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Phillips 66 WRB Refinery
Complex Trailer B, Room 212
Spur 119 North
Borger, TX 79008

October 21, 2020

Karen Scott
Industrial and Hazardous Waste Permits Section
Waste Permits Division, Mail Code 130
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, Texas 78711-3087

Re: Technical NOD 2 Response (Revised 10_2020) to Class 3 Permit Modification Application
Phillips 66, Borger Refinery
Hazardous Waste Permit No. 50078
EPA ID # TXD980626774
Solid Waste Registration No. 30111

Dear Ms. Scott:

Please see attached revised response to Item T6 (a) of the Technical NOD 2 letter issued by the TCEQ on August 11, 2020 and telephone conversation on October 7, 2020 regarding the Class 3 Permit Modification referenced above for the Phillips 66 Borger Refinery. This response includes a Technical NOD 2 Response Key, changed pages, and redline strikeout pages. Please replace the original pages submitted in the application dated August 2020 as summarized in the table below.

Changed Pages Key

Application Section	Replaced pages (replace August 2020 pages with pages dated October 2020)	Added pages
Section VII	Revised closure costs for NHP in Table VII.B. – page 125; also updated Table VII.E.1 to reflect changes in NHP closure costs.	
NHP Closure Plan	Complete NHP Closure Plan and Appendices replaced	

Ms. Karen Scott

Technical NOD 2 Response (Revised 10_2020) to Phillips 66 Class 3 Permit Modification

One original and three copies of the changed pages and signature pages have been provided, along with a redline/strikeout version identifying the changes. An electronic copy of the changed pages has been submitted to the TCEQ Region 1 office.

Please call me at 806-275-1817 or email at Spencer.Cave1@p66.com or contact Carson Christie, Remediation Management Program Manager for Phillips 66 at 806-275-2205 or email at Carson.L.Christie@p66.com if there are any questions regarding this response or if you need additional information to process the Permit Modification.

Sincerely,

A handwritten signature in blue ink, appearing to read "Sandy Keys", with a stylized flourish at the end.

Sandy Keys
Environmental Team Leader
Phillips 66, Borger Refinery

cc: Spencer Cave, Phillips 66, Borger Refinery
Carson Christie, Phillips 66 Remediation Management

Phillips 66 Response Key to Application Deficiencies – Technical NOD #2_Rev 10_2020

ID	App. Part	App. Section	Location	Citation	Error Type	Deficiency Description/Resolution	Phillips 66 Response to Comment
T6	B	VII	Application Tab – ATT B.VII.A.3, NHP Closure Plan	40 CFR 264.228; 264.310(a) & (b); 264.14(b); & Provision VII.E.	Incorrect/ Ambiguous	a) ORIGINAL DEFICIENCY: Increase the clay thickness to a minimum of 2 ft. for the closure of the North Holding Pond (NHP) as discussed during telephone conversation on 7/27/2020. CHANGED DEFICIENCY: As discussed during telephone conversation on 10/7/2020, revise submittal from August 2020 to include the composite GCL/CCL in the capping profile originally presented in the May 2020 submittal.	a) Revised text in ATT B.VII.A.3, NHP Closure Plan and attachments including drawings and Appendix A - Design Report (and associated CQA Plan, and HELP Modeling). Changes provided as redline as well as a complete replacement of the ATT B.VII.A.3, NHP Closure Plan. Revised cost estimate to reflect composite GCL/CCL in NHP Closure Plan and on Table VII.B page 125. Also updated Table VII.E.1 to reflect changes in NHP closure costs.

Signature Page

I, Darrel L. Hail, General Manager, Phillips 66 Company (Borger Refinery)
(Operator) (Title)

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 who manage the system, or those 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 there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature: Darrel L. Hail Date: 10-20-2020

To be completed by the Operator if the application is signed by an Authorized Representative for the Operator

I, _____, hereby designate _____
[Print or Type Name] [Print or Type Name]

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a Texas Water Code or Texas Solid Waste Disposal Act permit. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any permit which might be issued based upon this application.

Printed or Typed Name of Operator or Principal Executive Officer

Signature

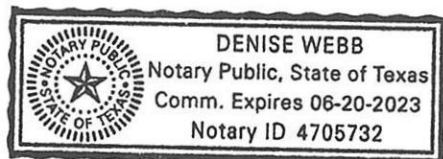
SUBSCRIBED AND SWORN to before me by the said

On this 20th day of October, 2020

My commission expires on the 20th day of June, 2023

Notary Public in and for Hutchinson County, Texas

[Note: Application Must Bear Signature & Seal of Notary Public]



Denise Webb

TABLE VII.B. - UNIT CLOSURE COST ESTIMATE (Continued)

Surface Impoundment 302		
Removal of Free Liquid		\$358,478
Stabilization of Waste		\$133,680
Backfill and Grading		\$1,322
Decontamination		\$5,999
Transportation		\$1,192,860
Treatment and Disposal		\$8,117,694
<i>Subtotal of Closure Costs</i>		<i>\$9,810,033</i>
Engineering Expenses (10%)		\$981,003
Certification of Closure		\$4,118
	subtotal	\$10,795,135
	Contingency (10% minimum)	\$1,079,515
	Cover Installation	\$403,913
	Total Unit Closure Cost	\$12,278,583 (2009)
	Total Unit Closure Cost	\$12,672,000 (2011)
	Total Unit Closure Cost	\$13,090,175 (2013)
	Total Unit Closure Cost	\$14,396,000 (2019)

Task	Cost
North Holding Pond	
Installation of Unclassified Fill	\$31,000
Installation of Clay layer	\$181,000
Installation of Geosynthetic Clay Liner	\$122,000
Installation of Geomembrane w drainage layer, engineered turf, and sand ballast	\$568,000
Installation of Storm Water Control	\$29,000
Decontamination	\$4,000
Subtotal of Closure Costs	\$935,000
Engineering Expenses (10%)	\$94,000
Survey Plat and Benchmark Installation	\$5,000
Certification of Closure	\$10,000
subtotal	\$1,044,000
Contingency (10% minimum)	\$104,000
Total Unit Closure Cost	\$1,224,000 (2019)

TOTAL PERMITTED FACILITY CLOSURE COST (all unit costs combined)	\$26,753,031 (2009)
	27,773,922 (2011)
	\$28,690,460 (2013)
	\$30,982,000 (2019)

TABLE VII.E.1. - PERMITTED UNIT CLOSURE COST SUMMARY

Closure Cost Estimate	
Unit	Cost
Hazardous Waste Landfill (Class I-H)	\$3,512,000
Surface Impoundment 301	\$11,850,000
Surface Impoundment 302	\$14,396,000
North Holding Pond	\$1,224,000
TOTAL EXISTING UNIT CLOSURE COST ESTIMATE	\$30,982,000 (2019) ¹

Proposed Unit Closure Cost Estimate	
Unit	Cost

¹As units are added or deleted from these tables through future permit amendments or modifications, the remaining itemized unit costs should be updated for inflation when re-calculating the revised total cost in current dollars.

Attachment B.VII.A.3 North Holding Pond Closure Plan

Table of Contents

1.0	Introduction	1-1
2.0	Closure Activities.....	2-1
3.0	Certification	3-1
4.0	Closure Schedule	4-1
5.0	Closure Cost Estimates.....	5-1

Table 1 – Unit Closure Cost Estimate

Figure B.VII.A.3-1 – Final Cover Design

Figure B.VII.A.3-2 – Cross-Section

Figure B.VII.A.3-3 – Details

Appendix A – Engineering Design Report

1.0 INTRODUCTION

This closure plan has been prepared to outline the steps that Phillips 66 (P66) will take to close the North Holding Pond Notice of Registration No. 036 (NOR#036), Hazardous Waste Permit No. 50078. This closure plan is prepared in accordance with federal (40 CFR §264 Subpart G, 264.310, and §264.113(d)) and state (30 TAC §335.174) requirements.

Phillips 66 Company (Phillips 66, CN604065912) operates the Borger Refinery (RN102495884), which is owned by a joint venture between Phillips 66 (P66) and Cenovus called WRB Refining LP (WRB, CN603215997). The mailing address to the facility is P.O. Box 271, Borger, Texas 79008-0271. The physical address for the facility is State Highway Spur 119 North, Borger, Texas 79007. P66 has been assigned a hazardous waste generator number by the U.S. Environmental Protection Agency (EPA) TXD980626774 and a Texas Commission on Environmental Quality (TCEQ) Solid Waste Notice of Registration Number 30111. Closure in accordance with this closure plan will begin within 180 days from receipt of the last known shipment of wastes at the North Holding Pond. Amendments to the plan may be proposed as a result of unexpected events that occur during closure and affect the ability of the closure plan to be implemented as designed.

The North Holding Pond is a 3.4-acre double-lined surface impoundment. It is a below-grade unit, constructed of 3 feet of compacted bentonite amended native soils with an overlying 100-mil HDPE liner. The North Holding Pond is in partial closure in accordance with the 1998 closure plan. The free liquid has been removed and the sludge has been stabilized. The impoundment is now being filled with non-hazardous waste. The partial closure permit modification was approved by TCEQ on April 21, 2004.

Closure of the North Holding Pond will generally consist of final grading to establish positive surface drainage and compaction followed by the installation of a clay and synthetic impermeable cover system to close the landfill.

2.0 CLOSURE ACTIVITIES

Closure certification for North Holding Pond (NOR #036) will be submitted to TCEQ upon completion of final closure activities in accordance with federal (40 CFR §264.115) and state (30 TAC §335.155) requirements.

A detailed engineering design report for the final cover system is included as Appendix A. The final cover system design is shown in Figure VII.A.3-1 and Figure VII.A.3-2 (previously presented in the 2001 permit modification). Figure VII.A.3-3 shows additional design details and the previously permitted final cover system. Closure activities are described below:

1. Waste will be covered with unclassified fill material as needed to achieve the desired grade and sloped appropriately. The fill will be placed using ordinary compaction techniques and compacted to 95% of maximum dry density and plus or minus three percent of optimum moisture content.
2. Final Cover System
 - a. The final cover system will be constructed in accordance with the CQA Plan (and Technical Specifications) included in Appendix A. The final cover system consists of the following:
 - i. A compacted clay liner (CCL) with a thickness of 1 foot and a permeability that is less than or equal to 1×10^{-7} centimeters per second (cm/sec) will be placed over the waste and/or fill material. The clay will have a plasticity index of greater than or equal to 15. A geosynthetic clay liner (GCL) with a permeability that is less than or equal to 5×10^{-9} cm/sec will be placed on top of the CCL.
 - ii. A 50-mil high density polyethylene (HDPE) or linear low-density polyethylene (LLDPE) geomembrane with an integrated drainage layer, will be placed over the GCL.
 - iii. A layer of engineered turf will be placed on top of the geomembrane's integrated drainage layer. The engineered turf will consist of synthetic blades of grass looped through two layers of 6-ounce woven geotextiles.
 - iv. A 0.5" layer of sand ballast will be incorporated on the surface of the engineered turf.
3. Stormwater run-on to the final cover system will be eliminated by the elevation of the final cover system over surrounding areas. Drainage patterns around the closure unit will be established to promote drainage away from the unit, by grading of surrounding soils. The slope of the final cover system will be a minimum of 2% and a maximum of 5%. The run-on control system will be capable of preventing flow onto the final cover system during peak discharge from at least a 100-year storm. The run-off control system will be capable of collecting and controlling the water volume resulting from a 24-hour, 100-year storm. Run-on and run-off collection and holding facilities will be managed weekly and after storms to

maintain design capacity of the system. Run-on and run-off will be managed to prevent eroding or otherwise damaging the final cover. The final cover will be inspected quarterly. A detailed stormwater analysis is included in Appendix A.

4. Areas outside the final cover system that are regraded or otherwise disturbed during closure activities will be seeded with native species.
5. Appropriate signs will be placed around the closed site.
6. Fencing will be maintained around the closed site.
7. Six brass benchmarks will be permanently mounted on concrete pads on the final cover system. The benchmarks will be spaced across the surface of the final cover system. The location and elevations of the benchmarks will be surveyed at the completion of construction activities, relative to the nearest existing survey monument. The location and elevation of the benchmarks will be surveyed annually to evaluate potential settlement during the post-closure period.
8. Hazardous wastes are not expected to be contacted during construction due to previous removal and stabilization measures, and subsequent placement of non-hazardous solid waste. In the event that hazardous wastes are encountered during construction, equipment that contacts hazardous waste will be decontaminated with high-pressure water. Wash water will be collected in the wash rack drainage system and pumped to the refinery's wastewater treatment system, or transported to a permitted off-site treatment or disposal facility. This decontamination will be conducted prior to placing the equipment in service in non-waste areas.

3.0 CERTIFICATION

A professional engineer licensed by the State of Texas, and a P66 representative, will certify that the North Holding Pond is closed in accordance with the approved closure plan. After closure activities are completed at the site, a report will be submitted to the TCEQ which includes the closure certification, a list of the maximum waste inventory, a description of the maximum extent of the final cover system footprint, a summary of the activities performed during closure, the results of tests or analyses performed, as-built drawings (including benchmarks), and a description of anticipated future land use as well as area topography reflecting as-built conditions.

A notation of the presence and location of waste disposed of in the NHP will be placed in the real property records of Hutchinson County, Texas when the unit is certified closed, in accordance with 40 CFR §264.116 requirements.

4.0 CLOSURE SCHEDULE

Provided that significant weather and/or contractor delays do not occur, closure activities for the North Holding Pond will be completed according to the following schedule:

1. Place unclassified fill	8 weeks
2. Construct final cover system	
Installation of CCL and GCL	6 weeks
Installation of geomembrane	4 weeks
Installation of engineered turf	2 weeks
Installation of sand ballast	1 week
3. Reshape Stormwater Run-on/Run-off Controls, Construct Fence	6 weeks
4. Set and Survey Benchmarks	4 weeks
5. Submittal of Closure Report and Certification	12 weeks

Total 43 weeks after the start of closure

5.0 CLOSURE COST ESTIMATES

Closure costs for the North Holding Pond are provided in Table 1. These closure costs were developed using a combination of EPA's preferred software, Costpro 6.0 and using 2019 cost estimates from material vendors and contractors. Estimates from Costpro are based upon 2007 unit costs; these costs were updated using standard inflation factors to give 2019 costs.

Tables/Figures/Drawings for North Holding Pond Closure Plan

Tables

Table 1 – Unit Closure Cost Estimate

Figures

Figure B.VII.A.3-1 – Final Cover Design

Figure B.VII.A.3-2 – Cross-Section

Figure B.VII.A.3-3 - Details

Drawings

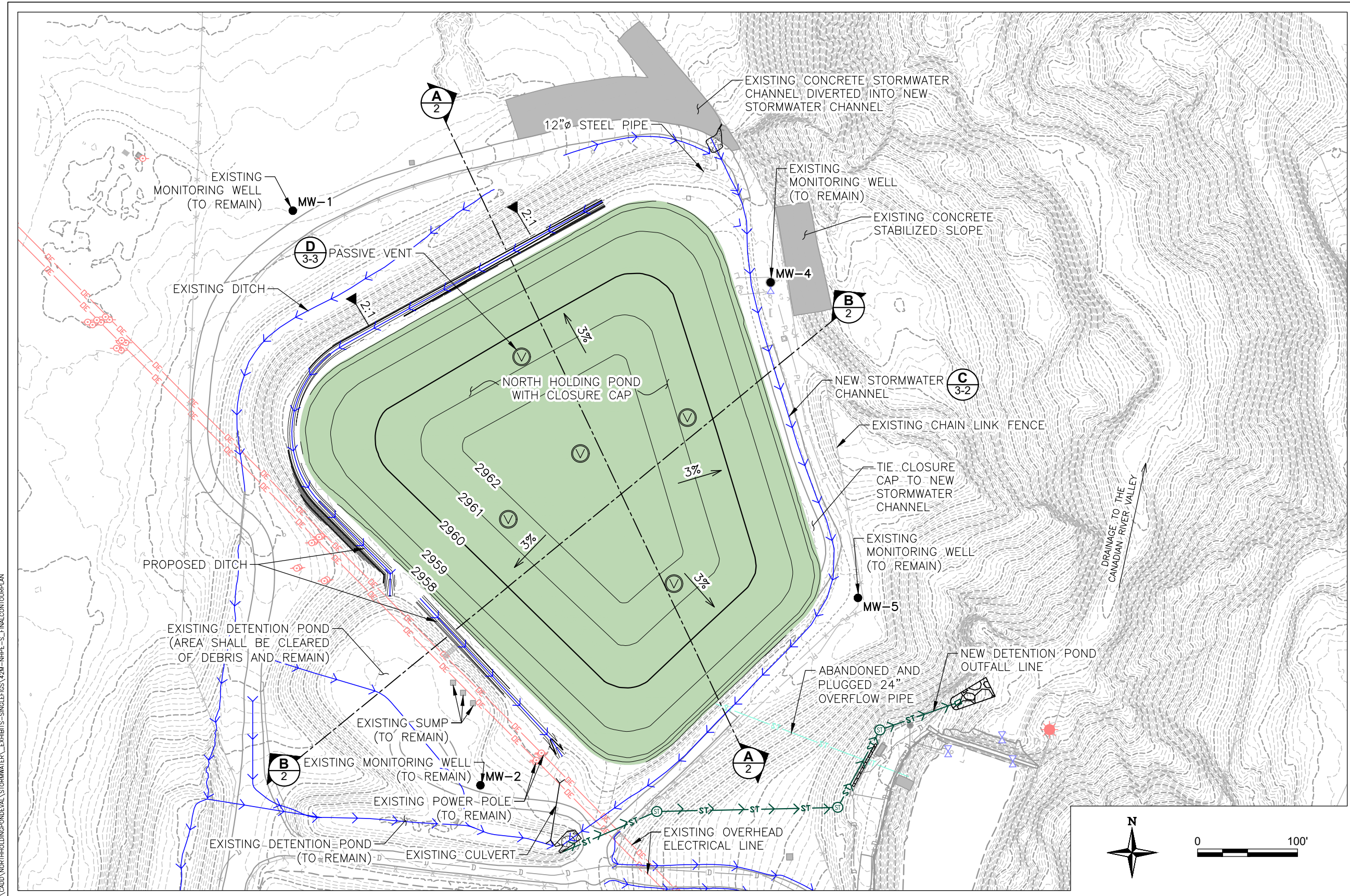
None

Table 1. Unit Closure Cost Estimate¹

Task	Cost
North Holding Pond	
Installation of Unclassified Fill	\$31,000
Installation of Clay layer	\$181,000
Installation of Geosynthetic Clay Liner	\$122,000
Installation of Geomembrane w drainage layer, engineered turf, and sand ballast	\$568,000
Installation of Storm Water Control	\$29,000
Decontamination	\$4,000
<i>Subtotal of Closure Costs</i>	<i>\$935,000</i>
Engineering Expenses (10%)	\$94,000
Survey Plat and Benchmark Installation	\$5,000
Certification of Closure	\$10,000
subtotal	\$1,044,000
Contingency (10% minimum)	\$104,000
Total Unit Closure Cost	\$1,224,000 (2019)

¹The cost basis for line items in the above table are based on a mixture of 2007 and 2019 costs; these items were adjusted to a common 2019 cost basis in the total closure cost.

MAJOR PROJECTS\BORGER REFINERY\CADD\NORTH HOLDING POND\STORMWATER\EXHIBITS\SINGLE PGS\221-NHPE-S_FINAL CONTOUR PLAN



NOTE:
CARE SHALL BE TAKEN DURING CONSTRUCTION NOT TO DISTURB ANY EXISTING MONITORING WELLS, SUMPS, AND FENCE.

CERTIFICATE OF ENGINEER

STATE OF TEXAS)
) SS:
COUNTY OF HUTCHINSON)

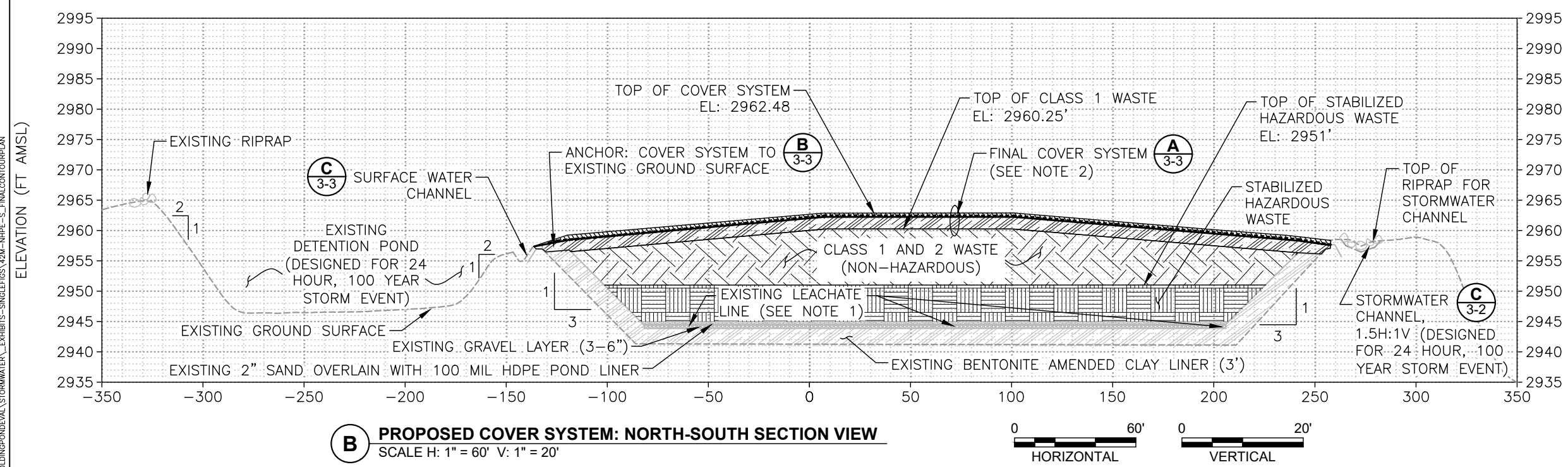
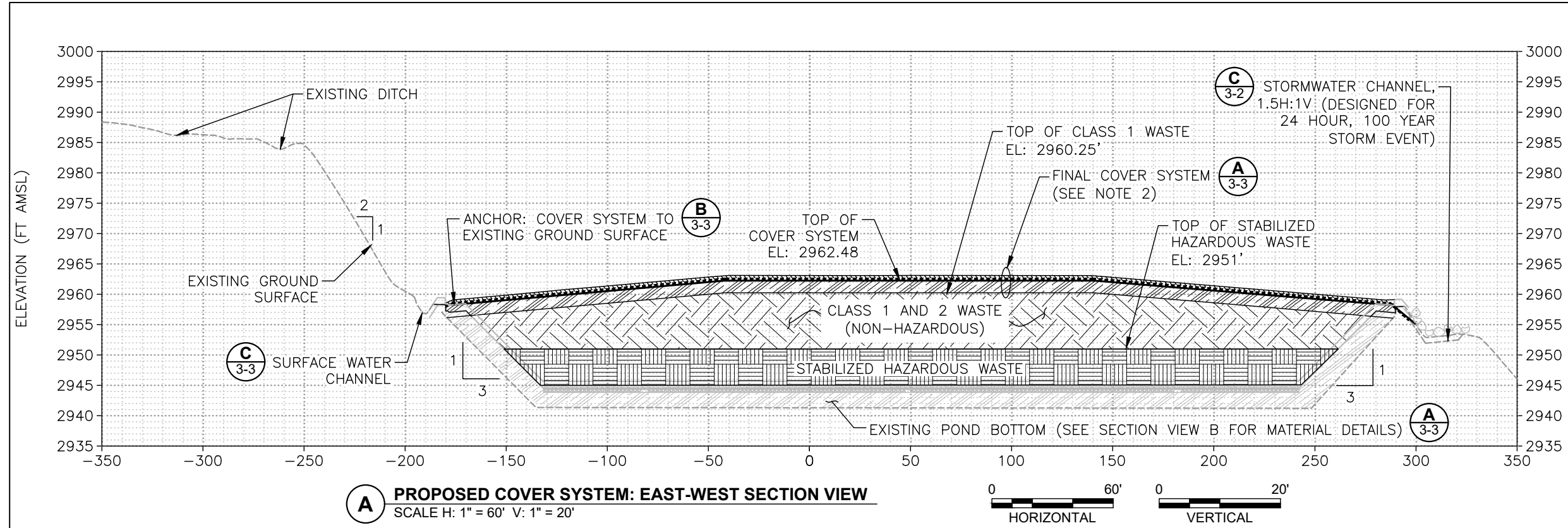
I, CAMERON TWING, HEREBY STATE TO THE BEST OF MY KNOWLEDGE AND UNDERSTANDING THAT THIS DESIGN AND ACCOMPANYING DRAWINGS HAVE BEEN PREPARED BY ME OR UNDER MY DIRECT SUPERVISION IN ACCORDANCE WITH STANDARD AND GENERALLY ACCEPTED ENGINEERING PRACTICES AND PROCEDURES IN EFFECT AT THE TIME.

TRIHYDRO CORPORATION:
TEXAS ENGINEERING FIRM F-131



NO.	REVISION	REV. BY	DATE	REFERENCE DRAWINGS:	ISSUED FOR: APPROVAL 10/14/2020	WRB Refining LP	NOTIF.#	WO NO.	WFA.#	MOC#	
		CHECKED	APPVD.								
4	ISSUE FOR APPROVAL	RJ	10/14/2020		DSN TH DWN RJ CHK CT APD		FIGURE B.VII.A.3-1 FINAL COVER DESIGN (IN-PLACE CLOSURE) NORTH HOLDING POND BORGER REFINERY BORGER, TX	CROSS REFERENCE:			
		CT									
2	ISSUE FOR APPROVAL	ST, CT	5/18/20					DOCUMENT #:			
		CT									
3	ISSUE FOR APPROVAL	RJ	8/25/2020								
		EB									

M:\OTDR\PHILLIPS66\PROJECTS\BORGER\REFINERY\CADD\NORTH HOLDING POND\WATER EXHIBITS\SINGLES\G5_V2M-NHPE-S_FINAL\CONTOUR PLAN



NOTES:

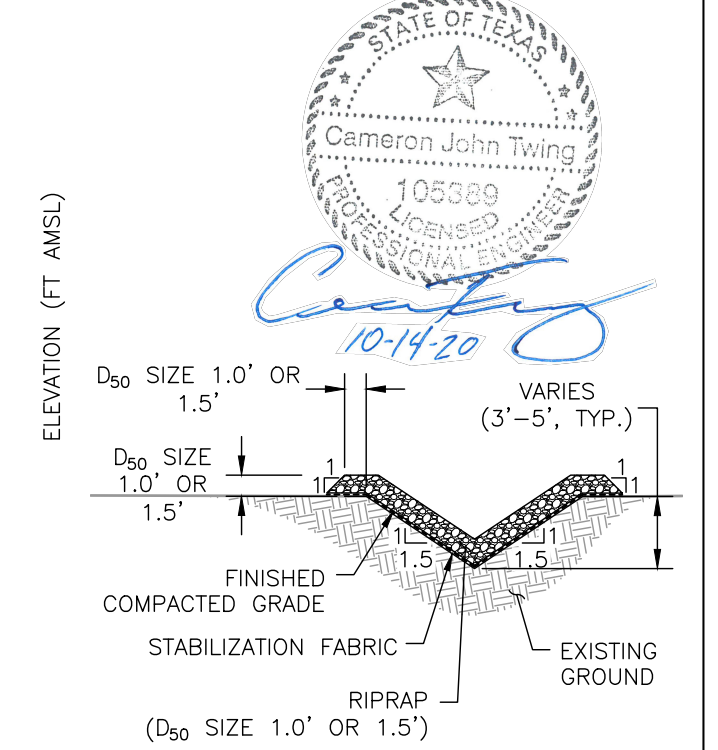
1. ORIGINALLY INSTALLED FOR LEAK DETECTION OF SURFACE IMPOUNDMENT. HAS FUNCTIONED AS LEACHATE COLLECTION SYSTEM SINCE PARTIAL CLOSURE IN 2005 AND CONVERSION TO A CLASS 1 AND 2 NON-HAZARDOUS WASTE LANDFILL.
2. UNCLASSIFIED FILL MATERIAL WILL BE USED AS NEEDED TO REACH DESIGN SUBGRADE ELEVATIONS. UNCLASSIFIED FILL THICKNESS WILL VARY DEPENDING ON THE TOP OF WASTE GRADE AND DESIGN SUBGRADE ELEVATIONS. UNCLASSIFIED FILL MATERIAL WILL BE OBTAINED FROM THE ON-SITE BORROW AREA AND WILL MEET THE PRODUCT REQUIREMENTS DESCRIBED IN SECTION 7.2.1 OF THE CONSTRUCTION QUALITY ASSURANCE PLAN.

CERTIFICATE OF ENGINEER

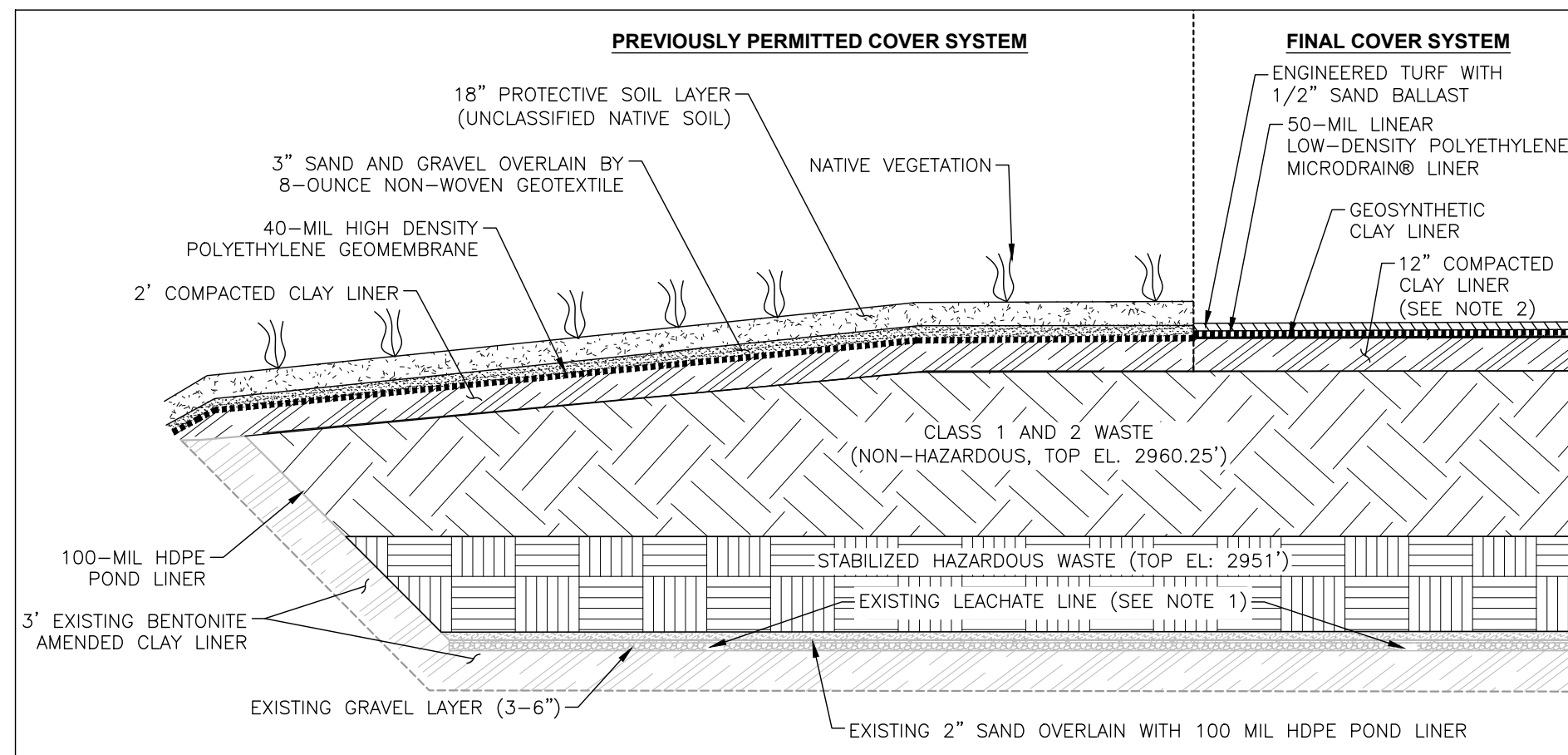
STATE OF TEXAS)
COUNTY OF HUTCHINSON) SS:

I, CAMERON TWING, HEREBY STATE TO THE BEST OF MY KNOWLEDGE AND UNDERSTANDING THAT THIS DESIGN AND ACCOMPANYING DRAWINGS HAVE BEEN PREPARED BY ME OR UNDER MY DIRECT SUPERVISION IN ACCORDANCE WITH STANDARD AND GENERALLY ACCEPTED ENGINEERING PRACTICES AND PROCEDURES IN EFFECT AT THE TIME.

TRIHYDRO CORPORATION:
TEXAS ENGINEERING FIRM F-131



NO.	REVISION	REV. BY	DATE	REFERENCE DRAWINGS:	ISSUED FOR:	WRB Refining LP	NOTIF.#	WO NO.	WFA.#	MOC#
4	ISSUE FOR APPROVAL	RJ	10/14/2020		APPROVAL					
2	ISSUE FOR APPROVAL	CT			10/14/2020					
2	ISSUE FOR APPROVAL	ST	5/18/20		DSN TH	FIGURE B.VII.A.3-2 CROSS SECTIONS				
3	ISSUE FOR APPROVAL	CT	5/18/20		DWN RJ	(IN-PLACE CLOSURE)				
		RJ	8/25/2020		CHK CT	NORTH HOLDING POND				
		EB			APD	BORGER REFINERY				
						BORGER, TX				



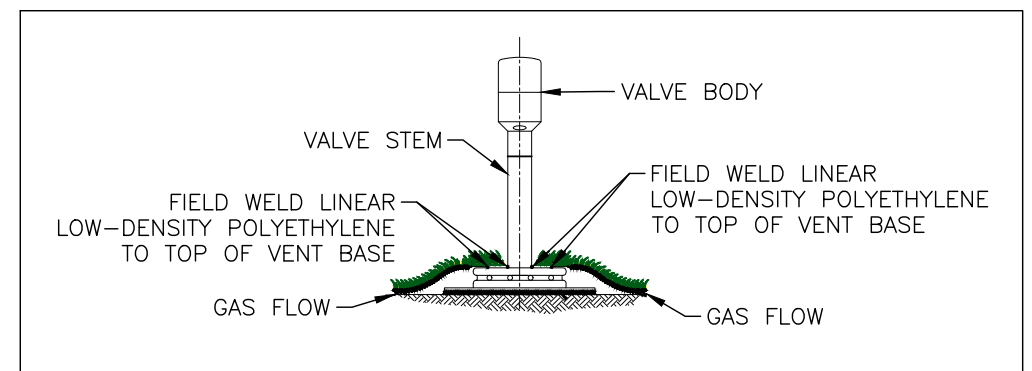
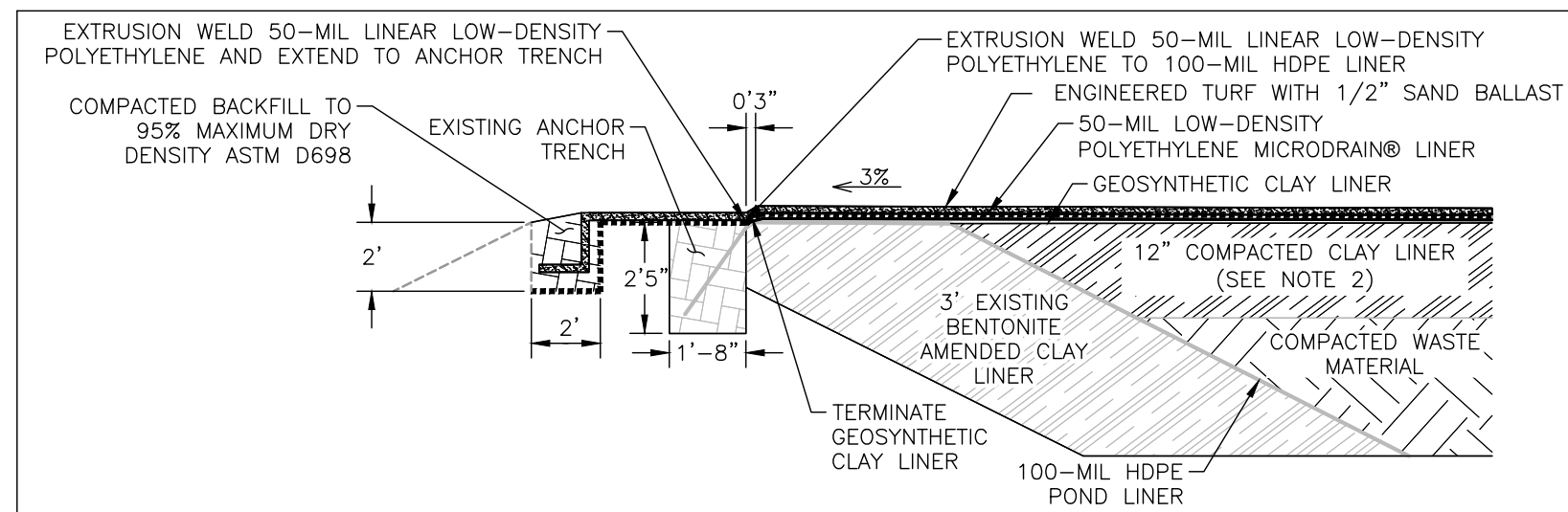
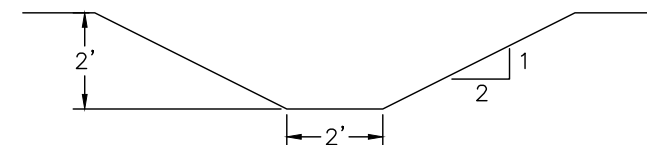
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CERTIFICATE OF ENGINEER

[illegible]

I, CAMERON TWING, HEREBY STATE TO THE BEST OF MY KNOWLEDGE AND UNDERSTANDING THAT THIS DESIGN AND ACCOMPANYING DRAWINGS HAVE BEEN PREPARED BY ME OR UNDER MY DIRECT SUPERVISION IN ACCORDANCE WITH STANDARD AND GENERALLY ACCEPTED ENGINEERING PRACTICES AND PROCEDURES IN EFFECT AT THE TIME.

TRIHEDRO CORPORATION:
TEXAS ENGINEERING FIRM F-131



NO.	REVISION	REV. BY	DATE	REFERENCE DRAWINGS:	ISSUED FOR: APPROVAL 10/14/2020	WRB Refining LP	NOTIF.#	WO NO.	WFA.#	MOC#	
		CHECKED	APPVD.								
1	ISSUE FOR APPROVAL	ST	5/18/2020				FIGURE B.VII.A.3-3 DETAILS (IN-PLACE CLOSURE) NORTH HOLDING POND BORGER REFINERYBORGER, TX	CROSS REFERENCE:			
		CT									
2	ISSUE FOR APPROVAL	RJ	8/25/2020		DSN TH			DOCUMENT #:			
		EB			DWN ST						
				CHK CT							
3	ISSUE FOR APPROVAL	RJ	10/14/2020	APD							
		EB									

Appendices to North Holding Pond Closure Plan

Appendix A – Engineering Design Report



CLOSURE PLAN MODIFICATION – DESIGN REPORT
NORTH HOLDING POND (PERMIT NO. HW-50078)
BORGER REFINERY, BORGER, TEXAS

October 15, 2020

Project #: 42M-002-008

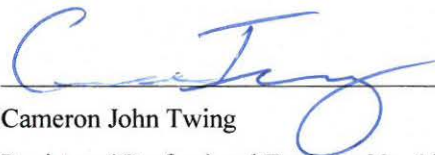
SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

ENGINEERING SOLUTIONS. ADVANCING BUSINESS.

CERTIFICATE OF ENGINEER

I certify that the Closure Plan Modification, which includes the Design Report, for the North Holding Pond Notice of Registration No. 036, Hazardous Waste Permit No. 50078 and associated structures was prepared by me or under my direct supervision with federal (40 CFR §264 Subpart G, 264.310) and state (30 TAC §335.174) requirements, and to the best of my knowledge is true and correct.

 10-15-20

Cameron John Twing

Registered Professional Engineer No. 105389

Trihydro Corporation #131



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- A. CONSTRUCTION QUALITY ASSURANCE PLAN
- B. HELP MODELING MEMO
- C. STORMWATER CALCULATIONS MEMO

1.0 INTRODUCTION

Phillips 66 Company (Phillips 66, CN604065912) operates the Borger Refinery (RN102495884), which is owned by a joint venture between Phillips 66 (P66) and Cenovus called WRB Refining LP (WRB, CN603215997). This engineering design report has been prepared to support the proposed final cover system design included in the Closure Plan, which outlines the steps that P66 will take to close the North Holding Pond (NHP), Notice of Registration No. 036 (NOR#036), Hazardous Waste Permit No. 50078. This engineering design report is prepared in accordance with federal (40 CFR §264 Subpart G, 264.310) and state (30 TAC §335.174) requirements.

2.0 BACKGROUND

The following general information is provided to describe the facility.

2.1 SITE OPERATING AND REGULATORY HISTORY

NHP was Registered in 1982 as Solid Waste Management Unit No. 36 under Texas Solid Waste Registration No. 30111, Hazardous Waste Permit HW-50078, EPA ID TXD980626774. The July 8, 2011 permit HW-50078 application, revised; June 13, 2013, June 28, 2013, December 10, 2013, April 9, 2014, and September 4, 2014; Modified (Class 1) revised on February 23, 2016, August 22, 2017, and October 11, 2017, and approved on October 25, 2017 [Tracking No. 21896851, RN102495884, CN604065912] authorizes the NHP Closure Plan (Section B.VII.A.3), Post Closure Care Plan (Section B.VII.C.1), and Engineering Report (Attachment B.V.D.2).

