

5.0 INSPECTIONS, MONITORING, AND REPORTING

5.1 Inspections

The Landfill Foreman is responsible for conducting and recording routine inspections of landfill facilities. The schedule for conducting routine inspections is provided in Table S-1. Forms for recording routine inspections are presented in Appendix I.

The District Manager is responsible for verifying the completeness of the inspection records on a quarterly basis.

5.2 Groundwater Monitoring

5.2.1 Detection Monitoring

The District has completed the 2-year program to determine the background water quality in each of the 12 monitoring wells constructed at the landfill site. The 2-year program consisted of bi-monthly sampling of each well. During the first year, the District sampled each well every other month; during the second year, the District also sampled every other month, skipping one month so that each calendar month was sampled during the 2-year program. The results of the 2-year program are used as a baseline for each well, and subsequent groundwater monitoring results for each well will be compared to this baseline data. Baseline data will be collected by 2 years of sampling following the construction of new wells.

The District will continue to conduct groundwater sampling on a semi-annual basis. The District Manager and the Landfill Foreman will coordinate the monitoring events, schedule the timing of groundwater sampling, sample or arrange for sampling of the wells, arrange for analysis of the groundwater samples, and arrange for interpretation of the analytical results. The groundwater samples will be analyzed for the constituents listed in UDEQ rules (R315-

308-4) for detection monitoring. The semi-annual detection monitoring samples will be compared to the baseline data and to ongoing averages for each well to determine if the data is statistically different from either the baseline data or from ongoing average data for each well. If statistically significant increases are detected in the Detection Monitoring Program, the District will begin an Assessment Monitoring Program, as required by UDEQ rules. Appendix F contains the District's Groundwater Quality Report and Groundwater Monitoring Plan.

Table S-1: Recommended Frequency of Inspection of Landfill Facilities

Landfill Facility	Inspection	Frequency
Landfill Cell	Daily and intermediate cover integrity. Stormwater and leachate collection (ponding). Run-on/run-off control integrity. Cell perimeter fence integrity.	Daily Daily Daily Daily
Stormwater/Leachate Pond	Perimeter fence integrity. Water depth. Liner system integrity. Water volume.	Daily Weekly Weekly Quarterly
Other Appurtenances	Entrance/main gate integrity. Perimeter fence integrity. Monitoring well integrity. Equipment maintenance. Site road integrity. Berm integrity.	Daily Weekly Monthly Monthly Quarterly Quarterly

5.2.2 *Assessment Monitoring*

If a statistically significant increase in groundwater contaminants is detected as part of the Detection Monitoring Program, the District will initiate the following actions:

- Notify UDEQ in writing, within 14 days of obtaining laboratory results. The notification will include identification of the constituents that have shown a statistically significant increase.
- Enter the laboratory results into the operating record for the landfill.

- Immediately resample the groundwater in all wells, or a subset of the wells as specified by the Executive Secretary, for all constituents listed in R315-308-4. Determine whether a statistically significant change has occurred such that the groundwater protection has been compromised.
- Notify UDEQ within 7 days of receipt of the results of the resampling if a statistically significant change has occurred.

Figure S-1 summarizes the requirements imposed on the District by UDEQ regulations to define the nature and extent of groundwater contamination, and to take corrective action if the source of the groundwater contamination is the landfill.

