Part A and Part B Permit Renewal Application for the

TRIASSIC PARK
WASTE DISPOSAL FACILITY

RCRA Permit No. NM0001002484

Chaves County, New Mexico

Volume 4
Permit Attachments

October 17, 2011
Revision 2 - July 5, 2013

Prepared for:

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Table of Contents

VOLUME 1

Application Organization Summary
Introduction
List of Acronyms
RCRA Regulatory Crosswalk

Part A Permit Application
Certification of Permit Application
EPA Hazardous Waste Permit Application
Facility Property Plat

Part B Permit Application
1. General Facility Standards
2. Treatment, Storage, and Disposal
3. Groundwater Protection
4. Waste Analysis Plan
5. Procedures to Prevent Hazards
6. Contingency Plan
7. Personnel Training
8. Closure and Post-Closure of Permitted Units
9. Waste Management
10. Corrective Action
11. 40 CFR 264 Subpart AA, BB & CC Regulations
12. References

Permit
Part 1 General Permit Conditions
Part 2 General Facility Conditions
Part 3 Hazardous Waste Storage In Containers
Part 4 Hazardous Waste Storage and Treatment in Tanks
Part 5 Treatment in the Surface Impoundment
Part 6 Hazardous Waste Disposal in the Landfill
Part 7 Vadose Zone Monitoring
Part 8 Closure and Post-Closure Care
Part 9 Corrective Action for Regulated Units
Part 10 Corrective Action for Solid Waste Management Units

Table of Contents (Continued)

VOLUME 2

Attachment

A General Facility Description and Information
B Procedures to Prevent Hazards
C Contingency Plan
C1 Emergency Equipment
C2 Emergency Coordinators
C3 Coordinating Agreements
C4 Evacuation Plans
D Inspection Procedures
D1 Inspection Schedules and Checklists
E Personnel Training
F Waste Analysis Plan
F1 Rationale for Analytical Parameter Selection
F2 Example Waste Profile Form
F3 Example Chain-of-Custody Form
F4 Waste Characterization Using Acceptable Knowledge
G Air Quality
H Ground Water Monitoring Waiver Request
I Vadose Zone Monitoring System Work Plan
J Action Leakage Rate and Response Action Plan
K Part A Permit Application
L Engineering Report
L1 Engineering Drawings **(Volume 3)**
L2 Specifications for Landfill, Surface Impoundment and Associated Facilities Liner and Cover System Construction
L3 Tank Integrity Assessment Certification
L4 New Landfill Engineering Calculations
L5 Landfill Stormwater and Leachate Recirculation Modeling
M Construction Quality Assurance Plan
N Operations and Maintenance Plan
O Closure Plan
O1 Compliance Schedules for Closure
O2 Financial Assurance for Closure
P Post-Closure Care Plan
P1 Financial Assurance for Post-Closure Care
Q Statistics for Release Determination
R Action Levels for Corrective Action
R1 Background Concentrations for Soil
R2 Vadose Zone Baseline Concentrations for Non-Leachates
R3 Background Concentrations for Ground Water
S Vadose Zone Monitoring Indicator Parameters

Table of Contents (Continued)

VOLUME 3

Attachment

L1 Engineering Drawings

VOLUME 4

Attachment

T Oil Well Log
U Lithology Logs and Plugging Logs
V Geophysical Logs
W Geotechnical Laboratory Results
X Grain Size Analyses
Y Cross-Sections
Z Construction Specifications

VOLUME 5

Attachment

AA Laboratory Test Results
BB Engineering Calculations
CC Surface Water Control Plan
DD Manufacturer Information

Attachment T

Oil Well Log

SCHLUMBERGER

BOREHOLE COMPENSATED SONIC LOG - GAMMA RAY

30-11S-31E

COUNTY CHAVES
FIELD or LOCATION WILDCAT
WELL RICHARDSON FEDERAL #1
COMPANY SUN OIL COMPANY

COMPANY SUN OIL COMPANY

WELL RICHARDSON FEDERAL #1

FIELD WILDCAT

COUNTY CHAVES STATE NEW MEXICO

LOCATION SE/4 SE/4

Sec. 30 Twp. 11-S Rge. 31-E

Other Services: FDC-GR, SNP, L, MLL

Permanent Datum: G.L. Elev. 4139
Log Measured From K.B., 8 Ft. Above Perm. Datum
Drilling Measured From K.B.

Elev.: K.B. 4147
D.F. [illegible]
G.L. 4139

Date	6-28-68				
Run No.	ONE				
Depth—Driller	4500				
Depth—Logger	4500				
Btm. Log Interval	4498				
Top Log Interval	0				
Casing—Driller	8 5/8 @ 450	@		@	
Casing—Logger	450				
Bit Size	7 7/8				
Type Fluid in Hole	SALT GEL / IMCO LOID				
Dens. / Visc.	10.5 / 33				
pH / Fluid Loss	6.0 / 20 ml	ml		ml	ml
Source of Sample					
R_m @ Meas. Temp.	@ °F	@ °F	@ °F	@ °F	
R_{mf} @ Meas. Temp.	@ °F	@ °F	@ °F	@ °F	
R_{mc} @ Meas. Temp.	@ °F	@ °F			
Source: R_{mf} R_{mc}					
R_m @ BHT	@ °F	@ °F	@ °F	@ °F	
Time Since Circ.					
Max. Rec. Temp.	°F	°F	°F		
Equip. / Location	3720 / HOBBS				
Recorded By	FREEMAN				
Witnessed By	BARKER				

ACCEPTED FOR RECORD
District Engineer

U. S. GEOLOGICAL SURVEY
ROSWELL, NEW MEXICO

FOLD HERE — The well name, location and borehole record data were furnished by the cu[illegible]

REMARKS

Changes in Mud Type or Additional Samples

Date	Sample No.	Depth	Type Fluid in Hole	Dens.	Visc.	pH	Fluid Loss	Source of Sample	R_m @ Meas. Temp.	R_{mf} @ Meas. Temp.	R_{mc} @ Meas. Temp.	Source: R_{mf} R_{mc}	R_m @ BHT	R_{mf} @ BHT	R_{mc} @ BHT
							ml		°F @	°F @	°F @		°F @	°F @	°F @