The NHP was constructed in the early 1980's as a 3.4-acre surface impoundment with a liner system consisting of 3-feet of bentonite amended clay, leak detection system, and 100-mil high-density polyethylene (HDPE) liner. The NHP's initial permitted waste capacity was 8.7 million gallons and was first put into service in 1982. The impoundment received oily sewer water from the Borger Refinery Drop Out Basins, Tank 3003, and Natural Gas Liquid (NGL) Wastewater System. These liquids were pumped to the Dixon Creek Surge Pond (now closed) prior to treatment at Dixon Creek wastewater treatment plant (WWTP) and discharge via Outfall 001. A Texas Commission on Environmental Quality (TCEQ) letter from 1992 acknowledged that P66 reported the NHP leak detection sumps were receiving liquids, indicating the HDPE liner had been breached. However, P66 maintains that the primary liner (the bentonite clay liner) has not been compromised, as indicated in approximately 25 years of groundwater monitoring. The leak detection sumps now essentially function as a leachate collection system.

The NHP was taken out of service in 1994 and replaced by the North Holding Tanks (Tanks 9600 and 9601), which receive the same oily sewer water. Between 1994 and 2004 the pond received no additional waste and the pond sediments were stabilized in place with a 15% Portland cement mixture. Phillips 66 received permit authorization from the TCEQ for a partial closure of the hazardous waste unit, allowing the available headspace remaining in the pond to be used for non-hazardous remediation related waste materials (mainly hydrocarbon impacted soils). A Class 2 permit modification application for Permit No. HW-50078 was submitted to the TCEQ on December 22, 2003 to seek approval to convert the NHP to a Class 1 and 2 non-hazardous waste landfill. The Class 2 permit modification was approved by the TCEQ on April 21, 2004 and the NHP was closed as a surface impoundment in accordance with 40 CFR 264.228(a)(1), 264.228(a)(2)(i), and 264.228(a)(2)(ii) and the approved Closure Plan in 2005. Following partial closure, Class 1 and 2 non-hazardous landfill operations began.

In November of 2016, P66 assessed potential design/construction issues relative to the closure of NHP. Alternative closure strategies were identified and then incorporated into a letter to Mr. Martin Torres of the TCEQ, *RE: Closure Plan Alternatives, North Holding Pond, WRB Borger Refinery, Phillips 66, Borger, TX, SWR No. 30111: EPA ID TXD980626774: CN603215997; RN 102495884; CP-50078*, dated February 1, 2017 (Phillips 66 2017a). The purpose of the letter was to provide an overview of the review findings and to provide a basis for discussion of possible modifications to the approved closure plan. On February 23, 2017 P66 and TCEQ met to discuss the possible modifications. The TCEQ responded in a letter to Mr. Ben Elliott on April 26, 2017 indicating that proposed alternatives to the NHP Closure Plan would require completion of a Class 3 permit modification in accordance with Texas Administrative Code (TAC) 335.69(k)J.3 (TCEQ 2017a).

A Class 1 permit modification was submitted to TCEQ on August 14, 2017 to meet requirements of the TAC for proposed maintenance activities that included (Phillips 66 2017b):

- Raising the elevation of the leachate collection system sump access
- Repairing tears on the exposed portion of the existing liner system at the banks of the NHP
- Repairing erosional features surrounding the permitted NHP area
- Removing out-of-service ancillary equipment associated with the historic NHP surface impoundment operations

On October 25, 2017, P66 received permit authorization from TCEQ (via Class 1a Modification to HW-50078, Attachment B.V.D.2) to carry out the proposed maintenance activities (TCEQ 2017b). P66 began the maintenance activities in 2017 and completed them in 2019.

On January 31, 2020 P66 submitted a Class 3 permit modification, which included a revised NHP closure plan, revised post closure plan, and supporting figures (Phillips 66 2020). On March 10, 2020 P66 received draft comments from TCEQ, which included a request for more information on the NHP final cover system. P66 and TCEQ met via a conference call on May 1, 2020 to discuss the requested information. The TCEQ formally submitted their comments to P66 on May 4, 2020. This design report has been prepared in response to the TCEQ comments from May 4, 2020 and the discussion held on May 1, 2020.

2.2 SITE CONDITIONS

NHP is operating as a Class 1 and 2 non-hazardous landfill. There is an estimated 1,034 cubic yards of capacity remaining in the unit until permitted waste grades are reached. P66 anticipates the landfill will reach capacity in 2022.

3.0 FINAL COVER SYSTEM

The following information is provided to describe the previously permitted final cover system (FCS) design and the proposed FCS design. The prepared FCS subgrade will be cleared of existing vegetation and soil stockpiles, remaining waste disposal/storage pits will be backfilled to match surrounding grades, and the existing surface profile will be compacted for acceptance of unclassified fill to reach design grades. The Closure Plan calls for placing unclassified fill material up to the desired grade using ordinary compaction techniques and compacted to 95% of maximum dry density and plus or minus three percent moisture content. The unclassified fill material will be graded to form a mound in the center of the impoundment footprint, sloped at 2-5% toward the perimeter, and then covered with a FCS as shown in Figure B.VII.A.3-2. Materials will be placed in accordance with the Construction Quality Assurance (CQA) plan and Engineering Specifications (Appendix A).

3.1 PREVIOUSLY PERMITTED FINAL COVER SYSTEM

The previously permitted FCS constitutes a traditional Resource Conservation Recovery Act (RCRA) Subtitle C (Hazardous Waste) FCS, which is designed to provide a low permeability barrier to prevent water infiltration; promote run-off; and, stabilize the surface. The previously permitted FCS includes the following as shown in Figure B.VII.A.3-3 (from top to bottom):

- 1.5-ft topsoil layer
- Non-woven geotextile
- 3-inch (in) sand or gravel layer (or geonet)
- 40-mil polyethylene membrane
- 2-foot (ft) compacted clay with a permeability of $\leq 1 \times 10^{-7}$ centimeters per second (cm/sec)
- Prepared subgrade

3.2 PROPOSED FINAL COVER SYSTEM

The proposed FCS was selected to improve constructability, short term effectiveness, and long-term reliability. The proposed FCS was designed to improve surface water runoff and provide a lower permeability barrier to water infiltration in comparison to the previously permitted FCS. Also, the proposed FCS will provide immediate stabilization of the surface. The proposed FCS will be constructed over any routine or intermediate cover already in place and include the following as shown in Figure B.VII.A.3-3 (from top to bottom):

- Engineered synthetic turf woven into two 6-ounce woven geotextiles, with ½” sand ballast (ClosureTurf®)
- MicroDrain® barrier layer (50-mil linear low-density polyethylene (LLDPE), with drainage studs on top side, and MicroSpike® on bottom side)
- Geosynthetic clay liner (GCL) with a permeability of $\leq 1 \times 10^{-9}$ cm/sec 1-ft compacted clay with a permeability of $< 1 \times 10^{-7}$ cm/sec
- Prepared subgrade including unclassified fill as described in Section 7.0 of the CQA Plan (Appendix A)

The semi-arid climate and the FCS are expected to reduce the potential for infiltration of precipitation, degradation of waste, and generation of leachate. In addition, the types of wastes in place in the unit will result in relatively low landfill gas generation rates. As a protective measure, a minimum of four passive gas vents will be installed to collect any gasses that accumulate below the geomembrane barrier layer. Based on the performance factors noted above, degradation and settlement of waste is not expected to be significant and does not warrant additional stability design or construction measures.

3.3 REGULATORY REQUIREMENTS

The FCS must meet the requirements described in 40 CFR Part 264, Subpart K. Specifically, the FCS must meet the requirements of 40 CFR 264.228(a)(2)(iii), also in 30 Texas Administrative Code (TAC) 335.169(a)(2) listed below.

- (iii) Cover the surface impoundment with a final cover designed and constructed to:
 - (A) Provide long-term minimization of the migration of liquids through the closed impoundment; 264.228(a)(2)(iii)(A)
 - (B) Function with minimum maintenance; 264.228(a)(2)(iii)(B)
 - (C) Promote drainage and minimize erosion or abrasion of the final cover; 264.228(a)(2)(iii)(C)
 - (D) Accommodate settling and subsidence so that the cover’s integrity is maintained; and 264.228(a)(2)(iii)(D)
 - (E) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present. 264.228(a)(2)(iii)(E)

The analysis considered to demonstrate the FCS is designed in a manner to meet the regulatory requirements listed above is discussed in the following section.

4.0 FINAL COVER SYSTEM DESIGN

The following sections provide comparisons between the previously permitted FCS and the proposed FCS and demonstrate how the proposed FCS meets the regulatory requirements from Section 3.3.

4.1 FINAL COVER SYSTEM PERFORMANCE AND EQUIVALENCY DEMONSTRATION

The previously permitted FCS and Proposed FCS were modeled using the Hydrologic Evaluation of Landfill Performance (HELP) software, which is a standard analysis tool for landfill design. The HELP model demonstrates that the proposed FCS performed superior to the previously permitted FCS with average annual percolation of 0.00000 inches versus 0.00006 inches through the barrier layer, respectively. The lower annual average percolation of the proposed FCS demonstrates its performance will exceed or is equivalent to the previously permitted FCS. Detailed model inputs and results are described in Appendix B.

4.2 FINAL COVER EROSION AND PROTECTION

The FCS drainage component and conveyance channels were designed to provide adequate stormwater capacity for a 24 hour, 100-year storm. Most of the precipitation that falls on the site is expected to be managed as surface water run-off. In 2018, P66 designed and installed a stormwater diversion channel around the east side of NHP to route surface water run-on around the NHP to a stabilized discharge (Figures B.VII.A.3-1, B.VII.A.3-2). Additionally, the stormwater channel has the capacity to convey surface water run-off from the NHP once the final cover system is in place. The stormwater channel typical section is shown on Figure B.VII.A.3-2. Several ditch sections will be graded around the west side of the NHP during final closure activities to convey the remaining run-on and run-off away from the FCS (Figures B.VII.A.3-1, B.VII.A.3-2). A typical section is shown on Figure B.VII.A.3-3. Detailed design calculations for the stormwater capacity are included in Appendix C.

4.3 FINAL COVER SYSTEM STABILITY

During hazardous waste stabilization activities completed in 2005 waste materials were mixed with Portland Type I cement, typically 25% by weight. Stabilized waste materials were required to have a minimum Unconfined Compressive Strength (UCS) of not less than 20 pounds per square inch (psi) at 7 days, in accordance with ASTM D2166 (Weston Solutions 2005). The stabilized hazardous waste is unlikely to be significantly further compressed by placement of the FCS.

Since 2005, non-hazardous waste has periodically been placed and graded in NHP. Construction techniques associated with placing waste materials in NHP was generally to compact soils to 80 to 90 percent of the maximum dry density.

Placement and grading of additional waste and fill materials will add weight at the surface and further consolidate the underlying soils. Additionally, storm events from 2005 to 2020 have periodically inundated the NHP. The saturation of the surface and the ponding of water in the area resulted in consolidation of the soils in NHP.

Based on field observation and a review of historic soil testing data at the refinery and the soil index properties in the greater Borger area, it is highly unlikely that soils with shrink/swell related movements would have been deposited in NHP (Phillips 66 1994). Low to Medium plasticity clay, Plasticity Indices between 10 and 15 have been encountered in the general area, but it is more likely that granular soils that are evident throughout the refinery were likely placed in NHP which have very low potential for movement based on the deposition, waste placement techniques, and the fact that granular soil density increases when fine soil particles are placed and then inundated with stormwater.

The previously permitted FCS thickness is approximately 3.75-feet, while the proposed FCS thickness is approximately 13-inches. The reduced proposed FCS profile and associated load will reduce settlement as a result of consolidation of the waste mass. Settlement areas, if they occur, under the proposed FCS will be readily identifiable through visual inspections and easily repaired. Identification of settlement issues associated with final cover systems similar to the previously permitted FCS may not be as readily identifiable as the soil covered geomembrane will bridge areas experiencing differential settlement.

4.4 FINAL COVER SYSTEM MAINTENANCE

Many typical maintenance activities required for the previously permitted FCS would not be necessary for the proposed FCS including mowing, erosion control, reseeding, fertilizing, and major storm repair. For the previously permitted FCS, a soil loss rate of 0.24 ton/acre/year was calculated using the National Resource Conservation Service (NRCS) Revised Universal Soil Loss Equation (RUSLE), Version 2.5.2.11 modeling software (RUSLE2) (Trihydro 2017). The memorandum describing the RUSLE2 modeling results was included in the letter from P66 to Martin Torres dated February 1, 2017 (P66 2017a). The proposed FCS would require sand ballast replacement at a rate of approximately 2% every 5 years according to Watershed Geo, manufacturer of ClosureTurf®. The reduction in activity and equipment on the FCS necessary for soil replacement reduces the chances of equipment damaging the FCS.

The most critical component of ClosureTurf® relative to UV degradation appears to be the exposed HDPE grass blades (Geosyntec 2015). Geosyntec demonstrated that a conservative half-life (synthetic turf grass blades lose 50% of their manufactured tensile strength) of the HDPE grass blades will be on the order of 100 years (Geosyntec 2015). The half-life has a factor of safety of about 2.8 to 4.0 when considering the tensile capacity performance requirements of the HDPE grass blades (Geosyntec 2015). Annual sampling for tensile strength in accordance with ASTM D2256 of the

HDPE grass blades was included in the Post-Closure Plan to verify integrity of the material throughout the post-closure period. A one-time turf replacement cost was also added to the Post-Closure Plan and cost estimate in the event that the synthetic turf loses 50% or more of its tensile strength through the post-closure period.

Wind tunnel testing was performed by Georgia Tech Research Institute (GTRI) to evaluate the required amount of sand ballast for various environmental conditions. The geotextile turf layer of ClosureTurf® is designed to be installed on top of the geomembrane and to remain in place without an anchoring system linking it to the geomembrane below (GTRI 2010). Rather, it relies on the interface friction and sand ballast added on top of the turf to ensure that it remains in place (GTRI 2010). The highest 2-minute wind speed recorded at the Hutchinson County Airport was 55.9 mph in 2013 according to available wind speed data from the National Oceanic and Atmospheric Administration (NOAA) (NOAA 2020). The highest 5-second wind speed recorded at the Hutchinson County Airport was 94 mph in 2013 (NOAA 2020). Data were available for 1999 to 2019. The wind tunnel testing conducted by GTRI demonstrated that the proposed FCS could sustain wind speeds up to 174 miles per hour, significantly higher than historical sustained and peak wind speeds near the NHP.

4.5 FINAL COVER SYSTEM CONSTRUCTION QUALITY ASSURANCE

The FCS is considered to be an engineered containment system as it includes a synthetic geomembrane barrier layer. A CQA plan is provided in Appendix A, with specifications included within. Contract documents, general requirements, and specifications will be prepared and compiled during the bidding phase of the project, prior to construction.

5.0 REFERENCES

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APPENDIX A

CONSTRUCTION QUALITY ASSURANCE PLAN



**CONSTRUCTION QUALITY ASSURANCE PLAN
PHILLIPS 66 NORTH HOLDING POND CLOSURE
BORGER, TEXAS
PERMIT NO. HW-50078**

October 15, 2020

Project #: 42M-002-008

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

ENGINEERING SOLUTIONS. ADVANCING BUSINESS.

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A. TECHNICAL SPECIFICATIONS

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

Phillips 66 Company (Phillips 66, CN604065912) operates the Borger Refinery (RN102495884), which is owned by a joint venture between Phillips 66 (P66) and Cenovus called WRB Refining LP (WRB, CN603215997). The North Holding Pond (NHP) is a 3.4-acre surface impoundment with a liner system consisting of 3-feet of bentonite amended clay, leak detection system, and 100-mil high-density polyethylene (HDPE) liner. The NHP is in partial closure in accordance with the 1998 closure plan. The free liquid has been removed and the sludge has been stabilized. The impoundment is now being filled with non-hazardous waste. The partial closure permit modification was approved by the Texas Commission of Environmental Quality (TCEQ) on April 21, 2004.

The NHP is nearing its permitted waste capacity, thus P66 is planning to close the NHP as required under TCEQ Permit Number HW-50078.

Closure construction will consist of placing unclassified fill; preparing a subgrade for the final cover liner system; constructing a composite liner system consisting of 12 inches of compacted soil liner and a Geosynthetic Clay Liner (GCL) for the barrier layer; a geomembrane barrier with an integrated drainage layer; and, a engineered synthetic turf with sand ballast (ClosureTurf®).

1.2 PURPOSE

The purpose of this Construction Quality Assurance (CQA) Plan is to provide a detailed guidance document for systematic and thorough CQA verification procedures which will typically be implemented during construction of the NHP final closure. This plan provides general and specific requirements of the overall CQA program to verify and document that construction is in substantial compliance with the contract documents and the design intent.

Requirements of the CQA program include the following:

1. Review of product submittals to verify construction materials are in compliance with the technical specifications.
2. Product quality assurance verification testing to verify all construction materials are in compliance with the technical specifications.
3. Construction monitoring and documentation to verify each unit of construction is in compliance with the technical specifications and construction was executed correctly using industry standard construction methods and the proper materials.

4. Construction verification testing to verify each installed or constructed unit of the closure system is in compliance with the technical specifications.
5. CQA documentation consisting of daily summary reports, CQA field logs, testing forms and reports, installation logs, document control binders, material control logs, photographic documentation, technical revisions, design modifications, as-built record drawings, and corrective action determination and verification reports.
6. Preparation of the final certification report that documents the CQA program implemented during construction and that landfill construction was completed in compliance with the contract documents and the design intent. The final Soil Liner Evaluation Report (SLER) and Geomembrane Liner Evaluation Report (GLER) will be submitted to the TCEQ at the completion of construction.

1.3 PROJECT ORGANIZATION

1.3.1 OWNER

The owner is P66 and is responsible for communicating with the CQA Organization and the TCEQ. The owner will request assistance from the CQA Organization and design engineer to resolve technical or regulatory issues during construction. The Owner is responsible for complying with TCEQ regulatory requirements.

1.3.2 DESIGN ENGINEER

The design engineer is responsible for landfill design and site engineering related to the design. Site engineering includes; 1) review and approval of product and construction submittals required by the contract documents, 2) technical issues related to construction, 3) interpretation of the technical specifications and the construction drawings, and 4) design modifications and technical revisions to the contract documents.

1.3.3 CQA CERTIFYING ENGINEER

The CQA Certifying Engineer is responsible for certifying to the Owner and the TCEQ that landfill construction is in compliance with the contract documents and the design intent. Specific responsibilities of the certifying engineer include; 1) providing a professional engineer registered in the State of Texas, 2) verification that all CQA procedures are correctly and completely implemented, 3) review of all CQA documentation, and 4) preparation of the SLER and GLER report.

1.3.4 CQA ORGANIZATION

The CQA Organization is the firm responsible for the overall construction quality assurance of the project.

1.3.5 GENERAL CONTRACTOR

The general contractor will be responsible for overall performance of the work in accordance with the contract documents and as shown on the construction drawings.

1.4 CQA PLAN FORMAT

This CQA Plan format organizes all necessary CQA verification procedures for each unit of construction, as defined by the technical specifications, into individually complete sections. This plan is presented as follows:

1. Sections 1.0 through 6.0 presents general information about the construction project and the general requirements of the CQA program.
2. Sections 7.0 through 13.0 includes written instructions and directions for the CQA Organization and provides detailed and specific CQA procedures to be implemented for each unit of closure construction as it relates to site work.

2.0 GENERAL REQUIREMENTS

2.1 SECTION SUMMARY

General requirements of the CQA program include:

1. Product quality assurance verification testing
2. Construction monitoring
3. Construction verification testing
4. Project meetings
5. Submittal review
6. Documentation

2.2 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

Products and material sources will be sampled and tested to verify compliance with the technical specifications.

Testing requirements, methods and sampling frequencies are specified for each work element described in this plan.

All material samples will be recorded into appropriate Testing Control Logs, assigned sample numbers, and processed by the CQA Organization for either on-site or off-site testing.

Testing Control Logs document the following:

1. Sample numbers
2. Product or material types
3. Required testing
4. Sampling locations and dates
5. Testing completion dates
6. Brief summary of the testing results

Each material sampled and tested will be archived on site for a period of one year. Archived samples will be stored and sealed in plastic containers tagged with:

1. Sample number
2. Product or material type

3. Project name and number
4. Date for discarding the sample

The following products or materials require quality assurance verification testing.

1. Earth fill for unclassified fill
2. Liner system subgrade
3. Low-permeability compacted soil liner
4. Geosynthetic clay liner (GCL)
5. Structured geomembrane barrier and drainage layer
6. ClosureTurf® synthetic turf
7. Sand ballast layer

A recommended schedule of testing frequencies is discussed in later sections of this plan.

2.3 CONSTRUCTION MONITORING

The closure will be monitored and documented to verify compliance with the technical specifications and that construction was executed correctly using industry standard construction methods and the proper materials. Monitoring guidelines and procedures are specified for each work element section in this plan.

2.4 CONSTRUCTION VERIFICATION TESTING

Construction verification testing will be performed on installed or constructed components of the final cover system to verify compliance with the technical specifications. Construction verification testing will be performed by either the Contractor or the CQA Organization, as required by this plan. Construction verification testing includes the following:

1. Permeability of fine-grained soils.
2. Nuclear density and moisture content of in-place unclassified fill and soil liner.
3. In-place density by the drive-cylinder method to verify nuclear density/moisture testing gauge (densometer) is providing accurate results.
4. Geomembrane seam analysis.
5. Air pressure testing of fusion welded geomembrane seams.

6. Vacuum testing of extrusion welded geomembrane seams and repairs.
7. Sand ballast material classification and gradation.

A recommended schedule of testing frequencies is discussed later in this plan.

2.5 PROJECT MEETINGS

Project meetings will be held in accordance with Section 4.0 of this CQA Plan.

2.6 SUBMITTAL REVIEW

Submittal review will be completed in accordance with Section 5.0 of this CQA Plan.

2.7 DOCUMENTATION

Documentation will be completed in accordance with Section 6.0 of this CQA Plan.

3.0 REFERENCES

3.1 SECTION SUMMARY

Section 3.1 provides an overview of the following references:

1. Project reference documents
2. Industry standards and technical reference documents
3. Soils testing standards and methods
4. Standard Operating Procedures (SOP) for soils testing
5. Geosynthetics testing standards and methods

3.2 PROJECT REFERENCE DOCUMENTS

The project manual and construction drawings provide background, design, and contractual information, and are used in conjunction with this CQA Plan.

3.3 INDUSTRY STANDARDS AND TECHNICAL REFERENCE DOCUMENTS

The following industry standards and technical reference documents were used in the preparation of this CQA Plan.

1. ASTM Standards and Other Specifications and Test Methods on the Quality Assurance of Landfill Liner Systems. American Society for Testing and Materials. 1994.
2. EPA Technical Guidance Document, Quality Assurance and Quality Control for Waste Containment Facilities. United States Environmental Protection Agency. 1993.
3. Standard Specifications for Transportation Materials and Methods of Sampling and Testing. American Association of State Highway and Transportation Officials (AASHTO). 1987.

3.4 SOILS TESTING STANDARDS AND METHODS

Soils testing standards and methods which apply as referenced in the technical specifications and this CQA Plan are provided in Table 1.

3.5 STANDARD OPERATING PROCEDURES FOR SOILS TESTING

The CQA Organization will perform soils testing on site during construction. The CQA Organization, or their laboratory subconsultant's, Standard Operating Procedures (SOP) for soils testing will be maintained on-site for reference and written direction.

3.6 GEOSYNTHETICS TESTING STANDARDS AND METHODS

Geosynthetics testing standards and methods listed in Table 2 apply as referenced in this CQA Plan.

4.0 PROJECT MEETINGS

4.1 SECTION SUMMARY

Communication and coordination between the Owner, Design Engineer, Contractor, and CQA Organization are important to achieve quality construction. To establish successful communications, coordination, and an overall environment of teamwork, a series of project meetings will be held. The meetings will be administered by the Owner, Design Engineer, or CQA Organization to 1) clearly define responsibility and authority of each organization involved in the project, 2) resolve communication problems, misunderstandings, and misinterpretations, 3) find solutions to unanticipated developments, and 4) to identify, prevent and correct problems and deficiencies that may occur during the construction process. Project meetings include the following:

1. Pre-construction Meeting
2. Progress Meetings
3. Preparatory Meetings

4.2 PRECONSTRUCTION MEETING

The Owner will schedule the pre-construction meeting after the construction contract is awarded and the major subcontractors and material suppliers have been established. The CQA objectives of this meeting are to 1) clearly define the roles, responsibility and authority of each organization and individual involved in the project, 2) review details of the CQA program and expectations, and 3) establish a foundation of cooperation to achieve quality construction. The CQA Organization will address the following agenda:

1. Distribution of this CQA Plan
2. Introduction, role, authority, and responsibilities of each organization and individual involved in the project
3. Establish lines of communications
4. Design review in coordination with the Design Engineer
5. Construction schedule
6. Contractor's QC procedures and responsibilities
7. Submittal review and approval procedures
8. Non-conformance and corrective action procedures
9. Construction restrictions due to weather conditions
10. Weekly progress and preparatory meetings

Meeting minutes and items for resolution will be recorded by the Owner's Representative and distributed to all parties in attendance.

The following representatives from each organization are required to attend the pre-construction meeting.

1. Owner's Project Manager
2. Design Engineer
3. Contractor's Project Manager and on-site Superintendent
4. CQA Organization's CQA Officer
5. Representatives from the local and state regulatory agencies are encouraged to attend the meeting

4.3 PROGRESS MEETINGS

The Owner will schedule and administer weekly (or other period) progress meetings. The CQA objectives of these meetings are to 1) maintain lines of communication, 2) review procedures and results of the CQA program, and 3) maintain and improve the established foundation of cooperation to achieve quality construction. The CQA Organization will address the following agenda:

1. Review minutes relevant to CQA of previous progress meeting
2. Review work progress
3. Review and update construction schedule. Obtain projected schedule for the next 2 weeks from Contractor
4. CQA and QC related field observations, problems, decisions, and conflicts
5. Presentation of CQA verification testing results
6. Review and up-date Submittal Log in coordination with the Design Engineer and Contractor
7. Coordination of projected work progress
8. Maintenance of quality and work standards
9. Acknowledgments and recognition of quality construction practices and QC procedures

Meeting minutes and items for resolution will be recorded by the Owner and distributed to all parties in attendance. The following representatives from each organization are required to attend the weekly progress meetings:

1. Owner's Project Manager
2. Design Engineer
3. Contractor's on-site Superintendent
4. CQA Organization's CQA Manager

4.4 PREPARATORY MEETINGS

In coordination with the Design Engineer, the CQA Organization will schedule and hold informal preparatory meetings prior to the following units of construction:

1. Embankment operations
2. Landfill subgrade preparation
3. Low-perm soil liner construction and/or geosynthetic clay liner installation
4. Geomembrane installation
5. ClosureTurf® installation
6. Sand ballast installation
7. Perimeter stormwater control structure construction
8. Anchor trench construction

The CQA objective of these preparatory meetings is to establish a thorough understanding of the upcoming unit of construction and of the CQA procedures and testing that will be implemented during construction. To achieve this objective, the CQA Organization's CQA Officer will address the following agenda:

1. Review materials needed for the work and the product section of the technical specifications
2. Review the construction requirements section of the technical specifications
3. Review construction staking and grade control staking needed to complete the work
4. Review test records and Contractor's quality control test procedures
5. CQA test procedures
6. Review required submittals
7. Coordination, scheduling, and sequencing of the work
8. Equipment and manpower

Meeting minutes will be recorded by the CQA Organization and distributed to the Owner and all parties in attendance.

The following representatives from each organization are required to attend the preparatory meetings.

1. Contractor's on-site Superintendent
2. Subcontractors as appropriate to the work
3. CQA Organization's CQA Officer and CQA Monitor(s)

5.0 SUBMITTALS

5.1 SECTION SUMMARY

This section describes methods and procedures required during the submittal review process for the following:

1. Submittal Control Log
2. Submittal review procedures

5.2 SUBMITTAL CONTROL LOG

A Submittal Control Log will be prepared by the CQA Organization that will list all submittals required by the technical specifications. The Submittal Control Log will be issued to the Contractor and will be maintained by the CQA Organization in coordination with the Contractor and Design Engineer during construction. The control log documents:

1. Submittal numbers
2. Referenced specification sections
3. Submittal descriptions
4. Received dates
5. Reviewer
6. Action taken determinations
7. Return dates

5.3 SUBMITTAL REVIEW PROCEDURES

Two copies of each submittal listed in the Submittal Control Log or, if mutually approved, an electronic submittal will be submitted by the Contractor in accordance with the technical specifications. The submittals will be forwarded to the Design Engineer for review. The CQA Organization may perform a preliminary review of submittals for compliance with the technical specifications and issue a verbal Approval for Use at the recommendation of the Design Engineer. The CQA Organization will notify the Design Engineer that no corrective action determinations were required prior to issuing a verbal Approval for Use. All submittals not in compliance with the technical specifications must be immediately forwarded to the Design Engineer for review and corrective action determinations.

At the completion of the review process the Design Engineer will stamp both copies of each submittal with Action Taken determinations. The Action Taken determinations and the return dates will be recorded on the Submittal Control Log. One copy of the reviewed submittal will be returned to the Contractor, one copy will be archived in the submittal documentation control binder.

The CQA Organization will review and up-date the Submittal Control Log in coordination with the Contractor and Design Engineer at the weekly progress meetings.

The CQA Organization will inspect materials delivered to the site to verify these materials are the same as what was approved in the submittal process. When material is delivered it will be placed in administrative hold until inspected and approved for use by the CQA Organization. Material different than what was included in the submittal process will subject to corrective action, as discussed in Section 6.6.

6.0 DOCUMENTATION

6.1 SECTION SUMMARY

This section of the CQA Plan summarizes the following documentation required during the project:

1. Daily summary reports
2. CQA field logs
3. Construction and testing forms
4. Testing reports
5. Corrective action determination and verification reports
6. As-built record drawings
7. Photographic documentation
8. Documentation control
9. Final certification report
10. Documentation archive storage

6.2 DAILY SUMMARY REPORTS

A computer generated summary report will be prepared daily by the CQA Organization. This report will summarize all construction activities, CQA verification procedures, CQA testing, and QC testing completed during the day. The daily summary report will contain the following information:

1. Title block containing; 1) project name, 2) project number, 3) project location, 4) Owner, 5) date, and 6) summary report number.
2. Description of weather conditions including low and high temperature readings, cloud cover, and precipitation.
3. Summary of the day's on-going construction activities for each unit of construction. This summary will also include equipment, personnel, and subcontractors utilized for each unit of construction and identification of areas in which the construction is taking place.
4. Summary of CQA verification procedures implemented during the day's construction for each unit of construction. This summary will include construction monitoring, construction verification testing, and quality control procedures.

5. Summary of CQA product verification testing and presentation of testing results.
6. Summary of any project meetings or pertinent discussions including list of attendees, action items and resolutions.
7. Areas of non-conformance for substandard work and corrective action measures.
8. Summary of materials received and accompanying QC documentation provided by supplier.
9. If necessary, attachments of cross-referencing CQA field logs, construction and testing forms, testing reports, and corrective action reports to substantiate any corrective action determinations or CQA decisions.
10. Record of site visitors.
11. Signature of CQA Officer.

Daily summary reports will be submitted to the Owner on a daily basis and to the Design Engineer on a weekly basis.

6.3 CQA FIELD LOGS

CQA Monitors will maintain individual field logs issued by the CQA Officer. Each field log is assigned a unique cross-referencing number and will contain daily entries of the CQA Monitor. The CQA Monitors will provide a written chronological framework of construction activities, construction monitoring, construction testing, production verification testing, and quality control procedures performed during the day in the area of the monitor's responsibility. CQA Monitor's field log entries will be addressed by the CQA Officer in the daily summary report.

CQA field logs will be submitted to the CQA Officer on a daily basis for preparation of the daily summary report and may be reviewed by the Design Engineer on a weekly basis.

6.4 CONSTRUCTION AND TESTING FORMS

Construction activities, CQA procedures, laboratory testing, and construction testing will be recorded on appropriate construction and testing forms. The following construction and testing forms typically are issued by the CQA Officer:

1. Soil Testing Forms
 - a. Soils Testing Control Log
 - b. Soils Test Request - Sample Custody Log
 - c. Sieve Analysis of Granular Soils
 - d. Nuclear Density/Moisture Tests
 - e. Moisture Content of Soils

2. Geosynthetics Forms

- a. Geosynthetics Testing Control Log
- b. Geosynthetics Delivery and Control Log
- c. Geosynthetics Test Request – Sample Custody Log
- d. Geomembrane Deployment/Seaming Log
- e. Geomembrane Repair Log

Completed construction and testing forms will be submitted to the CQA Officer for review on a daily basis and will be addressed by the CQA Officer in the daily summary report.

6.5 TESTING REPORTS

Testing reports may be issued by independent testing laboratories contracted by the CQA Organization to perform various product verification and construction testing.

Testing reports will be addressed within one day of receipt by the CQA Officer in the daily summary report.

6.6 CORRECTIVE ACTION DETERMINATION AND VERIFICATION REPORTS

Corrective action determination and verification reports will be issued to the Contractor by either the Design Engineer or the CQA Officer for construction or materials not in compliance with the technical specifications or for defective workmanship or materials, even if there is compliance with the technical specifications. Corrective action determination and verification reports will contain the following information:

1. Title block containing; 1) project name, 2) project number, 3) project location, 4) Owner, 5) date, and 6) Corrective action determination and verification report number.
2. Location and description of the problem area or corrective action determination.
3. If necessary, attachments of cross-referencing CQA field logs, construction and testing forms, testing reports, supporting sketches, and photographs to describe and substantiate the corrective action determination.
4. If necessary, additional testing required to determine the extent of corrective action measures.
5. Corrective measures necessary to correct the area of construction or material to compliance with the technical specifications as determined by the Engineer or CQA Officer.

6. Corrective action measures implemented and verification of these measures. Additional verification testing performed to verify compliance with the technical specifications.
7. If necessary, attachments of cross-referencing CQA field logs, construction and testing forms, testing reports, supporting sketches, and photographs to describe and verify the corrective action measures taken.
8. Signature of the issuing Design Engineer or CQA Officer and follow-up signature verifying corrective measures taken.

6.7 AS-BUILT RECORD DRAWINGS

As-built record drawings will be maintained by the Contractor and will be reviewed and verified by the CQA Organization. The record drawings will show actual as-built conditions of landfill construction and will adequately reflect that construction is in substantial compliance with the design intent. Irrelevant deviations in actual construction that do not substantially affect the design intent may not be incorporated into the record drawings, but they will be addressed in the final certification report. Record drawings will be prepared during the construction process by making modifications and red-line markups as they occur to a single set of construction drawings designated as the “*Site As-built Record Drawings*.” At the completion of construction, the CQA Organization, in coordination with the Design Engineer, will incorporate all as-built conditions into the “*Final As-built Record Drawings*.” The final record drawings will contain revision numbers and dates, review signatures of the Design Engineer and CQA Officer.

The Owner is required by the technical specification to perform as-built surveys and provide record drawings for the following units of construction:

1. Limits, contours, and grade breaks of landfill subgrade and final grades and establishment of 50-foot grid points for soil liner thickness verification.
2. Limits, contours, and grade breaks of soil liner and final grades and layer thickness verification at 50-ft grid points.
3. Limits of geomembrane installation.
4. Contours and grade breaks of borrow area excavation and stockpiles at 100-foot stations (x,y,z) and angle points.

These additional survey records will be incorporated into the final set of record drawings.

6.8 PHOTOGRAPHIC DOCUMENTATION

All construction activities will be continually photographed to clearly show and define construction methods and as-built conditions of completed units of construction. Photographs will include:

1. Product or material sources and stockpiles
2. In progress construction methods for each unit of construction
3. Completed units of construction
4. Damaged, rejected, or substandard units of construction
5. In progress corrective action measures to rectify damaged, rejected, or substandard units of construction
6. Completed units of construction as the result of corrective action measures
7. Design modifications

Photographs will be identified by number, date, and time of the photograph. The CQA Organization will maintain a cross-referencing photographic log documenting the subject matter of each photograph.

6.9 DOCUMENTATION CONTROL

Complete documentation of construction and the CQA program will be controlled and secured in an electronic file management system maintained at the site by the CQA Organization and shared with the Owner and Design Engineer. This documentation control structure organizes and indexes all construction and CQA documents and is intended to allow easy access to all documents for review and audit by the Owner, Design Engineer, or regulatory agencies. The following is a preliminary list and contents of the *CQA Documentation* established by the CQA Organization.

1. Title: Project Administration Documentation.
 - Progress meeting minutes, preparatory meeting minutes, Owner correspondences, Design Engineer correspondences, Contractor correspondences, CQA Organization correspondences, and miscellaneous correspondences.
2. Title: CQA Daily Summary and Contractor Field Reports.
 - Daily summary reports prepared by the CQA Officer and CQA Monitors and field reports prepared by the Contractor dated from the beginning of the project to the completion of the project.
3. Title: Submittals.
 - Submittal Control Log, submittal transmittal cover sheets, and all reviewed submittals required by the technical specifications.

4. Title: Soils CQA.

- Soils Testing Control Log, moisture content test results, moisture-density relations test results, permeability test results, sieve analysis results, nuclear density test results, cylinder-drive density test results, Atterberg Limits results, soil analysis results, summary of laboratory testing, and summary of nuclear density testing.

5. Title: Geosynthetics CQA.

- Geosynthetics Testing Control Log, Installer daily field reports, geomembrane test reports, geotextile test reports, geomembrane seam analysis results, panel layout drawings, geosynthetics delivery and control logs, subgrade acceptance forms, geomembrane deployment/welding logs, and geomembrane repair logs.

6. Title: Project Manual and CQA Plan.

- Project Manual and CQA Plans.

7. Title: Photograph Log.

- Construction and CQA photographs and cross-referencing photographic log.

6.10 FINAL CERTIFICATION REPORT

At the completion of the project, the Design Engineer and the CQA Organization will prepare the final SLER and GLER. The reports will consist of information and data generated by the CQA program and will document that landfill construction is in compliance with the contract documents and the design intent. At a minimum, the report will contain the following information:

1. Summary of construction methods for each unit of construction completed.
2. Summary of the CQA program implemented during construction and specific CQA verification procedures for each unit of construction completed.
3. Results of product quality assurance verification testing and construction testing.
4. Design modifications and technical revisions to the contract documents.
5. Final as-built record drawings.
6. Statement of compliance.
7. Signature and stamp of the Certifying Engineer.

6.11 DOCUMENTATION ARCHIVE STORAGE

At the completion of the project and following submittal of the final certification report, all original documentation generated by construction and by the CQA program will be archived at the on-site offices of the Owner with duplicate copies stored at the home offices of the CQA Organization.

7.0 UNCLASSIFIED FILL CQA

7.1 GENERAL

7.1.1 SECTION SUMMARY

CQA monitoring, verification procedures, and testing to verify unclassified fill materials and construction methods are in compliance with the technical specifications.

7.2 PRODUCTS

7.2.1 EARTHFILL

Unclassified fill material will be used as needed to reach design subgrade elevations. Unclassified fill thickness will vary depending on the top of waste grade and design subgrade elevations. Unclassified fill material will be obtained from the on-site borrow area and will meet the following product requirements:

1. Free of organic, saturated, oversized, or other unsuitable materials.
2. Free of frost, ice or snow.
3. Free of contaminants.
4. Maximum particle size of four (4) inches, unless otherwise approved by Design Engineer.

7.2.2 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

Verify that unclassified fill materials are free of organic, saturated, frozen, deleterious, oversized, and other unsuitable materials by performing frequent visual examinations of the material as the material is being excavated from the borrow area.

Perform moisture-density relations (ASTM D 698) testing to determine the maximum dry density and optimum moisture content for each material type used as unclassified fill at frequencies provided in Table 3.

7.3 EXECUTION

7.3.1 CONSTRUCTION AND CQA PREPARATION

Prior to fill operations, perform the following CQA verification procedures.

1. Hold a preparatory meeting in accordance with Section 4.4 of this CQA Plan.
2. If necessary, verify erosion control measures are in place.
3. Verify measures are implemented to protect utilities, temporary benchmarks, and existing structures from damage.
4. Verify base survey is performed on site borrow area (stockpile) for computation of measurement and payment quantities prior to and after embankment operations. Verify borrow area (stockpile) is graded with uniform lines and grades to provide accurate measurement and payment survey.
5. Verify construction and grade control staking.

7.3.2 UNCLASSIFIED FILL CQA MONITORING AND TESTING

To verify compliance of unclassified fill operations with the technical specifications, perform the following CQA verification procedures:

1. Verify fills are placed to the limits, lines and grades as shown on the Drawings.
2. Verify excavated soils not intended or used as fill material are removed and stockpiled.
3. Verify fill material is keyed into subgrade as shown on the Drawings.
4. Verify fill materials are placed and compacted in loose lifts not exceeding 8 inches.
5. Verify the top of each lift is scarified prior to placing subsequent lifts. If a sheepsfoot or pad-foot compactor is used for compaction, scarifying may not be required subject to Design Engineer approval.
6. Verify unclassified fill lift surfaces are maintained to prevent moisture loss and desiccation cracking. Verify repair of desiccated areas prior to placement of subsequent lifts.
7. Perform nuclear density-moisture testing (ASTM D 6938) to verify fill materials are moisture conditioned and compacted to the values specified in the technical specifications. Perform tests every 500 cubic yards of in-place material. (Refer to Earthworks Schedule of Testing Frequencies presented in Table 3).
8. Perform one drive-cylinder density test (ASTM D 2937) for every 30 nuclear density-moisture tests to verify nuclear density gauge is providing accurate results. (Refer to Earthworks Schedule of Testing Frequencies presented in Table 3).

7.3.3 FINAL SURFACE PREPARATION CQA MONITORING

In order to verify compliance of final surface preparation operations with the technical specifications, perform the following CQA verification procedures:

1. Verify that all debris and protrusions greater than 1-inch are pressed into or removed from the final subgrade.
2. Verify final surface is graded to lines and grades shown on the construction drawings and are final graded to a tolerance of ± 0.10 -foot of design grade at.
3. Verify the completed surface is finished with a pneumatic steel drum compactor. Verify removal of ridges gouges, and ruts greater than 1-inch.
4. Verify moisture conditioning of completed surface as necessary.