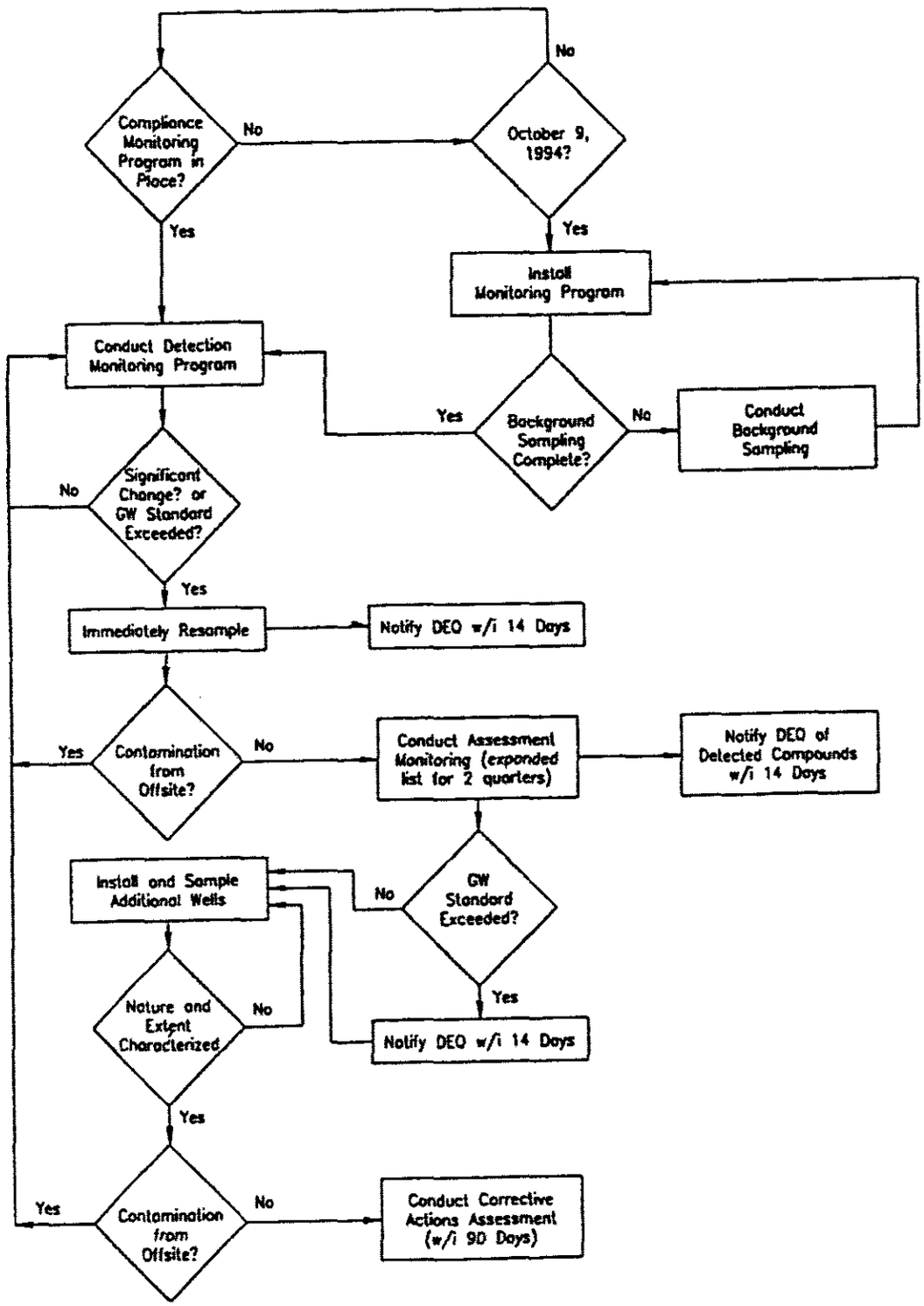
5.3 Landfill Gas Monitoring

The District began a landfill gas monitoring program by conducting an initial surface survey for combustible gases, and by purchasing a combustible gas indicator (CGI). During the initial survey, no measurable combustible gases were detected on the site, and landfill gas monitoring stations were established for future monitoring events.

The District will continue to conduct combustible gas monitoring at the established stations on a quarterly basis. The District Manager and the Landfill Foreman will coordinate the gas monitoring events with groundwater monitoring events, and will arrange for interpretation of the monitoring results if combustible gases are detected at any station.

If concentrations of combustible gasses exceed the standard set in the UDEQ Rules, the District will implement the requirements imposed on the District by UDEQ regulations in effect at the time of the permit or revisions of the permit.