Scale Changes

Type Log	Depth	Scale Up Hole	Scale Down Hole

Equipment Data

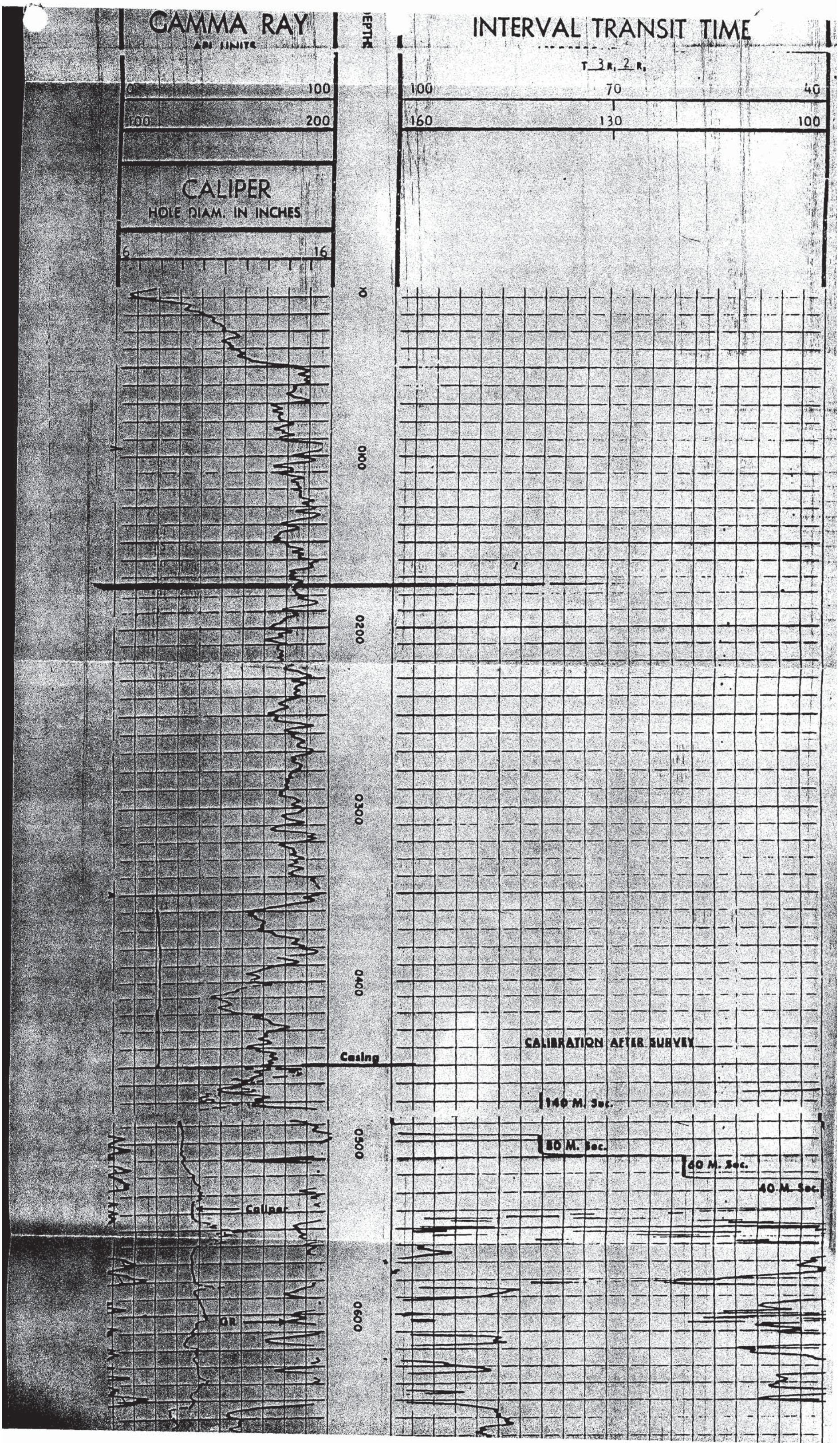
Run No.	Tool Type	Pad Type	Tool Pos.	Other

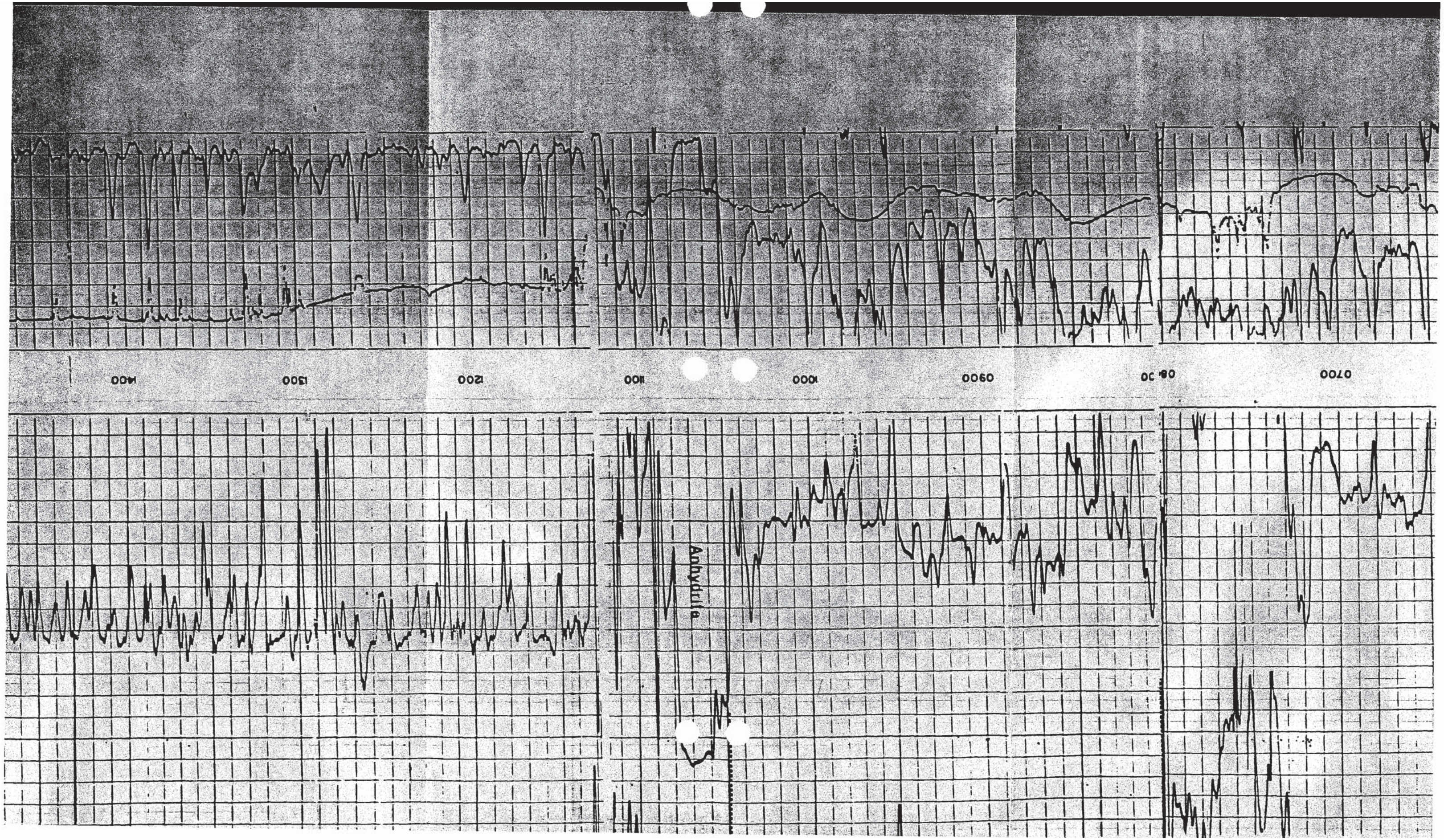
C.D. USED S.O. CALIPER
Equip. Used CART. No. SLH-A-72
PANEL No. SLP-A-48
SONDE No. SLS-A-105