7.3.4 BORROW AREA CQA MONITORING

To verify compliance of borrow area excavation operations with the technical specifications, perform the following CQA verification procedures:

1. Verify excavation of borrow area with sides slopes no steeper than 2H:1V.
2. Verify borrow area is maintained with positive drainage patterns directed away from borrow area.
3. Verify borrow area is watered as necessary for dust control.
4. Verify borrow area is graded with uniform lines and grades to provide accurate measurement and payment survey.
5. Verify final borrow area is restored and graded with grades directed to provide positive drainage patterns surrounding the completed borrow area.
6. Verify final surface is track-walked with dozer cleat marks running perpendicular to the slope.

8.0 LANDFILL SUBGRADE PREPARATION CQA

8.1 GENERAL

8.1.1 SECTION SUMMARY

CQA monitoring procedures to verify subgrade preparation operations are in compliance with the technical specifications. Landfill subgrade preparation includes:

1. Grading landfill subgrade
2. Removal and disposal of excavated waste material
3. Final surface preparation

8.2 PRODUCTS

8.2.1 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

Perform moisture-density relations (ASTM D 698) testing on a 5-gallon sample to determine the maximum dry density and optimum moisture content for each subgrade material as described in Table 3.

8.3 EXECUTION

8.3.1 CONSTRUCTION AND CQA PREPARATION

Prior to landfill subgrade preparation operations, perform the following CQA verification procedures:

1. Hold a preparatory meeting in accordance with Section 4.4 of this CQA Plan.
2. If necessary, verify erosion control measures are in place.
3. Verify measures are implemented to protect utilities, temporary benchmarks, and existing structures from damage.
4. Verify construction and grade control staking.
5. Verify dust control operations are available.
6. Verify traffic control and barricades are coordinated with Owner.
7. Verify operations and haul routes are coordinated with landfill operations.
8. Verify subgrade underdrain pipes (if required) are placed along toe before placing subgrade unclassified fill.

9. Verify unclassified fill is placed in accordance with the technical specifications.
10. Verify as-built survey of completed landfill subgrade is performed and provided in accordance with the technical specifications. As-built survey must be completed prior to geosynthetic installations.

8.3.2 CQA MONITORING

To verify compliance of landfill subgrade preparation operations with the technical specifications, perform the following CQA verification procedures:

1. Verify landfill subgrade is graded to provide smooth uniform surface.
2. If necessary, verify removal of excavated waste materials and disposal of in active landfill.
3. Verify removal of all debris, rocks greater than four (4) inches in diameter, and all protruding wood and metal from the completed surface.
4. Verify dust control measures are implemented when necessary.
5. Verify final surface is graded to the lines and grades shown on the Drawings and to a tolerance of ± 0.10 -foot of design grade.
6. Verify the completed surface is finished with a pneumatic steel drum roller. Verify removal of ridges gouges, and ruts greater than 2-inches.
7. Verify moisture conditioning of completed surface as necessary.

9.0 SOIL LINER CQA

9.1 GENERAL

9.1.1 SECTION SUMMARY

This section summarizes the following CQA procedures:

1. CQA assistance, monitoring procedures, and testing during soil liner test pad construction.
2. CQA monitoring procedures and testing to verify soil liner materials and construction methods are in compliance with the technical specifications.

9.1.2 SOILS INVESTIGATION OF EXISTING CLAY SOURCES

The Owner will perform investigations and testing on soil liner material from the on-site borrow source to determine its acceptability as a low-perm soil component of the composite liner system. In the event the source does not meet product specifications for soil liner, the owner will conduct laboratory testing to determine the amount of bentonite addition required to meet the specified hydraulic conductivity.

A “Zone of Acceptable Compaction” establishes a relationship of in-place dry density and moisture content that achieves the specified permeability of the soil liner. The “Zone of Acceptable Compaction” is for guidance only, passing criteria for the in-place soil liner is permeability.

9.1.3 SOIL LINER TEST PAD CONSTRUCTION

The Contractor is required to construct a soil liner test pad prior to actual construction of the soil liner in the landfill cell. The intent of the test pad is to simulate construction of the actual soil liner, including processing, moisture conditioning, lift thickness, placement, grading, compaction efforts, and finishing operations. The intent of the test pad is to also verify that requirements of the technical specifications can be met.

9.1.4 SUBMITTALS

Review the following submittal that was due with the Contractor's with bid.

1. List of proposed equipment and description of construction methods to excavate, moisture condition, haul, place, compact, finish, maintain, and protect soil liner in accordance with the technical specifications.
2. Bentonite technical data including:
 - The type and origin of the bentonite (natural sodium, sodium enriched, or calcium bentonite)
 - The montmorillonite content
 - The content of materials other than montmorillonite
 - The presence or absence of polymers or additives

9.2 PRODUCTS

9.2.1 SOIL LINER MATERIAL VERIFICATION TESTING

Perform the following product verification testing, and as summarized in Table 4, prior to and during test pad construction and actual soil liner operations:

1. Moisture-density relation checkpoints to verify materials correspond with the established "Zone of Acceptable Compaction" and to detect any changes in the consistency of the soil liner material. Perform checkpoints for each material type and at a minimum of one test per each lift.
2. Particle size analysis and hydrometer to verify product gradation requirements of the technical specifications. Perform size analysis and hydrometer for every 1,850 yd³ of material used to construct the soil liner.
3. Atterberg Limits to verify plasticity index. Perform Atterberg Limits for every 1,850 yd³ of material used to construct the soil liner.
4. Continually examine soil liner materials to verify materials contain no organic, saturated, oversized, or other unsuitable materials.

9.3 EXECUTION

9.3.1 SOIL LINER MIXING

The soil liner material will be spread in a controlled manner to achieve uniform thickness in a pre-determined mixing location. The bentonite will be applied at a rate equivalent to the percent of bentonite (by dry weight) determined as part of project specific testing prior to liner construction. The bentonite spreader should be equipped with an

electronically variable mechanical or weight-controlled spreader allowing an application accuracy of 0.01 pounds per square foot. The CQA Organization will monitor the bentonite deposited over a known area to verify the bentonite application rate. A road reclaimer (CAT RM300 or Design Engineer approved equivalent) will be used to mix the bentonite with the soil using the number of passes determined in the test pad. Controls should be established so the mixing depth does not exceed the lift thickness to prevent mixing the underlying layers. The first three passes will be conducted without adding water. Water may be added after the initial three passes. Once the soils are mixed with bentonite, the soil-bentonite mixture will be hydrated to within 2% of the optimum moisture content and allowed to hydrate for 24 hours prior to placement as liner. Water required to achieve the specified water content may be added to the soil during liner placement and compaction.

Upon completion of mixing operations, the soil liner will be hauled to the test pad and the CQA organization will conduct the CQA activities as described below.

9.3.2 TEST PAD CONSTRUCTION CQA

Verify Contractor schedules test pad construction a minimum of 14 days prior to actual soil liner construction. The test pad will be constructed utilizing the intended mixing, lacing and compaction machinery. The test pad will be designed to provide the following information:

1. Suitability of the mixing method and mixture composition (does not apply to on-site soils which meet soil liner requirements).
2. The ability of the specified soil-bentonite admixture to achieve the permeability requirement.
3. The suitability of the method of placement and compaction requirements to achieve the permeability requirements.
4. Recommendations for the operation and management of the chosen mixing and water addition techniques.
5. Recommendations for the compaction of the liner, including the thickness of each lift, the weight and type of compaction equipment, and minimum number of passes required to achieve the compaction specification.

During test pad construction document the following:

1. Every equipment type and size utilized by the Contractor to haul, place, moisture condition, aerate, compact, grade, and finish the soil liner.
2. Every equipment type and size utilized by the Contractor to place and incorporate bentonite.
3. Moisture conditioning and aeration procedures.

4. Lift thickness prior to and after compaction.
5. Lift bonding procedures.
6. Overall description and chronological framework of construction activities.

Test pad will consist of a minimum 2-foot thick fill of soil liner material. At a minimum, CQA verification of the test pad should include:

1. Verify the test pad is constructed with a top deck of 25-feet wide by 50-foot long, and provides 4H:1V ramps onto and off the pad along the width of the pad.
2. Verify soil liner materials are not contaminated with any other soil materials.
3. Verify test pad is constructed in accordance with the technical specifications. At a minimum, the final 2-foot thick soil liner should have 4 separate compacted lifts but may require 8 or more to achieve the required hydraulic conductivity.
4. Perform the product verification testing outlined in Section 9.2.1 of this CQA Plan and the following construction testing. Work closely with the Contractor in providing accurate and timely testing data. The Contractor will rely heavily on the data provided to adjust or modify the construction methods necessary to achieve the required hydraulic conductivity.
5. Perform nuclear density and moisture content on each compacted lift will be conducted to verify the relative compaction is within the established "Zone of Acceptable Compaction". Perform oven-dried moisture content testing at every nuclear test location to correct nuclear moisture content readings.
6. Conduct in-place density by the drive-cylinder method to verify the nuclear density gauge is working properly and is providing reliable testing results.
7. Perform hydraulic conductivity on undisturbed samples obtained from each compacted lift to verify the hydraulic conductivity of the in-place soil liner.
8. Provide Design Engineer with documentation of test pad construction equipment and methods, product verification testing results, and construction testing results. The Design Engineer will review the results of test pad construction and testing and may modify the construction requirements and testing criteria specified in the technical specifications for actual construction of the soil liner.

9.3.3 SOIL LINER CONSTRUCTION AND CQA PREPARATION

Prior to soil liner construction, perform the following CQA verification procedures:

1. Hold a preparatory meeting in accordance with Section 4.4 of this CQA Plan.
2. Review testing methods and frequencies included in Table 4.
3. If necessary, verify erosion control measures are in place.
4. Verify measures are implemented to protect utilities, temporary benchmarks, and existing structures from damage.
5. Verify construction staking and grade control stakes at 50-foot grid and grade breaks. GPS machine control will be allowed in lieu of staking.
6. Verify landfill subgrade is complete and in accordance with the technical specifications. Verification includes submission and acceptance of as-built survey of completed subgrade.
7. Verify Contractor provides full-time grade checker during soil liner placement to control grade, lift thickness, and tolerances.
8. Verify Contractor utilizes the same equipment and construction methods used to construct the test pad (and achieve the required hydraulic conductivity) to construct the actual soil liner in the landfill cell.
9. Verify Contractor schedules soil liner placement operations to facilitate CQA product verification and construction testing. Placement of succeeding soil liner lifts will not be allowed until passing results for compaction, moisture content, and permeability are achieved from each lift of the in-place soil liner.

9.3.4 SOIL LINER CONSTRUCTION CQA

Perform the following CQA monitoring procedures and testing to verify soil liner materials and construction methods are in compliance with the technical specifications (or as modified by results of soil liner test pad construction).

1. Verify soil liner is placed and graded to the limits, lines and grades as shown on the construction drawings.
2. Perform the product verification testing outlined in Section 9.2.1 of this CQA Plan.
3. Verify first lift of soil liner is placed in a loose lift not exceeding 8-inches and is compacted without penetrating the underlying subgrade material. If subgrade material is penetrated, verify Contractor increases loose lift thickness to prevent contamination of soil liner with subgrade materials.
4. Verify subsequent lifts of soil liner are placed in loose lifts not exceeding 6-inches. The final 1-foot thick soil liner should have a minimum of 2 separate compacted lifts, but may require more to achieve the required hydraulic conductivity.

5. Verify lifts are compacted with fully penetrating foot compactor (sheepsfoot roller) or kneading pad foot roller and moisture content is adjusted to specified range.
6. Perform nuclear density and moisture content on each compacted lift to verify the relative compaction is within the established “Zone of Acceptable Compaction”. Perform oven-dried moisture content testing at every nuclear test location to correct nuclear moisture content readings. Perform five (5) nuclear density and moisture content tests per every lift per acre of in-place material.
7. Perform in-place density by the drive-cylinder method to verify the nuclear density gauge is working properly and is providing reliable testing results. At a minimum, perform one test per 20 nuclear density-moisture tests.
8. Perform hydraulic conductivity on undisturbed samples obtained from each compacted lift to verify the hydraulic conductivity of the in-place soil liner. At a minimum, perform one hydraulic conductivity test every acre per 6-inch lift.
9. Verify lifts are scarified, blended, and compacted together to prevent smooth zones and provide bonding between lifts.
10. Verify new soil liner lifts are scarified, blended, compacted, and keyed-into the existing soil liner.
11. Verify completed lifts are protected from damage, desiccation, and moisture loss. Verify complete repair of damaged lifts prior to placing succeeding lifts.
12. The in-place soil liner must have permeability less than or equal to 1×10^{-7} cm/sec. If soil liner does not meet the specified permeability, verify Contractor reworks areas, or removes and replaces materials to meet the specified permeability.

9.3.5 FINAL SURFACE PREPARATION CQA

Perform the following CQA monitoring procedures to verify the final surface of the soil liner is in compliance with the technical specifications.

1. Verify all exposed rock protruding greater than 0.5-inch is removed from the completed soil liner surface. In no case will sharp protrusions be allowed even if less than 0.5-inch.
2. Verify final surface is graded to the lines and grades shown on the construction drawings and within the tolerances specified in the technical specifications. The absolute minimum thickness is 1-foot and maximum thickness is 1.1 feet.
3. Verify the completed surface is finished with a pneumatic steel drum roller. Verify the removal of abrupt edges, ridges, gouges, tire tracks, desiccation cracks, and ruts greater than 0.5 inches.

4. Verify completed surface is moisture conditioned as necessary to prevent surface drying and desiccation.
5. Verify Owner performs and provides as-built surveys (thickness verification) of completed soil liner prior to geomembrane installation.

9.3.6 MAINTENANCE AND REPAIR CQA

1. Verify all hubs, grade control stakes, and survey stakes are removed. Verify repair of all holes, including those excavated or driven for nuclear density testing and permeability testing with approved moisture-conditioned soil liner material or bentonite/soil admixture.
2. Verify soil liner moisture content and surface condition is maintained and protected within the specified moisture content range until covered by geomembrane. Protective measures may include covering the soil liner with temporary plastic sheeting or soil.
3. Verify completed surface is not allowed to desiccate. If desiccation cracks are greater than 0.2 feet deep or 0.5 inches wide, verify the full depth and length of the crack is excavated, and repaired with additional moisture-conditioned soil liner material. If desiccation cracks are less than 0.2 feet deep or 0.5 inches wide, verify moisture conditioning and compaction with steel-drum roller.
4. Verify the repair of all weather and erosion related damage to the soil liner not covered by GCL and geomembrane. Verify the Contractor implements measures to not to allow water to run or collect under the GCL and geomembrane installation. If water runs or collects under the GCL and geomembrane, causing erosion and/or saturation of the soil liner, verify the removal of GCL and geomembrane to allow soil-liner to air dry and/or the removal and replacement of soil liner material entirely, or moisture conditioning, re-compaction, and finishing of soil liner to the requirements of the technical specifications.
5. Verify the repair of soil liner surfaces found to be out-of-grade-tolerance as follows:
 - Scarifying and moisture conditioning (water spray) surface.
 - Placement of additional moisture-conditioned soil liner material.
6. If surface is greater than 0.1 feet out-of-grade-tolerance, re-compact soil liner backfill with sheepsfoot or pad foot roller. If surface is less than 0.1 feet out-of-grade-tolerance, re-compact soil liner backfill with steel drum roller.
7. Grading or trimming of repaired surface within tolerance. Steel-drum rolling the surface smooth.
8. Verify the repair of wheel ruts on soil liner surface caused by geomembrane deployment equipment.

10.0 GEOSYNTHETIC CLAY LINER CQA

10.1 GENERAL

10.1.1 SECTION SUMMARY

CQA verification procedures to verify Geosynthetic Clay Liner (GCL) materials and installation methods are in compliance with the technical specifications.

10.1.2 SUBMITTAL REVIEW AND APPROVAL

The following GCL submittals are required before GCL is shipped to the site in accordance with the technical specifications:

1. Two 1-foot by 1-foot samples representative of the GCL material meeting these specifications of the material that will be shipped to the site
2. Product data sheet and complete description of GCL that meet or exceed the product requirements described in Table 5 and the technical specifications
3. Manufacturer's quality control testing reports for GCL rolls delivered to the site. At a minimum, GCL tests specified in Table 5 must be included in the testing reports.

Collect two copies of each submittal listed above and initiate submittal review and approval process as outlined in Section 5.0 of this CQA plan.

10.1.3 DELIVERY, STORAGE, AND HANDLING

Prior to delivery and storage of the GCL rolls, observe and verify an elevated surface is prepared to store the rolls. This storage area must be elevated off the ground, away from where water can accumulate and prepared in a manner that the GCL rolls do not create a dam for ponding water. If the GCL rolls are to be stored for a long period of time, recommend to the Owner that the rolls be stored in an enclosed facility or in the enclosed shipping trailers.

During delivery of the GCL rolls, perform the following verification procedures:

1. Obtain a copy of the packing list accompanying the GCL rolls.
2. Complete the *Geosynthetics Delivery and Control Log* for shipment of GCL. Attach a copy of the accompanying packing list to the completed *Geosynthetics Delivery and Control Log*. This log documents and controls the following:

- Delivery dates.
 - GCL roll numbers.
 - GCL roll batch/lot numbers or production dates.
 - CQA personnel monitoring the delivery of the GCL rolls.
 - Total quantity of GCL delivered with each shipment and the accumulated total quantity of GCL delivered to the site.
 - Receipt of manufacturer's quality control test reports for each roll of GCL.
 - Completion of quality assurance verification testing.
 - Additional notes including rejection of materials, condition of delivered materials and other materials included with the shipments.
3. Verify GCL rolls are unloaded, handled, and transported with nylon or other cloth straps that do not damage the GCL rolls or protective covering.
 4. Verify GCL rolls are stored and protected from damage and moisture intrusion. Verify protective coverings are waterproof and damaged coverings are repaired, or removed and replaced completely.
 5. Verify GCL rolls are stacked only three rolls high, are supported along the entire width of each roll and that a 3-foot wide access path is left between the stacked rows of GCL.
 6. Identify and separate damaged or rejected GCL rolls.
 7. If GCL rolls have been contacted by moisture during shipping, separate affected rolls for bentonite moisture content testing. If the moisture content of the bentonite is greater than 50 percent, identify and mark the affected roll as "DRY OUT DURING INSTALLATION".

10.2 PRODUCTS

10.2.1 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

The following quality assurance verification testing will be performed by the geosynthetics testing laboratory to verify compliance with the product requirements of the technical specifications and as summarized in Table 5.

1. Bentonite Mass per Unit Area (ASTM D5993)
2. Bentonite Moisture Content (ASTM D2216)
3. GCL Tensile Strength (ASTM D6768) GCL Index Flux (ASTM D6496)

4. GCL Peel Strength (ASTM D6496)
5. GCL Hydraulic Conductivity (ASTM D5084)
6. Bentonite Free Swell Index (ASTM D5890)
7. Bentonite Fluid Loss (ASTM D5891)

10.3 EXECUTION

10.3.1 CQA PREPARATION

Prior to GCL installation perform the following CQA verification procedures hold a preparatory meeting in accordance with Section 4.4 of this CQA Plan.

10.3.2 EXAMINATION OF GCL SUBGRADE

Prior to GCL installation, examine the GCL subgrade as follows:

1. Verify Geosynthetics Contractor's daily acceptance of the compacted soil liner and document acceptance with the site superintendent's signature on the daily *GCL Deployment/Seaming Log*.

10.3.3 GCL DEPLOYMENT CQA

To verify compliance of GCL deployment operations with the technical specifications perform the following CQA verification procedures:

1. Record the following information on the *GCL Deployment/Seaming Log*:
 - Subgrade Acceptance (SA). Physical description and approximate area of subgrade accepted by the Geosynthetics Contractor and approved by the CQA Organization for daily GCL installation.
 - Temperature (T). Ambient and GCL surface temperatures with a description of the current weather conditions. Record every two hours and document dramatic changes in temperature and weather conditions.
 - Moisture Content (MC). Moisture content of GCL bentonite, roll or area sampled and time of sampling.
 - Panel (P). Assigned panel number, GCL roll number, panel dimensions, and area of panel.
2. Using a graph computation sheet, field sketch a panel layout drawing of the GCL panels deployed during the day. Attach this field sketch to the completed GCL Deployment/Seaming Log. These daily field sketches will be transposed to the master panel layout drawing.
3. In general, verify GCL is installed in accordance with manufacturer's instructions.

4. Verify protective covering on the GCL rolls are not removed until the roll is transported into place of installation and is immediately ready for deployment.
5. Verify GCL is installed with the machine direction (lengthwise) of the roll is oriented down and centered in the drainage troughs.
6. Verify corrections or adjustments are made to panels that become askew to the center line of the trough.
7. Verify GCL is installed with sufficient tension to prevent excessive overlapping, insufficient overlapping, wrinkles, and folds.
8. Verify panels are overlapped a minimum of 12-inches along the width (ends) of the panels.
9. Verify underlying soil liner is not damaged.
10. Verify damaged soil liner is completely repaired.
11. Verify the removal of materials that could damage the GCL or adversely affect the hydraulic conductivity of the GCL.
12. Continually inspect the GCL panels and overlaps for damage, thin areas, excessively hydrated areas, and other items that could damage the GCL or adversely affect the hydraulic conductivity of the GCL.
13. Verify damaged GCL is removed entirely or repaired in accordance with Section 16.3.4 of this CQA Plan.
14. Verify all deployed GCL is completely covered by the overlying geomembrane and secured in one day.
15. Verify small areas of the GCL not covered by the geomembrane, and protected by other temporary means (e.g. plastic sheeting).
16. Verify deployed GCL is protected from becoming excessively hydrated (rain or snow).
17. Verify excessively hydrated GCL material with moisture content greater than 50 percent is dried-out or removed and replaced entirely.
18. Verify GCL is adequately ballasted during placement operations and ballast is left in place until GCL is covered with the overlying geomembrane.
19. Verify geomembrane is also adequately ballasted.

10.3.4 REPAIR CQA

Verify damaged GCL is removed entirely or repaired in accordance with the following guidelines:

1. Verify repair (patching) material is the same material as the damaged GCL.
2. Verify patches extend a minimum of 12-inches in all directions beyond the damaged area and machine direction of the patches aligns with the machine direction of the damaged GCL.

11.0 GEOMEMBRANE CQA

11.1 GENERAL

11.1.1 SECTION SUMMARY

CQA monitoring procedures, guidelines, and testing for the following areas to verify geomembrane material and installation methods are in compliance with the technical specifications:

1. Review and approval of submittals
2. Geomembrane quality assurance verification testing
3. Extrusion welding beads or rods quality assurance verification
4. Geomembrane seam analysis
5. Installation monitoring, verification, and documentation
6. Monitoring, verification, and documentation of Installer's quality control procedures

11.1.2 SUBMITTALS

The following geomembrane submittals are required from the manufacturer in accordance with the technical specifications:

1. Product data sheets and complete description of geomembrane that meets or exceeds the product requirements of the technical specifications. Submittal due with Bid.
2. Sample of geomembrane that is representative of roughness of texturing on both sides. This sample will be used as a standard for manufacturing. A pointed depth micrometer may be used to compare relative roughness of texturing. Submittal due with Bid.
3. Geomembrane resin certificate of compliance with product requirements as presented in the technical specifications. Submittal due before geomembrane shipment to the site.
4. Geomembrane resin specific gravity quality control test reports. Submittal due before geomembrane shipment to the site.
5. Certification listing percentages of processing aids, antioxidants, and additives other than carbon black added to the geomembrane resin. Submittal due before geomembrane shipment to the site.

6. Manufacturer's quality control testing reports for geomembrane rolls delivered to the site. At a minimum, tests specified in the technical specifications or Table 6 must be included in the testing reports. Submittal due before geomembrane shipment to the site.
7. Instructions for handling, storing, installing, and repairing geomembrane. Submittal due before geomembrane shipment to the site.
8. Extrusion welding beads or rod certificate of compliance with product requirements of the technical specifications. Submittal due before geomembrane shipment to the site.
9. Manufacturer's warranty in compliance with the technical specifications. Submittal due after geomembrane delivery.

The following geomembrane submittals are required from the installer in accordance with the technical specifications:

1. Installer's Geomembrane Installation Quality Control Manual. Submittal due 14 days prior to geomembrane installations.
2. Proposed geomembrane panel layout drawings. Submittal due 14 days prior to geomembrane installations.
3. Resume of geomembrane installation superintendent. Submittal due 14 days prior to geomembrane installations.
4. Resume of geomembrane master welder. Submittal due 14 days prior to geomembrane installations.
5. Resume of welding and quality control crew. Submittal due 14 days prior to geomembrane installations.
6. Installation warranty in compliance with the technical specifications. Submittal due at the completion of the geomembrane installation.
7. Completed geomembrane panel layout drawings. Submittal due at the completion of the geomembrane installation.

Collect two copies of each submittal listed above and initiate submittal review process as outlined in Section 5.0 of this CQA Plan.

11.1.3 DELIVERY, STORAGE, AND HANDLING

Prior to delivery and storage of the geomembrane rolls, observe and verify a bedding layer surface is prepared to store the rolls.

During delivery of the geomembrane rolls, perform the following CQA verification procedures:

1. Obtain a copy of the packing list accompanying the geomembrane rolls.
2. Complete the Geomembrane Delivery and Control Log for each shipment of geomembrane rolls. Attach a copy of the accompanying packing list to the completed Geomembrane Delivery and Control Log. This log documents and controls the following:
 - Delivery dates.
 - Geomembrane roll numbers.
 - Geomembrane roll batch/lot numbers or production dates.
 - CQA personnel monitoring the delivery of the geomembrane rolls.
 - Total quantity of geomembrane delivered with each shipment and the accumulated total quantity of geomembrane delivered to the site.
 - Receipt of manufacturer's quality control test reports for each roll of geomembrane.
 - Completion of quality assurance verification testing.
 - Additional notes including rejection of materials, condition of delivered materials and other materials included with the shipments.
3. Verify geomembrane rolls are unloaded, handled, and transported with nylon or other cloth straps that do not damage the geomembrane rolls.
4. Verify geomembrane rolls are stacked only three rolls high and that a 3-foot wide access path is left between the stacked rows of geomembrane.
5. Identify and separate damaged or rejected geomembrane rolls.
6. Determine which geomembrane rolls will be sampled for quality assurance verification testing by either individual roll numbers, batch/lot numbers, or production dates. Select one geomembrane roll for sampling and testing for every 100,000 square feet of material produced for the project. Conformance samples should be obtained and tested by the CQA Organization and/or the CQA laboratory and test results reviewed by the CQA Manager and/or certifying engineer prior to shipment to the site.
7. Sample the selected geomembrane rolls for quality assurance verification testing using the following sampling procedure:

- Cut and remove the first three feet of geomembrane material from across the entire width of the roll. Store this first three feet of material near the stacked rolls of geomembrane for later use by the Installer.
 - Cut and remove the next 12 inches of material from across the entire width of the roll. This 12-inch section of material is the quality assurance verification testing sample.
 - Assign a quality assurance verification test number to the sample and mark the following information directly on the sample with an indelible marker:
 - Machine direction of the sample.
 - Manufacturer's geomembrane roll number.
 - Quality assurance verification test number.
8. Complete the Geomembrane Test Request and Sample Custody Log and ship samples to the geosynthetics testing laboratory via overnight delivery.

11.2 PRODUCTS

11.2.1 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

The following quality assurance verification testing will be performed by the geosynthetics testing laboratory to verify compliance with the product requirements of the technical specifications included in Table 6:

1. Density (ASTM D 792 or ASTM D 1505)
2. Tensile Properties (ASTM D 6693)
3. Carbon Black Content (ASTM D 1603)
4. Carbon Black Dispersion – core of sheet only (ASTM D 5596)
5. Sheet Thickness (ASTM D 5994)
6. Asperity Height for textured geomembrane (ASTM D 7466)
7. Puncture Resistance (ASTM D 4833)

Upon completion of the above quality assurance verification testing and receipt of the testing results, the CQA Organization will review all test results for compliance with the technical specifications. The CQA Organization will report any non-compliance of the test results to the Design Engineer.

Additional quality assurance verification testing or corrective action measures as the result of non-complying test results will be determined by the Design Engineer.

11.2.2 FIELD TESTING EQUIPMENT

Prior to geomembrane deployment, confirm the following with the Installer:

1. Verify Installer provides a field tensiometer capable of measuring seam strength for trial welds. Verify tensiometer has been calibrated within the last year and is accurate within 2 pounds.
2. Verify Installer provides a 1-inch (width) by 6-inch (length) cutting die and cutting press for cutting seam specimens from the trial welds.

11.3 EXECUTION

11.3.1 GENERAL CQA PREPARATION

Prior to geomembrane installations, perform the following CQA verification procedures:

1. Hold preparatory meeting for geomembrane installation in accordance with Section 4.4 of this CQA Plan.

11.3.2 EXAMINATION OF GEOMEMBRANE SUBGRADE

Prior to geomembrane installations, perform the following CQA verification procedures:

1. Verify liner subgrade surface that the geomembrane will be installed on is complete and in compliance with the technical specifications.
2. Verify Installer's daily acceptance of the liner subgrade surface. Document acceptance with the site superintendent's signature on the daily Geomembrane Deployment/Welding Log.

11.3.3 CQA INSTALLATION PREPARATION

Prior to welding operations verify trial welds are prepared for each welding machine that will be used during the day. Verify the following procedures are used during preparation of the trial welds:

1. Trial welds are prepared for both fusion welding machines and extrusion guns.
2. At a minimum, trial welds are prepared at the beginning of the shift (am) and at mid-shift (pm).

3. Trial weld samples for fusion welding machines are a minimum of 6-feet in length with the trial weld centered down the length of the sample.
4. Trial weld samples for extrusion guns are a minimum of 3-feet in length with the trial weld centered down the length of the sample.

Verify trial weld is allowed to cool to ambient conditions. After cooling, verify excessive material is cut from the beginning and the end of the trial weld sample (approximately 4-inches from each end).

Verify four 1-inch specimens are cut with the cutting die and are spaced evenly along the length of the trial weld. Observe and verify field testing of two specimens for peel adhesion (peel) and two specimens for bonded seam strength (shear) in accordance with the technical specifications. Each specimen must pass their respective peel or shear test.

Peel test specimens must meet the following criteria:

1. The break is a film-tearing bond (FTB) or exceeds 400% strain.
2. There is no more than 10 percent peel penetration into the weld.
3. The quantitative value for peel strength is 63 lb./in for fusion welds and 57 lb./in for extrusion welds.

Shear test specimens must meet the following criteria:

1. The quantitative value for elongation is a minimum of 50%.
2. The quantitative value for shear strength is 75 lb./in. for both fusion and extrusion welds.

If any test specimens fail either peel or shear testing, the entire trial weld is considered failing. Verify the above trial weld procedure and field testing is repeated if any of the four specimens fail in either peel or shear. If the trial weld repeats in failure, verify the failing welding machine or extrusion gun is not used until proper adjustments are made or the machine or gun is repaired. Verify repeat trial weld failures pass two consecutive peel and shear tests. If the welding machine or extrusion gun continually fails field testing, verify the machine or gun is tagged and completely removed from service.

11.3.4 DEPLOYMENT CQA

To verify compliance of geomembrane installation operations with the technical specifications, perform the following CQA verification procedures:

1. Record the following information on the Geomembrane Deployment/Welding Log. Abbreviations in parenthesis following each verification procedure are used on the Geomembrane Deployment/Welding Log:
 - Subgrade Acceptance (SA). Physical description and approximate area of subgrade accepted by the Installer and approved by the CQA Organization for daily geomembrane installation.
 - Temperature (T). Ambient and geomembrane surface temperatures with a description of the current weather conditions. Record every two hours and document dramatic changes in temperature and weather conditions.
 - Trial Welds (TW). Time of trial weld, type of welding equipment, welding equipment number, welding operator, and results of field peel and shear testing.
 - Panel (P). Assigned panel number, geomembrane roll number, panel dimensions, and area of panel.
2. Field sketch a panel layout drawing of the geomembrane panels deployed during the day. Attach this field sketch to the completed Geomembrane Deployment/Welding Log. These daily field sketches will be transferred to the master panel layout drawing.
3. Verify panels are deployed parallel to the slope, with the panels running down the entire length of the slope. Verify corrections or adjustments are made to panels that become askew to the parallel line of the slope.
4. Verify panels are overlapped to the proper length as required by the fusion welding machines. At a minimum the panels should be overlapped 4-inches. Verify the alignment of the overlap is consistent and overlap indicator points are marked approximately every 20-feet along the entire length of the panels.
5. Verify geomembrane is not damaged during handling, transport, or deployment operations. Verify damaged geomembrane is repaired or removed entirely.
6. Verify underlying subgrade is not damaged during deployment. Verify any detected damaged subgrade is completely repaired.
7. Verify excessive wrinkling of the geomembrane does not occur and compensation for stress bridging is added during deployment operations. Verify excessive wrinkles and stress bridging are repaired or removed entirely.
8. Verify Installer only deploys the quantity of geomembrane that can be completely welded and secured in one day.
9. Verify, immediately after panels running through ditches are welded, sandbags are placed end-to-end along the entire length of the flow line to prevent geomembrane stress bridging through the ditch lines.

11.3.5 FUSION WELDING CQA

To verify compliance of geomembrane fusion welding operations with the technical specifications, perform the following CQA verification procedures:

1. Record the following information on the Geomembrane Deployment/Welding Log.
 - Seam (S). Assigned seam number, welding equipment number that welded the seam, welding operator, and length of the welded seam.
 - End of Seam Test. (EST). If the Installer's quality control program requires that specimens be taken from the end of each welded seam and tested for peel adhesion, record these results using the same criteria as trial welds. If the Installer records these results, request a copy of the results and this verification procedure can be omitted from the Geomembrane Deployment/Welding Log.
 - Destructive Sample (DS). Assigned sample number, seam number sample is located on, location of sample within the seam, welding equipment number that welded the seam, welding operator, and results of field peel adhesion test results.
2. Verify welding operations only take place when the ambient temperature is between 40°F and 110°F. Measure ambient and in-place geomembrane temperatures and record readings every two hours on the Geomembrane Deployment/Welding Log. Special weather welding plans must be submitted and approved by the Design Engineer to weld outside this range.
3. Verify fusion welding machines complete trial weld procedures as specified in Section 11.3.3 of this CQA Plan prior to welding operations.
4. Verify power source is capable of producing sufficient and constant voltage under the combined line load of multiple welders and other equipment.
5. Verify welding surfaces are thoroughly cleaned prior to and during welding operations.
6. Verify seams are welded at the same speed, temperature, roller pressure, and gauge settings used to prepare the trial weld. Verify operators record welding machine numbers, operators, machine settings, times, and dates on each seam welded.
7. Closely observe each fusion welding machine to verify the machine is not adversely affecting or damaging the parent geomembrane material outside the welding area.

11.3.6 EXTRUSION WELDING CQA

To verify compliance of geomembrane extrusion welding operations with the technical specifications, perform the following CQA verification procedures:

1. Verify extrusion welding is used for repair operations, where welding is inaccessible to fusion welding machines.
2. Verify extrusion guns complete trial weld procedures as specified in Section 11.3.3 of this CQA Plan prior to welding operations.
3. Verify geomembrane is overlapped a minimum of 4-inches for extrusion welding.
4. Verify repair patches are cut square with rounded corners and are large enough to extend a minimum of 4-inches in all directions over the repair area.
5. Verify geomembrane and repair patches are tack-welded in place to prevent movement during grinding and extrusion welding operations.
6. Verify the outer edge of repair patches and the adjacent underlying geomembrane are disc-ground to remove surface debris and oxidation. Verify grinding is not parallel to seam.
7. Verify nozzles of extrusion guns are purged to remove solidified extrudate.
8. Verify extrusion weld completely covers the entire width of the grind area and extrusion safety welds extend 4-inches up the intersecting fusion weld (if applicable).
9. Verify extrusion weld repair (safety) patches are welded over all fusion welded seam intersections.

11.3.7 REPAIR CQA

To verify geomembrane is completely repaired and tested, perform the following CQA verification procedures:

1. After geomembrane deployment, welding, seam analysis sampling, and QC procedures, inspect the geomembrane installation to locate, mark, identify, number, and record defective areas for repair. Include all installation repairs (e.g. safety patches, air pressure patches, destructive seam sample patches, and geomembrane boots). Record the following information on the Geomembrane Repair Log.
 - Repair Number
 - Repair Description
 - Repair Location

2. After the repair is completed, verify and record the following QC information on the Geomembrane Repair Log:
 - Repair Date
 - Vacuum Test Date
 - Vacuum Test Result

11.3.8 INSTALLER'S QUALITY CONTROL

The CQA program requires the verification of quality control procedures performed by the geomembrane Installer in accordance with the technical specifications and the Installer's own Geomembrane Installation Quality Control (QC) Manual. At a minimum, verify Installer is performing the following QC procedures in accordance with the technical specifications:

1. Maintaining a geomembrane panel layout drawing during the geomembrane installation. The drawing must include; a) roll and panel numbers; b) seam numbers; c) geomembrane limits; and d) seam analysis sample locations.
2. Performing all quality control procedures and testing in accordance with the Installer's Geomembrane Installation Quality Control Manual, except where amended or modified by the Design Engineer or in the technical specifications.
3. Maintaining daily deployment logs and panel layout drawings as the deployment progresses. Logs must be submitted to the CQA Organization daily and include; 1) panel and seam numbers, 2) panel dimensions, and 3) deployment quantities.
4. Maintaining daily welding logs. Logs must be submitted to the CQA Organization daily and include; 1) welding machine numbers, 2) operators, 3) machine settings, and 4) times and dates for each seam welded.
5. Air pressure testing each fusion welded seam.
6. Vacuum testing each extrusion welded repair and length of seam.

Air pressure testing of fusion welded seams.

1. Verify each fusion welded seam is air pressure tested by the Installer and is in accordance with the following procedures:
 - The air pump must be capable of generating and maintaining 40 psi of pressure and equipped with a regulator and pressure gauge. Pressure feed needles must have pressure gauges accurate to 1 psi.

- Both ends of the fusion welded seam are sealed with vise-grip plate clamps or extrusion weld. Heat may be applied to the seam ends to aid in sealing the seam in conjunction with the clamps.
 - The air pressure needle is inserted into the fusion weld channel at one end of the seam.
 - The channel is pressurized to 30-35 psi and pressure is maintained for 5 minutes.
 - Air is released from the opposite end of the seam to verify that the entire length of the fusion weld channel was pressurized. If channel does not maintain pressure with a maximum allowable pressure loss of 2 psi over the 5-minute test period or does not stabilize at all, verify that the defective area is located and isolated. Repeat air pressure test procedures in both directions from the defective area.
2. Record the following air pressure testing information on the Geomembrane Deployment/Welding Log. Abbreviations in parenthesis following each verification procedure are used on the Geomembrane Deployment/Welding Log.
- Air Pressure Test (AP). Seam number tested, start time of the air pressure test and initial air pressure (psi), termination time of the air pressure test and ending air pressure (psi), and length of seam or portion of seam successfully tested.

Vacuum testing of extrusion welded repairs.

1. Verify each extrusion welded seam and repair is vacuum tested by the Installer and is in accordance with the following procedures:
 - Vacuum pump is capable of generating and maintaining 30 inches of mercury and is equipped with a regulator and vacuum gauge. Vacuum boxes have clean view windows and vacuum gauges are accurate to 1 psi.
 - Extrusion welds are saturated with soap/water solution.
 - View-box is placed over the saturated weld, an airtight seal is created, and vacuum is applied to the weld.
 - Vacuum is maintained for 10 seconds and weld is examined for leaks. Leaks are detected by the presence of excessive bubbles. Detected leaks are marked for follow up extrusion welding repair. Detected leaks are re-vacuumed tested after repair operations to verify that the leaks were successfully repaired.
2. Record the following vacuum testing information on the Geomembrane Repair Log:
 - Assigned repair number, location and description of repair, vacuum test dates, and vacuum test results.

11.3.9 DESTRUCTIVE SEAM SAMPLING AND TESTING PROCEDURES

Determine seam analysis sample locations by the stratified random sampling (SRS) method. The SRS method allows random selection of a single sample location anywhere within the required sampling interval specified within the technical specifications. In coordination with the Geosynthetics Contractor, perform the following seam analysis sampling procedures.

1. Destructive seam samples will be a minimum of 12-inches wide by 36-inches long with the weld centered down the length of the sample. Sample sizes may be increased at the request of the CQA Organization and/or the Geosynthetics Contractor.
2. Divide the sample into equal sections. A minimum of one section for destructive testing and one section for archival storage.
3. The Geosynthetics Contractor may obtain and test any seam sample at its option.
4. If there is a failing test, follow the procedures described in Section 11.3.10 of this CQA Plan.
5. Repair sample locations in accordance with Section 11.3.7 of this CQA Plan and vacuum test repair in accordance with Section 11.3.8 of this CQA Plan.
6. Based on the destructive sampling method of attributes, the Design Engineer may increase or decrease the sampling interval based on the information in Table 7.

11.3.10 FAILED SEAM ANALYSIS PROCEDURES

In coordination with the Installer, perform the following CQA verification procedures in the event of a seam analysis sample failure determined by either field testing or laboratory seam analysis:

1. Track the welded seam 10-feet in both directions away from the failed seam analysis sample location. Cut a small 8-inch wide by 8-inch long sample from each location. Cut two 1-inch specimens from each end of the sample, and field test specimens for peel adhesion in accordance with Section 12.3.3 of this CQA Plan. If either of the specimens fail the field peel test at either location, continue tracking the welded seam at 10-foot intervals until specimens successfully pass the field peel tests. If specimens continually fail field peel tests at 10-foot intervals, the entire seam or portion of the welded seam will be repaired at the discretion of the CQA Organization.
2. Verify the failed length of seam is repaired with an 18-inch wide extrusion welded cap strip. Tack and extrusion welding the leading flap of the fusion welded seam is not permitted. Verify the extrusion welded cap strip is vacuum tested in accordance with Section 11.3.8 of this CQA Plan.