Figure S-1: Utah Requirements for Groundwater Monitoring



6.0 CONTINGENCY AND CORRECTIVE ACTION PLANS

The following sections describe the contingency and corrective action plans that will be implemented if fire, explosion, failure of run-off/run-on structures, release of explosive gases, or contamination of groundwater occurs.

6.1 Fire

No burning of wastes is planned in the active landfill cell area. Limited burning may be planned, permitted, and accomplished during clearing of new landfill cell construction areas, and perimeter fence and drainage channel maintenance. No other burning activities are planned at the Bayview Landfill.

Two other types of fires, fires in loaded vehicles and fires in disposed wastes, must be anticipated and response activities planned. Each of these is discussed below. The preferred method of fighting fires in the Bayview Landfill will consist of smothering the fire with soil. Water will contribute to the formation of leachate, and should only be used as a last resort if the fire cannot be smothered.

6.1.1 Loaded Vehicle Fires

In the event that a transport vehicle enters the landfill site carrying a burning or smoldering load of waste, landfill operations personnel will take the following actions:

- Direct the vehicle to a designated section of the landfill away from the working face. Direct the driver to deposit his load and to clear the area as quickly as possible.
- Immediately cover the burning waste with sufficient soil to completely smother the fire. Allow the waste to cool for several days, or longer if necessary.
- If necessary, spray equipment and the transfer vehicle with water to cool the equipment while working the fire. This will not be necessary if the equipment is pushing or dumping soil on the burning wastes in front of the advancing equipment.

- If landfill operations personnel cannot control the fire, the County Fire Marshall will be contacted.
- Notify the UDEQ immediately and provide written documentation within 14 days of the fire.

6.1.2 Working Face/Below Cover Fire

In the event of a working face fire or a fire below cover, landfill operations personnel will take the following actions:

- Evacuate all non-essential personnel from the area of the fire. Non-essential personnel would include transfer truck drivers, laborers/spotters, and visitors.
- Isolate the burning material from other wastes to the extent possible. Use compactor blades and dozers to move the burning materials away from other wastes; this may not be possible if the fire is below cover soil.
- Immediately cover the burning waste with sufficient soil to completely smother the fire. Allow the waste to cool for several days, or longer if necessary.
- If necessary, spray equipment and the transfer vehicle with water to cool the equipment while working the fire. This will not be necessary if the equipment is pushing or dumping soil on the burning wastes in front of the advancing equipment.
- If landfill operations personnel cannot control the fire, the County Fire Marshall will be contacted.
- Notify the UDEQ immediately and provide written documentation within 14 days of the fire.

6.2 Explosion

In the event that an explosion should occur at the landfill or in any structure associated with the landfill, landfill operations personnel will take the following actions:

- Immediately evacuate the area surrounding the explosion, including any adjacent buildings. Shut down and abandon any equipment near the explosion that is hot and may provide an ignition source for additional explosions.

- Account for all personnel. Contact the County Fire Marshall and the emergency dispatcher (911). Contact the District Manager.
- Restrict the explosion area to any entry until emergency response personnel clear the area.
- Notify the UDEQ immediately and provide written documentation within 14 days of the explosion.

6.3 Failure of Run-Off/Run-On Structures

Failure of run-off structures may allow the release of contaminated water into the environment. Failure of run-on structures may allow stormwater to mingle with and become leachate. Neither of these conditions is desirable.

6.3.1 Failure of Run-Off Structures

In the event that a failure of run-off structures is discovered during routine or non-routine inspections, landfill operations personnel will take the following actions:

- As soon as practical, suspend acceptance of wastes at the landfill, if necessary, and inform the transfer stations of this suspension.
- Use landfill compactor and dozer equipment to construct temporary berms to contain the run-off. Divert the flow of run-off water away from surface water drainage channels.
- Resume landfilling operations as soon as possible after the run-off is contained. Inspect the temporary berms as frequently as possible, but not less frequently than once every 2 hours.
- Assess the impact of the release of run-off as soon as practicable following the event. Assess the need for permanent improvements in the temporary berms, or other run-off control structures, as soon as practicable following control of the run-off.
- Notify the UDEQ immediately and provide written documentation within 14 days of the release event.