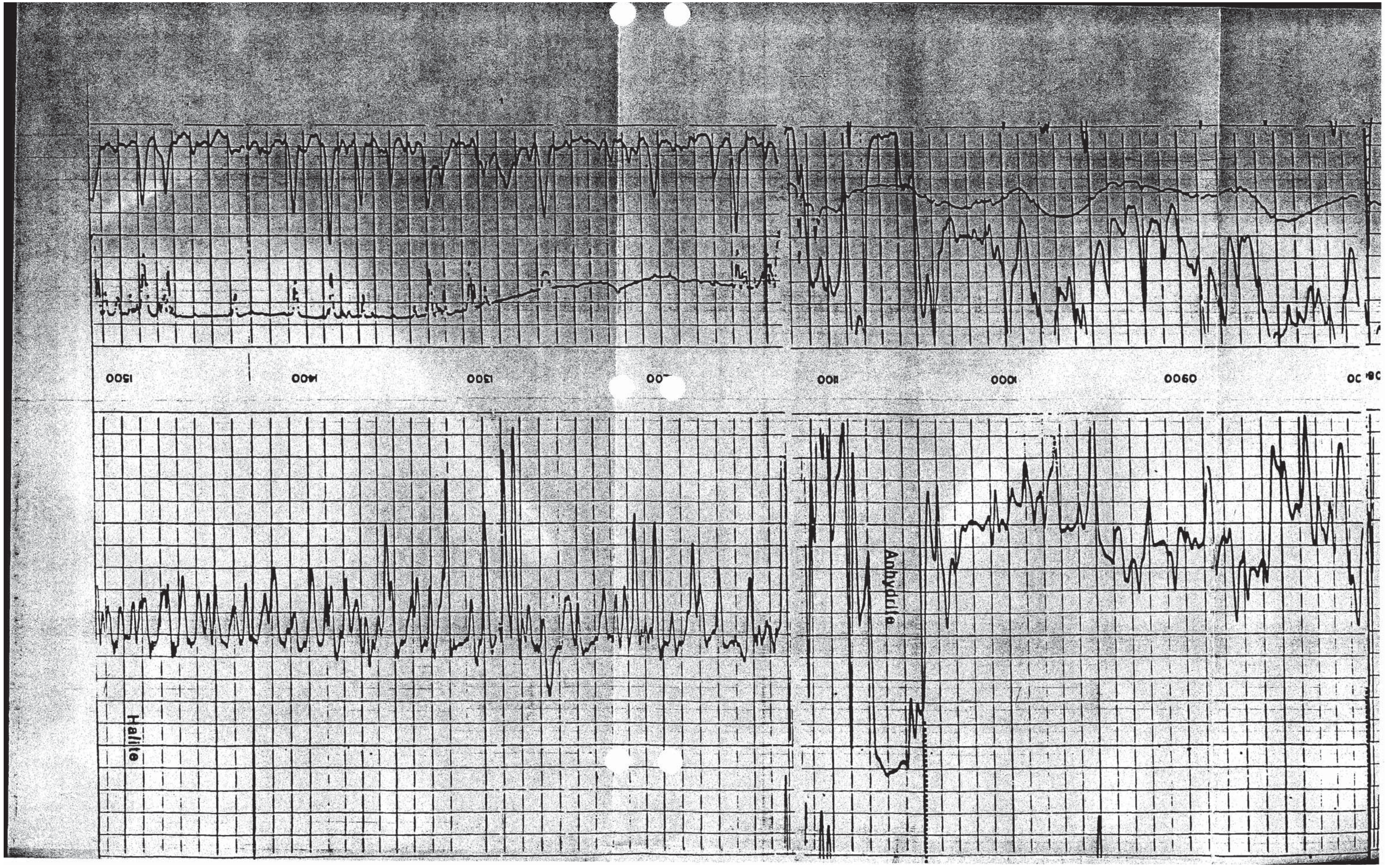
CALIBRATION	BACKGND. CPS.	SOURCE CPS.	GALV. INCR. DIVISIONS	SENS. TAP. (RECORD)	SENS. TAP (FOR CAL.)
GAMMA RAY	160	440	82.5	400	800

TIME RECORDING SPEED (FT./MIN.) CONST. 40/50

Velocity (feet per second) 1,000,000


GAMMA RAY
API UNITS
0
100
100
200
CALIPER
HOLE DIAM. IN INCHES
6
16
DEPTH
0100
0200
0300
0400
0500
0600
Casing
Caliper
GR
INTERVAL TRANSIT TIME
T 3R, 2R,
100
70
40
160
130
100
CALIBRATION AFTER SURVEY
140 M. Sec.
80 M. Sec.
60 M. Sec.
40 M. Sec.


0700
0830
0900
1000
1100
1200
1300
1400
Anhydrite


1500
1400
1300
1100
1000
0900
Anhydrite
Halite

Attachment U

Lithology Logs and Plugging Logs

COMMERCIAL LAND FARMS
A New Mexico Enterprise
Serving New Mexico's Needs

October 6, 2000

Mr. Steve Pullen
New Mexico Environmental Dept.
Hazardous & Radioactive Materials Bureau
2044 A Galisteo Street
Santa Fe, New Mexico 87502

re: Plugging of the Remaining Site Characteristic Wells

Dear Mr. Pullen:

Gandy Marley Inc. plugged the original boreholes with mudstone drill cuttings and a cement cap. These boreholes were drilled in the early 1990's in the sandhills and most of them are no longer visible. All other NMED requested boreholes have been plugged in accordance with your regulations. The only remaining open boreholes are PB-14, WW-1 and WW-2. These holes will be plugged to NMED guidelines after receiving the permit for Triassic Park Waste Disposal Facility and before construction begins.

Please call me if you have any questions concerning this matter.