3. If the re-test sample fails laboratory seam analysis, repeat the above procedures.
4. Sample extrusion welded cap strips exceeding 100-feet in length for seam analysis.

11.3.11WRINKLES

Temperature changes may cause wrinkles to develop in the geomembrane. Any wrinkles that can fold over will be repaired either by cutting out excess material or, if possible, by allowing the geomembrane to contract by temperature reduction. In no case will material be placed over the geomembrane that could result in the geomembrane folding. The CQA Organization will monitor geomembrane for wrinkles and notify the Geosynthetics Installer if wrinkles are forming. The CQA Organization is then responsible for documenting corrective action to remove the wrinkles on the Daily Progress Report form.

12.0 CLOSURETURF® CQA

12.1 GENERAL

12.1.1 SECTION SUMMARY

CQA procedures, guidelines, and testing to verify the turf component materials and installation methods are in compliance with the technical specifications.

12.1.2 SUBMITTAL REVIEW

The following geotextile submittals are required 14 days prior to ClosureTurf® installation in accordance with the technical specifications:

1. Sample, product data sheet, and complete description of ClosureTurf® that meet or exceed the product requirements of the technical specifications and Table 8.
2. Manufacturer's quality control testing reports for ClosureTurf® rolls delivered to the site. At a minimum, tests specified in the technical specifications must be included in the testing reports.
3. Instructions for storage, installation, and repair of ClosureTurf®.
4. Collect two copies of each submittal listed above and initiate submittal review process as outlined in Section 5.0 of this CQA Plan.

12.1.3 DELIVERY, STORAGE, AND HANDLING

Prior to delivery and storage of the ClosureTurf® rolls, observe and verify that an elevated surface is prepared to store the rolls.

During delivery of the ClosureTurf® rolls, perform the following CQA verification procedures:

1. Obtain a copy of the packing list accompanying the ClosureTurf® rolls.
2. Complete the Geosynthetics Delivery and Control Log for each shipment of ClosureTurf®. Attach a copy of the accompanying packing list to the completed Geosynthetics Delivery and Control Log. This log documents and controls the following:
 - Delivery dates.
 - ClosureTurf® roll numbers.

- ClosureTurf® roll batch/lot numbers or production dates.
 - CQA personnel monitoring the delivery of the ClosureTurf® rolls.
 - Total quantity of ClosureTurf® delivered with each shipment and the accumulated total quantity of ClosureTurf® delivered to the site.
 - Receipt of manufacturer's quality control test reports for each roll of ClosureTurf®.
 - Completion of quality assurance verification testing.
 - Additional notes including rejection of materials, condition of delivered materials and other materials included with the shipments.
3. Verify ClosureTurf® rolls are delivered with opaque protective coverings.
 4. Verify ClosureTurf® rolls are unloaded, handled, and transported with nylon or other cloth straps that do not damage the ClosureTurf® rolls or the protective coverings.
 5. Verify ClosureTurf® rolls are stored and protected from damage and damaged protective coverings are replaced.
 6. Verify ClosureTurf® rolls are stacked only five rolls high and a 3-foot wide access path is left between the stacked rows of ClosureTurf®.
 7. Identify and separate damaged or rejected ClosureTurf® rolls.
 8. Determine which ClosureTurf® rolls will be sampled for quality assurance verification testing by either individual roll numbers, batch/lot numbers, or production dates. Select one ClosureTurf® roll for sampling and testing for every 100,000 square feet of material delivered to the site. Identify selected rolls and separate the rolls so that the rolls are stored on the top row of the five-roll stack.
 9. Sample the selected ClosureTurf® rolls for quality assurance verification testing using the following sampling procedure:
 - Cut and remove the first three feet of ClosureTurf® material from across the entire width of the roll. Store this first three feet of material near the stacked rolls of ClosureTurf® for later use by the Installer.
 - Cut and remove the next 18 inches of material from across the entire width of the roll. This 18-inch section of material is the quality assurance verification testing sample.

- Assign a quality assurance verification test number to the sample and mark the following information directly on the sample with a white paint marker.
 - Machine direction of the sample.
 - Manufacturer's ClosureTurf® roll number.
 - Quality assurance verification test number.

10. Immediately re-wrap the sampled ClosureTurf® roll with its protective covering. Use additional impermeable plastic sheeting if needed to completely cover the roll.

11. Complete the Geosynthetics Test Request and Sample Custody Log and ship samples to the geosynthetics testing laboratory via overnight delivery.

12.2 PRODUCTS

12.2.1 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

The following quality assurance verification testing will be performed by the geosynthetics testing laboratory to verify compliance with the ClosureTurf® product requirements of the technical specifications which are provided in Table 8:

1. ClosureTurf®

- Yarn Weight (ASTM D5261)
- CBR Puncture (ASTM D6241)
- Tensile Strength of Product (ASTM D4595)
- Tensile Strength of Yarn (ASTM D2256)

Upon completion of the above quality assurance verification testing and receipt of the testing results, the CQA Organization will review all test results for compliance with the technical specifications. The CQA Organization will report non-compliance to the Design Engineer.

Additional quality assurance verification testing or correction action measures as the result of non-complying test results will be determined by the Design Engineer.

12.3 EXECUTION

12.3.1 CQA PREPARATION

Prior to ClosureTurf® installations, perform the following CQA verification procedures:

1. Hold preparatory meeting in accordance with Section 4.4 of this CQA Plan.
2. Verify geomembrane installation is complete and in accordance with the technical specifications.
3. The geomembrane surface is free of stones or debris that could damage the turf or geomembrane during the turf installation process.

12.3.2 CLOSURETURF® INSTALLATIONS CQA

1. In general, verify ClosureTurf® is installed in accordance with manufacturer's instructions.
2. Verify ClosureTurf® is deployed from the top of the slope in a manner where the leading edge of the roll stays at the top of the slope with the grass filaments pointing up the slope.
3. Verify installation equipment or methods do not damage underlying geomembrane by handling, traffic, leakage of hydrocarbons, or by other means. Verify small equipment such as generators are placed on rub sheets above geosynthetics materials.
4. Verify ClosureTurf® is adequately ballasted during placement operations and that ballast is left in place until geotextile is covered with the overlying cover sand layer.
5. Verify ClosureTurf® is installed with sufficient tension to prevent excessive overlapping, insufficient overlapping, wrinkles, and folds.
6. Verify ClosureTurf® panels are overlapped with sufficient material to create a thermal bond or prayer fold for sewing operations.
7. Verify the seaming operations use stitching or thermal bonding. Seaming must be performed using a 4-inch overlap. Stitched seams shall be fastened with a heavy-duty textile stitching machine or equivalent means. A prayer-type seam is constructed using a Nulong sewing machine or approved equivalent. Sewing shall use 207 polyester thread or equivalent.
8. Verify no horizontal seams are placed on side slopes greater than 10-percent, except when part of a patch.
9. Verify stitching operations do not expose woven geotextiles
10. Verify rocks, excessive dust, excessive moisture, or other materials that could hamper sewing operations are not entrapped under the ClosureTurf® or within the overlap.

11. Verify in-place ClosureTurf® is not left exposed and uncovered beyond the time limitations recommended by the Manufacturer.
12. Verify the ends of the ClosureTurf® panels are permanently anchored in the anchor trench and covered with a minimum of 2-feet of soil after seaming operations are completed and sand ballast has been placed.
13. Verify the ClosureTurf® and underlying geosynthetics are not damaged or displaced during placement of the sand ballast layer. Sand material shall be placed over the ClosureTurf® system with equipment ground pressure less than five pounds per square foot (psi). No equipment shall be left running and unattended over the constructed ClosureTurf® system.

12.3.3 CLOSURETURF® REPAIR CQA

Verify damaged ClosureTurf® is removed entirely or repaired in accordance with the following guidelines:

1. Sand shall be removed from the area surrounding the repair to prevent migration of sand into the SGN drainage layer. Sand removal shall be performed using a blower, vacuum, or other means that will not damage the underlying geomembrane.
2. Holes or tears in the turf shall be repaired by placing a patch extending 2 feet beyond the edges of the hole or tear.
3. Where the hole or tear width across the roll is more than 50 percent of the roll width, the damaged area will be cut out across the entire roll, and the two portions of the turf will be joined.
4. All artificial turf repairs will be completed using a heatbond seam, achieved with either a hand held Leister or a Varimat V2 leistering machine.

13.0 SAND BALLAST CQA

13.1 GENERAL

13.1.1 SECTION SUMMARY

CQA monitoring procedures to verify sand ballast materials and construction methods of the ClosureTurf® system are in compliance with the technical specifications.

13.2 PRODUCTS

The sand layer shall have a minimum thickness of ½ inch and a maximum thickness of ¾ inch. The sand shall be worked into the turf layer as in-fill between the synthetic yarn blades. The physical characteristics of the sand layer shall be evaluated through laboratory testing prior to construction and will be visually inspected during construction. The sand shall be tan or light brown in color. Additional materials testing during construction will be at the discretion of the CQA Consultant based on the variability of material observed by the CQA Consultant and/or if the sand source is changed.

13.2.1 PRODUCT QUALITY ASSURANCE VERIFICATION TESTING

Verify the sand ballast consists of a highly permeable sand with a Universal Soil Classification of SW or SP and meets the graduation requirements presented in Table 9 prior to delivery of the ballast material.

13.3 EXECUTION

13.3.1 CONSTRUCTION AND CQA PREPARATION

Prior to sand ballast placement, perform the following CQA verification procedures.

1. Hold a preparatory meeting in accordance with Section 4.4 of this CQA Plan.
2. Verify underlying geosynthetics and turf installation is complete and in accordance with the technical specifications.

13.3.2 SAND BALLAST CQA MONITORING

The Installer shall place the sand ballast in the geotextile artificial turf in accordance with the following:

1. The ½-inch to ¾-inch thick sand ballast layer shall be installed in two lifts of ¼-inch to ½-inch thickness.
2. No equipment shall be allowed on slopes exceeding 15% until the sand ballast is in place. On flatter slopes, ATV and vehicles will be allowed prior to sand ballast placement if the tire pressure is less than 15 psi.
3. Precautions must be taken to ensure that the geosynthetics are not displaced as the sand ballast is being placed.
4. Placement of the sand ballast shall not occur with snow or ice on the artificial turf and must occur during dry weather conditions.

During construction, the CQA Organization will:

1. Verify that grade control is performed prior to work.
2. Verify that underlying geosynthetic installations are not damaged during placement operations. Identify and mark damaged geosynthetics and verify that damage is repaired.
3. Verify that a minimum thickness of ½ inch and a maximum thickness of ¾ inches of sand is placed on the synthetic turf. Frequency will be 10 measurements per acre of turf installed. Additional measurements shall be taken if the CQA Organization visually identifies areas that appear to have insufficient sand ballast.
4. Examine 12-inch by 12-inch grids, and verify that a minimum of 90% of the HDPE grass blades protrude through the ballast. The exposed blades shall be counted in a representative area and compared to the standard grass blade count of uncovered material. The percentage of protruding blades shall be calculated, and sand shall be adjusted accordingly. A minimum of 4 tests shall be conducted per acre, and any increased frequency shall be at the discretion of the CQA Organization.
5. Verify the sand ballast is spread using blower equipment, ATVs with oscillating brushes, golf type equipment, or a combination of these. Sand placement shall be monitored to verify that underlying geosynthetic installations are not damaged during sand placement, and to verify that a sufficient thickness of sand is applied. Proper embedment of the sand is essential to prevent migration of the sand during storm events. Special care shall be taken to ensure proper sand embedment and HDPE blade protrusion through the sand ballast.

TABLES

**TABLE 1. NORTH HOLDING POND
SOIL TESTING STANDARDS**

Number	Testing Standard	Description
1	AASHTO T11	Standard Method of Test for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing
2	ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3	ASTM D 698	Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
4	ASTM D 2216	Standard Test Method for Laboratory Determination of Water Moisture Content of Soil and Rock
5	ASTM D 2434	Standard Test Method for Permeability of Granular Soils
6	ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods
7	ASTM D 2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
8	ASTM D 4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
9	ASTM D 5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

**TABLE 2. NORTH HOLDING POND
GEOSYNTHETICS TESTING STANDARDS**

Number	Testing Standard	Description
1	ASTM D 792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
2	ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
3	ASTM D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
4	ASTM D 1603	Standard Test Method for Carbon Black Content in Olefin Plastics
5	ASTM D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
6	ASTM D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane
7	ASTM D 7466	Standard Test Method for Measuring Asperity Height of Textured Geomembranes
8	ASTM D 4833	Standard Test Method for Index Puncture of Geotextiles, Geomembranes, and Related Products
9	ASTM D 6392	Standard Practice for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
10	ASTM D 4437	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes

**TABLE 3. NORTH HOLDING POND
EARTHWORKS SCHEDULE OF TESTING FREQUENCIES**

MATERIAL	REQUIRED TESTING	MINIMUM SPECIFICATION	TESTING FREQUENCY
UNCLASSIFIED FILL - PRE-CONSTRUCTION TESTING			
Unclassified Fill	Moisture Density Relations ASTM D698		1 test per material type
			1 check point per 10,000 yd ³
	Visual Examination		Continuous during excavation operations
	Nuclear Density-Moisture ASTM D 6938	95% Max. Dry Density	1 test per 500 yd ³ of in-place material, or one test per 500 lf in backfilled trenches
	Drive-Cylinder Density ASTM D2937	+/- 3% Optimum Moisture	1 test per 30 Nuclear Density-Moisture tests
UNCLASSIFIED FILL - CONSTRUCTION TESTING			
Unclassified Fill	Moisture Density Relations ASTM D698		1 check point per 10,000 yd ³
	Visual Examination		Continuous during excavation operations
	Nuclear Density-Moisture ASTM D 6938	95% Max. Dry Density	1 test per 500 yd ³ of in-place material
	Drive-Cylinder Density ASTM D2937	+/- 3% Optimum Moisture	1 test per 30 Nuclear Density-Moisture tests
SUBGRADE - CONSTRUCTION TESTING			
Subgrade	Moisture Density Relations ASTM D698	95% Max. Dry Density +/- 3% Optimum Moisture	1 test per material type

**TABLE 4. NORTH HOLDING POND
SOIL LINER SCHEDULE OF TESTING FREQUENCIES**

REQUIRED TESTING	MINIMUM SPECIFICATION	TESTING FREQUENCY
PRE-CONSTRUCTION TESTING		
Visual Examination		Continuous during excavation from borrow area
Grain Size Distribution ASTM C136	> 30% Passing # 200 100% Passing 1-inch	1 test per source
Atterberg Limits ASTM D 4318	LL $\geq$ 30 PI > 15	1 test per source
Hydraulic Conductivity ASTM D 5084	$K \leq 1 \times 10^{-7}$ cm/s	One per Moisture Density Relations
Moisture Density Relations ASTM D 698		1 test per material type
Oven Moisture Content ASTM D 2216		1 per nuclear density test until correlation is established (minimum 10)
CONSTRUCTION TESTING		
Grain Size Distribution ASTM C 136	> 30% Passing # 200 100% Passing 1-inch	1 test per 1,850 yd ³
Atterberg Limits ASTM D 4318	LL > 30 PI > 15	1 test per 1,850 yd ³
Hydraulic Conductivity ASTM D 5084	$K \leq 1 \times 10^{-7}$ cm/s	1 per acre per 6-inch lift
Moisture Density Relations (check point) ASTM D 698		1 test per 6,500 yd ³
Drive Cylinder ASTM D 2937		1 per 20 nuclear tests
Oven Moisture Content ASTM D 2216		1 per nuclear density test until correlation is established (minimum 10)
Nuclear Density-Moisture ASTM D 6938		6 tests per lift per acre

**TABLE 5. NORTH HOLDING POND
GCL SCHEDULE OF TESTING FREQUENCIES**

MATERIAL	REQUIRED TESTING	MINIMUM SPECIFICATION	MANUFACTURER OR SUPPLIER	MQC TESTING FREQUENCY	CONFORMANCE TESTING FREQUENCY
GEOSYNTHETIC CLAY LINER (GRI - GCL3)					
GCL	Bentonite Mass Per Unit Area (ASTM D5993)	0.75 lb/ft ²		1 per 40,000 ft ²	1 per 100,000 ft ²
	Bentonite Moisture Content (ASTM D2216)	<= 35%		1 per 40,000 ft ²	
	Tensile Strength (ASTM D6768)	23 lb/in		1 per 200,000 ft ²	
	Hydraulic Conductivity (ASTM 5084)	5x10 ⁻⁹ cm/sec		1 per week/production line	1 per 100,000 ft ²
	Peel Strength (D6496)	2.1 lb/in		1 per 5,000 yd ²	
Bentonite	Free Swell Index (ASTM D5890)	24 ml	1 per 50 tons	1 per 50 tons	
	Fluid Loss (ASTM D5891)	18 ml	1 per 50 tons	1 per 50 tons	
Geotextile	Mass/Unit Area (ASTM D5261)	3 oz/yd ²	1 per 200,000 ft ²		
	Grab Tensile Strength (ASTM D4632)	90 lb	1 per 200,000 ft ²		

**TABLE 6. NORTH HOLDING POND
LLDPE SCHEDULE OF TESTING FREQUENCIES**

MATERIAL	REQUIRED TESTING	MINIMUM SPECIFICATION	TESTING FREQUENCY
GEOMEMBRANE PROPERTIES (GRI GM-17) & MQC TESTING FREQUENCY			
Geomembrane	Asperity Height (ASTM D 7466).	16	every 2nd roll
	Grab Tensile Strength (ASTM D4632)	0.939 g/cc	200,000 lb
	Tensile Properties (ASTM D 6693)		20,000 lb
	1. Break Strength	75 lb/in (min. avg)	
	2. Break Elongation	250% (min. avg)	
	2% Modulus (ASTM D5323)	3000	per formulation
	Tear Resistance (ASTM D1004)	27	45,000 lb
	Puncture Resistance (ASTM D 4833)	55 (min. avg)	45,000 lb
	Drainage Stud Height	0.13 inches	per roll
	Carbon Black Content (ASTM D 4218)	2%-3%	20,000 lb
	Carbon Black Dispersion (ASTM D 5596)	See Note 1	45,000 lb
	Oxidative Induction Time - Standard (ASTM D 3895)	100 hours	200,000 lb
	Oxidative Induction Time - High Pressure (ASTM D 5885)	400 Min.	200,000 lb
	Oven Aging @ 85°C (ASTM D 5721)		Per Each Formulation
	a. Standard OIT (min. ave. - % retained after 90 days) (ASTM D 3895)	35%	
	b. High Pressure OIT (min. ave. - % retained after 90 days) (ASTM D 5885)	60%	
	UV Resistance (ASTM D7238)		Per Each Formulation
	a. Standard OIT (min. ave.) (ASTM D 3895)	Not Recommended	
	b. High Pressure OIT (min. ave. - % retained after 1600 hrs) (ASTM D 5885)	35%	
Resin	Density (ASTM D 1505 or ASTM D 792 Method B	0.932 g/cm3	1 per Resin batch
	Melt Index (ASTM D 1238 Condition E)	< 1.0 g per 10 minutes	1 per Resin batch
	Oxidative Induction Time	100 hr.	1 per formulation
	Standard OIT or High Pressure OIT (ASTM D 3895 or ASTM D 5885)	400 min.	1 per formulation
Extrudate or Bead	Density (ASTM D 1505 or ASTM D 792 Method B	0.939 g/cm3	1 per resin lot or batch
	Carbon Black Content (ASTM D 1603)	2-3%	
	Melt Index (ASTM D 1238 Condition E)	< 1.0 g per 10 minutes	

**TABLE 6. NORTH HOLDING POND
LLDPE SCHEDULE OF TESTING FREQUENCIES**

MATERIAL	REQUIRED TESTING	MINIMUM SPECIFICATION	TESTING FREQUENCY
QUALITY ASSURANCE GEOMEMBRANE TESTING			
Geomembrane	Density (ASTM D 792 or 1505)	0.939 g/cc	1 test per 100,000 ft ²
	Tensile Properties (ASTM D 6693)		
	1. Break Strength	60 lb/in (min. avg)	
	2. Break Elongation	100% (min. avg)	
	Carbon Black Content (ASTM D 1603)	2%-3%	
	Carbon Black Dispersion (ASTM D 5596)	See Note 1	
	Thickness (ASTM D 5994)	47.5 mil (min avg)	
	Asperity Height (ASTM D 7466).	16	
	Puncture Resistance (ASTM D 4833)	55 (min. avg)	
Seam Analysis (ASTM D 6392)			
Peel	Peel Strength (ASTM D4437)	Fusion 63 lb/in Extrusion 57 lb/in	1 test per 500 linear feet of welded seam to start, then method of attributes
	Elongation	min. 50% ²	
Shear	Shear (ASTM D4437)	75 lb/in	

Notes:

- Carbon black dispersion (only near spherical agglomerates) for 10 different views:
* 9 in Categories 1 or 2 and 1 in Category 3
- Elongation measurements should be omitted for field testing.

**TABLE 7. NORTH HOLDING POND
DESTRUCTIVE SAMPLING INTERVALS**

Percent of Passing Seam Analysis	Sampling Modifications*
100	Decrease interval to 1000 LF
90-100	Decrease interval to 750 LF
60-90	Maintain interval at 500 LF
30-60	Increase interval to 250 LF

*Note that sampling modifications will not be considered until 20 percent of testing is completed.

**TABLE 8. NORTH HOLDING POND
CLOSURE TURF SCHEDULE OF TESTING FREQUENCIES**

REQUIRED TESTING	MINIMUM SPECIFICATION	MQC TESTING FREQUENCY	CONFORMANCE TESTING FREQUENCY
Yarn Weight (ASTM D5261)	>= 20 oz/sq yard	1 test per 100,000 ft ²	1 test per 50,000 ft ²
Tensile Strength of Yarn (ASTM D2256)	15 lb min.	1 test per 100,000 ft ²	1 test per 50,000 ft ²
CBR Puncture (ASTM D6241)	1500 lb. (MARV)	1 test per 100,000 ft ²	1 test per 50,000 ft ²
Tensile Product (MD/XD) (ASTM D4595)	2100 MD/ 1600 XD lb/ft MARV	1 test per 100,000 ft ²	1 test per 50,000 ft ²
Interface Friction (ASTM D5321)	21(d) Peak	1 test per 100,000 ft ²	None
Engineered Turf Fiber UV Stability (ASTM G147)	>60% retained @ 100 years	1 test per 100,000 ft ²	None
Backing System UV Stability (Exposed) (ASTM G154)	110 lb/ft retained at 6,500 hrs	1 test per 100,000 ft ²	None

**TABLE 9. NORTH HOLDING POND
SAND BALLAST SCHEDULE OF TESTING FREQUENCIES**

REQUIRED TESTING	MINIMUM SPECIFICATION	PRE-CONSTRUCTION TESTING	CONSTRUCTION TESTING
CONFORMANCE TESTING			
Visual Examination			Continuous during placement operations
Void Content - Method A (ASTM C1252)	>= 40%	1 test per source	1 test per 175 yd ³
Relative Density (ASTM C128)	>= 2.40	1 test per source	1 test per 175 yd ³
Sieve Analysis - (ASTM C 136)	See Specification	1 test per source	1 test per 175 yd ³

APPENDIX A

TECHNICAL SPECIFICATIONS

SECTION 01050 SURVEYING

PART 1 GENERAL

1.01 SECTION SUMMARY

- A. Surveying requirements.
- B. Submittals.
- C. Surveying performed by OWNER.
- D. Construction staking performed by CONTRACTOR to layout the Work.
- E. Surveying performed by OWNER to determine measurement and payment quantities.
- F. Surveying performed by OWNER to prepare as-built record drawings.
- G. Surveying Accuracy and Tolerances.

1.02 SURVEYING REQUIREMENTS

- A. Employ a Land Surveyor registered in the State of Texas and acceptable to OWNER, to perform survey work described in this Section.

1.03 SUBMITTALS

- A. Submit with bid, name, address, and phone number of proposed Land Surveyor.
- B. Submit before starting survey work, certificate of Land Surveyor's Errors and Omissions current insurance coverage.
- C. Submit upon request, documentation verifying the accuracy of the survey work.

1.04 SURVEYS PERFORMED BY OWNER

- A. OWNER has reference control points and benchmark elevations in the vicinity of the project. OWNER will provide drawing and/or coordinates of the reference control points prior to construction. All other necessary reference points to perform the Work will be established by CONTRACTOR. CONTRACTOR will replace any pins, hubs, benchmarks, or other survey markers destroyed or displaced by CONTRACTOR at CONTRACTOR's expense.
- B. OWNER will perform surveying for Certification Surveys and As-Built Record Drawings.
- C. OWNER may use line and grade points and markers established by the CONTRACTOR as part of the Work.

1.05 CONSTRUCTION STAKING TO LAYOUT AND PERFORM THE WORK

- A. CONTRACTOR will provide initial construction staking necessary to commence construction. CONTRACTOR will provide grade staking as required to complete the work in accordance with the Drawings and Technical Specifications.

1.06 SURVEYING FOR AS-BUILT RECORD DRAWINGS

- A. OWNER will perform the following as-built surveys and provide record drawings at 50-scale for the following items.
 - 1. Limits, contours, and grade breaks of subgrade on 50-foot point-over-point grid (x,y,z).
 - 2. Limits, contours, and grade breaks of soil liner on 50-foot point-over-point grid (x,y,z) for layer thickness verification.
 - 3. Limits of landfill geomembrane installation at 50-foot stations (x,y,z) and angle points.
 - 4. Alignment and grade of stormwater ditches and stormwater culvert pipes at 50-foot stations (x,y,z) and angle points.
 - 5. Alignment, width and grade of all roadways at 50-foot stations (x,y,z) and angle points.

1.08 SURVEYING ACCURACY AND TOLERANCES

- A. Perform control traverse field surveys and computations to an accuracy of 1:10,000.
- B. Tolerances for setting survey stakes are as follows.

Type of Point	Horizontal Position	Elevation
Permanent reference points	1: 10,000	±0.01 foot
Earthwork	1: 2,000	±0.10 foot

- C. Tolerances for thickness and elevations of the granular drainage layer and cover soil layer are as follows unless otherwise specified.
 - 1. Soil Liner Layer Thickness - 0.0 / + 0.1 foot
 - 2. Elevations ± 0.10 foot
 - 3. Line ± 0.30 foot

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END SECTION 01050

SECTION 02220 EARTHWORK

PART 1 GENERAL

The directives outlined in this document apply to the WORK performed by the CONTRACTOR unless otherwise noted.

1.01 SECTION SUMMARY

A. Excavation

1. Excavation of suitable earth fill materials to construct the unclassified fill and compacted soil liner for the final cover system.

B. Unclassified Fill

1. Unclassified fill to achieve design grades in the landfill closure limits.

1.02 RELATED SECTIONS

A. Section 1050 – Surveying

B. Section 02250 – Soil Liner

1.03 REFERENCES

- A. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
- B. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.
- C. ASTM D2937 Density of Soil in Place by the Drive-Cylinder Method.

1.04 QUALITY ASSURANCE VERIFICATION TESTING AND DESIGNATION OF MATERIAL TYPES

- A. CQA ORGANIZATION will perform the following quality assurance verification testing prior to and during embankment operations.
 1. Moisture-density relations (ASTM D698) to determine the maximum dry density and optimum moisture content for each different type of embankment material.
 2. Nuclear density and moisture content (ASTM D 6938) to verify relative compaction.
 3. In-place density by the drive-cylinder method (ASTM D2937) to verify that the nuclear density gauge is working properly and providing reliable test results

- 4. Visual examination and sampling to verify that embankment materials contain no organic, saturated, oversized, or other unsuitable materials.
- B. The CONTRACTOR shall cooperate with CQA ORGANIZATION in the performance of quality assurance verification testing.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. Removed from on-site unclassified fill and soil liner borrow sources.
- B. Topsoil and organic soil contain organic material (grassy vegetation, roots, etc.).

2.02 UNCLASSIFIED FILL

- A. Obtained from on-site borrow sources.
- B. Free of organic, saturated, oversized, or other unsuitable materials.
- C. Maximum particle size of four (4) inches, unless otherwise approved by Engineer.

2.03 CONSTRUCTION WATER

- A. Obtain from OWNER provided source.

PART 3 EXECUTION

3.01 PREPARATION AND EXAMINATION

- A. Locate, identify, and protect all utilities and existing structures from damage (including overhead and suspended utilities).
- B. Coordinate with utility company and OWNER to locate utilities, if applicable.
- C. Provide dust control. Water haul roads several times each day and when requested by OWNER.
- D. Coordinate traffic control and barricades with OWNER.
- E. Coordinate operations and haul routes with site operations. Maintain OWNER's access to and from operating facilities.
- F. CONTRACTOR will provide construction staking and grade control. Establish lines, grade, contours and datum. Protect temporary benchmarks and offset construction staking.
- G. OWNER will perform topographic surveys and mapping prior to starting any excavation or fill for measurement and payment purposes.
- H. Perform and provide as-built surveys in accordance with Section 01050.

3.02 TOPSOIL

- A. Strip and remove surface of all vegetation, roots, and organic soil.
- B. Stockpile topsoil at the direction of the OWNER and CQA ORGANIZATION.
- C. Upon completion of borrow area grading, place topsoil uniformly over the borrow area.

3.03 EXCAVATION

- A. Strip and remove surface of all vegetation, roots, and organic soil.
- B. Excavate borrow source to the limits, lines, and grades at the direction of the OWNER and CQA ORGANIZATION.
- C. Contractor responsible for stormwater control and will be required utilize best management practices (BMP)s to manage stormwater run-on/run-off.
- D. Grade perimeter of excavation to prevent surface water run-off from entering the excavation.
- E. Dewater excavation as necessary.
- F. Notify OWNER of unexpected subsurface conditions. Discontinue work in affected area until notified to resume work by the OWNER or CQA ORGANIZATION.
- G. If waste is encountered during grading activities or excavation activities, work will stop and the CQA ORGANIZATION notified to determine action. Contractor may be required to remove waste and stockpile, unless adequate cover can be established to maintain design requirements.

3.04 UNCLASSIFIED FILL

- A. Place unclassified fill to the limits, lines and grades as shown on the Drawings.
- B. Place in loose lifts not exceeding 8-inches. Unclassified fill thickness will vary depending starting grade and design grade established.
- C. Moisture condition each lift to ± 3.0 percent of the optimum moisture content and compact to a minimum of 95 percent relative compaction as determined by ASTM D698. Unclassified fill compacted to densities lower than the specified minimum density (95%), or unclassified fill compacted at a moisture content outside the specified acceptable range shall be reworked in-place to meet the density and moisture requirements or removed and replaced by acceptable unclassified fill compacted to meet requirements by the CONTRACTOR. Sample quantities are listed in the CQA tables associated with these specifications. Locations not meeting required density and moisture content will be reworked at the contractor's expense, until verified passing by CQA ORGANIZATION.
- D. Scarify the top of each lift prior to placing subsequent lifts. Additional scarifying is not required if a sheep-foot or pad-foot compactor is used for compaction.

- E. Maintain embankment lift surfaces to prevent moisture loss and desiccation cracking. Repair desiccated areas prior to placing subsequent lifts.
- F. Do not place frozen unclassified fill material or place material over frost or snow impacted base layer.

3.05 FINAL SUBGRADE PREPARATION

- A. Grade final subgrade surface to the limits, lines, and grades as shown on the Drawings. Fine grade to a tolerance of 0.0 to 0.10 feet below design grade.
- B. Maintain subgrades to prevent moisture loss and desiccation cracking. Repair desiccated areas.
- C. Remove all debris and rocks greater than 1-inch in diameter from the completed surface.
- D. Roll the completed surface with a steel drum roller. *For clay liner subgrade, remove ridges, gouges and ruts greater than 1-inch.*
- E. Moisture condition completed surface as necessary.
- F. OWNER will perform as-built survey of completed borrow source and unclassified fill in accordance with Section 01050. As-built survey must be completed, submitted, and accepted prior to soil liner construction.
- G. OWNER will perform and provide measurement and payment surveys in accordance with Sections 01050.

END SECTION 02220

SECTION 02223 TRENCHING AND BACKFILLING

PART 1 GENERAL

The directives outlined in this document apply to the WORK performed by the CONTRACTOR unless otherwise noted.

1.01 SECTION SUMMARY

- A. Trenching and backfilling.

1.02 RELATED SECTIONS

- A. Section 01050 - Surveying
- B. Section 02220 - Earthworks
- C. Section 02771-1 - LLDPE Geomembrane

PART 2 PRODUCTS

2.01 UNCLASSIFIED FILL

- A. In accordance with Section 02220

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide alignment control staking at 50-foot stations for anchor trenches.
- B. Locate, identify, and protect utilities and existing structures from damage.

3.04 ANCHOR TRENCHES

- A. Excavate at locations and to dimensions shown on the Drawings.
- B. Round inside edge of anchor trench or protect with 4-foot wide strip of geotextile cushion. Remove materials from trench that may damage geomembrane.
- C. Backfill anchor trench with earthfill or material excavated from the trench (if material meets specifications outlined by Section 02220 – Earthworks) to dimensions shown on the Drawings and only after engineered turf layer placement operations are complete.
- D. Place earthfill in loose 12-inch lifts.
- E. Moisture condition and compact each lift with manual hand tampers or by wheel-rolling with rubber tired equipment to a minimum 95 percent relative compaction as determined by ASTM D698.

- F. Repair damaged geomembrane if damage occurs during trenching and backfill operations. The CONTRACTOR shall be responsible for repairs to the geomembrane at no additional cost to the OWNER.
- G. Remove geomembrane and closure turf tails so that material is adequately covered in the anchor trench and the terminal ends do not surface.
- H. Receive approval from QCA Organization prior to backfilling anchor trenches.

END SECTION 02223

SECTION 02250 SOIL LINER

PART 1 GENERAL

The directives outlined in this document apply to the WORK performed by the CONTRACTOR unless otherwise noted.

1.01 SECTION SUMMARY

- A. Quality assurance verification and testing.
- B. Excavation and processing of liner material from on-site borrow source.
- C. Construction of soil liner test pad.
- D. Construction and maintenance of soil liner.

1.02 RELATED SECTIONS

- A. Section 01050 - Surveying
- B. Section 02220 - Earthwork
- C. Section 02271-1 - LLDPE Geomembrane
- D. Section 02774 - Geosynthetic Clay Liner

1.03 REFERENCES

- A. ASSHTO T11 #200 Sieve Wash of Soils and Aggregates.
- B. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
- C. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
- D. ASTM D2216 Laboratory Determination of Water (Moisture) Content of Soil and Rock.
- E. ASTM D2937 Density of Soil in Place by the Drive-Cylinder Method.
- F. ASTM D6938 In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.
- G. ASTM D4318 Determining Liquid Limit, Plastic Limit, and Plasticity Index for Soils.
- H. ASTM D5084 Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

1.04 SUBMITTALS

- A. Submit the following with the Contractor's bid:
 - 1. List of proposed equipment and description of construction methods to excavate, moisture condition, haul, place, compact, finish, maintain, and protect soil liner in accordance with this Section.
- B. Submit the following information at least 5 days prior to delivery of bentonite amendment material (if used) used for mixing with soil liner material:
 - 1. The type and origin of the bentonite component (natural sodium, sodium enriched bentonite, or calcium bentonite)
 - 2. The montmorillonite content
 - 3. Content of materials other than montmorillonite.
 - 4. Presence or absence of polymers or additives.

1.05 QUALITY ASSURANCE VERIFICATION TESTING

- A. CQA ORGANIZATION will perform the following quality assurance verification testing prior to and during soil liner operations.
 - 1. Determine amount of bentonite addition required to be applied to borrow soils to achieve a hydraulic conductivity of 1×10^{-7} cm/s and meet the requirements set forth in the technical specifications 30-days prior to construction of the test pad.
 - 2. Apply moisture-density relations to determine a "Zone of Acceptable Compaction" for each different type of soil liner material. The "Zone of Acceptable Compaction" will establish a relationship of in-place dry density and moisture content that achieve the specified permeability of the soil liner. The "Zone of Acceptable Compaction" is for guidance only; passing criteria for the in-place soil liner is permeability.
 - 3. Nuclear density and moisture content.
 - 4. In-place density by the drive-cylinder method used to verify nuclear density tests.
 - 5. Oven-dried moisture content.
 - 6. Atterberg Limits.
 - 7. Particle size analysis and #200 washes.
 - 8. Hydraulic conductivity.
 - 9. Visual examination and sampling to verify soil liner materials contain no organic, saturated, oversized, or other unsuitable materials.

- B. The CONTRACTOR shall cooperate with CQA ORGANIZATION in the performance of quality assurance verification testing.
- C. Allow up to 10 days for hydraulic conductivity testing for any given area or lift.

PART 2 PRODUCTS

2.01 SOIL LINER

- A. The CONTRACTOR shall obtain soil liner material from on-site borrow area. On-site soils must meet the following requirements:
 - 1. Percent passing (by weight), of fine material passing the No. 200 sieve greater than 30 percent.
 - 2. Percent passing (by weight), of fine material passing the one inch sieve equal to 100 percent.
 - 3. Plasticity index (PI) greater than 15 percent.
 - 4. Liquid Limit (LL) greater than or equal to 30.
 - 5. Free of organic, saturated, oversized, or other unsuitable materials.
 - 6. Hydraulic conductivity less than or equal to 1×10^{-7} when moisture conditioned, placed, and compacted in accordance with this Section.
- B. Addition of bentonite amendment to on-site soils may be required to meet the specifications outlined in Section 2.01.A. Bentonite used for amendment shall be in granular or pulverized form.
- C. Off-site borrow materials may be used if the material meets the requirements of these specifications without bentonite amendments. The proposed soil liner materials shall be approved by the OWNER and the DESIGN ENGINEER prior to use.
- D. Required proportion of on-site soils and bentonite, and the suitability of the soil liner material shall be verified by the CQA ORGANIZATION by evaluation and testing conducted by the CQA ORGANIZATION prior to and as part of the test pad construction.

2.02 CONSTRUCTION WATER

- A. Obtain from OWNER furnished source. Contractor required to haul water to the project location.

PART 3 EXECUTION

3.01 PREPARATION OF BENTONITE AMENDED SOIL LINER MATERIAL

- A. If onsite soils require bentonite amendments to meet the specified soil liner requirements, the following procedures shall be implemented to prepare the bentonite amended soil liner material:
 - 1. Use a soil liner material as determined by pre-construction testing and outlined in 2.01. The soil liner material shall be placed in measured loose lifts with a measured quantity of bentonite and blended using a rotary mixer (Caterpillar RM300 or DESIGN ENGINEER approved equivalent). Care shall be taken to not incorporate subgrade soils into the bentonite/soil blend.
 - 2. Do not apply water during the first three passes of the rotary mixer. Water may be added after the initial three passes.
 - 3. Water shall be added in a uniform manner either with the rotary mixer and the materials moisture conditioned to within 2% of the optimum moisture content or slightly higher in extreme heat conditions to account for moisture loss due to evaporation. The material will be hydrated for a minimum of 24 hours prior to placement as liner. The remaining water required to reach the appropriate water content may be added to the soil in-place during liner placement and compaction.
- B. Contractor shall blend the material in the mixing area prior to placement in the test pad. Samples will be obtained for hydraulic conductivity testing and tested prior to placement by the CQA ORGANIZATION. Samples will be remolded at the testing laboratory within the range specified in this section. Pre-construction tests shall be performed for hydraulic conductivity by the CQA ORGANIZATION to verify the blended material meets the hydraulic conductivity specification of 1×10^{-7} cm/sec or lower.

3.02 TEST PAD CONSTRUCTION

The intent of the test pad is to simulate construction of the actual soil liner in the landfill cell including processing, moisture conditioning, bentonite addition, lift thickness, placement, grading, compaction efforts, and finishing operations. The intent of the test pad is to also verify that requirements of this specification can be met.

- A. Construct test pad a minimum of 14 days prior to actual soil liner construction.
- B. Use equipment and construction methods used proposed to construct the soil liner to construct the test pad.
- C. Test pad shall consist of a minimum 2-foot thick fill of soil liner material. Construct test pad with a top deck of 25-feet wide by 50-feet long. Provide 4H:1V ramps onto and off the pad along the width of the pad and a 2H:1V slope the length the pad. The DESIGN ENGINEER shall provide a drawing for the configuration of the test pad prior to construction.
- D. Do not contaminate soil liner material with any other soil materials.

- E. Construct test pad in accordance with Parts 3.03 and 3.04 of this Section.
- F. CQA ORGANIZATION will document construction equipment and methods and perform quality assurance verification testing outlined in Part 1.05 of this Section. The DESIGN ENGINEER will review the results of test pad construction and may modify the construction requirements and testing criteria specified in Part 3.03.

3.02 PREPARATION AND EXAMINATION OF LANDFILL CLOSURE SITE

- A. CQA ORGANIZATION shall verify landfill closure subgrade is complete and in accordance with Section 02220 Earthwork. Verification includes submission of as-built survey of completed subgrade by the OWNER and acceptance of as-built survey by the CQA ORGANIZATION.
- B. Locate, identify and protect all utilities and existing structures from damage (including overhead and suspended utilities).
- C. Provide dust control.
- D. Coordinate traffic control and barricades with OWNER.
- E. Coordinate operations and haul routes with landfill operations.
- F. Provide construction staking and grade control stakes at 50-foot grid and grade breaks or utilize construction equipment equipped with GPS grade control.
- G. Provide full-time grade checker during soil liner placement to control grade, lift thickness, and tolerances or provide equipment with GPS grade control.
- H. Protect temporary benchmarks and construction staking from disturbance during construction.

3.03 SOIL LINER CONSTRUCTION

- A. Place soil liner to the limits, lines, and grades as shown on the Drawings.
- B. Process soil liner material to meet the project specifications in accordance with the specified blend and procedures identified during construction of the test pad.
- C. Scarify liner subgrade areas to a depth of two inches to ensure adequate bonding.
- D. Place initial soil line lift at 8-inches in depth to prevent contamination of soil liner with subgrade materials.
- E. Place subsequent lifts of soil liner in loose lifts not exceeding 6-inches in thickness. Lift thickness may be adjusted (decreased) depending on permeability results. The final 1-foot thick soil liner shall consist of a minimum of 2 separate compacted lifts but may require 4 or more to achieve the required permeability. No loose lift shall be thicker than the pads of the compactor so complete bonding with the previous lift is achieved.