6.3.2 Failure of Run-On Structures

Failure of run-on control structures may temporarily overload the leachate collection system, but is generally less serious than failure of run-off control structures. In the event that failure of run-on control structures is discovered during routine or non-routine inspections, landfill operations personnel will take the following actions:

- Immediately mobilize landfill compactor or dozer equipment to construct temporary berms, swales, or other structures to temporarily divert surface water run-on from the active landfill cell. Assess the need to suspend acceptance of waste.
- Assess the need for permanent run-on control structures as soon as practicable.
- Notify the UDEQ immediately and provide written documentation within 14 days of the failure event.

6.4 Release of Explosive Gases

It is unlikely that a release of explosive gas will occur from the lined Bayview Landfill cells. However, it is possible that landfill gas concentrations will exceed the regulatory requirements in one or more gas monitoring locations. For purposes of this contingency plan, a release is defined as the detection of more than 25% of the lower explosive limit (LEL) in a landfill building, or more than 100% LEL at the property boundary. The LEL is 5% by volume of methane in air. If a release of explosive gases is detected, landfill operations personnel will take the following actions:

- Immediately suspend landfilling operations and determine if landfill personnel or structures are threatened. If so, personnel will be evacuated immediately, and building doors will be opened to allow gases to escape. Notify the transfer stations of the suspension of operations.
- As soon as possible, determine if off-site buildings or other structures are threatened. If so, immediately notify the County Fire Marshall.

- Monitor the release area, and all other landfill gas monitoring locations, until the emergency condition has been eliminated.
- Determine temporary corrective actions as soon as possible, and permanent corrective actions as soon as practicable, following detection of the release.
- Notify the UDEQ immediately and provide written documentation within 14 days of the release event.

6.5 Groundwater Contamination

Contingency and corrective actions following the detection of groundwater contamination are described in Figure S-1.

7.0 ALTERNATIVE WASTE HANDLING PROCEDURES

Landfill operations have been adapted for wet weather by constructing an all-weather, asphalt-paved roadway from the site entrance to the active cell. The site soils, including those used as daily cover, consist primarily of sands and gravels. In the semi-arid climate of the Bayview Landfill site, experience has shown that precipitation has little effect on the operation of the landfill, especially given the nature of the cover soils. The District does not believe that alternate waste handling plans are necessary for this site with respect to wet weather operations.

All reasonable caution and prudence will be exercised to not dispose of wastes during any unreasonable weather conditions. If unforeseen weather conditions occur, the District Manager, or his designee, will be informed and will coordinate any changes in operations. The District Manager will consider the system-wide requirements (including transfer station requirements) in determining what changes, if any, need to be made in operations at the landfill.

8.0 MONITORING EQUIPMENT MAINTENANCE

8.1 General

The inspection schedule for groundwater monitoring wells and landfill gas monitoring stations is presented in Section 5. This section describes the more detailed inspection and maintenance of these landfill structures.

8.2 Groundwater Monitoring Wells

All groundwater monitoring wells will be thoroughly inspected during each sampling event. The detailed inspection will note signs of deterioration or failure of the protective steel casing, the concrete pad and bollards, and the polyvinyl chloride (PVC) well casing and screen. If damage is discovered, the nature of the problem will be recorded and reported to the District Manager who will make a decision to repair, replace, or abandon the well. This decision will be documented in the operating record for the landfill, and the required actions will be completed prior to the next scheduled monitoring event.

The monitoring well locations will be maintained on a routine basis. Weeds will be removed at least every 6 months, approximately 2 weeks prior to each scheduled sampling event. During the weed removal, landfill personnel will note any obvious indications that the well has been damaged to allow the Landfill Foreman and the District Manager to assess the situation.

Bollards and well casing materials will be inspected during each sampling event to determine whether painting or other routine maintenance is required.