Sincerely,

Dale Gandy

W:WP/602/ReOct2000Permit/Gandy Ltr
10/5/00 sko

Gandy Marley, Inc. • Box 1658 • Roswell, NM 88201 • (505) 398-4960 • FAX (505) 398-6887

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-1 Section NW NE 8 T 11S R 31E

Project Gandy Marley Elevation 4152

Driller Larry JAB Date 07/11/94

Comments

GSA Color	Lith		Description
5R4/6			fn gr. red-brn ss
5YR4/1			brn-gray siltstone
5Y6/1			fn gr. lt. olive gray ss
10R 5/4		50'	pale red brn mudstone
10R 4/2			grayish red mudstone
10R 4/6			mod red-brn mudstone
10R 3/4			dk red-brn mudstone
10R 4/6		100'	mod red-brn mudstone
10R 3/4			dk red-brn mudstone
5Y6/1		150'	gra-gray siltstone damp @ 158'
10R 4/6			mod red-brn mudstone
10R 3/4			dk red-brn mudstone
		200'	

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-2 Section NW SW 17 T 11S R 31E

Project Gandy Marley Elevation 4150

Driller Larry JAB Date 07/11/94

Comments

GSA Color	Lith		Description
10R 5/4			red-brn soil
10R 7/4			pale red-brn siltstone
			dk red-brn mudstone
10R 4/6			mod red-brn mudstone
		50'	
10R 4/2			gray-red siltstone
10YR 5/4			mod yell-brn mudstone
10R 3/4			dk red-brn siltstone
10R 3/4		100'	dk red-brn clayey siltstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-3 Section SE NE 18 T 11S R 31E

Project Gandy Marley Elevation 4135

Driller Larry JAB Date 07/11/94

Comments

GSA Color	Lith		Description
			lt brn soil & fn sl
10R 5/4			pale red-brn mudstone
10R 5/4			
5R 5/4			med red siltstone
10R 4/6		50'	med red-brn mudstone
10R 5/4			
10R 5/4			pale red-brn siltstone
10R 5/4			pale red-brn mudstone
			pale red-brn siltstone
10R 4/6		100'	med red-brn mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-4 Section NE SE 18 T 11 S R 31 E

Project Gandy Marley Elevation 4139

Driller Larry JAB Date 07/12/94

Comments

GSA Color	Lith		Description
10R 6/6			mod red-org surface ss
10R 6/2			red-brn silty ss
10R 5/4			
			pale red-brn mudstone
10R 4/2		50'	gray-red silty mudstone
			mod red-brn mudstone
10R 4/2			gray-red silty mudstone
10R 4/6			mod red-brn mudstone
10R 4/2			gray-red mudstone
10R 4/6		100'	mod red-brn mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-5 Section NE SE 18 T 11S R 31E

Project Gandy Marley Elevation 4142

Driller Larry DATB Date 07/12/94

Comments

GSA Color	Lith		Description
10 R 5/4			lt gray to pale red-Sra silt w/ gravel @ 25'
10 R 5/4			pale red-Sra mudstone
10 R 4/6		50'	mod red-Sra mudstone
10 R 4/2			gray-red siltstone
10 R 4/6			mod red-Sra mudstone
10 R 5/4		100'	pale red-Sra mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-6 Section NW SE 18 T 11S R 31E

Project Gandy Marley Elevation 4120

Driller Larry DATB Date 07/12/94

Comments 50' N + 35' E of grid point (7' below grid pt.)

GSA Color	Lith	Description
10R 4/6		mod red-org surface ss
10R 4/6		mod red-brn mudstone
10R 6/2		pale red siltstone
	50'	
10R 4/6		mod red-brn mudstone
10R 3/4		dk red-brn mudstone
	100'	

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-7 Section SW SE 18 T 11S R 31E

Project Gandy Marley Elevation 4118

Driller Larry JAB Date 07/17/94

Comments 140' E + 25' N of grid pt.

GSA Color	Lith		Description
			fn tan surface sa + gravel
10 R 4/2			gray-red siltstone
5 YR 6/1			lt gray-brn siltstone
10 R 4/6		50'	mod red-brn mudstone
10 R 6/2			pale red-brn mudstone
10 R 4/6			mod red-brn mudstone
10 R 4/2		100'	gray-red mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-8 Section NW SE 18 T 11S R 31E

Project Gandy Morley Elevation 4117

Driller Larry JAB Date 07/13/94

Comments 50' S + 10' W of grid point

GSA Color	Lith		Description
			surface ss + gravel
10 R 4/2			gray-red siltstone
5 YR 6/1		30'	lt gray-brn siltstone
10 R 4/6			mod red-brn mudstone
10 R 4/2			gray-red mudstone
		100'	

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-9 Section SW SE 18 T 11 S R 31 E

Project Gandy Marley Elevation 4138

Driller Larry JAB Date 07/13/94

Comments 50' E of grid point

GSA Color	Lith		Description
			surface ss & gravel
10R 4/2			gray-red siltstone
10R 4/6			mod red-brn mudstone & silty clay
		50'	
10R 4/2			gray-red siltstone
N7			lt gray mudstone
10R 3/4			dk red-brn mudstone
10R 4/6		100'	mod red-brn mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-10 Section NW SE 18 T 11S R 31E

Project Gandy Marley Elevation 4131

Driller Larry JAB Date 07/13/94

Comments

GSA Color	Lith	Description
		sandy soil
10R 4/6		mod red-brn mudstone
10R 4/2		gray-red siltstone
10R 4/2	50'	gray-red mudstone
5YR 6/1		lt brn-gray siltstone
10R 4/6		mod red-brn mudstone
10R 4/2		gray-red mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-11 Section SW NE 18 T 11S R 31E

Project Gandy Marley Elevation 4119

Driller Larry JAB Date 07/13/94

Comments 5' lower than grid point

GSA Color	Lith		Description
10R 4/6			sandy ss w/ caliche
			mod red-brn mudstone
10R 4/2			gray-red siltstone
5YR 6/1		50'	lt gray-brn siltstone
10R 4/6			mod red-brn mudstone
10R 5/4			pale red-brn mudstone
10R 4/6			mod red-brn mudstone
10R 5/4			pale red-brn mudstone
10R 4/2		100'	gray-red mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-12 Section NE SE 18 T 11S R 31E

Project Gandy Marley Elevation 4132

Driller Larry JAB Date 07/14/94

Comments

GSA Color	Lith	Description
		surface ss & gravel
10R 5/4		pale red-brn siltstone
	50'	
10R 4/2		gray-red siltstone
5YR 4/1		lt gray brn siltstone
10R 4/2		gray-red siltstone
10R 4/6		mod red-brn mudstone
10R 4/2		gray-red siltstone
10R 4/6	100'	mod red-brn mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-13 Section SW SE 18 T 11S R 31E

Project Gandy Marley Elevation 4119

Driller Larry JAB Date 07/14/94

Comments

GSA Color	Lith		Description
			surface ss
10R 4/2			gray-red siltstone
5YR 4/1		50'	lt gray 5yr siltstone
10R 5/4			pale red-5yr mudstone
10R 4/6		100'	med red-5yr mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-14 Section SE SW 18 T 11S R 31E

Project Gandy Morley Elevation 4116

Driller Larry JAB Date 07/14/94

Comments 50' S & 80' E of grid point

GSA Color	Lith		Description
			surface ss & gravel
10R 4/2			gray-red siltstone
5YR 6/1		50'	lt gray-brn siltstone and very fn gr. ss
10R 4/2			gray-red siltstone
10R 4/6		100'	red-brn mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-140 Section SW SE 18 T 11 S R 31 E