- F. Compact the soil liner to at least 95% of the maximum dry density (ASTM D698) at a moisture content that falls within the "Acceptable Zone of Compaction," and as confirmed, or revised as applicable, based on final test results obtained from the soil liner test pad. The moisture content and density shall be uniform throughout the lift. The CONTRACTOR shall reduce the clod size of the soil liner to a size no greater than 1-inch or a size acceptable to the CQA ORGANIZATION, the method by which shall be approved by the CQA ORGANIZATION and OWNER prior to implementation.
- G. Compact lifts with kneading pad-foot compactor and adjust moisture content to specified range.
- H. Scarify, blend, and compact lifts together to prevent smooth zones and provide bonding between lifts.
- I. Protect completed lifts from damage, desiccation, and moisture loss. Repair damaged lifts prior to placing succeeding lifts.
- J. Schedule soil liner placement operations to facilitate quality assurance verification testing. Do not place succeeding lifts until passing results for compaction, moisture content, and permeability are achieved from the completed soil liner lift.
- K. Ensure the in-place soil liner has a permeability less than or equal to 1×10^{-7} cm/sec as determined by ASTM D5084 (Method D). If soil liner does not meet the specified permeability, the CONTRACTOR shall rework areas, or remove and replace materials to meet the specified permeability. Rework to areas of failed permeability shall be completed at no additional cost to the OWNER, even if materials were placed and compacted within the "Zone of Acceptable Compaction".

3.04 FINAL SURFACE PREPARATION

- A. Remove all exposed rock protruding greater than 0.5-inch from the completed soil liner surface. In no case will sharp protrusions be allowed even if less than 0.5-inch.
- B. Grade final surface to the lines and grades shown on the Drawings within the tolerances specified in Section 01050, Part 1.08. The absolute minimum thickness is 2.0 feet and maximum thickness is 2.1 feet. Do not over build soil liner thickness.
- C. Shall use a steel drum roller to complete the surface. Remove abrupt edges, ridges, gouges, tire tracks, desiccation cracks, and ruts greater than 0.5 inches.
- D. Compact corners and other areas not accessible by driven compaction equipment utilizing hand-operated 500-pound (minimum) vibratory plate or vibratory smooth-drum compaction equipment approved by CQA ORGANIZATION and OWNER.
- E. Moisture condition completed surface as necessary to prevent desiccation.
- F. Perform as-built surveys (thickness verification) of completed soil liner prior to geomembrane installation. As-built surveys shall be provided to the CQA ORGANIZATION.

3.05 MAINTENANCE AND REPAIR

- A. Remove all hubs, grade control stakes, and survey stakes. Repair all holes with approved moisture conditioned soil liner material or bentonite/soil admixture. Compact with suitable device (e.g. jumping jack) to achieve required material compaction.
- B. Maintain and protect soil liner moisture content and surface condition within specified moisture content range until covered by geomembrane. Protective measures may include covering the soil liner with temporary plastic sheeting.
- C. Shall not allow completed surface to desiccate. If desiccation cracks are greater than 0.2 feet deep or 0.5 inches wide, excavate the full depth and along the full length of the crack, and repair with additional soil liner material. If desiccation cracks are less than 0.2 feet deep or 0.5 inches wide, moisture condition and compact with steel drum roller.
- D. Repair all weather and erosion related damage to the soil liner not covered by geosynthetics at no additional cost to the OWNER. Do not allow water to run or collect under the geosynthetics installation. If water runs or collects under the geosynthetics, causing erosion and saturation, remove geosynthetics and then remove and replace soil liner material entirely. Depending on circumstances, the soil liner material may or moisture conditioned, re-compacted, and re-finished to the requirements of 3.03 and 3.04.
- E. Repair soil liner surfaces found to be out-of-grade-tolerance as follows:
 - 1. Scarify and moisture condition (water spray) surface.
 - 2. Place additional moisture-conditioned soil liner material.
 - 3. If surface is greater than 0.1 feet out-of-grade-tolerance, compact soil liner backfill with pad-foot compactor. If surface is less than 0.1 feet out-of-grade-tolerance, compact soil liner backfill with steel drum roller.
 - 4. Grade or trim repaired surface within tolerance. Steel drum roll surface smooth.
- F. Repair wheel ruts on soil liner surface caused by geomembrane deployment equipment.

3.06 SURVEY CONTROL

- A. Surveys of soil liner shall be conducted by the OWNER to verify quantities for payment purposes and verify thickness on a 50-foot point over point grid.

END SECTION 02250

SECTION 02771-1
LINEAR LOW DENSITY POLYETHYLENE (LLDPE) GEOMEMBRANE

PART 1 GENERAL

The directives outlined in this document apply to the WORK performed by the CONTRACTOR unless otherwise noted.

1.01 SECTION SUMMARY

- A. Furnishing and installing primary geomembrane.

1.02 RELATED SECTIONS

- A. Section 02774 – Geosynthetic Clay Liner.

1.03 REFERENCES

- A. ASTM D 792 - Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- B. ASTM D 1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique
- C. ASTM D 6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
- D. ASTM D 1603 - Standard Test Method for Carbon Black Content in Olefin Plastics
- E. ASTM D 5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- F. ASTM D 5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane
- G. ASTM D 7466 - Standard Test Method for Measuring Asperity Height of Textured Geomembranes
- H. ASTM D 4833 - Standard Test Method for Index Puncture of Geotextiles, Geomembranes, and Related Products
- I. ASTM D 6392 - Standard Practice for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- J. ASTM D 4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- K. GRI GM17 Standard Specification for Supply of LLDPE Geomembrane.
- L. GRI GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.04 SUBMITTALS

- A. Submit the following 21 days before geomembrane is shipped to the site.
 - 1. A 2-foot by 10-foot sample of geomembrane material meeting the specifications outlined in Part 2.02 and containing a degree of texturization representative of the material that will be shipped to the site. Materials shipped to the site that do not contain a degree of texturization comparable to the samples will be rejected.
- B. Submit the following 14 days prior geomembrane installations.
 - 1. Geomembrane Resin.
 - a. Certificate of Compliance with product requirements of Part 2.01 of this Section.
 - b. Specific Gravity quality control test reports.
 - c. Certification listing percentages of processing aids, antioxidants, and other additives other than carbon black added to the resin.
 - 2. Geomembrane Rolls.
 - a. Samples, product data sheets, and complete description of geomembranes that meet or exceed the product requirements of Part 2.02 of this Section.
 - b. Manufacturer's quality control testing reports for geomembrane rolls delivered to the site. At a minimum, tests specified in Part 2.02 of this Section must be included in the testing reports.
 - c. Certification stating that all geomembrane rolls are furnished by one supplier and that all rolls are manufactured from one resin type obtained from one resin supplier.
 - d. Instructions for handling, storing, installing, and repairing geomembrane.
 - e. Geomembrane Installation Quality Control Manual.
 - 3. Extrusion Welding Beads and Rod.
 - a. Certificate of Compliance with product requirements of Part 2.03 of this Section.
 - 4. LLDPE Pipe Boots
 - a. Shop drawings proposed pipe boot configuration and dimensions.

5. Proposed Geomembrane Panel Layout Drawings.
 - a. Drawings showing the proposed primary and secondary geomembrane panel layouts and penetration details in compliance with Drawings and this Section.
 6. Geomembrane INSTALLER Qualifications.
 - a. Resumes must include number of lineal feet of seam welded.
 - b. Resume of geomembrane installation superintendent.
 - c. Resume of geomembrane master welder.
 - d. Resume of welding and quality control crew.
- C. Submit at the completion of the geomembrane installation.
1. Manufacturer's warranty in compliance with Part 1.05 of this Section.
 2. Installation warranty in compliance with Part 1.05 of this Section.
 3. Completed geomembrane panel layout drawings.

1.05 WARRANTIES

- A. Twenty year prorata manufacturer warranty for the primary geomembranes against deterioration due to exposure to the elements, either exposed or buried.
- B. Two year nonprorata installation warranty for the primary geomembrane installations against defects.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Notify CQA ORGANIZATION of geomembrane shipment deliveries. Provide CQA ORGANIZATION with copy of packing list.
- B. Unload, handle, transport geomembrane rolls with nylon or other cloth straps that do not damage the geomembrane rolls.
- C. Prepare a bedding layer surface in an area indicated by CQA ORGANIZATION to store the geomembrane rolls.
- D. Only stack the geomembrane rolls three high.
- E. Leave a 3-foot wide access path between the stacked geomembrane rolls.
- F. Separate damaged or rejected geomembrane rolls as directed by CQA ORGANIZATION.

1.07 QUALITY ASSURANCE VERIFICATION TESTING

- A. CQA ORGANIZATION will sample geomembrane every 100,000 square feet of material delivered to the site or produced at the manufacturing plant and perform the following quality assurance verification testing to verify compliance with the product requirements of this Section.
 - 1. Tensile Properties
 - 2. Density
 - 3. Carbon Black Content
 - 4. Carbon Black Dispersion
 - 5. Sheet Thickness
 - 6. Asperity Height
 - 7. Puncture Resistance
- B. OWNER's acceptance of geomembrane will be based on results of quality assurance verification testing. Allow 7 days to complete testing.
- C. Assist CQA ORGANIZATION with sampling procedures by separating selected rolls during unloading operations.
- D. CQA ORGANIZATION will perform laboratory seam analysis approximately every 500 lineal feet of welded geomembrane seam in accordance with Part 3.07 of this Section. OWNER's acceptance of welded geomembrane seams will be based on results of the CQA ORGANIZATION'S seam analysis. Allow 2 days to complete seam analysis.
 - 1. Based on the destructive sampling method of attributes, the DESIGN ENGINEER may increase or decrease the sampling interval based on information in Table 7 of the CQA Plan.
- E. Assist CQA ORGANIZATION with seam analysis sampling procedures by cutting samples and repairing sample locations.

PART 2 PRODUCTS

2.01 GEOMEMBRANE RESIN

- A. Linear low density polyethylene (LLDPE) new, first quality, compounded, and manufactured specifically for producing LLDPE geomembrane.
- B. No mixing of different resin types during manufacturing.
- C. No second run or recycled materials in manufacturing.

- D. Having a Specific Gravity (ASTM D 792) of 0.939 gm/cm³ measured after adding carbon black.

2.02 GEOMEMBRANE

- A. Linear low density polyethylene (LLDPE).
- B. Geomembrane shall have drainage studs on one side (up) and textured on the other (down). Texture cannot be sprayed on.
- C. Non-textured edges along roll length.
- D. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black or pigment. Identify percentage of processing aids, antioxidants, and other additives other than carbon black.
- E. Do not exceed 3.5 percent by weight of finished geomembrane for total combined processing aids, antioxidants, carbon black, and other additives.
- F. All additives for UV protection, thermal stability, color, or processing agents must not “bloom” to the surface over time or inhibit welding.
- G. Materials produced in the United States or Canada.
- H. Finished geomembrane rolls free from blemishes, holes, pin holes, bubbles, blisters, excessive gels, undispersed resins, undispersed carbon black, contamination by foreign materials, and nicks or cuts.
- I. Meeting the following minimum average roll values (MARV) specified in **Table 02772-1A** for the proposed 50-mil textured LLDPE MicroDrain[®].

**TABLE 02771-1A
50-MIL TEXTURED LLDPE MICRODRAIN® PROPERTIES**

TEST	MINIMUM AVERAGE ROLL VALUE	MQC ⁽¹⁾ TEST FREQUENCY
Sheet Thickness (ASTM D 5994)	47.5 ⁽²⁾	per roll
Asperity Height (ASTM D 7466)	16 mils (min avg)	Every 2 nd roll
Density with carbon black (ASTM D 792 or ASTM 1505)	0.939 gm/cm ³	200,000 lbs
Drainage Stud Height	0.130 inches	Per roll
Tensile Properties		
Break Stress	75 ppi (min avg)	20,000 lbs
Break Elongation	250% (min. avg)	
Tear Resistance (ASTM D 1004)	27 lb. (min avg)	45,000 lbs
Puncture Resistance (ASTM D 4833)	55 lb. (min avg)	45,000 lbs
Carbon Black Content (ASTM D 1603)	2.0 to 3.0 %	45,000 lbs
Carbon Black Dispersion (ASTM D 5596)	Category 1 or 2	45,000 lbs
Oxidation Induction Time (ASTM D 5885)	400 hours (min avg)	200,000 lbs
2% Modulus (ASTM D 5323)		
Stress Crack Resistance (ASTM D 5397)	3000 lbs/in (max)	Per formulation
Axi-Symmetric Break Resistance Strain (ASTM D 5617)	300 hours 30% min	Per GRI-GM10 Per formulation
⁽¹⁾ Manufacturing Quality Control. ⁽²⁾ The minimum average allowable thickness.		

2.03 EXTRUSION WELDING BEADS OR ROD

- A. Made from same resin as the geomembrane.
- B. Thoroughly disperse additives throughout beads or rod.
- C. Containing 2 to 3 percent carbon black.
- D. Free of contamination by moisture or foreign materials.

2.04 FIELD TESTING EQUIPMENT

- A. Field tensiometer capable of measuring seam strength for trial welds. Calibrated and accurate within 2 pounds.
- B. One-inch (width) x six-inch (length) cutting die for cutting seam specimens for testing trial welds.

PART 3 EXECUTION

3.01 EXAMINATION OF GEOMEMBRANE SURFACE

- A. Complete and sign Subgrade Acceptance form provided by CQA ORGANIZATION verifying that the surface the geomembrane will be installed on is acceptable. CQA ORGANIZATION will also verify subgrade acceptance.

3.02 PREPARATION

- A. Prepare adequate number of sandbags to ballast the geomembrane during deployment operations. Use free-draining sand or gravel material to fill the sandbags.
- B. Do not rely on anchor trenches shown on the Drawings to secure the geomembrane during construction. INSTALLER is responsible for temporary anchorage during construction.
- C. Prior to welding operations, prepare trial welds for each welding machine that will be used during the day. Trial welds will be prepared for both fusion and extrusion welding machines. At a minimum, trial welds will be prepared the beginning of the shift and at mid-shift. Trial weld samples for fusion welding machines will be a minimum of 6-feet in length and samples for extrusion guns will be a minimum of 3-feet in length with the trial weld centered down the length of the sample.
- D. Allow trial weld to cool to ambient conditions. After cooling, cut excessive material from the beginning and the end of the trial weld sample (approximately 4-inches from each end). Using the cutting die, cut four 1-inch specimens, spaced evenly along the length of the trial weld.
- E. Using the field tensiometer, test the specimens for peel adhesion (peel) and bonded seam strength (shear). Alternate the specimens peel, shear, peel, shear. Peel test both sides of the weld for fusion welded samples. The rate of separation for both the peel and the shear test is 2-inch per minute. Test specimens only when the Engineer is present.
- F. Each specimen must pass their respective test (peel or shear).
 - 1. 50-mil LLDPE Geomembrane:

Peel test specimens must meet all three of the following criteria:

 - a. The break is a film tearing bond (FTB).
 - b. There is no more than 25 percent peel penetration into the weld.
 - c. The quantitative value for peel strength is a minimum of 57 ppi for extrusion welded seams.
 - d. The quantitative value for peel strength is a minimum of 63 ppi for fusion welded seams

2. Shear test specimens must meet both of the following criteria:
 - a. The quantitative value for shear strength is a minimum of 75 ppi for extrusion welded seams.
 - b. The quantitative value for shear strength is a minimum of 75 ppi for fusion welded seams.
- G. If any of the four test specimens fail either peel or shear testing, the entire trial weld is considered failing. Repeat the above trial weld procedure and field testing if any of the four specimens fail in either peel or shear. If the trial weld repeats in failure, do not use the failing welding machine until proper adjustments are made or the machine is repaired. Repeat trial weld failures must pass two peel and shear test consecutively. If the welding machine continually fails field-testing, tag and completely remove the machine from service.
- H. Conduct additional trial welds at mid-day, and whenever adjustments are made to the welding machines.

3.03 DEPLOYMENT

- A. Deploy panels parallel to the slope, running the panels down the entire length of the slope. Correct or make adjustments to panels that become askew to the parallel line of the slope.
- B. Overlap panels a minimum of 4-inches. Keep the alignment of the overlap consistent by marking overlap indicator points.
- C. Do not damage geomembrane during handling, transport, or deployment operations. Remove or repair damaged geomembrane. Repairs to damaged geomembrane will be completed by the CONTRACTOR at no additional cost to the OWNER.
- D. Do not damage the underlying soil layers or geotextile installation. Repair damaged soil layers or geotextile. Repairs to damaged soil layers or geotextile will be completed by the CONTRACTOR at no additional cost to the OWNER.
- E. Only deploy the quantity of geomembrane that can be completely welded and secured in one day. Securely ballast (sandbag) the geomembrane at the end of the day. If wind conditions are high use geomembrane rolls as extra ballast. INSTALLER is responsible for temporary anchorage during construction.
- F. Avoid excessive wrinkles and compensate for stress bridging during deployment operations. Remove and repair excessive wrinkles and stress bridging. Excessive wrinkles and stress bridging will be removed and repaired even if these conditions occur during placement operations of the succeeding soil or geosynthetic layer.
- G. Immediately after panels running through ditch flow lines or slope toes are welded, place sandbags end-to-end along the entire length of the flow line to prevent geomembrane stress bridging through the ditch.

- H. When deploying textured geomembrane above a geotextile, or a GCL, always use a slip sheet to avoid snagging and weakening the geotextile fibers, or damaging the bentonite surface.

3.04 FUSION WELDING

- A. Welding operations will only take place when the ambient temperature is between 40°F and 110°F. Measure ambient temperature 6-inches above the in-place geomembrane. Special weather seaming plans must be submitted and approved by Engineer to weld outside this range.
- B. Fusion weld all seams. Extrusion welding will only be used for repair and patching operations.
- C. Fusion welding machines must complete trial weld procedures and pass field testing as specified in Part 3.02 of this Section prior to welding operations.
- D. Use power source capable of producing sufficient and constant voltage under the combined line load of other welders and equipment.
- E. Thoroughly clean welding surface.
- F. Weld panels at the same speed, temperature, roller pressure, and gauge settings used to prepare the trial weld. Adjust the above settings as temperature conditions indicate. Record welding machine number, operator, machine settings, time, and date on each seam welded.

3.05 EXTRUSION WELDING

- A. Extrusion guns must complete trial weld procedures and pass field testing as specified in Part 3.02 of this Section prior to welding operations.
- B. Overlap geomembrane a minimum of 4-inches.
- C. Cut square repair patches with rounded corners large enough to extend a minimum of 4-inches in all directions over the repair area.
- D. Tack-weld geomembrane or repair patches in place to prevent movement during grinding and extrusion welding operations.
- E. Disc-grind the outer edge of overlapped geomembrane or repair patches and the adjacent underlying geomembrane to remove surface debris and oxidation. Do not grind parallel to seam.
- F. Purge nozzle of extrusion gun to remove solidified extrudate.
- G. Completely cover the entire width of the grind area with extrusion weld. Extend extrusion safety welds 4-inches up the intersecting fusion weld (if applicable).
- H. Extrusion weld repair (safety) patches at all fusion welded seam intersections.

3.06 QUALITY CONTROL

A. General Quality Control

1. Perform all quality control procedures and testing in accordance with the INSTALLER's Geomembrane Installation Quality Control Manual, except where amended or modified by the DESIGN ENGINEER or this Section.
2. Maintain a geomembrane panel layout drawing during the geomembrane installation. Include in the drawing; 1) roll and panel numbers; 2) seam numbers; 3) geomembrane limits; 4) anchor trench locations; and 5) seam analysis sample locations.

B. Deployment Quality Control

1. Coordinate with CQA ORGANIZATION in assigning panel identification and corresponding seam numbering system.
2. Maintain daily deployment logs and panel layout drawings as the deployment progresses. Record panel and seam numbers, panel dimensions, and deployment quantities. Submit daily deployment logs to Engineer.

C. Fusion Welding Quality Control

1. Maintain daily welding logs. Record welding machine number, operator, machine settings, time, and date for each seam welded. Submit daily welding logs to CQA ORGANIZATION.
2. Air pressure test each fusion-welded seam. Provide air pump capable of generating and maintaining 40 psi of pressure equipped with a regulator and pressure gauge. Provide pressure feed needles with pressure gauges accurate to 1 psi. Perform the following air pressure test procedure.
 - a. Seal both ends of the fusion-welded seam with vise-grip plate clamps or extrusion weld. Heat may be applied to the seam ends to aid in sealing the seam in conjunction with the clamps. Due to the potential hazard of igniting landfill gas, DO NOT use propane torches or any other flame-producing device.
 - b. At one end of the seam, insert air pressure needle into the fusion weld channel.
 - c. Pressurized channel to 30-35 psi. Maintain pressure for 5 minutes.
 - d. Release air from the opposite end of the seam to verified that the entire length of the fusion weld channel was pressurized. If channel does not maintain pressure with a maximum allowable pressure loss of 2 psi over the 5 minute test period or does not stabilize at all, locate defective area, isolate, and repeat air pressure test procedures in both directions from the defective area.

- e. Maintain air pressure test logs. Record seam numbers, beginning and ending air pressures, beginning and ending test times, lengths of tested seam, and defective areas.

D. Extrusion Welding Quality Control

1. Maintain daily welding logs. Record welding machine number, operator, machine settings, time, and date. Submit daily welding logs to CQA ORGANIZATION.
2. Vacuum test each extrusion welded repair and length of seam. Provide vacuum pump capable of generating and maintaining 30 inches of mercury equipped with a regulator and vacuum gauge. Provide vacuum box with a clean view window, and vacuum gauge accurate to 1 psi. Perform the following vacuum test procedure.
 - a. Saturate extrusion weld with soap/water solution.
 - b. Place view box over the saturated weld, create an airtight seal, and apply vacuum to the weld.
 - c. Maintain vacuum for 10 seconds and examine weld for leaks. Leaks are detected by the presence of excessive bubbles. Mark detected leaks for follow up extrusion weld repair. Re-vacuum test detected leaks after repair operations to verify that the leaks were successfully repaired.
 - d. Maintain repair logs. Assign and record repair numbers, vacuum test dates, and vacuum test results.

E. Seam Analysis Sampling Procedures

1. CQA ORGANIZATION will determine seam analysis sample locations at minimum intervals of 500 lineal feet of welded seam. CQA ORGANIZATION OR DESIGN ENGINEER may decrease or increase this frequency based on previous seam analysis results. INSTALLER will cut samples at its discretion.
2. Repair sample holes in accordance with Part 3.05 of this Section. Vacuum test repair in accordance with Part 3.06 of this Section.
3. Seam analysis samples will be 12-inches wide by 36-inches long with the weld centered down the length of the sample. Samples sizes may be modified at the request of the INSTALLER or CQA ORGANIZATION. Cut one 1-inch specimen from each end of the sample, and field test specimens for peel adhesion in accordance with Part 3.02 of this Section. If these specimens pass the field peel test, submit sample for laboratory seam analysis. If either of the specimens fail the field peel test, perform Failed Seam Analysis Procedures in accordance with Part 3.08 of this Section.
4. Divide the remaining sample into equal two sections and submit to CQA ORGANIZATION for quality assurance seam analysis and archive storage.
5. INSTALLER may take and test any sample at its option.

3.07 LABORATORY SEAM ANALYSIS

- A. CQA ORGANIZATION will perform seam analysis in accordance with the following procedures.
 - 1. Seam analysis will be performed at qualified geosynthetics testing laboratory independent of the geomembrane manufacturer and INSTALLER.
 - 2. Seam analysis includes peel adhesion and bonded seam strength (ASTM D4437). Five specimens will be tested for each method.
 - 3. All five of the specimens must meet the criteria specified in paragraph E, Part 3.02 of this Section.
 - 4. Both sides of fusion-welded seams will be tested for peel adhesion.
- B. OWNER's acceptance of the welded geomembrane seams will be based on the results of laboratory seam analysis.
- C. Allow 24 hours to complete seam analysis after submission of the samples.

3.08 FAILED SEAM ANALYSIS PROCEDURES

- A. Perform the following procedures in the event of a seam analysis sample failure determined by field-testing or laboratory seam analysis.
 - 1. Track the welded seam 10-feet in both directions away from the failed seam analysis sample location. Cut a small 8-inch wide by 8-inch long sample from each location. Cut one 1-inch specimen from each end of the sample, and field test specimens for peel adhesion in accordance with Part 3.02 of this Section. If these specimens pass the field peel test, submit a 12-inch wide by 18-inch long re-test sample from both locations for laboratory seam analysis. If either of the specimens fail the field peel test at either location, continue tracking the welded seam at 10-foot intervals until specimens successfully pass the field peel tests and a sample can be submitted for laboratory seam analysis. If specimens continually fail field peel tests at 10-foot intervals, the entire seam or portion of the welded seam will be repaired at the discretion of the CQA ORGANIZATION.
 - 2. Repair the failed length of seam determined by field peel testing with an 18-inch wide cap strip. Extrusion weld the cap strip in accordance with Part 3.04 of this Section. Tack and extrusion welding the leading flap of the fusion-welded seam is not permitted. Vacuum test extrusion welded cap strip in accordance with Part 3.05 of this Section.
 - 3. If the re-test sample fails laboratory seam analysis, repeat the above procedures.
- B. Seam analysis samples will be taken from extrusion welded cap strips exceeding 100-feet in length, at the CQA ORGANIZATION'S discretion.

3.09 REPAIRS

- A. Available repair procedures include:
 - 1. Patching: Extrusion welding a patch of geomembrane over seam intersections and defects.
 - 2. Spot welding: A bead of molten extrudate placed on a flaw up to ¼-inch wide.
 - 3. Capping: A strip of geomembrane extrusion welded over a defective area.
 - 4. Removal and replacement.
- B. All repairs must be thoroughly checked with a vacuum box.

END SECTION 02771-1

SECTION 02771-2 CLOSURETURF®

PART 1 GENERAL

1.01 SECTION SUMMARY

- A. Product specifications for ClosureTurf®
- B. Furnishing and installing ClosureTurf® synthetic turf component.

1.02 RELATED SECTIONS

- A. Section 02771-1 – Linear Low Density Polyethylene (LLDPE) Liner
- B. Section 02771-3 – Sand Infill

1.03 REFERENCES

- A. ASTM D 5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles
- B. ASTM D 2256 – Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method
- C. ASTM D 6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
- D. ASTM D 4595 – Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
- E. ASTM D 5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- F. ASTM G 147 – Standard Practice for Conditioning and Handling of Nonmetallic materials for Natural and Artificial Weathering Tests
- G. ASTM G 154 – Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials
- H. Aerospace, Transportation and Advanced Systems Laboratory, Georgia Tech Research Institute – Aerodynamic Evaluations of ClosureTurf™ Ground Cover. 2010.
- I. WatershedGeo – ClosureTurf® Design Guidelines Manual v05.19

1.04 SUBMITTALS

- A. Manufacturer
 - 1. Provide the following Manufacturer's Quality Control (MQC) testing data:

- a. Provide inspection records of the tufting procedures for every 100,000 square feet of engineered turf.
 - b. Inspection records that indicates the following properties as they relate to the product specifications described in Part 2.01 of this specification including:
 - i. Tufting gauge
 - ii. Pile height
 - iii. Total product weight
 - iv. CBR Puncture (ASTM D6241)
 - v. Tensile Strength Product (ASTM D4595)
 - vi. Tensile Strength of Yarn (ASTM D2256)
- B. Submit the following 14 days prior geomembrane installations.
 - 1. Engineered Turf
 - a. Certificate of Compliance with product requirements of Part 2.01 of this Section.
 - 2. Proposed Panel Layout Drawings.
 - a. Drawings indicating the panel layout and field seams
 - 3. INSTALLER Qualifications.
 - a. Documentation that the INSTALLER is an approved ClosureTurf® INSTALLER.
 - b. ClosureTurf® Installation Schedule
 - c. Installation capabilities, including:
 - i. Information on seaming, testing, and deployment equipment proposed for this project.
 - ii. Average daily production anticipated for this project; and,
 - iii. Construction Quality Control (CQC) procedures.
 - d. Resumes of:
 - i. Project designated turf seaming supervisor
 - ii. CQA supervisor

- iii. All personnel who will perform seaming operations including:
 - (a) Date hired and duration of employment
 - (b) Installed at least 5,000,000 square feet of geomembrane materials
 - (c) Engineered turf fusion seamers shall be factory trained by DemTech
- e. Geosynthetics INSTALLER personnel shall attend ClosureTurf® orientation prior to the job beginning if this is their first ClosureTurf® installation.
- C. Submit at the completion of the engineered turf installation.
 - 1. Completed geomembrane panel layout drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Notify CQA ORGANIZATION of engineered turf shipment deliveries. Provide CQA ORGANIZATION with copy of packing list which includes the manufacturer's name, product identification, lot number, roll number, and roll dimensions.
- B. Unload, handle, transport engineered turf rolls with nylon or other cloth straps that do not damage the geomembrane rolls and preserve the integrity of the protective covering
- C. Store on a level surface graded to drain away from engineered turf rolls.
- D. Only stack the geomembrane rolls three high.
- E. Leave a 3-foot wide access path between the stacked geomembrane rolls.
- F. Separate damaged or rejected geomembrane rolls as directed by CQA ORGANIZATION.

1.06 QUALITY ASSURANCE VERIFICATION TESTING

- A. CQA ORGANIZATION will sample engineered turf every 50,000 square feet of material delivered to the site or produced at the manufacturing plant and perform the following quality assurance verification testing to verify compliance with the product requirements of this Section.
 - 1. Total Product Weight
 - 2. CBR Puncture (ASTM D6241)
 - 3. Tensile Strength of Product (ASTM D4595)
 - 4. Tensile Strength of Yarn (ASTM D2256)

- B. Owner's acceptance of geomembrane will be based on results of quality assurance verification testing. Allow 7 days to complete testing.
- C. Assist CQA ORGANIZATION with sampling procedures by separating selected rolls during unloading operations.

PART 2 PRODUCTS

2.01 CLOSURETURF® ENGINEERED TURF COMPONENT

- A. Engineered turf manufactured by Watershed Geo
- B. Meeting the following minimum average roll values (MARV) specified in **Table 02772-2A** for the proposed engineered turf product.

**TABLE 02771-2A
CLOSURE TURF® ENGINEERED TURF PROPERTIES**

TEST	MINIMUM AVERAGE ROLL VALUE	MQC ⁽¹⁾ TEST FREQUENCY
CBR Puncture (ASMT D6241)	1500 lb.	100,000 ft ²
Tensile Strength Product (MD/XD) (ASTM D4595)	2,100 MD/1,600 XD lb./ft.	100,000 ft ²
Aerodynamic Evaluation (GTRI Wind Tunnel)	120 mph w/ max. uplift of 0.12 lb/ft ²	
Engineered Turf Fiber Stability (ASTM G147)	>60% retained tensile strength at 100 yrs (projected)	
Backing System UV Stability Index Test (ASTM G1545 Modified Cycle 1.UVA340)	110 lbs/ft retained tensile strength at 6500 hrs. (projected)	
Internal Friction of Combined Components (ASTM D5321)	35°, min	
Yarn Weight (Total Product Weight) (ASTM D5261)	>= 20 oz/sq. yard	100,000 ft ²
Tensile Strength of Yarn (ASTM D2256)	15 lbs. min.	100,000 ft ²
⁽¹⁾ Manufacturing Quality Control.		

2.02 SEWING THREAD

- A. Sewing thread shall be 207 Polyester or equivalent.

2.03 FIELD TESTING EQUIPMENT

- A. Field tensiometer capable of measuring seam strength for trial welds. Calibrated and accurate within 2 pounds.
- B. One-inch (width) x six-inch (length) cutting die for cutting seam specimens for testing trial welds.

PART 3 EXECUTION

3.01 EXAMINATION OF ENGINEERED TURF SURFACE

- A. Complete and sign Subgrade Acceptance form provided by CQA ORGANIZATION verifying that the surface the engineered turf will be installed on is acceptable. CQA ORGANIZATION will also verify engineered turf acceptance.

3.02 PREPARATION

- A. Prepare adequate number of sandbags to ballast the engineered turf during deployment operations. Use free-draining sand or gravel material to fill the sandbags.
- B. Coordinate anchor trench excavation with Earthwork Contractor. Do not rely on anchor trenches shown on the Drawings to secure the engineered turf during construction. INSTALLER is responsible for temporary anchorage during construction.
- C. Prior to welding operations, prepare trial welds for each welding machine that will be used during the day. Trial welds will be prepared fusion welding machines. At a minimum, trial welds will be prepared the beginning of the shift, after any break, or any time after the machine is turned off for more than 30 minutes. The CQA Organization may request a trial weld seam if they believe the operator or fusion welding apparatus is not functioning properly. Trial weld samples for fusion welding machines will be a minimum of 3-feet in length and 12 inches in width with the trial weld centered down the length of the sample.
- D. Allow trial weld to cool to ambient conditions before seam snapping or panel adjustments are applied.
- E. A manual peel/pull test is performed and a passing seam is based on visual criteria.
- F. The criterial for a passing trial weld includes:
 - 1. A passing trial weld is achieved when approximately 75% of the top turf panel tufts transfer to the bottom turf panel.
 - 2. Two consecutive trial welds meet the visual passing criteria.
- G. If any of the two test specimens fail, both trial welds are considered failing. Repeat the above trial weld procedure and field testing if any of the two specimens fail. If the trial weld repeats in failure, do not use the failing welding machine until proper adjustments are made or the machine is repaired. Repeat trial weld failures must pass two visual inspections consecutively. If the welding machine continually fails field-testing, tag and completely remove the machine from service.

- H. Conduct additional trial welds at mid-day, and whenever adjustments are made to the welding machines.

3.03 DEPLOYMENT

- A. Deploy panels from the top of the slope in a way that the engineered turf filaments are pointing upslope after deployment is complete.
- B. Overlap panels a minimum of 5-inches. Keep the alignment of the overlap consistent by marking overlap indicator points.
- C. Do not damage engineered turf during handling, transport, or deployment operations. Remove or repair damaged engineered turf.
- D. Do not damage the underlying geomembrane. Repair damaged geomembrane.
- E. Only deploy the quantity of engineered turf that can be completely welded and secured in one day. Securely ballast (sandbag) the geomembrane at the end of the day. If wind conditions are high use engineered turf rolls as extra ballast. INSTALLER is responsible for temporary anchorage during construction.
- F. Avoid excessive wrinkles and compensate for stress bridging during deployment operations. Remove and repair excessive wrinkles and stress bridging. Excessive wrinkles and stress bridging will be removed and repaired even if these conditions occur during placement operations of the succeeding sand ballast layer.

3.04 SEWN SEAMS

- A. Sew all longitudinal and transverse seams.
- B. Deploy first panel with turf filaments facing up.
- C. Deploy subsequent panels turf side down, on top of the previous panel.
- D. After each panel is seamed, flip onto the geomembrane component with care to avoid pulling of tufts in the drainage studs.
- E. Sewn seams shall consist of a prayer type seam installed with a Newlong sewing machine or equivalent.
- F. Sewing will occur between the first and second row of tufts on the both sides of panel.

3.05 FUSION WELDING (FOR REFERENCE ONLY)

- A. Welding operations will only take place when the ambient temperature is between 40°F and 110°F. Measure ambient temperature 6-inches above the in-place geomembrane. Special weather seaming plans must be submitted and approved by CQA ORGANIZATION to weld outside this range.
- B. Fusion welding machines must consist of a DemTech VM20/4/A fusion welder only.

- C. Use power source capable of producing sufficient and constant voltage under the combined line load of other welders and equipment.
- D. Thoroughly clean welding surface.
- E. Fusion welded seams require a minimum of 5-inches of overlap.
- F. Frayed or loose geotextile strands will be cut off or removed.
- G. Prior to starting the production fusion seaming, trial seams must be performed as outlined in Section 3.02.
- H. Demonstrate the preparation methods and equipment utilized for removal of the selvage from the outside edge of the rolls of turf (i.e. trimming and cutting devices).
- I. Mechanical or hot knife trimming and cutting devices will be utilized for salvage trimming.
- J. Demonstrate and control the fraying of geotextile strands when performing the removal of selvage.
- K. Any damage that occurs due to production seaming will be repaired as outlined in the WG Installation guidance Documents.
- L. Any defects will be repaired as outlined in Section 3.06
- M. Weld panels at the same speed, temperature, roller pressure, and gauge settings used to prepare the trial weld. Adjust the above settings as temperature conditions indicate. Record welding machine number, operator, machine settings, time, and date on each seam welded.

3.06 EQUIPMENT ON THE TURF

- A. During Construction
 - 1. On slopes exceeding 15% no equipment will be allowed until sand infill is in place.
 - 2. On Slopes less than 15% ATV type vehicles will be allowed prior to infill placement if the tire/track ground contact pressure is less than 5 psi.
- B. Post Construction (full specified sand infill thickness)
 - 1. On slopes exceeding 15%
 - a. Temporary or transient loads, allowable tire/track ground contact pressure will be limited to 35 psi.
 - b. Regularly trafficked areas will be designed and approved by the DESIGN ENGINEER.
 - 2. On Slopes less than 15%

- a. Temporary or transient loads, allowable tire/track ground contact pressure will be limited to 85 psi.
 - b. Regularly trafficked areas will be designed and approved by the DESIGN ENGINEER.
 - c. Allowable tire/track ground contact pressures may be increased with the written approval of the DESIGN ENGINEER.
- C. Any activity that may be identified during construction by the Owner, CQA Organization as being a possible danger to the integrity of the ClosureTurf® system will be prohibited regardless of any prior approval.

3.07 REPAIRS

- A. When repairs to engineered turf occur, the CQA Organization must observe the following:
 - 1. Repairs are completed by using a heat-bonded seam.
 - 2. All tie-in seams along flatter slopes (i.e. less than 15%) with length greater than 25 feet will use an approved heat bonded seam so as consistent pressure is achieved throughout the seam.
 - 3. A handheld heat gun with a pressure wheel will be used in small areas.

3.08 QUALITY CONTROL

- A. General Quality Control
 - 1. Perform all quality control procedures and testing in accordance with the INSTALLER's Installation Quality Control Manual, except where amended or modified by the Engineer or this Section.
 - 2. Maintain a engineered turf panel layout drawing during the engineered turf installation. Include in the drawing; 1) roll and panel numbers; 2) seam numbers; 3) geomembrane limits; 4) anchor trench locations; and 5) seam analysis sample locations.
- B. Deployment Quality Control
 - 1. Coordinate with CQA ORGANIZATION in assigning panel identification and corresponding seam numbering system.
 - 2. Maintain daily deployment logs and panel layout drawings as the deployment progresses. Record panel and seam numbers, panel dimensions, and deployment quantities. Submit daily deployment logs to CQA ORGANIZATION.

C. Sewn Seam Quality Control

1. Verify engineered turf tufts are not excessively pulled out by the installation process.

D. Fusion Welding Quality Control

1. Maintain daily welding logs. Record welding machine number, operator, machine settings, time, and date for each seam welded. Submit daily welding logs to CQA ORGANIZATION.

END SECTION 02771-2

SECTION 02771-3 SAND INFILL

PART 1 GENERAL

1.01 SECTION SUMMARY

The directives outlined in this document apply to the WORK performed by the CONTRACTOR unless otherwise noted.

- A. This section describes product requirements and installation requirements for the sand infill component of the ClosureTurf® final cover system.

1.02 RELATED SECTIONS

- A. Section 02771-1 – Linear Low Density Polyethylene (LLDPE) Liner
- B. Section 02771-2 – ClosureTurf®

1.03 REFERENCES

- A. ASTM C1252 Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influence by Particle Shape, Surface Texture, and Grading) Method A.
- B. ASTM C128 Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate.
- C. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

1.05 SUBMITTALS

- A. Submit the following 14 days before sand infill material is shipped to site:
 - 1. Product data sheets and complete description of sand material that meet or exceed the product requirements of Part 2.01 of this Section.
 - 2. Suppliers quality control testing demonstrating the proposed material's void content, relative density, and gradation meet the product requirements of Part 2.01 of this Section.
- B. Submit written description of sand infill placement methods describing equipment and application methods 14 days prior to sand infill installation.

1.04 QUALITY ASSURANCE VERIFICATION TESTING

- A. CQA ORGANIZATION will perform the following quality assurance verification testing prior to and during sand infill placement operations.
 - 1. Uncompacted void content of sand infill (ASTM C1252)
 - 2. Relative density of sand infill (ASTM C128)

3. Sieve analysis of sand infill (ASTM C136)
 4. Visual examination and sampling to verify that sand materials contain no organic, saturated, oversized, or other unsuitable materials.
- B. Cooperate with CQA ORGANIZATION in the performance of quality assurance verification testing.