8.3 Gas Monitoring Locations

Gas monitoring locations will be maintained on a routine basis. Weeds will be removed from the vicinity of each monitoring location at least every 3 months, approximately 2 weeks prior to each scheduled sampling event.

9.0 DISEASE VECTOR CONTROL

For landfills in Utah, disease vectors essentially consist of rodents and birds. This section describes the methods that the Bayview Landfill personnel will use to control rodents and birds.

9.1 Rodent Control

The primary method of rodent control is to eliminate conditions favorable for the reproduction of rodents through proper compaction of wastes and proper placement of daily cover. If landfill personnel observe the presence of rodents, more frequent application of cover soils will be considered.

If the primary method of rodent control does not produce satisfactory results, the District may employ poisoning. A poison control program must include the following conditions:

- Poison traps must be set by experienced, professional exterminators.
- Poison traps may only be set within areas with controlled access. This means that the trapped area must be within the site's security fencing, and the security gates must be locked for the duration of the poisoning program whenever landfill personnel are not on-site.
- Occupational Health and Safety Administration (OSHA) requires warning signs of acceptable color and size to be permanently fixed to the outside of the access gate and fencing, at spacings not to exceed 150 feet, for the duration of the poisoning program. A minimum of one sign per side of the fence is required.
- Landfill personnel must conduct a daily inspection of each poison trap, and notify the professional exterminator if disruptions of any traps are noted.
- The professional exterminator must conduct periodic inspections of the poison traps.
- Written documentation of the poisoning program must be maintained at the maintenance building. The documentation must include: the number and exact location(s) of the poison traps; the name of the poison(s) (including both chemical and brand name, and a

listing of ingredients); the quantity of poison contained in each trap; and the medically accepted antidotes or treatments for the poison(s).

- The professional exterminator must submit monthly reports to the District Manager documenting the status of the poisoning program. The reports shall include the number and location of traps, the quantities of poison(s) used during the past month, and any changes in the program instituted during the past month.
- Poison supplies shall be stored on-site in a separate, locked, and properly labeled enclosure. Access to the poison shall be restricted to the professional exterminator and the Landfill Foreman, or his designee.

9.2 Bird Control

As with rodent control, the primary method of controlling birds is to control the conditions favorable to their existence. The following methods will be used as needed:

- Minimizing the size of the working face. This is the most effective method of controlling birds since it reduces the area available for feeding. More frequent cover and higher degrees of compaction of the wastes may also serve to minimize the opportunities for feeding.
- Minimizing the accumulation of water in depressions, ponds, or other features near the active working face. The lack of water makes a landfill a less attractive feeding area for birds.
- Use of noise or other frightening techniques. These techniques offer short-term reductions in the numbers of birds feeding at a landfill.

If the primary methods do not produce satisfactory results, a destructive method of control may need to be implemented. Destructive methods may cause harm or death to some birds, and authorization must be obtained from local officials prior to implementing a destructive program.

10.0 WASTE SCREENING

The primary location for screening of wastes will be the transfer stations. All transfer station personnel will receive periodic training in detecting wastes that are prohibited for disposal at the

landfill. This training will consist of an initial training and annual refresher training. These personnel will conduct routine inspections and random load inspections as specified in the operations plan for the transfer stations.

The landfill equipment operators will also receive periodic training in detecting prohibited wastes. This training will consist of an initial training and annual refresher training; however, the landfill operational personnel will provide secondary waste screening only.

11.0 RECYCLING

The primary location for recycling will be the transfer stations. These locations are best suited for separating recyclable materials, and separation will be difficult or impossible after the wastes have been compacted and loaded into over-the-road trucks. The landfill operations personnel may segregate tires, large and bulky wooden wastes, and similar materials upon receipt at the landfill; however, this recycling activity is considered secondary to recycling at the transfer stations.

12.0 COMPOSTING

A compost program utilizing yard waste and biosolids is proposed for the Bayview Landfill. A plan of operations and permission to implement the compost operations has been submitted under separate cover. A copy of the Plan of Operations is included with this Permit Application as Appendix R.