Project Gandy Morley Elevation 4118

Driller Larry JAB Date 07/17/94

Comments 400' East of PB-14

GSA Color	Lith	Description
		surface ss & gravel
10R 4/6		med red-brn mudstone
10R 4/2		gray-red siltstone
	50	
		dk gray mudstone
10R 4/6		med red-brn mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-15 Section SW SE 18 T 11S R 31E

Project Gandy Marley Elevation 4129

Driller Larry JAB Date 07/14/94

Comments 25' S & 20' W of grid point

GSA Color	Lith		Description
			red-brn silty soil
10R 4/6			mod red-brn mudstone
5YR 4/1		50'	brn gray siltstone
10R 5/4			pale red-brn mudstone
10R 4/6		100'	mod red-brn mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-16 Section SE SE 18 T 11S R 31E

Project Gandy Marley Elevation 4161

Driller Larry JAB Date 07/14/94

Comments 5' lower than grid point

GSA Color	Lith		Description
			surface ss + gravel
10R 5/4			pale red-brn siltstone
10R 4/2		50'	gray-red siltstone
10R 4/6			med red-brn mudstone
10R 4/2			gray-red siltstone
		100'	lt gray mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-17 Section SE SE 18 T 11 S R 31 E

Project Gandy Marley Elevation 4141

Driller Larry JAB Date 07/14/94

Comments

GSA Color	Lith		Description
			surface ss + gravel
10R 4/2			gray-red siltstone
10R 4/6			mod red-brn mudstone
		50'	
10R 4/2			gray-red siltstone
10R 4/6			mod red-brn mudstone
10R 5/4		100'	pale red-brn mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-18 Section SE SE 18 T 11 S R 31 E

Project Gandy Marley Elevation 4142

Driller Larry JAB Date 07/15/94

Comments

GSA Color	Lith		Description
			tan surface ss & gravel
			tan siltstone & ss w/ gravel
10R 4/6			mod red-brn mudstone
10R 5/4		50'	pale red-brn siltstone
10R 4/6			mod red-brn mudstone
10R 4/2			gray-red siltstone
10 R5/4		100'	pale red-brn mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-19 Section SW SW 17 T 1S R 3E

Project Gandy Marley Elevation 4152

Driller Larry JAB Date 07/15/94

Comments

GSA Color	Lith		Description
			surface ss + gravel
10R 5/4		50'	pale red-brown mudstone
10R 4/2			gray-red siltstone
		100'	

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-20 Section NW SW 17 T 11S R 31E

Project Gandy Marley Elevation 4157

Driller Larry JAB Date 07/15/94

Comments

GSA Color	Lith		Description
			surface ss & gravel
			lt gray-tan siltstone & ss
			dk gray mudstone
10R 4/6		30'	mod red-Sra mudstone w/ silt @ bottom
10R 5/4			pale red-Sra siltstone
10R 4/6			mod red-Sra mudstone
10R 4/2			gray-red siltstone
		100'	

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-21 Section SWSW 17 T 11S R 31E

Project Gandy Marley Elevation 4148

Driller Larry JAB Date 07/15/94

Comments 500' N of section corner

GSA Color	Lith		Description
			surface ss & gravel
10R 4/6			mud red-brn mudstone
10R 4/2			gray-red siltstone
10R 5/4			pale red-brn mudstone
		50'	
10R 4/2			gray-red siltstone
			dk red-brn mudstone
10R 3/4			
			lt gray mudstone
10R 4/2		100'	gray-red siltstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-22 Section NW SW 17 T 11 S R 31 E

Project Gandy Marley Elevation 4143

Driller Larry DAB Date 07/15/94

Comments

GSA Color	Lith		Description
			surface ss & gravel
10R 4/6			med red-brn mudstone
10R 4/2			gray-red siltstone
10R 5/4			pale red-lrn siltstone
10R 4/6		50'	med red-brn mudstone
			gray-red siltstone
10R 4/2			
		100'	lt gray siltstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-23 Section NW SW 17 T 11S R 31E

Project Gandy Marley Elevation 4151

Driller Larry JAB Date 07/16/94

Comments

GSA Color	Lith		Description
			surface & lt tan ss
10R 4/2			gray-red siltstone
10R 4/6			
10R 4/2			mod red-Sm to gray-red mudstone
10R 4/6		50'	gray-red siltstone
10R 4/6			mod red-Sm mudstone
10R 5/4			pale red-Sm siltstone
			gray-red siltstone
		100'	dk red-Sm to lt gray mudstone
			gray-red siltstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-24 Section SW SW 17 T 11 S R 31 E

Project Gandy Morley Elevation 4154

Driller Larry DAB Date 07/15/94

Comments

GSA Color	Lith		Description
			surface ss + gravel
10R 4/6			mod red-brn mudstone
		50'	gray-red siltstone
			mod red-brn mudstone
		100'	gray-red siltstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-25 Section SW/NW 17 T 11S R 31E

Project Gandy Marley Elevation 4144

Driller Larry JAB Date 07/16/94

Comments

GSA Color	Lith		Description
			surface is a gravel
10 R 5/4			pale red-5R mudstone
10 R 4/6			med red-5R mudstone
10 R 4/2			gray-red siltstone
10 R 4/2		50'	med-red-5R mudstone to gray-red siltstone
10 R 4/6			med red-5R mudstone
10 R 5/4			pale red-5R to gray-red siltstone
10 R 4/2		100'	

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-26 Section NW NW 9 T 11 S R 31 E

Project Gandy Marley Elevation 4183

Driller Larry JAB Date 02/16/94

Comments

GSA Color	Lith	Description
		surface ss & gravel
10 R 4/2		gray-red siltstone
5 Y 6/4	50'	dusky yellow tan ss
5 Y R 6/1		lt tan gray siltstone
		dk tan-gray tan ss
	100'	
10 R 4/2		gray-red tan ss
10 R 4/2		lt gray-red tan ss
10 R 4/6		med red-tan tan ss
10 R 5/4	150'	pale red-tan tan ss
10 R 4/6		med red-tan siltstone tan ss
5 Y R 6/1		lt tan-gray
10 R 4/2		gray-red tan ss
10 R 4/6		med red-tan mudstone
	200'	

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-27 Section NW NE 9 T 11S R 31E

Project Gandy Marley Elevation 4144

Driller Larry JAB Date 07/16/94

Comments

GSA Color	Lith		Description
			surface sa & gravel
			lt yell-brn sa
10R 4/2			gray-red mudstone
10R 4/2		50'	gray-red siltstone
10R 5/4			pale red-brn mudstone
10R 4/2			gray-red siltstone & brn sa
		100'	lt gray siltstone
10R 4/2			gray-red siltstone
10R 4/6			med red-brn mudstone
10R 5/4		150'	pale red-brn siltstone
10R 4/2			gray-red siltstone
		200'	lt gray silt to brn sa

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-28 Section SW SW 17 T 11S R 31E

Project Gandy Morley Elevation 4159

Driller Larry JAB Date 07/16/94

Comments 4' lower than grid pt.