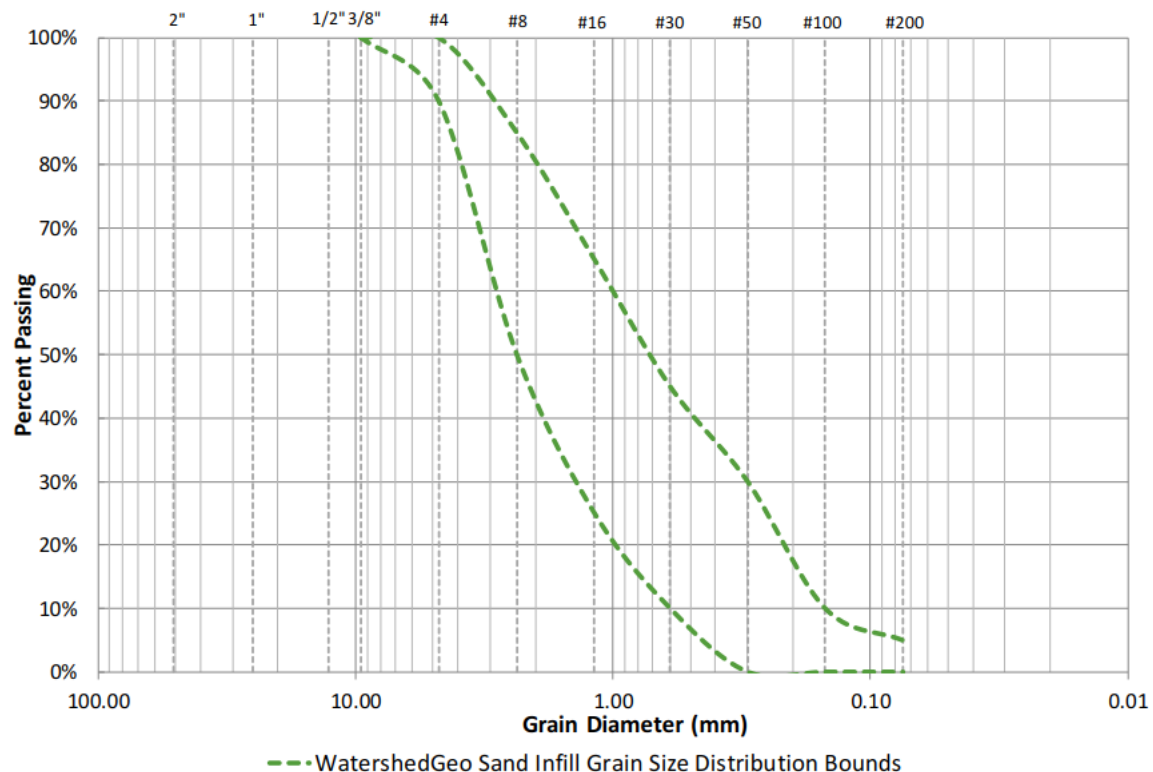
PART 2 PRODUCTS

2.01 SAND INFILL

- A. Uncompacted Void Content (ASTM C1242) $\geq 40\%$
- B. Specific Gravity (ASTM C128) ≥ 2.40
- C. Grain Size Distribution (ASTM C136)

**TABLE 02771-3A
SAND INFILL GRAIN SIZE DISTRIBUTION**

	3/8" (9.5 mm)	<	100%
90%	< #4 (4.75 mm)	<	100%
50%	< #8 (2.36 mm)	<	85%
25%	< #16 (1.18 mm)	<	65%
10%	< #30 (0.60 mm)	<	45%
0	< #50 (0.30 mm)	<	30%
0	< #100 (0.15 mm)	<	10%
0	< #200 (0.075 mm)	<	5%



PART 3 EXECUTION

3.01 EQUIPMENT ON THE TURF

A. During Construction

1. On slopes exceeding 15% no equipment will be allowed until sand infill is in place.
2. On Slopes less than 15% ATV type vehicles will be allowed prior to infill placement if the tire/track ground contact pressure is less than 5 psi.

B. Post Construction (full specified sand infill thickness)

1. On slopes exceeding 15%
 - a. Temporary or transient loads, allowable tire/track ground contact pressure will be limited to 35 psi.
 - b. Regularly trafficked areas will be designed and approved by the DESIGN ENGINEER.
2. On Slopes less than 15%
 - a. Temporary or transient loads, allowable tire/track ground contact pressure will be limited to 85 psi.
 - b. Regularly trafficked areas will be designed and approved by the DESIGN ENGINEER.
 - c. Allowable tire/track ground contact pressures may be increased with the written approval of the DESIGN ENGINEER.

C. Any activity that may be identified during the course of construction by the Owner, CQA ORGANIZATION as being a possible danger to the integrity of the ClosureTurf® system will be prohibited regardless of any prior approval.

3.02 SAND BALLAST INFILL PLACEMENT

A. Sand infill that is placed between the tufts of the engineered turf component:

1. The sand infill layer will be placed to a ½ inch minimum thickness not to exceed ¾ inch thick.
2. Will consist wholly of sand meeting Part 2 of this specification.
3. The CQA ORGANIZATION shall check final thickness of sand infill at a rate of approximately 20 times per acre.

- B. ClosureTurf® Sand Infill Grain Size Parameters are shown in Section 2.01, Table 1.
1. The CQA ORGANIZATION shall observe that the following requirements regarding Sand Infill are met:
 - a. Installation of sand infill will only be performed by a Watershed Geosynthetics' licensed and approved installer.
 - b. Areas that are to receive sand infill must be accepted by the CQA Organization before placement of sand infill takes place.
- C. SAND INFILL INSTALLATION
1. Prior to installation, the Sand Infill Installer will explain with detail the method of sand infill deployment to be used during the pre-construction meeting. The contractor shall take into account recent OSHA requirements for silica exposure for sand placement methods.
 2. The sand infill is worked into the Engineered Turf between the synthetic yarn blades.
 3. Conveyor systems and/or Express Blowers will be used to spread and place the sand infill.
 4. That sand infill placement does not occur with snow or ice on the Engineered Turf component.
 5. That previously installed ClosureTurf® components are not displaced or damaged as a result of the sand infill component installation.
- D. CQA ORGANIZATION shall observe and/or verify:
1. The sand infill is worked into the Engineered Turf between the synthetic yarn blades with a brush.
 2. Conveyor systems and/or Express Blowers will be used to spread and place the sand infill.
 3. The method for measuring the sand infill thickness will be performed utilizing a digital caliper, or a DESIGN ENGINEER approved alternate measuring device.
- E. OWNER will perform surveys in accordance with Section 01050.

END SECTION 02221-3

APPENDIX B

HELP MODELING MEMO



memorandum

To: Project File
From: Ms. Melissa Hinman
Date: October 15, 2020
Re: North Holding Pond – HELP Model Design Calculations

BACKGROUND

Phillips 66 Company (Phillips 66, CN604065912) operates the Borger Refinery (RN102495884), which is owned by a joint venture between Phillips 66 (P66) and Cenovus called WRB Refining LP (WRB, CN603215997). This memo has been prepared to evaluate the proposed cover system design to close the North Holding Pond (NOR#036).

The North Holding Pond (NHP) is a 3.4-acre surface impoundment with a liner system consisting of 3-feet of bentonite amended clay, leak detection system, and 100-mil high-density polyethylene (HDPE) liner. The North Holding Pond is in partial closure in accordance with the 1998 closure plan. The free liquid has been removed and the sludge has been stabilized. The impoundment is now being filled with non-hazardous waste. The partial closure permit modification was approved by the Texas Commission of Environmental Quality (TCEQ) on April 21, 2004.

OBJECTIVE

The following calculations will demonstrate the performance of the proposed final cover system is superior or equivalent to the previously permitted cover system for the North Holding Pond during the 30-year post closure period. The calculations for the hydrologic evaluation of the cover systems presented below were modeled using the Hydrologic Evaluation of Landfill Performance (HELP) software, Version 3.07. The proposed cover system and previously permitted cover system elements are summarized in **TABLE 1**.

TABLE 1. COVER SYSTEM ELEMENTS

Proposed Cover System	Previously Permitted Cover System
Engineered Turf with ½" sand ballast	18" Vegetative Support and Protective Cover Layer
	Non-woven fabric
130-mil Linear Low-Density Polyethylene (LLDPE) MicroDrain® (integrated in to geomembrane)	3" Sand or gravel drainage layer
50-mil LLDPE Geomembrane	40-mil HDPE geomembrane liner layer
0.24" Geosynthetic Clay Liner and 12" Compacted Clay	24" Compacted clay



MODELING ASSUMPTIONS

Weather Data

Precipitation and mean temperature data were synthetically generated utilizing average monthly values for Borger, Texas from the National Oceanic and Atmospheric Administration (NOAA) Climate Data Online, Data Tools 1981-2010 Normals. Solar radiation data were synthetically generated utilizing coefficients for Amarillo, Texas modified to the site's latitude of 35.71 degrees. The precipitation data for the 100-year, 24-hour rainfall event for Borger was 3.88 in.

Relative humidity and evapotranspiration data used in the model reflect the default HELP data for Amarillo, Texas modified to the site's latitude of 35.71 degrees.

For the proposed cover the evaporative zone depth assumed was 0.63 in. (0.5 in. sand ballast and 0.13 in. studded drainage layer that is part of the LLDPE geomembrane). A leaf index of 0 was utilized as the synthetic turf is constructed of HDPE and will not transpire.

For the previously permitted cover the evaporative zone depth assumed was 18 in. and a leaf index of 2 was utilized based on the assumption a fair stand of grass will be established on the final cover.

100% of the area will have runoff.

Initial Soil Moisture Content

The initial soil moisture content for the soil layers and snow water were computed as nearly steady-state values by the HELP Model program.

Runoff Curve Number

The runoff curve number (88.4) was computed by the HELP Model using soil texture #13 with a fair stand of grass, a surface slope of 3% and a slope length of 260 feet for the previously permitted cover.

A runoff curve number of 92 was manually input based on data provided by WatershedGeo, the ClosureTurf® manufacturer.

Final Cover Section Input

The final cover cross section for the proposed (TABLE 2) and previously permitted cover (TABLE 3) systems were modeled using the HELP Model and included layers described in the following tables.



TABLE 2. PROPOSED COVER SYSTEM

MATERIAL	LAYER TYPE	HELP MODEL MATERIAL TEXTURE NO.	ASSUMPTIONS
Engineered Turf with ½" sand ballast	1-Vertical Percolation Layer	2	Default HELP values for hydraulic conductivity and porosity were utilized.
130-mil LLDPE MicroDrain®	2-Lateral Drainage Layer	0	Hydraulic conductivity of 31.57 cm/s represent the long-term hydraulic conductivities with a performance reduction factor of 2.4 applied. ¹
50-mil LLDPE Geomembrane	4-Geomembrane Liner	36	Default HELP values for hydraulic conductivity and porosity were utilized. Assume 1 pinhole per acre and a "good" placement quality, which is conservative based on Construction Quality Assurance (CQA) requirements.
0.24" Geosynthetic Clay Liner and 12" Compacted Clay	3-Barrier Soil Liner	0	Hydraulic Conductivity of 3.435×10^{-8} cm/s is the calculated effective saturated hydraulic conductivity of the GCL and the compacted clay. ²

Notes:

¹ MicroDrain® hydraulic conductivity value and reduction factor from "Hydrologic Performance of Synthetic Turf Cover Systems and Their Equivalency to Prescriptive Cover Systems" (Carlson et al. 2019)

² The EPA's user guide for the HELP model was followed to calculate the effective saturated hydraulic conductivity of the barrier soil liner.

TABLE 3. PREVIOUSLY PERMITTED COVER SYSTEM

MATERIAL	LAYER TYPE	HELP MODEL MATERIAL TEXTURE NO. (1)	ASSUMPTIONS
18" Vegetative Support and Protective Cover Layer	1-Vertical Percolation Layer	13	Utilized soil type with a hydraulic conductivity (3.3×10^{-5} cm/s) similar to site soils (1×10^{-8} to 5×10^{-5} cm/sec)
Non-woven fabric	Not modeled	Not modeled	
3" Sand and gravel drainage layer	2-Lateral Drainage Layer	0	User input hydraulic conductivity of 3.3×10^{-2} cm/sec selected as 3 orders of magnitude greater than topsoil as specified in permitted closure plan.



MATERIAL	LAYER TYPE	HELP MODEL MATERIAL TEXTURE NO. (1)	ASSUMPTIONS
40-mil high density polyethylene (HDPE) geomembrane liner layer	4-Geomembrane Liner	35	Default HELP values for hydraulic conductivity and porosity were utilized. Assume 1 pinhole per acre and a “good” placement quality, which is conservative based on CQA requirements.
24” Compacted clay	3-Barrier Soil Liner	16	Utilized a soil type with a hydraulic conductivity matching the permitted hydraulic conductivity for the compacted clay liner of 1×10^{-7} cm/sec.

Note:

(1) Total porosity, field capacity, and wilting point used in the model were the default values for the selected HELP material texture number.

MODELING RESULTS

The results of the modeling are presented in Attachment A and summarized in **TABLE 4** below. HELP modeling was conducted over a 100-year period.

TABLE 4. HELP MODELING RESULTS

HELP RESULTS	PROPOSED COVER		PREVIOUSLY PERMITTED COVER	
	INCHES	MM	INCHES	MM
Average Annual Precipitation	22.97	583.44	22.97	583.44
Average Runoff	2.972	75.49	1.439	36.55
Average Annual Evapotranspiration	4.665	118.49	20.655	524.64
Average Annual Percolation through Barrier Layer	0.00000	0.00000	0.00006	0.001524

CONCLUSION

The average annual percolation of 0.00000 inches through the barrier layer of the proposed cover is less than the average annual percolation of 0.00006 inches through the previously permitted cover, is based on the conservative calculations by the HELP Model. The lower annual average percolation of the proposed final cover demonstrates it will perform which exceeds or is equivalent to the previously permitted cover system.



Project File
October 15, 2020
Page 5

REFERENCES

Carlson, C., Zhu, M., Ebrahimi, A. 2019. Hydrologic Performance of Synthetic Turf Cover Systems and Their Equivalency to Prescriptive Cover Systems. February 10-13, 2019; Houston, TX: Geosynthetics Conference.

QUALITY CONTROL	
Calculations By:	TE
Calculations Checked By:	MH
Calculations Reviewed By:	CT

42M-002-008

ATTACHMENT A

PROPOSED COVER HELP MODEL OUTPUT



```
*****
*****
**
**
**          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:\NHP\DATA4.D4
TEMPERATURE DATA FILE: C:\NHP\DATA7.D7
SOLAR RADIATION DATA FILE: C:\NHP\DATA13.D13
EVAPOTRANSPIRATION DATA: C:\NHP\DATA11.D11
SOIL AND DESIGN DATA FILE: C:\NHP\opt2.D10
OUTPUT DATA FILE: C:\NHP\opt2.OUT

TIME: 16:32 DATE: 5/ 8/2020

```
*****
```

TITLE: NORTH HOLDING POND - OPTION 2

```
*****
```

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0
THICKNESS = 0.50 INCHES

POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0241	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.250000004000E-01	CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.13	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0061	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	31.5699997000	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	260.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 36

THICKNESS	=	0.05	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.	=	0.399999993000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.24	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.	=	0.343499984000E-07 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	92.00	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	0.6	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.013	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	0.304	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.013	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	9.193	INCHES
TOTAL INITIAL WATER	=	9.193	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
AMARILLO TEXAS

STATION LATITUDE	=	35.71 DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00
START OF GROWING SEASON (JULIAN DATE)	=	95
END OF GROWING SEASON (JULIAN DATE)	=	303
EVAPORATIVE ZONE DEPTH	=	0.6 INCHES
AVERAGE ANNUAL WIND SPEED	=	13.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	55.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	52.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	57.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	57.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING

COEFFICIENTS FOR AMARILLO TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-----	-----	-----	-----	-----	-----
0.71	0.69	1.54	1.79	2.68	3.28
2.68	3.56	2.09	1.94	1.03	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR AMARILLO TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-----	-----	-----	-----	-----	-----
38.50	41.90	49.30	58.10	67.30	76.20
80.60	79.40	71.80	60.60	48.20	38.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR AMARILLO TEXAS
AND STATION LATITUDE = 35.71 DEGREES

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.15	69514.516	100.00
RUNOFF	1.217	4417.716	6.36
EVAPOTRANSPIRATION	4.661	16919.994	24.34
DRAINAGE COLLECTED FROM LAYER 2	13.2718	48176.629	69.30
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	0.000	0.142	0.00

SOIL WATER AT START OF YEAR	9.193	33370.086	
SOIL WATER AT END OF YEAR	9.193	33370.230	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.94	101422.203	100.00
RUNOFF	3.968	14404.554	14.20
EVAPOTRANSPIRATION	5.072	18409.941	18.15
DRAINAGE COLLECTED FROM LAYER 2	18.9003	68608.070	67.65
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0025		
CHANGE IN WATER STORAGE	0.000	-0.370	0.00
SOIL WATER AT START OF YEAR	9.193	33370.230	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.10	76593.000	100.00
RUNOFF	2.536	9205.100	12.02
EVAPOTRANSPIRATION	5.478	19886.479	25.96
DRAINAGE COLLECTED FROM LAYER 2	13.0858	47501.402	62.02
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.58	78335.430	100.00
RUNOFF	2.059	7475.807	9.54
EVAPOTRANSPIRATION	3.682	13364.661	17.06
DRAINAGE COLLECTED FROM LAYER 2	15.8388	57494.937	73.40
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.77	75395.094	100.00
RUNOFF	1.002	3635.646	4.82
EVAPOTRANSPIRATION	5.201	18879.016	25.04
DRAINAGE COLLECTED FROM LAYER 2	14.5676	52880.437	70.14
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.012	0.00

ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.15	87664.516	100.00
RUNOFF	4.089	14842.455	16.93
EVAPOTRANSPIRATION	5.151	18698.168	21.33
DRAINAGE COLLECTED FROM LAYER 2	14.9102	54123.863	61.74
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.44	74197.195	100.00
RUNOFF	1.911	6935.774	9.35

EVAPOTRANSPIRATION	4.058	14729.002	19.85
DRAINAGE COLLECTED FROM LAYER 2	14.3346	52034.535	70.13
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	0.137	497.878	0.67
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.330	33867.738	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.28	91766.406	100.00
RUNOFF	3.812	13836.615	15.08
EVAPOTRANSPIRATION	5.207	18899.994	20.60
DRAINAGE COLLECTED FROM LAYER 2	16.1120	58486.543	63.73
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.150	543.245	0.59
SOIL WATER AT START OF YEAR	9.330	33867.738	
SOIL WATER AT END OF YEAR	9.480	34410.984	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.33	70167.898	100.00
RUNOFF	2.624	9524.913	13.57
EVAPOTRANSPIRATION	2.831	10277.644	14.65
DRAINAGE COLLECTED FROM LAYER 2	14.1616	51406.465	73.26
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	-0.287	-1041.124	-1.48
SOIL WATER AT START OF YEAR	9.480	34410.984	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT

PRECIPITATION	22.40	81312.016	100.00
RUNOFF	2.052	7448.376	9.16
EVAPOTRANSPIRATION	4.368	15856.794	19.50
DRAINAGE COLLECTED FROM LAYER 2	15.8960	57702.598	70.96
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.084	304.212	0.37
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.277	33674.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.18	105923.406	100.00
RUNOFF	2.848	10339.919	9.76
EVAPOTRANSPIRATION	7.125	25865.432	24.42
DRAINAGE COLLECTED FROM LAYER 2	18.1735	65969.680	62.28
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	1.033	3748.354	3.54

SOIL WATER AT START OF YEAR	9.277	33674.070	
SOIL WATER AT END OF YEAR	9.248	33570.949	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.061	3851.475	3.64
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.82	71946.602	100.00
RUNOFF	2.283	8288.470	11.52
EVAPOTRANSPIRATION	3.951	14343.427	19.94
DRAINAGE COLLECTED FROM LAYER 2	14.7017	53367.262	74.18
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	-1.116	-4052.567	-5.63
SOIL WATER AT START OF YEAR	9.248	33570.949	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	1.061	3851.475	5.35
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.09	91076.711	100.00
RUNOFF	2.848	10338.269	11.35
EVAPOTRANSPIRATION	6.267	22751.021	24.98
DRAINAGE COLLECTED FROM LAYER 2	15.9745	57987.402	63.67
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.15	54994.516	100.00
RUNOFF	1.631	5920.577	10.77
EVAPOTRANSPIRATION	3.094	11229.421	20.42
DRAINAGE COLLECTED FROM LAYER 2	10.4255	37844.504	68.82
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0014		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.42	66864.609	100.00
RUNOFF	1.200	4356.324	6.52
EVAPOTRANSPIRATION	4.814	17474.369	26.13
DRAINAGE COLLECTED FROM LAYER 2	12.4060	45033.906	67.35
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.01	79896.305	100.00
RUNOFF	3.641	13215.442	16.54
EVAPOTRANSPIRATION	3.931	14268.033	17.86
DRAINAGE COLLECTED FROM LAYER 2	14.4388	52412.820	65.60
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.31	55575.305	100.00
RUNOFF	1.486	5393.886	9.71

EVAPOTRANSPIRATION	3.069	11140.818	20.05
DRAINAGE COLLECTED FROM LAYER 2	10.7550	39040.586	70.25
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.27	77210.102	100.00
RUNOFF	2.389	8672.902	11.23
EVAPOTRANSPIRATION	5.451	19787.137	25.63
DRAINAGE COLLECTED FROM LAYER 2	13.4298	48750.051	63.14
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.00	98010.016	100.00
RUNOFF	5.556	20168.148	20.58
EVAPOTRANSPIRATION	3.918	14221.061	14.51
DRAINAGE COLLECTED FROM LAYER 2	17.5264	63620.781	64.91
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT

PRECIPITATION	15.09	54776.699	100.00
RUNOFF	1.264	4587.510	8.37
EVAPOTRANSPIRATION	3.109	11284.935	20.60
DRAINAGE COLLECTED FROM LAYER 2	10.7174	38904.258	71.02
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.54	67300.219	100.00
RUNOFF	3.345	12140.685	18.04
EVAPOTRANSPIRATION	2.861	10383.902	15.43
DRAINAGE COLLECTED FROM LAYER 2	12.3173	44711.848	66.44
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	0.018	63.757	0.09

SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.210	33433.617	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	26.25	95287.508	100.00
RUNOFF	3.223	11698.722	12.28
EVAPOTRANSPIRATION	4.935	17915.662	18.80
DRAINAGE COLLECTED FROM LAYER 2	18.0980	65695.617	68.94
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	-0.006	-22.502	-0.02
SOIL WATER AT START OF YEAR	9.210	33433.617	
SOIL WATER AT END OF YEAR	9.204	33411.113	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.005	0.00

ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.73	75249.898	100.00
RUNOFF	2.908	10557.721	14.03
EVAPOTRANSPIRATION	3.593	13043.321	17.33
DRAINAGE COLLECTED FROM LAYER 2	14.2397	51690.117	68.69
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	-0.011	-41.255	-0.05
SOIL WATER AT START OF YEAR	9.204	33411.113	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.014	0.00

ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.92	83199.617	100.00
RUNOFF	2.271	8245.218	9.91
EVAPOTRANSPIRATION	4.068	14765.494	17.75
DRAINAGE COLLECTED FROM LAYER 2	16.4976	59886.422	71.98
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0022		
CHANGE IN WATER STORAGE	0.083	302.450	0.36
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.276	33672.309	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.80	86394.008	100.00
RUNOFF	2.237	8119.025	9.40
EVAPOTRANSPIRATION	6.850	24866.164	28.78
DRAINAGE COLLECTED FROM LAYER 2	14.7965	53711.250	62.17
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	-0.083	-302.450	-0.35
SOIL WATER AT START OF YEAR	9.276	33672.309	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.41	70458.312	100.00
RUNOFF	1.780	6462.535	9.17
EVAPOTRANSPIRATION	4.776	17336.844	24.61
DRAINAGE COLLECTED FROM LAYER 2	12.8447	46626.211	66.18
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.009	32.683	0.05
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.202	33402.543	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.64	85813.219	100.00
RUNOFF	1.865	6768.195	7.89

EVAPOTRANSPIRATION	5.109	18546.631	21.61
DRAINAGE COLLECTED FROM LAYER 2	16.6752	60531.070	70.54
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0022		
CHANGE IN WATER STORAGE	-0.009	-32.683	-0.04
SOIL WATER AT START OF YEAR	9.202	33402.543	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.17	76847.117	100.00
RUNOFF	1.709	6202.729	8.07
EVAPOTRANSPIRATION	4.946	17952.709	23.36
DRAINAGE COLLECTED FROM LAYER 2	14.3411	52058.305	67.74
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	0.174	633.357	0.82
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.367	34003.215	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.90	97646.984	100.00
RUNOFF	4.052	14707.945	15.06
EVAPOTRANSPIRATION	4.803	17433.322	17.85
DRAINAGE COLLECTED FROM LAYER 2	18.2201	66139.086	67.73
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	-0.174	-633.357	-0.65
SOIL WATER AT START OF YEAR	9.367	34003.215	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.013	0.00

ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT

PRECIPITATION	25.88	93944.398	100.00
RUNOFF	3.616	13125.238	13.97
EVAPOTRANSPIRATION	5.742	20842.186	22.19
DRAINAGE COLLECTED FROM LAYER 2	16.5224	59976.312	63.84
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0022		
CHANGE IN WATER STORAGE	0.000	0.661	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33370.520	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.006	0.00

ANNUAL TOTALS FOR YEAR 31

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.80	90024.008	100.00
RUNOFF	2.803	10174.625	11.30
EVAPOTRANSPIRATION	6.036	21911.082	24.34
DRAINAGE COLLECTED FROM LAYER 2	15.9611	57938.941	64.36
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.000	-0.661	0.00

SOIL WATER AT START OF YEAR	9.193	33370.520	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 32

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.36	92056.812	100.00
RUNOFF	2.723	9883.026	10.74
EVAPOTRANSPIRATION	4.733	17182.592	18.67
DRAINAGE COLLECTED FROM LAYER 2	17.8425	64768.320	70.36
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	0.061	222.856	0.24
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.254	33592.715	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.009	0.00

ANNUAL TOTALS FOR YEAR 33

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.27	62690.117	100.00
RUNOFF	0.719	2610.606	4.16
EVAPOTRANSPIRATION	4.696	17044.965	27.19
DRAINAGE COLLECTED FROM LAYER 2	11.8491	43012.168	68.61
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	0.006	22.357	0.04
SOIL WATER AT START OF YEAR	9.254	33592.715	
SOIL WATER AT END OF YEAR	9.260	33615.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 34

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.87	101168.094	100.00
RUNOFF	5.569	20216.410	19.98
EVAPOTRANSPIRATION	4.217	15306.130	15.13
DRAINAGE COLLECTED FROM LAYER 2	18.1517	65890.758	65.13
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	-0.068	-245.212	-0.24
SOIL WATER AT START OF YEAR	9.260	33615.070	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

ANNUAL TOTALS FOR YEAR 35

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.38	70349.398	100.00
RUNOFF	0.724	2628.988	3.74
EVAPOTRANSPIRATION	5.414	19653.125	27.94
DRAINAGE COLLECTED FROM LAYER 2	13.2412	48065.699	68.32
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	1.579	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33371.437	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

ANNUAL TOTALS FOR YEAR 36

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.52	74487.617	100.00
RUNOFF	3.230	11723.593	15.74
EVAPOTRANSPIRATION	3.273	11880.292	15.95
DRAINAGE COLLECTED FROM LAYER 2	13.9733	50723.223	68.10
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	0.044	160.487	0.22
SOIL WATER AT START OF YEAR	9.193	33371.437	
SOIL WATER AT END OF YEAR	9.237	33531.926	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

ANNUAL TOTALS FOR YEAR 37

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.59	67481.711	100.00
RUNOFF	2.454	8909.412	13.20

EVAPOTRANSPIRATION	3.344	12140.296	17.99
DRAINAGE COLLECTED FROM LAYER 2	12.8358	46594.059	69.05
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.004	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	-0.045	-162.066	-0.24
SOIL WATER AT START OF YEAR	9.237	33531.926	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 38

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.07	61964.105	100.00
RUNOFF	0.859	3117.153	5.03
EVAPOTRANSPIRATION	3.736	13562.092	21.89
DRAINAGE COLLECTED FROM LAYER 2	12.4752	45284.824	73.08
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

ANNUAL TOTALS FOR YEAR 39

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.27	88100.109	100.00
RUNOFF	4.066	14758.231	16.75
EVAPOTRANSPIRATION	4.760	17279.980	19.61
DRAINAGE COLLECTED FROM LAYER 2	15.4440	56061.871	63.63
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

ANNUAL TOTALS FOR YEAR 40

	INCHES	CU. FEET	PERCENT

PRECIPITATION	24.65	89479.516	100.00
RUNOFF	1.694	6150.279	6.87
EVAPOTRANSPIRATION	5.869	21305.996	23.81
DRAINAGE COLLECTED FROM LAYER 2	17.0762	61986.504	69.27
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	0.010	36.727	0.04
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.203	33406.586	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

ANNUAL TOTALS FOR YEAR 41

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.48	70712.414	100.00
RUNOFF	2.100	7622.201	10.78
EVAPOTRANSPIRATION	4.862	17647.461	24.96
DRAINAGE COLLECTED FROM LAYER 2	12.5288	45479.453	64.32
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	-0.010	-36.727	-0.05

SOIL WATER AT START OF YEAR	9.203	33406.586	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 42

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.16	91330.805	100.00
RUNOFF	2.277	8266.765	9.05
EVAPOTRANSPIRATION	4.680	16987.361	18.60
DRAINAGE COLLECTED FROM LAYER 2	18.2029	66076.672	72.35
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.001	0.00

ANNUAL TOTALS FOR YEAR 43

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.81	100950.336	100.00
RUNOFF	3.588	13023.431	12.90
EVAPOTRANSPIRATION	5.806	21075.201	20.88
DRAINAGE COLLECTED FROM LAYER 2	18.1671	65946.492	65.33
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	0.249	905.135	0.90
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.232	33512.770	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.210	762.223	0.76
ANNUAL WATER BUDGET BALANCE	0.0000	0.072	0.00

ANNUAL TOTALS FOR YEAR 44

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.59	89261.711	100.00
RUNOFF	3.716	13489.295	15.11
EVAPOTRANSPIRATION	5.246	19043.187	21.33
DRAINAGE COLLECTED FROM LAYER 2	15.8672	57597.828	64.53
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	-0.239	-868.613	-0.97
SOIL WATER AT START OF YEAR	9.232	33512.770	
SOIL WATER AT END OF YEAR	9.203	33406.383	
SNOW WATER AT START OF YEAR	0.210	762.223	0.85
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

ANNUAL TOTALS FOR YEAR 45

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.39	77645.703	100.00
RUNOFF	1.217	4417.427	5.69
EVAPOTRANSPIRATION	4.116	14942.576	19.24
DRAINAGE COLLECTED FROM LAYER 2	16.0597	58296.773	75.08
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	-0.003	-11.078	-0.01
SOIL WATER AT START OF YEAR	9.203	33406.383	
SOIL WATER AT END OF YEAR	9.200	33395.305	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

ANNUAL TOTALS FOR YEAR 46

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.33	59277.906	100.00
RUNOFF	1.891	6863.788	11.58
EVAPOTRANSPIRATION	4.591	16663.893	28.11
DRAINAGE COLLECTED FROM LAYER 2	9.8556	35775.668	60.35
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0013		
CHANGE IN WATER STORAGE	-0.007	-25.445	-0.04
SOIL WATER AT START OF YEAR	9.200	33395.305	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

ANNUAL TOTALS FOR YEAR 47

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.05	98191.508	100.00
RUNOFF	3.362	12205.005	12.43

EVAPOTRANSPIRATION	5.940	21563.570	21.96
DRAINAGE COLLECTED FROM LAYER 2	17.7474	64422.926	65.61
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 48

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.27	77210.109	100.00
RUNOFF	2.665	9674.837	12.53
EVAPOTRANSPIRATION	4.857	17632.289	22.84
DRAINAGE COLLECTED FROM LAYER 2	13.7474	49902.957	64.63
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

ANNUAL TOTALS FOR YEAR 49

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.01	94416.305	100.00
RUNOFF	4.101	14884.872	15.77
EVAPOTRANSPIRATION	4.020	14591.031	15.45
DRAINAGE COLLECTED FROM LAYER 2	17.8899	64940.379	68.78
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

ANNUAL TOTALS FOR YEAR 50

	INCHES	CU. FEET	PERCENT

PRECIPITATION	25.28	91766.406	100.00
RUNOFF	1.861	6756.082	7.36
EVAPOTRANSPIRATION	6.039	21922.135	23.89
DRAINAGE COLLECTED FROM LAYER 2	17.3797	63088.156	68.75
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

ANNUAL TOTALS FOR YEAR 51

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.42	95904.602	100.00
RUNOFF	4.954	17982.834	18.75
EVAPOTRANSPIRATION	5.130	18622.783	19.42
DRAINAGE COLLECTED FROM LAYER 2	16.3289	59273.793	61.80
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0022		
CHANGE IN WATER STORAGE	0.007	25.188	0.03

SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.200	33395.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

ANNUAL TOTALS FOR YEAR 52

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.56	60112.805	100.00
RUNOFF	1.293	4694.248	7.81
EVAPOTRANSPIRATION	3.010	10927.794	18.18
DRAINAGE COLLECTED FROM LAYER 2	12.2633	44515.941	74.05
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	-0.007	-25.188	-0.04
SOIL WATER AT START OF YEAR	9.200	33395.047	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.005	0.00

ANNUAL TOTALS FOR YEAR 53

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.78	86321.414	100.00
RUNOFF	3.760	13650.543	15.81
EVAPOTRANSPIRATION	4.256	15448.106	17.90
DRAINAGE COLLECTED FROM LAYER 2	14.9290	54192.090	62.78
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	0.835	3030.652	3.51
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.248	33571.020	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.779	2829.491	3.28
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 54

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.58	107375.430	100.00
RUNOFF	3.767	13675.795	12.74
EVAPOTRANSPIRATION	6.154	22340.418	20.81
DRAINAGE COLLECTED FROM LAYER 2	20.3529	73881.117	68.81
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0027		
CHANGE IN WATER STORAGE	-0.695	-2521.941	-2.35
SOIL WATER AT START OF YEAR	9.248	33571.020	
SOIL WATER AT END OF YEAR	9.232	33512.770	
SNOW WATER AT START OF YEAR	0.779	2829.491	2.64
SNOW WATER AT END OF YEAR	0.101	365.800	0.34
ANNUAL WATER BUDGET BALANCE	0.0000	0.032	0.00

ANNUAL TOTALS FOR YEAR 55

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.93	68715.930	100.00
RUNOFF	2.804	10177.842	14.81
EVAPOTRANSPIRATION	3.796	13780.195	20.05
DRAINAGE COLLECTED FROM LAYER 2	12.4516	45199.152	65.78
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	-0.122	-441.295	-0.64
SOIL WATER AT START OF YEAR	9.232	33512.770	
SOIL WATER AT END OF YEAR	9.211	33437.273	
SNOW WATER AT START OF YEAR	0.101	365.800	0.53
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

ANNUAL TOTALS FOR YEAR 56

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.11	98409.312	100.00
RUNOFF	2.933	10645.314	10.82
EVAPOTRANSPIRATION	5.159	18727.936	19.03
DRAINAGE COLLECTED FROM LAYER 2	19.0368	69103.469	70.22
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0025		
CHANGE IN WATER STORAGE	-0.019	-67.416	-0.07
SOIL WATER AT START OF YEAR	9.211	33437.273	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

ANNUAL TOTALS FOR YEAR 57

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.52	85377.625	100.00
RUNOFF	4.602	16707.043	19.57

EVAPOTRANSPIRATION	4.904	17799.971	20.85
DRAINAGE COLLECTED FROM LAYER 2	14.0139	50870.566	59.58
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.035	0.00

ANNUAL TOTALS FOR YEAR 58

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.77	64505.109	100.00
RUNOFF	2.060	7478.300	11.59
EVAPOTRANSPIRATION	2.978	10809.291	16.76
DRAINAGE COLLECTED FROM LAYER 2	12.7321	46217.500	71.65
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

ANNUAL TOTALS FOR YEAR 59

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.77	64505.102	100.00
RUNOFF	2.524	9163.584	14.21
EVAPOTRANSPIRATION	3.610	13103.770	20.31
DRAINAGE COLLECTED FROM LAYER 2	11.4187	41449.902	64.26
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0015		
CHANGE IN WATER STORAGE	0.217	787.823	1.22
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.248	33571.074	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.162	586.607	0.91
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

ANNUAL TOTALS FOR YEAR 60

	INCHES	CU. FEET	PERCENT

	-----	-----	-----
PRECIPITATION	30.41	110388.305	100.00
RUNOFF	4.356	15810.556	14.32
EVAPOTRANSPIRATION	5.182	18812.145	17.04
DRAINAGE COLLECTED FROM LAYER 2	20.4366	74185.016	67.20
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0027		
CHANGE IN WATER STORAGE	0.435	1580.564	1.43
SOIL WATER AT START OF YEAR	9.248	33571.074	
SOIL WATER AT END OF YEAR	9.232	33512.770	
SNOW WATER AT START OF YEAR	0.162	586.607	0.53
SNOW WATER AT END OF YEAR	0.613	2225.476	2.02
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

ANNUAL TOTALS FOR YEAR 61

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	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.01	105306.320	100.00
RUNOFF	5.882	21351.617	20.28
EVAPOTRANSPIRATION	6.375	23140.701	21.97
DRAINAGE COLLECTED FROM LAYER 2	17.4056	63182.348	60.00
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	-0.652	-2368.387	-2.25

SOIL WATER AT START OF YEAR	9.232	33512.770	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.613	2225.476	2.11
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.036	0.00

ANNUAL TOTALS FOR YEAR 62

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.48	67082.406	100.00
RUNOFF	1.504	5459.158	8.14
EVAPOTRANSPIRATION	3.119	11322.083	16.88
DRAINAGE COLLECTED FROM LAYER 2	13.8571	50301.148	74.98
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.011	0.00

ANNUAL TOTALS FOR YEAR 63

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.00	98010.008	100.00
RUNOFF	3.233	11734.974	11.97
EVAPOTRANSPIRATION	5.856	21256.482	21.69
DRAINAGE COLLECTED FROM LAYER 2	17.9055	64997.062	66.32
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	0.006	21.477	0.02
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.199	33391.336	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 64

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.90	86756.992	100.00
RUNOFF	3.462	12566.325	14.48
EVAPOTRANSPIRATION	4.524	16422.404	18.93
DRAINAGE COLLECTED FROM LAYER 2	15.8446	57516.023	66.30
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.069	252.243	0.29
SOIL WATER AT START OF YEAR	9.199	33391.336	
SOIL WATER AT END OF YEAR	9.268	33643.578	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.008	0.00

ANNUAL TOTALS FOR YEAR 65

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.89	83090.687	100.00
RUNOFF	3.755	13630.556	16.40
EVAPOTRANSPIRATION	4.219	15313.666	18.43
DRAINAGE COLLECTED FROM LAYER 2	14.9802	54378.168	65.44
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	-0.064	-231.697	-0.28
SOIL WATER AT START OF YEAR	9.268	33643.578	
SOIL WATER AT END OF YEAR	9.204	33411.883	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

ANNUAL TOTALS FOR YEAR 66

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.38	99389.422	100.00
RUNOFF	4.144	15042.011	15.13
EVAPOTRANSPIRATION	5.793	21029.807	21.16
DRAINAGE COLLECTED FROM LAYER 2	17.4544	63359.613	63.75
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	-0.012	-42.023	-0.04
SOIL WATER AT START OF YEAR	9.204	33411.883	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

ANNUAL TOTALS FOR YEAR 67

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.82	100986.609	100.00
RUNOFF	5.536	20096.037	19.90

EVAPOTRANSPIRATION	5.476	19876.941	19.68
DRAINAGE COLLECTED FROM LAYER 2	16.8082	61013.609	60.42
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0022		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 68

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	32.45	117793.500	100.00
RUNOFF	6.685	24266.686	20.60
EVAPOTRANSPIRATION	6.785	24631.121	20.91
DRAINAGE COLLECTED FROM LAYER 2	18.8847	68551.500	58.20
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0025		
CHANGE IN WATER STORAGE	0.095	344.187	0.29
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.248	33571.031	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.039	143.016	0.12
ANNUAL WATER BUDGET BALANCE	0.0000	0.005	0.00

ANNUAL TOTALS FOR YEAR 69

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.24	84361.203	100.00
RUNOFF	3.148	11428.249	13.55
EVAPOTRANSPIRATION	4.351	15793.733	18.72
DRAINAGE COLLECTED FROM LAYER 2	15.8356	57483.402	68.14
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	-0.095	-344.187	-0.41
SOIL WATER AT START OF YEAR	9.248	33571.031	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.039	143.016	0.17
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

ANNUAL TOTALS FOR YEAR 70

	INCHES	CU. FEET	PERCENT

PRECIPITATION	21.52	78117.602	100.00
RUNOFF	4.217	15309.391	19.60
EVAPOTRANSPIRATION	4.173	15149.753	19.39
DRAINAGE COLLECTED FROM LAYER 2	13.1291	47658.461	61.01
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

ANNUAL TOTALS FOR YEAR 71

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.47	85196.102	100.00
RUNOFF	2.345	8514.038	9.99
EVAPOTRANSPIRATION	5.181	18807.637	22.08
DRAINAGE COLLECTED FROM LAYER 2	15.7159	57048.621	66.96
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.227	825.795	0.97

SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.212	33441.316	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.208	754.339	0.89
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

ANNUAL TOTALS FOR YEAR 72

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.65	74959.516	100.00
RUNOFF	1.576	5719.453	7.63
EVAPOTRANSPIRATION	4.017	14580.358	19.45
DRAINAGE COLLECTED FROM LAYER 2	15.2853	55485.465	74.02
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	-0.227	-825.795	-1.10
SOIL WATER AT START OF YEAR	9.212	33441.316	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.208	754.339	1.01
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

ANNUAL TOTALS FOR YEAR 73

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.09	98336.711	100.00
RUNOFF	4.593	16673.887	16.96
EVAPOTRANSPIRATION	5.217	18937.145	19.26
DRAINAGE COLLECTED FROM LAYER 2	17.2798	62725.656	63.79
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 74

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.84	108319.211	100.00
RUNOFF	3.470	12594.602	11.63
EVAPOTRANSPIRATION	6.420	23305.164	21.52
DRAINAGE COLLECTED FROM LAYER 2	19.9503	72419.422	66.86
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0027		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 75

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	32.99	119753.703	100.00
RUNOFF	8.015	29095.840	24.30
EVAPOTRANSPIRATION	5.358	19447.785	16.24
DRAINAGE COLLECTED FROM LAYER 2	19.6171	71210.047	59.46
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0026		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.029	0.00

ANNUAL TOTALS FOR YEAR 76

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.32	106431.609	100.00
RUNOFF	5.712	20734.414	19.48
EVAPOTRANSPIRATION	4.524	16420.311	15.43
DRAINAGE COLLECTED FROM LAYER 2	18.9347	68733.078	64.58
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0025		
CHANGE IN WATER STORAGE	0.150	543.779	0.51
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.343	33913.637	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.024	0.00

ANNUAL TOTALS FOR YEAR 77

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.50	67155.008	100.00
RUNOFF	2.434	8834.682	13.16

EVAPOTRANSPIRATION	2.948	10700.844	15.93
DRAINAGE COLLECTED FROM LAYER 2	13.2681	48163.238	71.72
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	-0.150	-543.779	-0.81
SOIL WATER AT START OF YEAR	9.343	33913.637	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 78

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.92	90459.594	100.00
RUNOFF	3.997	14509.966	16.04
EVAPOTRANSPIRATION	5.027	18249.689	20.17
DRAINAGE COLLECTED FROM LAYER 2	15.8851	57662.992	63.74
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.010	36.931	0.04
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.203	33406.789	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

ANNUAL TOTALS FOR YEAR 79

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.33	81057.906	100.00
RUNOFF	3.399	12338.158	15.22
EVAPOTRANSPIRATION	4.046	14687.855	18.12
DRAINAGE COLLECTED FROM LAYER 2	14.8950	54068.809	66.70
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	-0.010	-36.931	-0.05
SOIL WATER AT START OF YEAR	9.203	33406.789	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

ANNUAL TOTALS FOR YEAR 80

	INCHES	CU. FEET	PERCENT

	-----	-----	-----
PRECIPITATION	17.86	64831.801	100.00
RUNOFF	0.842	3055.621	4.71
EVAPOTRANSPIRATION	4.384	15915.661	24.55
DRAINAGE COLLECTED FROM LAYER 2	11.6668	42350.449	65.32
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0015		
CHANGE IN WATER STORAGE	0.967	3510.073	5.41
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.248	33570.902	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.912	3309.030	5.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.006	0.00

ANNUAL TOTALS FOR YEAR 81

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	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.52	70857.617	100.00
RUNOFF	2.569	9324.905	13.16
EVAPOTRANSPIRATION	4.117	14946.244	21.09
DRAINAGE COLLECTED FROM LAYER 2	13.8007	50096.512	70.70
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0018		
CHANGE IN WATER STORAGE	-0.967	-3510.073	-4.95

SOIL WATER AT START OF YEAR	9.248	33570.902	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.912	3309.030	4.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

ANNUAL TOTALS FOR YEAR 82

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.45	88753.516	100.00
RUNOFF	2.469	8961.838	10.10
EVAPOTRANSPIRATION	6.352	23058.756	25.98
DRAINAGE COLLECTED FROM LAYER 2	15.6289	56732.902	63.92
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 83

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.87	79388.102	100.00
RUNOFF	2.094	7601.854	9.58
EVAPOTRANSPIRATION	4.795	17405.955	21.93
DRAINAGE COLLECTED FROM LAYER 2	14.9808	54380.277	68.50
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

ANNUAL TOTALS FOR YEAR 84

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.64	71293.203	100.00
RUNOFF	2.731	9912.791	13.90
EVAPOTRANSPIRATION	4.499	16329.606	22.90
DRAINAGE COLLECTED FROM LAYER 2	12.4074	45038.918	63.17
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	0.003	11.878	0.02
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.196	33381.738	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

ANNUAL TOTALS FOR YEAR 85

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.23	55284.906	100.00
RUNOFF	1.702	6178.006	11.17
EVAPOTRANSPIRATION	3.133	11371.894	20.57
DRAINAGE COLLECTED FROM LAYER 2	10.3657	37627.473	68.06
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0014		
CHANGE IN WATER STORAGE	0.030	107.528	0.19
SOIL WATER AT START OF YEAR	9.196	33381.738	
SOIL WATER AT END OF YEAR	9.226	33489.266	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

ANNUAL TOTALS FOR YEAR 86

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.49	74378.703	100.00
RUNOFF	0.947	3437.951	4.62
EVAPOTRANSPIRATION	5.168	18761.303	25.22
DRAINAGE COLLECTED FROM LAYER 2	14.4074	52298.852	70.31
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	-0.033	-119.406	-0.16
SOIL WATER AT START OF YEAR	9.226	33489.266	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

ANNUAL TOTALS FOR YEAR 87

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.38	99389.414	100.00
RUNOFF	4.987	18103.678	18.21

EVAPOTRANSPIRATION	5.248	19051.357	19.17
DRAINAGE COLLECTED FROM LAYER 2	17.1445	62234.359	62.62
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0023		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

ANNUAL TOTALS FOR YEAR 88

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.19	58769.703	100.00
RUNOFF	0.821	2980.050	5.07
EVAPOTRANSPIRATION	3.899	14155.031	24.09
DRAINAGE COLLECTED FROM LAYER 2	11.4696	41634.613	70.84
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0015		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 89

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.12	65775.602	100.00
RUNOFF	1.694	6148.832	9.35
EVAPOTRANSPIRATION	3.339	12121.479	18.43
DRAINAGE COLLECTED FROM LAYER 2	13.0869	47505.270	72.22
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 90

	INCHES	CU. FEET	PERCENT

PRECIPITATION	19.58	71075.406	100.00
RUNOFF	2.606	9460.654	13.31
EVAPOTRANSPIRATION	3.906	14177.209	19.95
DRAINAGE COLLECTED FROM LAYER 2	13.0682	47437.520	66.74
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 91

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.14	113038.219	100.00
RUNOFF	5.132	18628.561	16.48
EVAPOTRANSPIRATION	6.577	23876.123	21.12
DRAINAGE COLLECTED FROM LAYER 2	19.4307	70533.508	62.40
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0026		
CHANGE IN WATER STORAGE	0.000	0.000	0.00

SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 92

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.22	58878.605	100.00
RUNOFF	1.551	5629.874	9.56
EVAPOTRANSPIRATION	2.742	9952.341	16.90
DRAINAGE COLLECTED FROM LAYER 2	11.9274	43296.383	73.53
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0016		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 93

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.88	101204.414	100.00
RUNOFF	4.277	15526.429	15.34
EVAPOTRANSPIRATION	5.011	18190.832	17.97
DRAINAGE COLLECTED FROM LAYER 2	18.5915	67487.125	66.68
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0025		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 94

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.00	54450.000	100.00
RUNOFF	1.449	5258.681	9.66
EVAPOTRANSPIRATION	2.602	9443.602	17.34
DRAINAGE COLLECTED FROM LAYER 2	10.9498	39747.727	73.00
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.005	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0014		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.015	0.00

ANNUAL TOTALS FOR YEAR 95

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.27	77210.125	100.00
RUNOFF	3.286	11927.324	15.45
EVAPOTRANSPIRATION	3.052	11077.056	14.35
DRAINAGE COLLECTED FROM LAYER 2	14.9327	54205.727	70.21
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.006	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.011	0.00

ANNUAL TOTALS FOR YEAR 96

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.96	108754.820	100.00
RUNOFF	2.874	10434.272	9.59
EVAPOTRANSPIRATION	7.128	25873.336	23.79
DRAINAGE COLLECTED FROM LAYER 2	19.9579	72447.172	66.62
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0026		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

ANNUAL TOTALS FOR YEAR 97

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	31.47	114236.102	100.00
RUNOFF	5.082	18446.670	16.15

EVAPOTRANSPIRATION	5.998	21772.734	19.06
DRAINAGE COLLECTED FROM LAYER 2	20.3903	74016.664	64.79
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0027		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

ANNUAL TOTALS FOR YEAR 98

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.32	73761.609	100.00
RUNOFF	1.646	5973.335	8.10
EVAPOTRANSPIRATION	3.649	13247.470	17.96
DRAINAGE COLLECTED FROM LAYER 2	15.0250	54540.785	73.94
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0020		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.008	0.00

ANNUAL TOTALS FOR YEAR 99

	INCHES	CU. FEET	PERCENT
PRECIPITATION	26.78	97211.430	100.00
RUNOFF	4.041	14667.964	15.09
EVAPOTRANSPIRATION	4.895	17767.855	18.28
DRAINAGE COLLECTED FROM LAYER 2	17.8445	64775.582	66.63
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.007	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0024		
CHANGE IN WATER STORAGE	0.000	0.000	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33369.859	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT

PRECIPITATION	28.58	103745.414	100.00
RUNOFF	5.197	18866.279	18.19
EVAPOTRANSPIRATION	4.061	14742.487	14.21
DRAINAGE COLLECTED FROM LAYER 2	19.3213	70136.281	67.60
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0026		
CHANGE IN WATER STORAGE	0.000	0.343	0.00
SOIL WATER AT START OF YEAR	9.193	33369.859	
SOIL WATER AT END OF YEAR	9.193	33370.203	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.69 2.67	0.72 3.49	1.51 2.08	1.73 2.23	2.79 1.05	3.15 0.85
STD. DEVIATIONS	0.60 1.36	0.54 2.16	1.09 1.39	1.30 1.91	1.53 1.07	1.54 0.84
RUNOFF						
TOTALS	0.018	0.013	0.139	0.204	0.309	0.496

	0.246	0.657	0.320	0.421	0.093	0.057
STD. DEVIATIONS	0.054	0.043	0.244	0.344	0.400	0.567
	0.309	0.829	0.421	0.653	0.182	0.208

EVAPOTRANSPIRATION

TOTALS	0.239	0.231	0.287	0.326	0.630	0.623
	0.622	0.589	0.338	0.334	0.183	0.263
STD. DEVIATIONS	0.208	0.202	0.250	0.300	0.429	0.420
	0.419	0.429	0.275	0.299	0.210	0.237

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.4844	0.4789	1.0826	1.1954	1.8461	2.0366
	1.7988	2.2371	1.4385	1.4764	0.7646	0.4982
STD. DEVIATIONS	0.4514	0.3925	0.7484	0.8132	0.8883	0.8537
	0.8540	1.1433	0.8513	1.1462	0.7561	0.5186

PERCOLATION/LEAKAGE THROUGH LAYER 4

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 3

AVERAGES	0.0008	0.0008	0.0017	0.0019	0.0029	0.0033
	0.0028	0.0035	0.0023	0.0023	0.0012	0.0008
STD. DEVIATIONS	0.0007	0.0007	0.0012	0.0013	0.0014	0.0014
	0.0013	0.0018	0.0014	0.0018	0.0012	0.0008

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	22.97	(4.466)	83398.2	100.00
RUNOFF	2.972	(1.4395)	10788.24	12.936
EVAPOTRANSPIRATION	4.665	(1.0804)	16933.93	20.305
LATERAL DRAINAGE COLLECTED FROM LAYER 2	15.33773	(2.64988)	55675.969	66.75923
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.007	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.002	(0.000)		
CHANGE IN WATER STORAGE	0.000	(0.2573)	0.00	0.000



PEAK DAILY VALUES FOR YEARS 1 THROUGH 100		
	(INCHES)	(CU. FT.)
PRECIPITATION	3.88	14084.400
RUNOFF	2.466	8950.0703
DRAINAGE COLLECTED FROM LAYER 2	1.59852	5802.63867
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00023
AVERAGE HEAD ON TOP OF LAYER 3	0.080	
MAXIMUM HEAD ON TOP OF LAYER 3	0.153	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	2.6 FEET	
SNOW WATER	1.87	6789.2432
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4989

MINIMUM VEG. SOIL WATER (VOL/VOL)

0.0208

*** 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.

↑

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.0121	0.0242
2	0.0008	0.0062
3	0.0000	0.0000
4	9.1800	0.7500
SNOW WATER	0.000	

ATTACHMENT B

PREVIOUSLY PERMITTED COVER HELP MODEL OUTPUT



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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:\NHP\DATA4.D4
TEMPERATURE DATA FILE: C:\NHP\DATA7.D7
SOLAR RADIATION DATA FILE: C:\NHP\DATA13.D13
EVAPOTRANSPIRATION DATA: C:\NHP\DATA11.D11
SOIL AND DESIGN DATA FILE: C:\NHP\data10.D10
OUTPUT DATA FILE: C:\NHP\permitUD.OUT

TIME: 12:14 DATE: 5/ 7/2020

```
*****
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TITLE: North Holding Pond - Permitted Final Cover System

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*****
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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 13

THICKNESS = 18.00 INCHES

POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3210 VOL/VOL
WILTING POINT	=	0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2725 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.330000003000E-04 CM/SEC

NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 3.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	3.00 INCHES
POROSITY	=	0.3970 VOL/VOL
FIELD CAPACITY	=	0.0320 VOL/VOL
WILTING POINT	=	0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0323 VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.329999998000E-01 CM/SEC
SLOPE	=	3.00 PERCENT
DRAINAGE LENGTH	=	260.0 FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.04 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	=	1.00 HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00 HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD

LAYER 4

TYPE 3 - BARRIER SOIL LINER

MATERIAL TEXTURE NUMBER 16

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4270	VOL/VOL
FIELD CAPACITY	=	0.4180	VOL/VOL
WILTING POINT	=	0.3670	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4270	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000001000E-06	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 260. FEET.

SCS RUNOFF CURVE NUMBER	=	88.40	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	4.906	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.740	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.978	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	15.251	INCHES
TOTAL INITIAL WATER	=	15.251	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM AMARILLO TEXAS

STATION LATITUDE	=	35.71	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	95	
END OF GROWING SEASON (JULIAN DATE)	=	303	
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	13.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	55.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	52.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	57.00	%

AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 57.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR AMARILLO TEXAS

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-----	-----	-----	-----	-----	-----
0.71	0.69	1.54	1.79	2.68	3.28
2.68	3.56	2.09	1.94	1.03	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR AMARILLO TEXAS

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
-----	-----	-----	-----	-----	-----
38.50	41.90	49.30	58.10	67.30	76.20
80.60	79.40	71.80	60.60	48.20	38.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR AMARILLO TEXAS
AND STATION LATITUDE = 35.71 DEGREES

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.15	69514.516	100.00
RUNOFF	0.465	1686.935	2.43
EVAPOTRANSPIRATION	18.392	66761.250	96.04
DRAINAGE COLLECTED FROM LAYER 2	0.2355	854.972	1.23
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.058	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0299		
CHANGE IN WATER STORAGE	0.058	211.276	0.30
SOIL WATER AT START OF YEAR	15.251	55360.180	
SOIL WATER AT END OF YEAR	15.309	55571.457	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.028	0.00

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.94	101422.203	100.00
RUNOFF	1.753	6361.691	6.27
EVAPOTRANSPIRATION	25.817	93716.367	92.40
DRAINAGE COLLECTED FROM LAYER 2	0.9151	3321.664	3.28
PERC./LEAKAGE THROUGH LAYER 4	0.000051	0.187	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1159		
CHANGE IN WATER STORAGE	-0.545	-1977.720	-1.95
SOIL WATER AT START OF YEAR	15.309	55571.457	
SOIL WATER AT END OF YEAR	14.764	53593.734	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.10	76593.000	100.00
RUNOFF	1.241	4504.747	5.88
EVAPOTRANSPIRATION	18.334	66551.187	86.89
DRAINAGE COLLECTED FROM LAYER 2	1.9563	7101.415	9.27
PERC./LEAKAGE THROUGH LAYER 4	0.000130	0.473	0.00
AVG. HEAD ON TOP OF LAYER 3	0.3467		
CHANGE IN WATER STORAGE	-0.431	-1564.813	-2.04
SOIL WATER AT START OF YEAR	14.764	53593.734	
SOIL WATER AT END OF YEAR	14.333	52028.922	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.006	0.00

ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.58	78335.430	100.00
RUNOFF	0.754	2737.023	3.49

EVAPOTRANSPIRATION	19.529	70891.773	90.50
DRAINAGE COLLECTED FROM LAYER 2	0.5990	2174.518	2.78
PERC./LEAKAGE THROUGH LAYER 4	0.000036	0.130	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0764		
CHANGE IN WATER STORAGE	0.698	2531.926	3.23
SOIL WATER AT START OF YEAR	14.333	52028.922	
SOIL WATER AT END OF YEAR	15.031	54560.848	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.054	0.00

ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.77	75395.094	100.00
RUNOFF	0.300	1088.535	1.44
EVAPOTRANSPIRATION	20.678	75060.227	99.56
DRAINAGE COLLECTED FROM LAYER 2	0.0048	17.335	0.02
PERC./LEAKAGE THROUGH LAYER 4	0.000003	0.010	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0006		
CHANGE IN WATER STORAGE	-0.212	-770.934	-1.02
SOIL WATER AT START OF YEAR	15.031	54560.848	
SOIL WATER AT END OF YEAR	14.818	53789.914	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.076	0.00

ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	24.15	87664.516	100.00
RUNOFF	1.754	6366.597	7.26
EVAPOTRANSPIRATION	22.057	80065.641	91.33
DRAINAGE COLLECTED FROM LAYER 2	0.4740	1720.626	1.96
PERC./LEAKAGE THROUGH LAYER 4	0.000027	0.098	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0598		
CHANGE IN WATER STORAGE	-0.135	-488.493	-0.56
SOIL WATER AT START OF YEAR	14.818	53789.914	
SOIL WATER AT END OF YEAR	14.684	53301.422	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.044	0.00

ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT

PRECIPITATION	20.44	74197.195	100.00
RUNOFF	0.795	2887.581	3.89
EVAPOTRANSPIRATION	16.370	59422.160	80.09
DRAINAGE COLLECTED FROM LAYER 2	1.3027	4728.766	6.37
PERC./LEAKAGE THROUGH LAYER 4	0.000068	0.248	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1648		
CHANGE IN WATER STORAGE	1.972	7158.454	9.65
SOIL WATER AT START OF YEAR	14.684	53301.422	
SOIL WATER AT END OF YEAR	16.656	60459.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.015	0.00

ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	25.28	91766.406	100.00
RUNOFF	1.821	6611.068	7.20
EVAPOTRANSPIRATION	23.378	84862.039	92.48
DRAINAGE COLLECTED FROM LAYER 2	0.4656	1690.212	1.84
PERC./LEAKAGE THROUGH LAYER 4	0.000028	0.100	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0588		
CHANGE IN WATER STORAGE	-0.385	-1397.059	-1.52

SOIL WATER AT START OF YEAR	16.656	60459.875	
SOIL WATER AT END OF YEAR	16.271	59062.816	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.051	0.00

ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.33	70167.898	100.00
RUNOFF	1.424	5170.198	7.37
EVAPOTRANSPIRATION	18.812	68288.875	97.32
DRAINAGE COLLECTED FROM LAYER 2	0.5249	1905.512	2.72
PERC./LEAKAGE THROUGH LAYER 4	0.000032	0.115	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0664		
CHANGE IN WATER STORAGE	-1.432	-5196.821	-7.41
SOIL WATER AT START OF YEAR	16.271	59062.816	
SOIL WATER AT END OF YEAR	14.839	53865.996	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.40	81312.016	100.00
RUNOFF	0.841	3053.951	3.76
EVAPOTRANSPIRATION	19.529	70891.687	87.18
DRAINAGE COLLECTED FROM LAYER 2	0.2360	856.712	1.05
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.057	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0301		
CHANGE IN WATER STORAGE	1.793	6509.598	8.01
SOIL WATER AT START OF YEAR	14.839	53865.996	
SOIL WATER AT END OF YEAR	16.632	60375.594	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.18	105923.406	100.00
RUNOFF	1.239	4499.068	4.25
EVAPOTRANSPIRATION	25.849	93831.141	88.58
DRAINAGE COLLECTED FROM LAYER 2	2.1398	7767.571	7.33
PERC./LEAKAGE THROUGH LAYER 4	0.000115	0.418	0.00

AVG. HEAD ON TOP OF LAYER 3	0.2723		
CHANGE IN WATER STORAGE	-0.048	-174.808	-0.17
SOIL WATER AT START OF YEAR	16.632	60375.594	
SOIL WATER AT END OF YEAR	15.523	56349.309	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	1.061	3851.475	3.64
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.82	71946.602	100.00
RUNOFF	0.974	3535.443	4.91
EVAPOTRANSPIRATION	19.661	71370.586	99.20
DRAINAGE COLLECTED FROM LAYER 2	0.6937	2518.108	3.50
PERC./LEAKAGE THROUGH LAYER 4	0.000040	0.144	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0875		
CHANGE IN WATER STORAGE	-1.509	-5477.653	-7.61
SOIL WATER AT START OF YEAR	15.523	56349.309	
SOIL WATER AT END OF YEAR	15.075	54723.133	
SNOW WATER AT START OF YEAR	1.061	3851.475	5.35
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.027	0.00

ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.09	91076.711	100.00
RUNOFF	1.715	6223.742	6.83
EVAPOTRANSPIRATION	22.191	80552.312	88.44
DRAINAGE COLLECTED FROM LAYER 2	1.1575	4201.882	4.61
PERC./LEAKAGE THROUGH LAYER 4	0.000061	0.222	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1473		
CHANGE IN WATER STORAGE	0.027	98.493	0.11
SOIL WATER AT START OF YEAR	15.075	54723.133	
SOIL WATER AT END OF YEAR	15.102	54821.625	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.064	0.00

ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.15	54994.516	100.00
RUNOFF	0.686	2490.765	4.53

EVAPOTRANSPIRATION	14.679	53283.348	96.89
DRAINAGE COLLECTED FROM LAYER 2	0.1594	578.507	1.05
PERC./LEAKAGE THROUGH LAYER 4	0.000012	0.043	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0203		
CHANGE IN WATER STORAGE	-0.374	-1358.152	-2.47
SOIL WATER AT START OF YEAR	15.102	54821.625	
SOIL WATER AT END OF YEAR	14.728	53463.473	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.42	66864.609	100.00
RUNOFF	0.425	1544.556	2.31
EVAPOTRANSPIRATION	16.562	60121.258	89.91
DRAINAGE COLLECTED FROM LAYER 2	0.4000	1451.961	2.17
PERC./LEAKAGE THROUGH LAYER 4	0.000024	0.088	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0504		
CHANGE IN WATER STORAGE	1.032	3746.712	5.60
SOIL WATER AT START OF YEAR	14.728	53463.473	
SOIL WATER AT END OF YEAR	15.760	57210.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.031	0.00

ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.01	79896.305	100.00
RUNOFF	1.922	6976.539	8.73
EVAPOTRANSPIRATION	20.792	75474.398	94.47
DRAINAGE COLLECTED FROM LAYER 2	0.4789	1738.268	2.18
PERC./LEAKAGE THROUGH LAYER 4	0.000028	0.103	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0611		
CHANGE IN WATER STORAGE	-1.183	-4293.004	-5.37
SOIL WATER AT START OF YEAR	15.760	57210.187	
SOIL WATER AT END OF YEAR	14.578	52917.180	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.004	0.00

ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT

PRECIPITATION	15.31	55575.305	100.00
RUNOFF	0.539	1956.215	3.52
EVAPOTRANSPIRATION	14.495	52617.676	94.68
DRAINAGE COLLECTED FROM LAYER 2	0.0385	139.768	0.25
PERC./LEAKAGE THROUGH LAYER 4	0.000005	0.018	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0049		
CHANGE IN WATER STORAGE	0.237	861.610	1.55
SOIL WATER AT START OF YEAR	14.578	52917.180	
SOIL WATER AT END OF YEAR	14.815	53778.793	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.27	77210.102	100.00
RUNOFF	1.038	3766.968	4.88
EVAPOTRANSPIRATION	19.065	69206.937	89.63
DRAINAGE COLLECTED FROM LAYER 2	1.0045	3646.441	4.72
PERC./LEAKAGE THROUGH LAYER 4	0.000055	0.199	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1266		
CHANGE IN WATER STORAGE	0.162	589.544	0.76

SOIL WATER AT START OF YEAR	14.815	53778.793	
SOIL WATER AT END OF YEAR	14.978	54368.336	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.00	98010.016	100.00
RUNOFF	3.320	12051.882	12.30
EVAPOTRANSPIRATION	22.686	82351.617	84.02
DRAINAGE COLLECTED FROM LAYER 2	0.8709	3161.365	3.23
PERC./LEAKAGE THROUGH LAYER 4	0.000051	0.185	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1110		
CHANGE IN WATER STORAGE	0.123	444.912	0.45
SOIL WATER AT START OF YEAR	14.978	54368.336	
SOIL WATER AT END OF YEAR	15.100	54813.246	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.054	0.00

ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.09	54776.699	100.00
RUNOFF	0.431	1562.987	2.85
EVAPOTRANSPIRATION	14.890	54050.605	98.67
DRAINAGE COLLECTED FROM LAYER 2	0.1121	406.878	0.74
PERC./LEAKAGE THROUGH LAYER 4	0.000009	0.033	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0143		
CHANGE IN WATER STORAGE	-0.343	-1243.800	-2.27
SOIL WATER AT START OF YEAR	15.100	54813.246	
SOIL WATER AT END OF YEAR	14.757	53569.445	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.54	67300.219	100.00
RUNOFF	2.266	8226.578	12.22
EVAPOTRANSPIRATION	15.241	55323.559	82.20
DRAINAGE COLLECTED FROM LAYER 2	0.5519	2003.248	2.98
PERC./LEAKAGE THROUGH LAYER 4	0.000032	0.117	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0694		
CHANGE IN WATER STORAGE	0.481	1746.684	2.60
SOIL WATER AT START OF YEAR	14.757	53569.445	
SOIL WATER AT END OF YEAR	15.239	55316.133	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.030	0.00

ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	26.25	95287.508	100.00
RUNOFF	2.255	8185.246	8.59
EVAPOTRANSPIRATION	20.259	73539.992	77.18
DRAINAGE COLLECTED FROM LAYER 2	3.8305	13904.696	14.59
PERC./LEAKAGE THROUGH LAYER 4	0.000378	1.373	0.00
AVG. HEAD ON TOP OF LAYER 3	1.0833		
CHANGE IN WATER STORAGE	-0.095	-343.833	-0.36
SOIL WATER AT START OF YEAR	15.239	55316.133	
SOIL WATER AT END OF YEAR	15.144	54972.297	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.031	0.00

ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.73	75249.898	100.00
RUNOFF	1.587	5762.624	7.66
EVAPOTRANSPIRATION	19.352	70249.406	93.35
DRAINAGE COLLECTED FROM LAYER 2	0.1514	549.427	0.73
PERC./LEAKAGE THROUGH LAYER 4	0.000011	0.041	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0191		
CHANGE IN WATER STORAGE	-0.361	-1311.590	-1.74
SOIL WATER AT START OF YEAR	15.144	54972.297	
SOIL WATER AT END OF YEAR	14.783	53660.707	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.009	0.00

ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.92	83199.617	100.00
RUNOFF	0.992	3602.497	4.33

EVAPOTRANSPIRATION	19.613	71194.609	85.57
DRAINAGE COLLECTED FROM LAYER 2	1.8919	6867.448	8.25
PERC./LEAKAGE THROUGH LAYER 4	0.000097	0.350	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2394		
CHANGE IN WATER STORAGE	0.423	1534.709	1.84
SOIL WATER AT START OF YEAR	14.783	53660.707	
SOIL WATER AT END OF YEAR	15.205	55195.418	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.002	0.00

ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.80	86394.008	100.00
RUNOFF	0.749	2718.973	3.15
EVAPOTRANSPIRATION	21.928	79597.711	92.13
DRAINAGE COLLECTED FROM LAYER 2	0.5930	2152.558	2.49
PERC./LEAKAGE THROUGH LAYER 4	0.000035	0.128	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0753		
CHANGE IN WATER STORAGE	0.530	1924.626	2.23
SOIL WATER AT START OF YEAR	15.205	55195.418	
SOIL WATER AT END OF YEAR	15.736	57120.043	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.41	70458.312	100.00
RUNOFF	0.518	1879.630	2.67
EVAPOTRANSPIRATION	19.609	71181.133	101.03
DRAINAGE COLLECTED FROM LAYER 2	0.1202	436.473	0.62
PERC./LEAKAGE THROUGH LAYER 4	0.000010	0.035	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0153		
CHANGE IN WATER STORAGE	-0.837	-3038.971	-4.31
SOIL WATER AT START OF YEAR	15.736	57120.043	
SOIL WATER AT END OF YEAR	14.898	54081.070	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT

PRECIPITATION	23.64	85813.219	100.00
RUNOFF	0.705	2558.708	2.98
EVAPOTRANSPIRATION	22.899	83124.016	96.87
DRAINAGE COLLECTED FROM LAYER 2	0.5035	1827.730	2.13
PERC./LEAKAGE THROUGH LAYER 4	0.000031	0.112	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0639		
CHANGE IN WATER STORAGE	-0.468	-1697.415	-1.98
SOIL WATER AT START OF YEAR	14.898	54081.070	
SOIL WATER AT END OF YEAR	14.431	52383.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.070	0.00

ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.17	76847.117	100.00
RUNOFF	0.686	2490.276	3.24
EVAPOTRANSPIRATION	19.458	70633.258	91.91
DRAINAGE COLLECTED FROM LAYER 2	0.0324	117.615	0.15
PERC./LEAKAGE THROUGH LAYER 4	0.000005	0.017	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0041		
CHANGE IN WATER STORAGE	0.993	3605.926	4.69

SOIL WATER AT START OF YEAR	14.431	52383.656	
SOIL WATER AT END OF YEAR	15.424	55989.582	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

ANNUAL TOTALS FOR YEAR 29

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	26.90	97646.984	100.00
RUNOFF	1.587	5760.464	5.90
EVAPOTRANSPIRATION	24.492	88907.719	91.05
DRAINAGE COLLECTED FROM LAYER 2	1.3152	4774.003	4.89
PERC./LEAKAGE THROUGH LAYER 4	0.000069	0.252	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1672		
CHANGE IN WATER STORAGE	-0.495	-1795.461	-1.84
SOIL WATER AT START OF YEAR	15.424	55989.582	
SOIL WATER AT END OF YEAR	14.930	54194.121	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.006	0.00

ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.88	93944.398	100.00
RUNOFF	1.714	6223.134	6.62
EVAPOTRANSPIRATION	23.351	84764.484	90.23
DRAINAGE COLLECTED FROM LAYER 2	0.6987	2536.220	2.70
PERC./LEAKAGE THROUGH LAYER 4	0.000040	0.145	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0892		
CHANGE IN WATER STORAGE	0.116	420.378	0.45
SOIL WATER AT START OF YEAR	14.930	54194.121	
SOIL WATER AT END OF YEAR	15.045	54614.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.038	0.00

ANNUAL TOTALS FOR YEAR 31

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.80	90024.008	100.00
RUNOFF	1.248	4532.006	5.03
EVAPOTRANSPIRATION	23.581	85599.172	95.08
DRAINAGE COLLECTED FROM LAYER 2	0.5548	2013.919	2.24
PERC./LEAKAGE THROUGH LAYER 4	0.000032	0.118	0.00

AVG. HEAD ON TOP OF LAYER 3	0.0708		
CHANGE IN WATER STORAGE	-0.584	-2121.220	-2.36
SOIL WATER AT START OF YEAR	15.045	54614.500	
SOIL WATER AT END OF YEAR	14.461	52493.277	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 32

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.36	92056.812	100.00
RUNOFF	1.365	4955.005	5.38
EVAPOTRANSPIRATION	22.217	80646.031	87.60
DRAINAGE COLLECTED FROM LAYER 2	0.7714	2800.296	3.04
PERC./LEAKAGE THROUGH LAYER 4	0.000045	0.163	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0985		
CHANGE IN WATER STORAGE	1.007	3655.296	3.97
SOIL WATER AT START OF YEAR	14.461	52493.277	
SOIL WATER AT END OF YEAR	15.468	56148.574	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 33

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.27	62690.117	100.00
RUNOFF	0.123	447.823	0.71
EVAPOTRANSPIRATION	17.252	62623.336	99.89
DRAINAGE COLLECTED FROM LAYER 2	0.0233	84.477	0.13
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0029		
CHANGE IN WATER STORAGE	-0.128	-465.544	-0.74
SOIL WATER AT START OF YEAR	15.468	56148.574	
SOIL WATER AT END OF YEAR	15.340	55683.031	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.008	0.00

ANNUAL TOTALS FOR YEAR 34

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.87	101168.094	100.00
RUNOFF	2.676	9715.480	9.60

EVAPOTRANSPIRATION	25.010	90784.484	89.74
DRAINAGE COLLECTED FROM LAYER 2	1.2011	4359.915	4.31
PERC./LEAKAGE THROUGH LAYER 4	0.000065	0.236	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1521		
CHANGE IN WATER STORAGE	-1.017	-3692.043	-3.65
SOIL WATER AT START OF YEAR	15.340	55683.031	
SOIL WATER AT END OF YEAR	14.323	51990.988	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

ANNUAL TOTALS FOR YEAR 35

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.38	70349.398	100.00
RUNOFF	0.117	423.129	0.60
EVAPOTRANSPIRATION	18.751	68066.234	96.75
DRAINAGE COLLECTED FROM LAYER 2	0.1412	512.466	0.73
PERC./LEAKAGE THROUGH LAYER 4	0.000011	0.039	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0178		
CHANGE IN WATER STORAGE	0.371	1347.545	1.92
SOIL WATER AT START OF YEAR	14.323	51990.988	
SOIL WATER AT END OF YEAR	14.694	53338.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.014	0.00

ANNUAL TOTALS FOR YEAR 36

	INCHES	CU. FEET	PERCENT
PRECIPITATION	20.52	74487.617	100.00
RUNOFF	1.295	4701.770	6.31
EVAPOTRANSPIRATION	17.406	63182.965	84.82
DRAINAGE COLLECTED FROM LAYER 2	0.2488	903.232	1.21
PERC./LEAKAGE THROUGH LAYER 4	0.000016	0.060	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0313		
CHANGE IN WATER STORAGE	1.570	5699.573	7.65
SOIL WATER AT START OF YEAR	14.694	53338.531	
SOIL WATER AT END OF YEAR	16.264	59038.105	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

ANNUAL TOTALS FOR YEAR 37

	INCHES	CU. FEET	PERCENT

	-----	-----	-----
PRECIPITATION	18.59	67481.711	100.00
RUNOFF	1.056	3834.298	5.68
EVAPOTRANSPIRATION	18.331	66543.234	98.61
DRAINAGE COLLECTED FROM LAYER 2	0.7021	2548.781	3.78
PERC./LEAKAGE THROUGH LAYER 4	0.000041	0.149	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0905		
CHANGE IN WATER STORAGE	-1.500	-5444.785	-8.07
SOIL WATER AT START OF YEAR	16.264	59038.105	
SOIL WATER AT END OF YEAR	14.764	53593.320	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

ANNUAL TOTALS FOR YEAR 38

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	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.07	61964.105	100.00
RUNOFF	0.193	702.388	1.13
EVAPOTRANSPIRATION	16.551	60080.508	96.96
DRAINAGE COLLECTED FROM LAYER 2	0.3711	1347.214	2.17
PERC./LEAKAGE THROUGH LAYER 4	0.000024	0.085	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0469		
CHANGE IN WATER STORAGE	-0.046	-166.113	-0.27

SOIL WATER AT START OF YEAR	14.764	53593.320	
SOIL WATER AT END OF YEAR	14.718	53427.207	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

ANNUAL TOTALS FOR YEAR 39

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.27	88100.109	100.00
RUNOFF	2.436	8843.934	10.04
EVAPOTRANSPIRATION	19.356	70260.562	79.75
DRAINAGE COLLECTED FROM LAYER 2	2.1466	7792.272	8.84
PERC./LEAKAGE THROUGH LAYER 4	0.000112	0.407	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2707		
CHANGE IN WATER STORAGE	0.331	1202.944	1.37
SOIL WATER AT START OF YEAR	14.718	53427.207	
SOIL WATER AT END OF YEAR	15.050	54630.152	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.007	0.00

ANNUAL TOTALS FOR YEAR 40

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.65	89479.516	100.00
RUNOFF	0.606	2200.535	2.46
EVAPOTRANSPIRATION	24.058	87330.648	97.60
DRAINAGE COLLECTED FROM LAYER 2	0.0148	53.638	0.06
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.013	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0019		
CHANGE IN WATER STORAGE	-0.029	-105.323	-0.12
SOIL WATER AT START OF YEAR	15.050	54630.152	
SOIL WATER AT END OF YEAR	15.021	54524.828	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 41

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.48	70712.414	100.00
RUNOFF	0.926	3360.398	4.75
EVAPOTRANSPIRATION	18.133	65824.414	93.09
DRAINAGE COLLECTED FROM LAYER 2	0.8394	3046.924	4.31
PERC./LEAKAGE THROUGH LAYER 4	0.000046	0.166	0.00

AVG. HEAD ON TOP OF LAYER 3	0.1056		
CHANGE IN WATER STORAGE	-0.419	-1519.515	-2.15
SOIL WATER AT START OF YEAR	15.021	54524.828	
SOIL WATER AT END OF YEAR	14.602	53005.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

ANNUAL TOTALS FOR YEAR 42

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.16	91330.805	100.00
RUNOFF	0.711	2579.278	2.82
EVAPOTRANSPIRATION	22.599	82032.742	89.82
DRAINAGE COLLECTED FROM LAYER 2	0.1419	515.131	0.56
PERC./LEAKAGE THROUGH LAYER 4	0.000011	0.039	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0178		
CHANGE IN WATER STORAGE	1.709	6203.606	6.79
SOIL WATER AT START OF YEAR	14.602	53005.312	
SOIL WATER AT END OF YEAR	16.311	59208.918	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.014	0.00

ANNUAL TOTALS FOR YEAR 43

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.81	100950.336	100.00
RUNOFF	1.484	5387.473	5.34
EVAPOTRANSPIRATION	27.061	98232.898	97.31
DRAINAGE COLLECTED FROM LAYER 2	0.5614	2037.791	2.02
PERC./LEAKAGE THROUGH LAYER 4	0.000034	0.122	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0712		
CHANGE IN WATER STORAGE	-1.297	-4707.993	-4.66
SOIL WATER AT START OF YEAR	16.311	59208.918	
SOIL WATER AT END OF YEAR	14.804	53738.703	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.210	762.223	0.76
ANNUAL WATER BUDGET BALANCE	0.0000	0.045	0.00

ANNUAL TOTALS FOR YEAR 44

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.59	89261.711	100.00
RUNOFF	1.650	5988.414	6.71

EVAPOTRANSPIRATION	22.362	81175.570	90.94
DRAINAGE COLLECTED FROM LAYER 2	0.9305	3377.716	3.78
PERC./LEAKAGE THROUGH LAYER 4	0.000050	0.183	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1187		
CHANGE IN WATER STORAGE	-0.353	-1280.156	-1.43
SOIL WATER AT START OF YEAR	14.804	53738.703	
SOIL WATER AT END OF YEAR	14.661	53220.770	
SNOW WATER AT START OF YEAR	0.210	762.223	0.85
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.010	0.00

ANNUAL TOTALS FOR YEAR 45

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.39	77645.703	100.00
RUNOFF	0.331	1200.023	1.55
EVAPOTRANSPIRATION	20.735	75266.594	96.94
DRAINAGE COLLECTED FROM LAYER 2	0.0279	101.352	0.13
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.015	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0035		
CHANGE IN WATER STORAGE	0.297	1077.746	1.39
SOIL WATER AT START OF YEAR	14.661	53220.770	
SOIL WATER AT END OF YEAR	14.958	54298.516	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.023	0.00

ANNUAL TOTALS FOR YEAR 46

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.33	59277.906	100.00
RUNOFF	0.845	3068.953	5.18
EVAPOTRANSPIRATION	15.780	57282.441	96.63
DRAINAGE COLLECTED FROM LAYER 2	0.3112	1129.682	1.91
PERC./LEAKAGE THROUGH LAYER 4	0.000019	0.070	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0398		
CHANGE IN WATER STORAGE	-0.607	-2203.242	-3.72
SOIL WATER AT START OF YEAR	14.958	54298.516	
SOIL WATER AT END OF YEAR	14.351	52095.273	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.002	0.00

ANNUAL TOTALS FOR YEAR 47

	INCHES	CU. FEET	PERCENT

PRECIPITATION	27.05	98191.508	100.00
RUNOFF	1.175	4266.221	4.34
EVAPOTRANSPIRATION	25.016	90806.672	92.48
DRAINAGE COLLECTED FROM LAYER 2	0.7386	2681.140	2.73
PERC./LEAKAGE THROUGH LAYER 4	0.000041	0.151	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0943		
CHANGE IN WATER STORAGE	0.120	437.303	0.45
SOIL WATER AT START OF YEAR	14.351	52095.273	
SOIL WATER AT END OF YEAR	14.472	52532.578	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

ANNUAL TOTALS FOR YEAR 48

	INCHES	CU. FEET	PERCENT
PRECIPITATION	21.27	77210.109	100.00
RUNOFF	1.124	4079.457	5.28
EVAPOTRANSPIRATION	19.272	69958.836	90.61
DRAINAGE COLLECTED FROM LAYER 2	1.0225	3711.501	4.81
PERC./LEAKAGE THROUGH LAYER 4	0.000056	0.202	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1290		
CHANGE IN WATER STORAGE	-0.149	-539.894	-0.70

SOIL WATER AT START OF YEAR	14.472	52532.578	
SOIL WATER AT END OF YEAR	14.323	51992.684	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

ANNUAL TOTALS FOR YEAR 49

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	26.01	94416.305	100.00
RUNOFF	2.385	8658.673	9.17
EVAPOTRANSPIRATION	22.293	80922.594	85.71
DRAINAGE COLLECTED FROM LAYER 2	1.3314	4832.906	5.12
PERC./LEAKAGE THROUGH LAYER 4	0.000070	0.256	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1682		
CHANGE IN WATER STORAGE	0.001	1.876	0.00
SOIL WATER AT START OF YEAR	14.323	51992.684	
SOIL WATER AT END OF YEAR	14.324	51994.559	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

ANNUAL TOTALS FOR YEAR 50

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	25.28	91766.406	100.00
RUNOFF	0.808	2934.781	3.20
EVAPOTRANSPIRATION	22.683	82337.766	89.73
DRAINAGE COLLECTED FROM LAYER 2	0.7979	2896.224	3.16
PERC./LEAKAGE THROUGH LAYER 4	0.000046	0.166	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1023		
CHANGE IN WATER STORAGE	0.991	3597.445	3.92
SOIL WATER AT START OF YEAR	14.324	51994.559	
SOIL WATER AT END OF YEAR	15.315	55592.004	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 51

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	26.42	95904.602	100.00
RUNOFF	3.047	11061.996	11.53
EVAPOTRANSPIRATION	20.568	74662.898	77.85
DRAINAGE COLLECTED FROM LAYER 2	2.8481	10338.757	10.78
PERC./LEAKAGE THROUGH LAYER 4	0.000169	0.614	0.00