GSA Color	Lith		Description
			surface ss & gravel
			dk gray mudstone
10R 4/6			mod red-brn mudstone
10R 5/4		50'	pale red-brn siltstone
			pale red-brn siltstone
10R 5/4			mod red-brn mudstone @ 53'
			mod red-brn mudstone
10R 4/6		100'	grayish siltstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-29 Section SW NE 18 T 11S R 31E

Project Gandy Marley Elevation 4129

Driller Larry JAB Date 07/17/94

Comments 5' lower than grid pt.

GSA Color	Lith		Description
			interbed ss & gravel
10R 4/6			mod red-brn mudstone
10R 4/2		50'	gray-red siltstone w/ lt gray brn ss & S.Ahm
10R 4/6			mod red-brn mudstone
10R 4/2			gray-red mudstone
		100	dk red-brn mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-30 Section NW SW 17 T 11S R 31E

Project Gandy Marley Elevation 4152

Driller Larry DAB Date 07/12/94

Comments

GSA Color	Lith		Description
			surface SS
			dk gray mudstone
10R 4/6			mod red-Sm mudstone
10R 5/4			pale red-Sm siltstone
10R 4/6		50'	mod red-Sm mudstone
10R 4/2			gray-red siltstone
10R 4/6			mod red-Sm mudstone
			lt gray mudstone
10R 4/2		100'	gray-red siltstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-31 Section SW NE 18 T 11 S R 31 E

Project Gandy Marley Elevation 4115'

Driller Larry DAB Date 07/17/94

Comments 4' lower than grid pt.

GSA Color	Lith		Description
			surface sc
10R 5/4			pale red-brn siltstone
10R 4/2		50'	lt gray-red siltstone
10R 4/6			mod red-brn mudstone
10R 3/4			dk red-brn mudstone
10R 4/6		100'	mod red-brn mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-32 Section NE SW 18 T 11 S R 31 E

Project Gandy Morley Elevation 4108

Driller Larry JAB Date 07/17/94

Comments

GSA Color	Lith		Description
			surface ss.
			pale red-brn silt & gravel
			dk gray siltstone
			lt gray siltstone
		50'	
10R 3/4			dk red-brn mudstone
10R 5/4			pale red-brn mudstone
10R 4/2		100'	gray red mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-33 Section SWSE 18 T 11S R 31E

Project Gandy Marley Elevation 4134

Driller Larry JAB Date 07/17/94

Comments

GSA Color	Lith		Description
			surface ss
10R 4/6			med red-brn mudstone
10R 4/2		50'	gray-red siltstone with clay @ 40'
10R 4/6			med red-brn mudstone
			lt gray mudstone
10R 5/4			pale red-brn mudstone
10R 4/2		100'	gray-red mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-34 Section NW NE 7 T 11 S R 31 E

Project Gandy Marley Elevation 4100

Driller Larry JAB Date 07/17/94

Comments

GSA Color	Lith		Description
			yell-brn-tan sub-ang ss
			lt brn siltstone
		50'	lt brn tan ss w/ gravel
10R 4/2			gray-red mudstone
10R 5/4		100'	pale red-brn mudstone
10R 4/6			mod red-brn mudstone
		150'	
10R 4/2			gray-red mudstone
			lt gray mudstone
			lt gray siltstone
		200'	lt gray mudstone

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-35 Section NW NW 8 T 11S R 31E

Project Gandy Marley Elevation 4124

Driller Larry JAB Date

Comments

GSA Color	Lith		Description
			tan surface ss
			pale red-brn siltstone & gravel
			pale red-brn siltstone
10R 4/2		50'	grayish-red siltstone
10R 4/6			mod red-brn mudstone
			lt gray siltstone & tn ss
		100'	
			dk gray mudstone
10R 4/6			mod red-brn mudstone
10R 4/2		150'	grayish-red mudstone
10R 5/4			pale red-brn mudstone
10R 4/2		200	grayish-red mudstone

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-36 Section NW SW 17 T 11 S R 31 E

Project Gandy Marley Elevation 4146

Driller Sonny Pool Date 07/24/95

Comments (A) on NMED drill plan

GSA Color	Lith		Description
			lt gray (caliche) soil
10R 4/6			mod red-brn clay
10R 5/4			pale red-brn silt
10R 4/6			mod red-brn clay
10R 4/6		50'	lt gray v. fn ss - silt
10R 4/6			mod red-brn clay
10R 5/4			pale red-brn silt
		100'	
10R 4/6			mod red-brn clay
10R 5/4			pale red-brn clay; trace silt @ 125'
	CORE	150'	
			cored interval 138'-148'

This revision supersedes
all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-37 Section NW SW 17 T 11 S R 31 E

Project Gandy Marley Elevation 4160

Driller Sonny Poole Date 07/25/95

Comments (B) on NMED drill plan

GSA Color	Lith		Description
			lt gray caliche soil
			lt gray silty clay
			dk gray clay
10 R 5/4		50'	pale red-brn clay
10 R 4/6			mod red-brn clay
10 R 4/6			mod red-brn silt w/ clay
10 R 5/4		100'	pale red-brn silt
10 R 4/6			mod red-brn silty clay
10 R 4/6			mod red-brn clay
	CORE		
			cored interval 148'-155'

This revision supersedes all previous information

S.M. Stoller Corporation

LITHOLOGY LOG

Hole No. PB-38 Section NE SW 17 T 11S R 31E

Project Gonzales Marlay Elevation 4182

Driller Sonny Pool Date 07/25/95

Comments (c) on NMED well plan

GSA Color	Lith	Description
		yell-brn silty soil
		QaS trace pebbles
		dk gray silty clay
	50	lt gray gran clay silt
10R 4/2		gray med clay
10R 4/6		mod red-brn clay
10R 5/4	100'	pale red-brn silt & clay
10R 4/6		mod red-brn clay
10R 5/4		pale red-brn silt with lt gray silt @ bottom
10R 4/6	150'	mod red-brn clay

This revision supersedes all previous information

BORING LOG NUMBER:

PB-39

SHEET 1 OF 1

LOC. ID: ELEVATION: 4130 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/3/99

INCLINATION: AZIMUTH: HAMMER WEIGHT: N/A DATE FINISHED: 8/3/99

LOCATION SKETCH

NORTH EDGE OF SITE ON SECTION CORNER (SEE LOCATION MAP)

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE / SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sand, brown clay with PreCambrian cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A
25		Red-brown claystone						
		Yellow brown claystone						
50		Red grey siltstone with red grey claystone @ 75'						
75								
100		Moderate red brown mudstone - damp @ top						
125		TD=120 FT.						
150								
175								
200								
225								

ADDITIONAL COMMENTS

GROUNDWATER

Bottom two joints wet where hole finished. Hole logged 9:30 8/4/99 water level @ 64.0'

Water measurement taken 12:20 8/4/99 @ 32.0'

Water measurement taken 3:20 8/4/99 @ 22.0'

Water measurement taken 8:00 8/5/99 @ 47.0'