AVG. HEAD ON TOP OF LAYER 3	0.4550		
CHANGE IN WATER STORAGE	-0.044	-159.688	-0.17
SOIL WATER AT START OF YEAR	15.315	55592.004	
SOIL WATER AT END OF YEAR	15.271	55432.316	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 52

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.56	60112.805	100.00
RUNOFF	0.598	2169.912	3.61
EVAPOTRANSPIRATION	15.920	57789.215	96.13
DRAINAGE COLLECTED FROM LAYER 2	0.1513	549.151	0.91
PERC./LEAKAGE THROUGH LAYER 4	0.000011	0.040	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0190		
CHANGE IN WATER STORAGE	-0.109	-395.498	-0.66
SOIL WATER AT START OF YEAR	15.271	55432.316	
SOIL WATER AT END OF YEAR	15.162	55036.820	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

ANNUAL TOTALS FOR YEAR 53

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.78	86321.414	100.00
RUNOFF	2.210	8021.332	9.29
EVAPOTRANSPIRATION	19.381	70353.023	81.50
DRAINAGE COLLECTED FROM LAYER 2	1.8903	6861.704	7.95
PERC./LEAKAGE THROUGH LAYER 4	0.000114	0.415	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2987		
CHANGE IN WATER STORAGE	0.299	1084.919	1.26
SOIL WATER AT START OF YEAR	15.162	55036.820	
SOIL WATER AT END OF YEAR	14.681	53292.246	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.779	2829.491	3.28
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

ANNUAL TOTALS FOR YEAR 54

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.58	107375.430	100.00
RUNOFF	1.764	6402.517	5.96

EVAPOTRANSPIRATION	27.125	98463.898	91.70
DRAINAGE COLLECTED FROM LAYER 2	1.2417	4507.262	4.20
PERC./LEAKAGE THROUGH LAYER 4	0.000065	0.235	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1587		
CHANGE IN WATER STORAGE	-0.551	-1998.563	-1.86
SOIL WATER AT START OF YEAR	14.681	53292.246	
SOIL WATER AT END OF YEAR	14.809	53757.375	
SNOW WATER AT START OF YEAR	0.779	2829.491	2.64
SNOW WATER AT END OF YEAR	0.101	365.800	0.34
ANNUAL WATER BUDGET BALANCE	0.0000	0.082	0.00

ANNUAL TOTALS FOR YEAR 55

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.93	68715.930	100.00
RUNOFF	1.395	5063.564	7.37
EVAPOTRANSPIRATION	16.499	59890.977	87.16
DRAINAGE COLLECTED FROM LAYER 2	1.0963	3979.693	5.79
PERC./LEAKAGE THROUGH LAYER 4	0.000061	0.222	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1419		
CHANGE IN WATER STORAGE	-0.060	-218.543	-0.32
SOIL WATER AT START OF YEAR	14.809	53757.375	
SOIL WATER AT END OF YEAR	14.850	53904.633	
SNOW WATER AT START OF YEAR	0.101	365.800	0.53

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.015	0.00

ANNUAL TOTALS FOR YEAR 56

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.11	98409.312	100.00
RUNOFF	1.110	4030.939	4.10
EVAPOTRANSPIRATION	23.885	86703.758	88.11
DRAINAGE COLLECTED FROM LAYER 2	1.7832	6473.026	6.58
PERC./LEAKAGE THROUGH LAYER 4	0.000095	0.345	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2258		
CHANGE IN WATER STORAGE	0.331	1201.234	1.22
SOIL WATER AT START OF YEAR	14.850	53904.633	
SOIL WATER AT END OF YEAR	15.181	55105.867	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

ANNUAL TOTALS FOR YEAR 57

	INCHES	CU. FEET	PERCENT

PRECIPITATION	23.52	85377.625	100.00
RUNOFF	2.780	10090.044	11.82
EVAPOTRANSPIRATION	21.008	76257.641	89.32
DRAINAGE COLLECTED FROM LAYER 2	0.5454	1979.861	2.32
PERC./LEAKAGE THROUGH LAYER 4	0.000032	0.116	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0699		
CHANGE IN WATER STORAGE	-0.813	-2950.095	-3.46
SOIL WATER AT START OF YEAR	15.181	55105.867	
SOIL WATER AT END OF YEAR	14.368	52155.770	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.058	0.00

ANNUAL TOTALS FOR YEAR 58

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.77	64505.109	100.00
RUNOFF	0.830	3014.282	4.67
EVAPOTRANSPIRATION	16.652	60447.566	93.71
DRAINAGE COLLECTED FROM LAYER 2	0.0080	29.209	0.05
PERC./LEAKAGE THROUGH LAYER 4	0.000003	0.011	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0010		
CHANGE IN WATER STORAGE	0.279	1014.021	1.57

SOIL WATER AT START OF YEAR	14.368	52155.770	
SOIL WATER AT END OF YEAR	14.647	53169.793	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.021	0.00

ANNUAL TOTALS FOR YEAR 59

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.77	64505.102	100.00
RUNOFF	1.469	5333.382	8.27
EVAPOTRANSPIRATION	15.630	56736.152	87.96
DRAINAGE COLLECTED FROM LAYER 2	0.4186	1519.433	2.36
PERC./LEAKAGE THROUGH LAYER 4	0.000024	0.089	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0525		
CHANGE IN WATER STORAGE	0.252	916.057	1.42
SOIL WATER AT START OF YEAR	14.647	53169.793	
SOIL WATER AT END OF YEAR	14.738	53499.242	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.162	586.607	0.91
ANNUAL WATER BUDGET BALANCE	0.0000	-0.012	0.00

ANNUAL TOTALS FOR YEAR 60

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	30.41	110388.305	100.00
RUNOFF	2.321	8424.145	7.63
EVAPOTRANSPIRATION	25.324	91927.500	83.28
DRAINAGE COLLECTED FROM LAYER 2	1.9564	7101.659	6.43
PERC./LEAKAGE THROUGH LAYER 4	0.000102	0.371	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2475		
CHANGE IN WATER STORAGE	0.808	2934.614	2.66
SOIL WATER AT START OF YEAR	14.738	53499.242	
SOIL WATER AT END OF YEAR	15.095	54794.984	
SNOW WATER AT START OF YEAR	0.162	586.607	0.53
SNOW WATER AT END OF YEAR	0.613	2225.476	2.02
ANNUAL WATER BUDGET BALANCE	0.0000	0.016	0.00

ANNUAL TOTALS FOR YEAR 61

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.01	105306.320	100.00
RUNOFF	3.198	11608.200	11.02
EVAPOTRANSPIRATION	24.712	89702.773	85.18
DRAINAGE COLLECTED FROM LAYER 2	1.7777	6453.181	6.13
PERC./LEAKAGE THROUGH LAYER 4	0.000094	0.343	0.00

AVG. HEAD ON TOP OF LAYER 3	0.2259		
CHANGE IN WATER STORAGE	-0.677	-2458.229	-2.33
SOIL WATER AT START OF YEAR	15.095	54794.984	
SOIL WATER AT END OF YEAR	15.031	54562.234	
SNOW WATER AT START OF YEAR	0.613	2225.476	2.11
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.054	0.00

ANNUAL TOTALS FOR YEAR 62

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.48	67082.406	100.00
RUNOFF	0.637	2310.762	3.44
EVAPOTRANSPIRATION	17.647	64057.215	95.49
DRAINAGE COLLECTED FROM LAYER 2	0.0064	23.413	0.03
PERC./LEAKAGE THROUGH LAYER 4	0.000003	0.011	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0008		
CHANGE IN WATER STORAGE	0.190	691.004	1.03
SOIL WATER AT START OF YEAR	15.031	54562.234	
SOIL WATER AT END OF YEAR	15.221	55253.238	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.000	0.00

ANNUAL TOTALS FOR YEAR 63

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.00	98010.008	100.00
RUNOFF	1.250	4537.256	4.63
EVAPOTRANSPIRATION	26.030	94490.367	96.41
DRAINAGE COLLECTED FROM LAYER 2	0.1772	643.337	0.66
PERC./LEAKAGE THROUGH LAYER 4	0.000013	0.046	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0224		
CHANGE IN WATER STORAGE	-0.458	-1661.045	-1.69
SOIL WATER AT START OF YEAR	15.221	55253.238	
SOIL WATER AT END OF YEAR	14.764	53592.191	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.042	0.00

ANNUAL TOTALS FOR YEAR 64

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.90	86756.992	100.00
RUNOFF	1.687	6122.974	7.06

EVAPOTRANSPIRATION	22.436	81441.398	93.87
DRAINAGE COLLECTED FROM LAYER 2	0.0275	99.673	0.11
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.016	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0035		
CHANGE IN WATER STORAGE	-0.250	-907.088	-1.05
SOIL WATER AT START OF YEAR	14.764	53592.191	
SOIL WATER AT END OF YEAR	14.514	52685.102	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

ANNUAL TOTALS FOR YEAR 65

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	22.89	83090.687	100.00
RUNOFF	2.227	8084.180	9.73
EVAPOTRANSPIRATION	19.311	70098.625	84.36
DRAINAGE COLLECTED FROM LAYER 2	1.2950	4700.750	5.66
PERC./LEAKAGE THROUGH LAYER 4	0.000070	0.254	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1636		
CHANGE IN WATER STORAGE	0.057	206.872	0.25
SOIL WATER AT START OF YEAR	14.514	52685.102	
SOIL WATER AT END OF YEAR	14.571	52891.977	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

ANNUAL TOTALS FOR YEAR 66

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.38	99389.422	100.00
RUNOFF	2.094	7602.431	7.65
EVAPOTRANSPIRATION	24.416	88630.086	89.17
DRAINAGE COLLECTED FROM LAYER 2	0.9863	3580.199	3.60
PERC./LEAKAGE THROUGH LAYER 4	0.000056	0.202	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1245		
CHANGE IN WATER STORAGE	-0.117	-423.545	-0.43
SOIL WATER AT START OF YEAR	14.571	52891.977	
SOIL WATER AT END OF YEAR	14.454	52468.430	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.050	0.00

ANNUAL TOTALS FOR YEAR 67

	INCHES	CU. FEET	PERCENT

PRECIPITATION	27.82	100986.609	100.00
RUNOFF	3.430	12451.944	12.33
EVAPOTRANSPIRATION	21.333	77439.250	76.68
DRAINAGE COLLECTED FROM LAYER 2	2.6674	9682.739	9.59
PERC./LEAKAGE THROUGH LAYER 4	0.000138	0.499	0.00
AVG. HEAD ON TOP OF LAYER 3	0.3394		
CHANGE IN WATER STORAGE	0.389	1412.139	1.40
SOIL WATER AT START OF YEAR	14.454	52468.430	
SOIL WATER AT END OF YEAR	14.843	53880.570	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.043	0.00

ANNUAL TOTALS FOR YEAR 68

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.45	117793.500	100.00
RUNOFF	3.462	12567.119	10.67
EVAPOTRANSPIRATION	27.840	101059.281	85.79
DRAINAGE COLLECTED FROM LAYER 2	0.6491	2356.292	2.00
PERC./LEAKAGE THROUGH LAYER 4	0.000038	0.136	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0823		
CHANGE IN WATER STORAGE	0.499	1810.680	1.54

SOIL WATER AT START OF YEAR	14.843	53880.570	
SOIL WATER AT END OF YEAR	15.303	55548.234	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.039	143.016	0.12
ANNUAL WATER BUDGET BALANCE	0.0000	-0.009	0.00

ANNUAL TOTALS FOR YEAR 69

	INCHES	CU. FEET	PERCENT
PRECIPITATION	23.24	84361.203	100.00
RUNOFF	1.172	4254.585	5.04
EVAPOTRANSPIRATION	20.981	76160.156	90.28
DRAINAGE COLLECTED FROM LAYER 2	0.6299	2286.522	2.71
PERC./LEAKAGE THROUGH LAYER 4	0.000036	0.132	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0800		
CHANGE IN WATER STORAGE	0.457	1659.816	1.97
SOIL WATER AT START OF YEAR	15.303	55548.234	
SOIL WATER AT END OF YEAR	15.799	57351.066	
SNOW WATER AT START OF YEAR	0.039	143.016	0.17
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.003	0.00

ANNUAL TOTALS FOR YEAR 70

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.52	78117.602	100.00
RUNOFF	2.069	7510.305	9.61
EVAPOTRANSPIRATION	19.824	71961.687	92.12
DRAINAGE COLLECTED FROM LAYER 2	1.1019	3999.924	5.12
PERC./LEAKAGE THROUGH LAYER 4	0.000059	0.214	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1391		
CHANGE IN WATER STORAGE	-1.475	-5354.504	-6.85
SOIL WATER AT START OF YEAR	15.799	57351.066	
SOIL WATER AT END OF YEAR	14.324	51996.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.022	0.00

ANNUAL TOTALS FOR YEAR 71

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	23.47	85196.102	100.00
RUNOFF	0.996	3614.864	4.24
EVAPOTRANSPIRATION	20.042	72753.977	85.40
DRAINAGE COLLECTED FROM LAYER 2	1.0142	3681.612	4.32
PERC./LEAKAGE THROUGH LAYER 4	0.000056	0.204	0.00

AVG. HEAD ON TOP OF LAYER 3	0.1272		
CHANGE IN WATER STORAGE	1.417	5145.418	6.04
SOIL WATER AT START OF YEAR	14.324	51996.562	
SOIL WATER AT END OF YEAR	15.534	56387.641	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.208	754.339	0.89
ANNUAL WATER BUDGET BALANCE	0.0000	0.032	0.00

ANNUAL TOTALS FOR YEAR 72

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.65	74959.516	100.00
RUNOFF	0.596	2164.540	2.89
EVAPOTRANSPIRATION	20.225	73416.648	97.94
DRAINAGE COLLECTED FROM LAYER 2	0.5123	1859.728	2.48
PERC./LEAKAGE THROUGH LAYER 4	0.000031	0.113	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0647		
CHANGE IN WATER STORAGE	-0.684	-2481.520	-3.31
SOIL WATER AT START OF YEAR	15.534	56387.641	
SOIL WATER AT END OF YEAR	15.058	54660.457	
SNOW WATER AT START OF YEAR	0.208	754.339	1.01
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

ANNUAL TOTALS FOR YEAR 73

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.09	98336.711	100.00
RUNOFF	2.354	8545.519	8.69
EVAPOTRANSPIRATION	23.552	85495.266	86.94
DRAINAGE COLLECTED FROM LAYER 2	1.1928	4330.027	4.40
PERC./LEAKAGE THROUGH LAYER 4	0.000063	0.228	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1521		
CHANGE IN WATER STORAGE	-0.009	-34.362	-0.03
SOIL WATER AT START OF YEAR	15.058	54660.457	
SOIL WATER AT END OF YEAR	15.049	54626.098	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

ANNUAL TOTALS FOR YEAR 74

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.84	108319.211	100.00
RUNOFF	1.809	6565.681	6.06

EVAPOTRANSPIRATION	25.614	92979.398	85.84
DRAINAGE COLLECTED FROM LAYER 2	1.6583	6019.551	5.56
PERC./LEAKAGE THROUGH LAYER 4	0.000089	0.321	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2102		
CHANGE IN WATER STORAGE	0.759	2754.245	2.54
SOIL WATER AT START OF YEAR	15.049	54626.098	
SOIL WATER AT END OF YEAR	15.807	57380.344	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.020	0.00

ANNUAL TOTALS FOR YEAR 75

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	32.99	119753.703	100.00
RUNOFF	5.047	18320.113	15.30
EVAPOTRANSPIRATION	25.204	91492.180	76.40
DRAINAGE COLLECTED FROM LAYER 2	3.6528	13259.784	11.07
PERC./LEAKAGE THROUGH LAYER 4	0.000235	0.854	0.00
AVG. HEAD ON TOP OF LAYER 3	0.6251		
CHANGE IN WATER STORAGE	-0.914	-3319.286	-2.77
SOIL WATER AT START OF YEAR	15.807	57380.344	
SOIL WATER AT END OF YEAR	14.893	54061.055	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.057	0.00

ANNUAL TOTALS FOR YEAR 76

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	29.32	106431.609	100.00
RUNOFF	3.660	13285.941	12.48
EVAPOTRANSPIRATION	19.608	71178.242	66.88
DRAINAGE COLLECTED FROM LAYER 2	3.9499	14338.006	13.47
PERC./LEAKAGE THROUGH LAYER 4	0.000567	2.056	0.00
AVG. HEAD ON TOP OF LAYER 3	1.6738		
CHANGE IN WATER STORAGE	2.101	7627.343	7.17
SOIL WATER AT START OF YEAR	14.893	54061.055	
SOIL WATER AT END OF YEAR	16.994	61688.398	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

ANNUAL TOTALS FOR YEAR 77

	INCHES	CU. FEET	PERCENT

	-----	-----	-----
PRECIPITATION	18.50	67155.008	100.00
RUNOFF	1.029	3734.817	5.56
EVAPOTRANSPIRATION	19.288	70016.570	104.26
DRAINAGE COLLECTED FROM LAYER 2	0.8548	3102.942	4.62
PERC./LEAKAGE THROUGH LAYER 4	0.000047	0.170	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1084		
CHANGE IN WATER STORAGE	-2.672	-9699.543	-14.44
SOIL WATER AT START OF YEAR	16.994	61688.398	
SOIL WATER AT END OF YEAR	14.322	51988.855	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.052	0.00

ANNUAL TOTALS FOR YEAR 78

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	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.92	90459.594	100.00
RUNOFF	1.893	6870.896	7.60
EVAPOTRANSPIRATION	21.475	77952.609	86.17
DRAINAGE COLLECTED FROM LAYER 2	1.3031	4730.374	5.23
PERC./LEAKAGE THROUGH LAYER 4	0.000068	0.245	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1646		
CHANGE IN WATER STORAGE	0.249	905.492	1.00

SOIL WATER AT START OF YEAR	14.322	51988.855	
SOIL WATER AT END OF YEAR	14.571	52894.348	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.025	0.00

ANNUAL TOTALS FOR YEAR 79

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.33	81057.906	100.00
RUNOFF	1.771	6429.615	7.93
EVAPOTRANSPIRATION	20.500	74416.461	91.81
DRAINAGE COLLECTED FROM LAYER 2	0.0029	10.688	0.01
PERC./LEAKAGE THROUGH LAYER 4	0.000003	0.010	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0004		
CHANGE IN WATER STORAGE	0.055	201.095	0.25
SOIL WATER AT START OF YEAR	14.571	52894.348	
SOIL WATER AT END OF YEAR	14.627	53095.441	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.037	0.00

ANNUAL TOTALS FOR YEAR 80

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	17.86	64831.801	100.00
RUNOFF	0.237	860.922	1.33
EVAPOTRANSPIRATION	16.147	58613.531	90.41
DRAINAGE COLLECTED FROM LAYER 2	0.0098	35.556	0.05
PERC./LEAKAGE THROUGH LAYER 4	0.000003	0.012	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0012		
CHANGE IN WATER STORAGE	1.466	5321.801	8.21
SOIL WATER AT START OF YEAR	14.627	53095.441	
SOIL WATER AT END OF YEAR	15.181	55108.215	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.912	3309.030	5.10
ANNUAL WATER BUDGET BALANCE	0.0000	-0.020	0.00

ANNUAL TOTALS FOR YEAR 81

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.52	70857.617	100.00
RUNOFF	1.262	4579.860	6.46
EVAPOTRANSPIRATION	18.159	65916.461	93.03
DRAINAGE COLLECTED FROM LAYER 2	1.3286	4822.966	6.81
PERC./LEAKAGE THROUGH LAYER 4	0.000070	0.253	0.00

AVG. HEAD ON TOP OF LAYER 3	0.1675		
CHANGE IN WATER STORAGE	-1.229	-4461.957	-6.30
SOIL WATER AT START OF YEAR	15.181	55108.215	
SOIL WATER AT END OF YEAR	14.864	53955.285	
SNOW WATER AT START OF YEAR	0.912	3309.030	4.67
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

ANNUAL TOTALS FOR YEAR 82

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	24.45	88753.516	100.00
RUNOFF	0.772	2800.682	3.16
EVAPOTRANSPIRATION	22.619	82108.516	92.51
DRAINAGE COLLECTED FROM LAYER 2	1.1941	4334.654	4.88
PERC./LEAKAGE THROUGH LAYER 4	0.000066	0.238	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1510		
CHANGE IN WATER STORAGE	-0.135	-490.650	-0.55
SOIL WATER AT START OF YEAR	14.864	53955.285	
SOIL WATER AT END OF YEAR	14.729	53464.637	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.080	0.00

ANNUAL TOTALS FOR YEAR 83

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.87	79388.102	100.00
RUNOFF	0.800	2904.345	3.66
EVAPOTRANSPIRATION	21.361	77540.289	97.67
DRAINAGE COLLECTED FROM LAYER 2	0.1144	415.126	0.52
PERC./LEAKAGE THROUGH LAYER 4	0.000009	0.034	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0146		
CHANGE IN WATER STORAGE	-0.405	-1471.717	-1.85
SOIL WATER AT START OF YEAR	14.729	53464.637	
SOIL WATER AT END OF YEAR	14.323	51992.918	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.022	0.00

ANNUAL TOTALS FOR YEAR 84

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.64	71293.203	100.00
RUNOFF	1.188	4311.919	6.05

EVAPOTRANSPIRATION	17.388	63119.785	88.54
DRAINAGE COLLECTED FROM LAYER 2	0.9180	3332.277	4.67
PERC./LEAKAGE THROUGH LAYER 4	0.000050	0.181	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1172		
CHANGE IN WATER STORAGE	0.146	529.031	0.74
SOIL WATER AT START OF YEAR	14.323	51992.918	
SOIL WATER AT END OF YEAR	14.469	52521.949	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

ANNUAL TOTALS FOR YEAR 85

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.23	55284.906	100.00
RUNOFF	1.036	3760.969	6.80
EVAPOTRANSPIRATION	14.049	50997.418	92.24
DRAINAGE COLLECTED FROM LAYER 2	0.1049	380.739	0.69
PERC./LEAKAGE THROUGH LAYER 4	0.000009	0.031	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0132		
CHANGE IN WATER STORAGE	0.040	145.743	0.26
SOIL WATER AT START OF YEAR	14.469	52521.949	
SOIL WATER AT END OF YEAR	14.509	52667.695	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.004	0.00

ANNUAL TOTALS FOR YEAR 86

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	20.49	74378.703	100.00
RUNOFF	0.196	710.755	0.96
EVAPOTRANSPIRATION	19.880	72163.039	97.02
DRAINAGE COLLECTED FROM LAYER 2	0.0011	4.014	0.01
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.008	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0001		
CHANGE IN WATER STORAGE	0.413	1500.852	2.02
SOIL WATER AT START OF YEAR	14.509	52667.695	
SOIL WATER AT END OF YEAR	14.922	54168.547	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.037	0.00

ANNUAL TOTALS FOR YEAR 87

	INCHES	CU. FEET	PERCENT

	-----	-----	-----
PRECIPITATION	27.38	99389.414	100.00
RUNOFF	2.625	9529.044	9.59
EVAPOTRANSPIRATION	22.667	82282.477	82.79
DRAINAGE COLLECTED FROM LAYER 2	1.9784	7181.753	7.23
PERC./LEAKAGE THROUGH LAYER 4	0.000103	0.375	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2518		
CHANGE IN WATER STORAGE	0.109	395.743	0.40
SOIL WATER AT START OF YEAR	14.922	54168.547	
SOIL WATER AT END OF YEAR	15.031	54564.289	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.025	0.00

ANNUAL TOTALS FOR YEAR 88

	-----	-----	-----
	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.19	58769.703	100.00
RUNOFF	0.205	745.279	1.27
EVAPOTRANSPIRATION	16.580	60187.008	102.41
DRAINAGE COLLECTED FROM LAYER 2	0.0729	264.643	0.45
PERC./LEAKAGE THROUGH LAYER 4	0.000007	0.025	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0093		
CHANGE IN WATER STORAGE	-0.669	-2427.261	-4.13

SOIL WATER AT START OF YEAR	15.031	54564.289	
SOIL WATER AT END OF YEAR	14.363	52137.027	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

ANNUAL TOTALS FOR YEAR 89

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	18.12	65775.602	100.00
RUNOFF	0.527	1912.907	2.91
EVAPOTRANSPIRATION	16.800	60984.750	92.72
DRAINAGE COLLECTED FROM LAYER 2	0.2275	825.680	1.26
PERC./LEAKAGE THROUGH LAYER 4	0.000015	0.056	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0284		
CHANGE IN WATER STORAGE	0.565	2052.191	3.12
SOIL WATER AT START OF YEAR	14.363	52137.027	
SOIL WATER AT END OF YEAR	14.928	54189.219	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.018	0.00

ANNUAL TOTALS FOR YEAR 90

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	19.58	71075.406	100.00
RUNOFF	1.038	3767.526	5.30
EVAPOTRANSPIRATION	18.674	67788.148	95.37
DRAINAGE COLLECTED FROM LAYER 2	0.0870	315.850	0.44
PERC./LEAKAGE THROUGH LAYER 4	0.000008	0.029	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0110		
CHANGE IN WATER STORAGE	-0.219	-796.174	-1.12
SOIL WATER AT START OF YEAR	14.928	54189.219	
SOIL WATER AT END OF YEAR	14.709	53393.047	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.027	0.00

ANNUAL TOTALS FOR YEAR 91

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	31.14	113038.219	100.00
RUNOFF	2.546	9240.598	8.17
EVAPOTRANSPIRATION	27.187	98688.820	87.31
DRAINAGE COLLECTED FROM LAYER 2	0.9277	3367.520	2.98
PERC./LEAKAGE THROUGH LAYER 4	0.000052	0.190	0.00

AVG. HEAD ON TOP OF LAYER 3	0.1175		
CHANGE IN WATER STORAGE	0.480	1741.083	1.54
SOIL WATER AT START OF YEAR	14.709	53393.047	
SOIL WATER AT END OF YEAR	15.188	55134.129	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.010	0.00

ANNUAL TOTALS FOR YEAR 92

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	16.22	58878.605	100.00
RUNOFF	0.634	2300.995	3.91
EVAPOTRANSPIRATION	16.183	58743.496	99.77
DRAINAGE COLLECTED FROM LAYER 2	0.2698	979.341	1.66
PERC./LEAKAGE THROUGH LAYER 4	0.000018	0.064	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0342		
CHANGE IN WATER STORAGE	-0.866	-3145.294	-5.34
SOIL WATER AT START OF YEAR	15.188	55134.129	
SOIL WATER AT END OF YEAR	14.322	51988.836	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

ANNUAL TOTALS FOR YEAR 93

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	27.88	101204.414	100.00
RUNOFF	1.946	7065.454	6.98
EVAPOTRANSPIRATION	24.623	89380.297	88.32
DRAINAGE COLLECTED FROM LAYER 2	0.7988	2899.590	2.87
PERC./LEAKAGE THROUGH LAYER 4	0.000046	0.168	0.00
AVG. HEAD ON TOP OF LAYER 3	0.1012		
CHANGE IN WATER STORAGE	0.512	1858.865	1.84
SOIL WATER AT START OF YEAR	14.322	51988.836	
SOIL WATER AT END OF YEAR	14.834	53847.699	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.038	0.00

ANNUAL TOTALS FOR YEAR 94

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	15.00	54450.000	100.00
RUNOFF	0.673	2441.413	4.48

EVAPOTRANSPIRATION	14.268	51793.379	95.12
DRAINAGE COLLECTED FROM LAYER 2	0.0284	102.987	0.19
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.016	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0036		
CHANGE IN WATER STORAGE	0.031	112.195	0.21
SOIL WATER AT START OF YEAR	14.834	53847.699	
SOIL WATER AT END OF YEAR	14.865	53959.895	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.011	0.00

ANNUAL TOTALS FOR YEAR 95

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	21.27	77210.125	100.00
RUNOFF	1.660	6025.019	7.80
EVAPOTRANSPIRATION	18.538	67292.414	87.15
DRAINAGE COLLECTED FROM LAYER 2	0.6192	2247.793	2.91
PERC./LEAKAGE THROUGH LAYER 4	0.000036	0.130	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0780		
CHANGE IN WATER STORAGE	0.453	1644.747	2.13
SOIL WATER AT START OF YEAR	14.865	53959.895	
SOIL WATER AT END OF YEAR	15.318	55604.641	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.019	0.00

ANNUAL TOTALS FOR YEAR 96

	INCHES	CU. FEET	PERCENT
PRECIPITATION	29.96	108754.820	100.00
RUNOFF	1.433	5203.594	4.78
EVAPOTRANSPIRATION	25.468	92449.094	85.01
DRAINAGE COLLECTED FROM LAYER 2	2.8669	10406.967	9.57
PERC./LEAKAGE THROUGH LAYER 4	0.000204	0.741	0.00
AVG. HEAD ON TOP OF LAYER 3	0.5486		
CHANGE IN WATER STORAGE	0.191	694.368	0.64
SOIL WATER AT START OF YEAR	15.318	55604.641	
SOIL WATER AT END OF YEAR	15.509	56299.008	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.056	0.00

ANNUAL TOTALS FOR YEAR 97

	INCHES	CU. FEET	PERCENT

PRECIPITATION	31.47	114236.102	100.00
RUNOFF	2.619	9506.340	8.32
EVAPOTRANSPIRATION	27.422	99541.352	87.14
DRAINAGE COLLECTED FROM LAYER 2	1.6978	6163.127	5.40
PERC./LEAKAGE THROUGH LAYER 4	0.000092	0.334	0.00
AVG. HEAD ON TOP OF LAYER 3	0.2142		
CHANGE IN WATER STORAGE	-0.269	-975.065	-0.85
SOIL WATER AT START OF YEAR	15.509	56299.008	
SOIL WATER AT END OF YEAR	15.241	55323.945	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.017	0.00

ANNUAL TOTALS FOR YEAR 98

	INCHES	CU. FEET	PERCENT
PRECIPITATION	20.32	73761.609	100.00
RUNOFF	0.557	2023.709	2.74
EVAPOTRANSPIRATION	19.808	71901.711	97.48
DRAINAGE COLLECTED FROM LAYER 2	0.2077	753.896	1.02
PERC./LEAKAGE THROUGH LAYER 4	0.000015	0.053	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0264		
CHANGE IN WATER STORAGE	-0.253	-917.750	-1.24

SOIL WATER AT START OF YEAR	15.241	55323.945	
SOIL WATER AT END OF YEAR	14.988	54406.195	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.015	0.00

ANNUAL TOTALS FOR YEAR 99

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	26.78	97211.430	100.00
RUNOFF	1.820	6607.295	6.80
EVAPOTRANSPIRATION	24.792	89994.305	92.58
DRAINAGE COLLECTED FROM LAYER 2	0.4114	1493.321	1.54
PERC./LEAKAGE THROUGH LAYER 4	0.000026	0.093	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0523		
CHANGE IN WATER STORAGE	-0.243	-883.620	-0.91
SOIL WATER AT START OF YEAR	14.988	54406.195	
SOIL WATER AT END OF YEAR	14.745	53522.574	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.040	0.00

ANNUAL TOTALS FOR YEAR 100

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	28.58	103745.414	100.00
RUNOFF	3.146	11418.242	11.01
EVAPOTRANSPIRATION	22.448	81486.633	78.54
DRAINAGE COLLECTED FROM LAYER 2	2.3334	8470.373	8.16
PERC./LEAKAGE THROUGH LAYER 4	0.000157	0.571	0.00
AVG. HEAD ON TOP OF LAYER 3	0.4188		
CHANGE IN WATER STORAGE	0.653	2369.586	2.28
SOIL WATER AT START OF YEAR	14.745	53522.574	
SOIL WATER AT END OF YEAR	15.397	55892.160	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.008	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
	-----	-----	-----	-----	-----	-----
PRECIPITATION						
TOTALS	0.69 2.67	0.72 3.49	1.51 2.08	1.73 2.23	2.79 1.05	3.15 0.85
STD. DEVIATIONS	0.60	0.54	1.09	1.30	1.53	1.54

	1.36	2.16	1.39	1.91	1.07	0.84
RUNOFF						

TOTALS	0.004 0.090	0.003 0.332	0.063 0.145	0.105 0.240	0.138 0.048	0.244 0.026
STD. DEVIATIONS	0.019 0.149	0.016 0.518	0.137 0.246	0.242 0.469	0.245 0.123	0.367 0.119
EVAPOTRANSPIRATION						

TOTALS	0.744 2.643	0.667 2.853	1.211 1.871	1.558 1.270	3.005 1.053	3.002 0.779
STD. DEVIATIONS	0.500 1.264	0.430 1.517	0.811 1.120	0.910 0.839	1.168 0.625	1.149 0.470
LATERAL DRAINAGE COLLECTED FROM LAYER 2						

TOTALS	0.0368 0.0199	0.0141 0.0373	0.0293 0.0436	0.1073 0.1144	0.1058 0.2014	0.0655 0.1041
STD. DEVIATIONS	0.0946 0.0467	0.0429 0.1157	0.0926 0.1154	0.2336 0.2480	0.1844 0.3974	0.1300 0.2590
PERCOLATION/LEAKAGE THROUGH LAYER 4						

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 3						

AVERAGES	0.0550 0.0298	0.0231 0.0558	0.0540 0.0674	0.1886 0.2304	0.1582 0.4784	0.1013 0.1952
STD. DEVIATIONS	0.1415 0.0698	0.0710 0.1731	0.2009 0.1783	0.4661 0.6340	0.2758 1.5689	0.2010 0.6694

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.97 (4.466)	83398.2	100.00
RUNOFF	1.439 (0.9255)	5222.75	6.262
EVAPOTRANSPIRATION	20.655 (3.4404)	74977.91	89.904
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.87933 (0.86703)	3191.952	3.82736
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00006 (0.00008)	0.203	0.00024
AVERAGE HEAD ON TOP OF LAYER 3	0.136 (0.217)		
CHANGE IN WATER STORAGE	0.001 (0.7798)	5.32	0.006



PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	3.88	14084.400
RUNOFF	2.066	7497.9219
DRAINAGE COLLECTED FROM LAYER 2	0.06526	236.87787
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000016	0.05776
AVERAGE HEAD ON TOP OF LAYER 3	17.637	
MAXIMUM HEAD ON TOP OF LAYER 3	24.104	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	82.2 FEET	

SNOW WATER 1.87 6789.2432

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4140

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2210

*** 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 100

LAYER	(INCHES)	(VOL/VOL)
1	4.7372	0.2632
2	0.4121	0.1374
3	0.0000	0.0000
4	10.2480	0.4270
SNOW WATER	0.000	

APPENDIX C

STORMWATER CALCULATIONS MEMO



memorandum

To: Project File
From: Mr. Nathan Ewert, P.E.
Date: August 25, 2020
Re: North Holding Pond – Stormwater Channel Design Model Calculations

BACKGROUND

Phillips 66 Company (Phillips 66, CN604065912) operates the Borger Refinery (RN102495884), which is owned by a joint venture between Phillips 66 (P66) and Cenovus called WRB Refining LP (WRB, CN603215997). This memo has been prepared to evaluate the proposed stormwater channel design to close the North Holding Pond (NOR#036).

The North Holding Pond (NHP) is a 3.4-acre surface impoundment with a liner system consisting of 3-feet of bentonite amended clay, leak detection system, and 100-mil high-density polyethylene (HDPE) liner. The North Holding Pond is in partial closure in accordance with the 1998 closure plan. The free liquid has been removed and the sludge has been stabilized. The impoundment is now being filled with non-hazardous waste. The partial closure permit modification was approved by the Texas Commission of Environmental Quality (TCEQ) on April 21, 2004.

OBJECTIVE

The following memorandum describes the evaluation and design of the proposed stormwater channels, existing detention pond, and outfall system which will capture and convey runoff from the North Holding Pond, once the final cap is in place, as shown on the attached Figure 1. The calculations for the evaluation of the channels, detention pond, and outlet system are presented below. Evaluation of the entire system was completed using the United States Army Corp Hydrologic Modeling System (HEC-HMS) software (Ver. 4.2.1) and Manning's open channel and pipe flow equations.

HYDROLOGIC MODELING

The North Holding Pond Cap (Cap) was subdivided into five sub-basins. The runoff from the sub-basins is collected and conveyed to the detention pond via the stormwater channels which run along the east and west side of the cap. The Soil Conservation Service (SCS) Curve Number method was used to calculate runoff from each sub-basin using the HEC-HMS software. Area weighted curve numbers for each sub-basin were calculated based on final cap surfacing conditions. Rainfall information from United States Geological Survey (USGS) Depth Duration Frequency of Precipitation for Texas were used to determine runoff amounts for the 10, 25, 50 and 100-year 24-hour events. Only the 100-year 24-hour event was used for sizing the channels and structures. Input parameters and peak runoff values for each sub-basin are summarized in Table 1.



HYDRAULIC MODELING

Hydraulic modeling for the main components of the stormwater channels, detention pond and outlet system were completed using HEC-HMS modeling software. HEC-HMS was used to route the runoff hydrographs through the system. Peak flows through each of the components of the system were used to confirm channel and pipe sizes using Manning's Equation for open channel and circular (pipe) flow.

East Stormwater Channel

The east stormwater channel (east channel) was divided into five segments along the east side of the cap and collects runoff from sub-basins 1, 2, and 3 (See Figure 1). The divisions within the east channel were based on changes in slope of the channel. Capacity calculations for each segment were completed using the specific slope of that segment along with the peak flow from HEC-HMS. The typical section for the east channel generally consisted of a "v section" with depth ranging from 3 feet to 4 feet and sides slopes of 1.5 ft to 1 ft (horizontal to vertical). The east channel was lined with angular rock riprap or recycled concrete with a D_{50} of 6 inches and a Manning's n value of 0.036, which was used in the calculations. East channel capacity calculations are summarized in Table 2.

The East Stormwater Channel discharges into the detention pond through a 30-inch corrugated metal pipe (CMP) culvert. Culvert capacity was analyzed using the Federal Highway Administration HY-8 culvert design software version 7.5. The CMP is approximately 83 feet long with a slope of 3.0 percent. At the peak flow for the east channel of 34 cubic feet per second (cfs) the culvert has a headwater elevation of 2,951.0 feet. The culvert overtopping elevation is 2,952 feet. Outlet velocity from the culvert is 8.7 feet per second (ft/s). The culvert outlet is protected by riprap with a D_{50} of 6 inches.

West Stormwater Channel

The west stormwater channel (west channel) runs along the west side of the cap collecting runoff from sub-basins 4 and 5. The same capacity calculation method of dividing the channel into segments based on the varying slope and using the peak runoff values from HEC-HMS was used to confirm channel sizing. The typical section for the west channel consists of a two feet deep trapezoidal section with a two-foot bottom width and 2:1 side slopes. Due to minimal slopes and velocities, there is no riprap lining along these channels, so a Manning's n value of 0.025 is used. West channel capacity calculations are summarized in Table 2.

Detention Pond

The existing detention pond that the stormwater channels discharge into has a storage volume of 2.63-acre feet at a maximum elevation of 2,950 feet and bottom elevation of 2,941 feet. Storage within the pond was modeled in HEC-HMS using a stage storage curve developed from survey of the pond. The maximum storage within the pond during the 100-year event is 0.7 ac-ft corresponding to an elevation of



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2,946.6 feet. Peak inflow into the pond is approximately 100cfs, the peak discharge from the pond is approximately 45 cfs.

Discharge from the pond is controlled by a two-foot diameter smooth polyethylene (PE 4710 DR11) outlet pipe which is projecting from fill at an invert elevation of 2,941 feet. The detention pond outlet pipe system hydraulics are further discussed in the Outfall Pipe section.

Outfall Pipe

The outfall pipe conveys stormwater runoff from the detention pond to the new outfall location within an existing drainage channel. The outfall pipe consists of approximately 350 feet of 30-inch PE 4710 DR11 pipe broken into six segments with slopes ranging from 3.1 percent to 21 percent. The outfall pipe discharges to a 43 foot by 14 foot by 2.9-foot riprap and angular concrete pad with a D₅₀ of 1.4 feet. Peak discharge through the outfall pipe is 45 cfs.

SUMMARY

Calculations summarized within this memorandum were used for the design of the Refinery Stormwater Improvement Project dated 5/24/2018.

QUALITY CONTROL	
Calculations By:	RJ/NE
Calculations Checked By:	JY
Calculations Reviewed By:	CT

42M-002-008

TABLES

TABLE 1. SUB-BASIN SUMMARY
BORGER REFINERY, HUTCHINSON COUNTY, TEXAS

Basin ID	Area (sq. mi.)	Area Weighted Curve Number	Percent Impervious	100-Year Peak Discharge (cfs)
Sub-Basin-1	0.00102	90	47	9
Sub-Basin-2	0.00257	89	0	21
Sub-Basin-3	0.00117	88	3	10
Sub-Basin-4	0.00292	89	0	25
Sub-Basin-5	0.00525	90	7	47

Notes:

cfs - cubic feet per second

sq. mi. - square miles

**TABLE 2. CHANNEL DESIGN SUMMARY
BORGER REFINERY, HUTCHINSON COUNTY, TEXAS**

Stormwater Channel	Channel Section^{1,2}	Channel Slope (ft/ft)	Length (ft)	Manning's n	Velocity (ft/s)	100-Year Normal Depth (ft)	100-Year Design Capacity (ft)
East Channel Reach 1	V-Ditch	0.140	38	0.036	13.7	0.9	3.0
East Channel Reach 1A	V-Ditch	0.070	70	0.036	9.7	1.0	3.0
East Channel Reach 2	V-Ditch	0.005	398	0.036	3.0	2.4	3.0
East Channel Reach 3	V-Ditch	0.025	201	0.036	6.7	2.0	3.5
East Channel Reach 3A	V-Ditch	0.015	108	0.036	5.2	2.2	3.5
West Channel Reach 4	Trapezoidal Channel	0.006	500	0.025	4.9	1.8	2.0
West Channel Reach 5	Trapezoidal Channel	0.005	200	0.025	4.5	1.8	2.0

Notes:

1 - V-Ditch section consist on varying depth and 1.5ft:1ft side slopes

2 - Trapezoidal Channel consists of 2ft depth, 2ft bottom width and 2ft:1ft side slopes

ft - feet

ft/s - feet per second

ft/ft - foot per foot

FIGURE