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

Water in 30 ft. offset was at 12.0' @8:00 8/5/99

DEPTH UNITS: 120 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/22/99	J.Bonner	K.Conrath	P.Corser

MONTGOMERY WATSON

PROJECT No. 1342602.02190200
AutoCAD FILE: SLPB39.DWG
SCALE: N/A
FIGURE No:

GANDY-MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-40

SHEET 1 OF 1

LOC. ID: ELEVATION: 4121 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/3/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/3/99

LOCATION SKETCH

NORTH OF PROPOSED EVAPORATION PONDS (SEE LOCATION MAP)

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE: SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sand, brown clay with PreCambrian cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A	
25		Red grey siltstone							
50									
75		Moderate red brown mudstone							
100		TD=90 FT.							
125									
150									
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 90 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/27/99	J.Bonner	K.Conrain	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB40.DWG
SCALE: N/A
FIGURE No:

GANDY-MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-41

SHEET 1 OF 1

LOC. ID: ELEVATION: 4118 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/3/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/3/99

LOCATION SKETCH

GRID LOCATION BH99-7

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE / SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sand, brown clay with caliche stains, rocks and PreCambrian cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A	
25		Red grey siltstone							
50		Moderate red brown mudstone							
75		TD=75 FT.							
100									
125									
150									
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 75 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrath	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB-41.DWG
SCALE: N/A
FIGURE No.

GANDY-MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-42

SHEET 1 OF 1

LOC. ID: ELEVATION: 4121 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/3/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/3/99

LOCATION SKETCH

GRID LOCATION BH99-4

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE: SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sandstone, brown clay & PreCambrian cobbles (caliche)				SEE ADDITIONAL COMMENTS	N/A	N/A	
25		Red grey silt with grey red clays @ 40'							
50									
75		Moderate red brown mudstone							
100		TD=90 FT.							
125									
150									
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

Water in 30 ft. offset was at 12.0' @8:00 8/5/99

DEPTH UNITS: 90 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/22/99	J.Bonner	K.Conrath	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602 02190200
AutoCAD FILE: SLPB-42.DWG
SCALE: N/A
FIGURE No.

GANDY-MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-43

SHEET 1 OF 1

LOC. ID: ELEVATION: 4130 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/4/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/4/99

LOCATION SKETCH

GRID LOCATION BH99-8

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE – SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES – USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sandstone, brown clay and cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A	
		Brown clay with caliche stained cobbles							
25		Red grey siltstone							
50		Light grey to light red grey siltstone							
75		Moderate red brown mudstone							
100		TD=100 FT.							
125									
150									
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary.
Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

Water in 30 ft. offset was at 12.0' @8:00 8/5/99

DEPTH UNITS: 100 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrath	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB43.DWG
SCALE: N/A
FIGURE No:

GANDY MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-44

SHEET 1 OF 1

LOC. ID: ELEVATION: 4128 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/4/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/4/99

LOCATION SKETCH

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE / SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sand with brown clay and caliche stained cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A	
25		Brown clay							
		Yellow-brown clay							
50		Red grey siltstone with red brown clays @ 50' & 70'. Light grey siltstone @ bottom							
75									
100		Moderate red brown mudstone							
		TD=110 FT.							
125									
150									
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 110 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrath	P.Carser

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB45.DWG
SCALE: N/A
FIGURE No.:

GANDY - MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-45

SHEET 1 OF 1

LOC. ID: ELEVATION: 4135 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/4/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/4/99

LOCATION SKETCH

GRID LOCATION BH99-9

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE / SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sand and caliche stained pebbles				SEE ADDITIONAL COMMENTS	N/A	N/A	
25		Brown mudstones							
50		Red brown mudstones with grey clay @ 45'							
75		Red grey siltstone							
100		Grey to light grey siltstone and fine sandstone							
125		Moderate red brown mudstone							
150		TD=120 FT.							
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary.
Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 120 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrath	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602 02190200
AutoCAD FILE: SLPB45.DWG
SCALE: N/A
FIGURE No:

GANDY - MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-46

SHEET 1 OF 1

LOC. ID: ELEVATION: 4130 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/4/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/4/99

LOCATION SKETCH

Grid location BH99-3

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE: SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES: USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY	ADDITIONAL COMMENTS
0	AIR ROTARY WITH 6 3/4 INCH BIT	Surface sandstone and caliche stained pebbles				SEE ADDITIONAL COMMENTS	N/A	N/A	
		Red brown mudstone							
25		Brown mudstone							
50		Red brown mudstone with grey red siltstone @ 55'							
75		Red grey siltstone with grey clay							
		Grey - light grey siltstone in fine sandstone							
		Red grey silty clay							
100		Moderate red brown mudstone							
125		TD=120 FT.							
150									
175									
200									
225									

DESCRIPTIONS

All descriptions based on Air Rotary.
Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 120 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrain	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB-46.DWG
SCALE: N/A
FIGURE No:

GANDY - MARLEY INC

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-47

SHEET 1 OF 1

LOC ID: ELEVATION: 4139 DATUM: MSL

PROJECT NAME: GANDY-MARLEY DRILL DATE: 8/5/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/5/99

LOCATION SKETCH

GRID LOCATION
BH99-6

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE – SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES – USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sandstone, brown clay and cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A
25		Red brown mudstone						
50		Grey red clayey siltstone						
		Yellow brown mudstone						
75		Red grey siltstone						
100		Grey to dark grey siltstone with light grey clays						
125		Moderate red brown mudstone						
		TD=130 FT.						
150								
175								
200								
225								

ADDITIONAL COMMENTS

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 130 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrath	P.Corser

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB-47.DWG
SCALE: N/A
FIGURE No.:

GANDY – MARLEY, INC.

SOIL BORING LOG FORM

BORING LOG NUMBER:

PB-48

SHEET 1 OF 1

LOC. ID: ELEVATION: 4194 DATUM: MSL

PROJECT NAME: GANDY MARLEY DRILL DATE: 8/5/99

INCLINATION: VERTICAL AZIMUTH: N/A HAMMER WEIGHT: N/A DATE FINISHED: 8/5/99

LOCATION SKETCH

1000 Ft. NORTH &
2000 Ft. EAST OF
1B-38

DEPTH (UNITS)	BORING METHOD	SOIL PROFILE – SOIL DESCRIPTION	GRAPHIC LOG	SAMPLES – USCS	NUMBER	TYPE	BLOW COUNT/6"	RECOVERY
0	AIR ROTARY WITH 6 3/4 INCH BIT	Fine surface sanstone and brown clays with caliche stained cobbles				SEE ADDITIONAL COMMENTS	N/A	N/A
25		Yellow brown mudstone						
50		Red grey siltstone						
		Red brown clay						
		Red grey mudstone						
75		Grey brown clayey siltstone						
100		Red grey mudstone						
		Red grey siltstone						
125		Red grey mudstone						
		Red grey clayey siltstone						
150								
175		Yellow brown mudstone						
		Moderate red brown mudstone						
200		TD=210 FT.						
225								

ADDITIONAL COMMENTS

Bottom 50 feet of drill pipe steam-cleaned prior to drilling. Wesson Oil used as "pipe dope".

Water level probe deconded and operational.

DESCRIPTIONS

All descriptions based on Air Rotary. Cutting samples obtained every 5 ft.

GEOPHYSICAL LOGS

- Thermal Neutron
- Gamma
- Caliper

Logs are attached

PLUGGING

Holes plugged with cement-bentonite grout by Atkins Environmental. Plugged from bottom up with trim line.
Due to presence of water, an additional hole was drilled @ 30 ft. offset.

DEPTH UNITS: 210 FT.
DRILLING CONTRACTOR: KEY DRILLING
DRILLER: JUSTIN BOWMAN

LOGGED BY: JAB
CHECKED BY:

REV. No.	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Issued for Review	9/2/99	J.Bonner	K.Conrath	P.Carser

GANDY MARLEY INC

MONTGOMERY WATSON

PROJECT No.: 1342602.02190200
AutoCAD FILE: SLPB-48.DWG
SCALE: N/A
FIGURE No.

SOIL BORING LOG FORM

Attachment V

Geophysical Logs

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-1
LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	160 FT.
DEPTH DRILLER	200 FT.	FLUID MATURE	
DEPTH LOGGER	198.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	197 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ BHT.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BOHNER

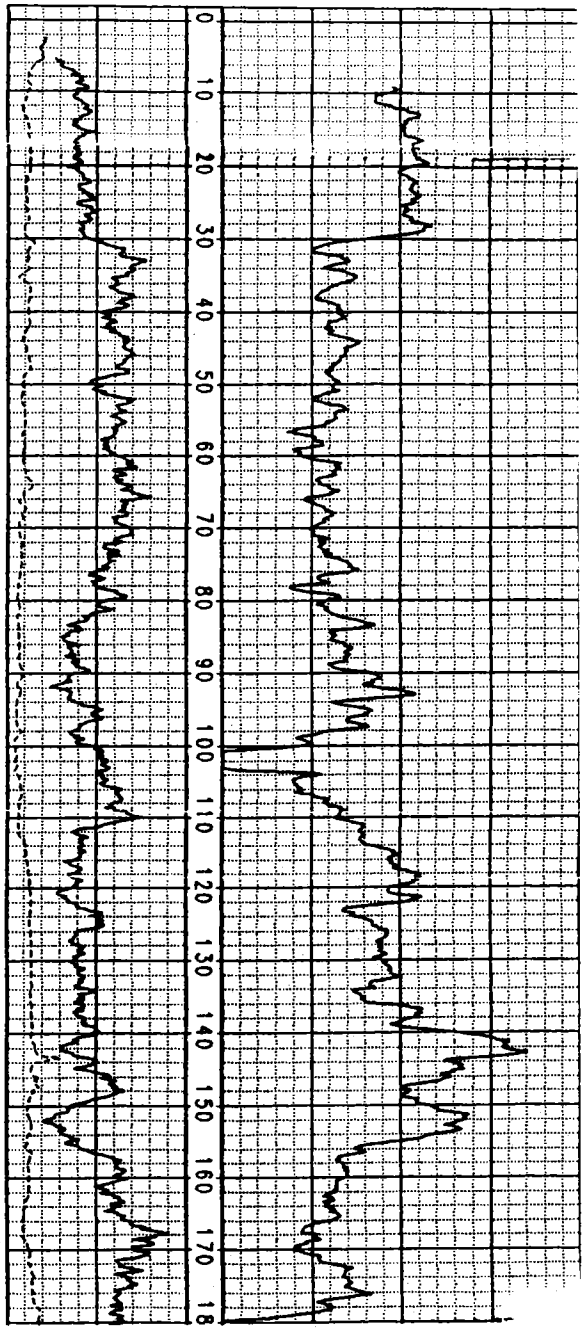
REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL PB-1

(\sdc\pb-1.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.

CALIPER INCHES 4 — 14
GAMMA RAY API 0 — 150
NEUTRON DRY API 2000 — 4500
NEUTRON WET API 200 — 800



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-2
LOCATION SEC: 17 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

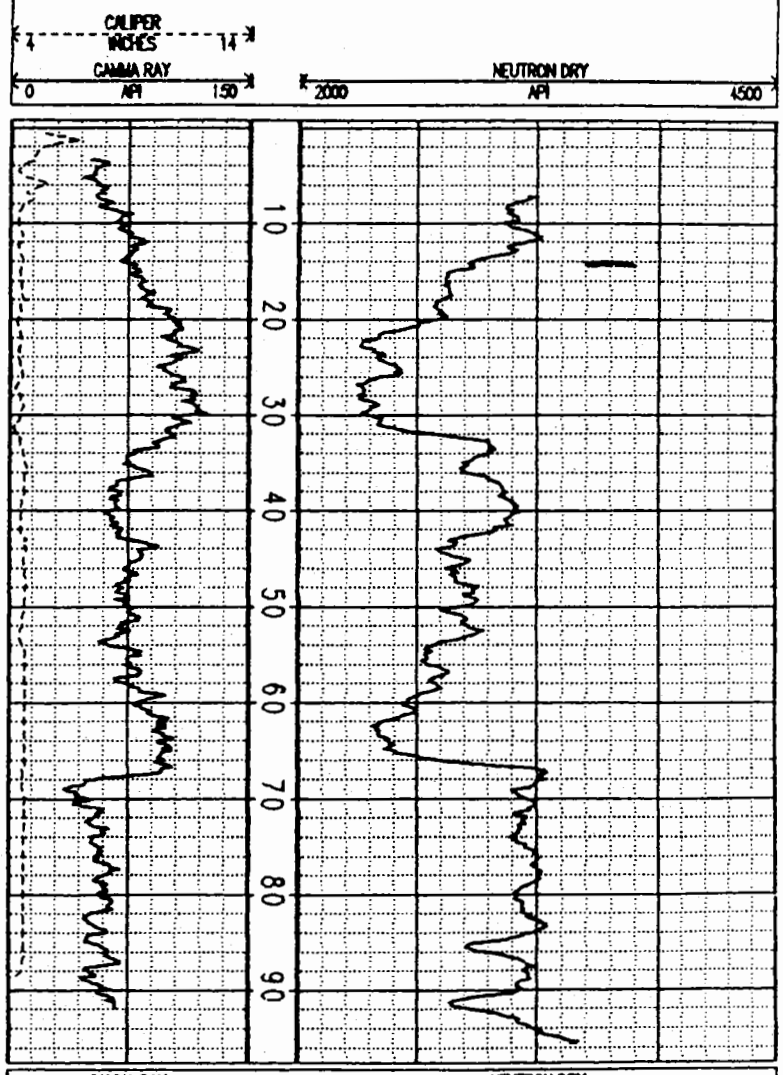
COMPANY GANDY CORPORATION
WELL: PB-2

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-2.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-2.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-3

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

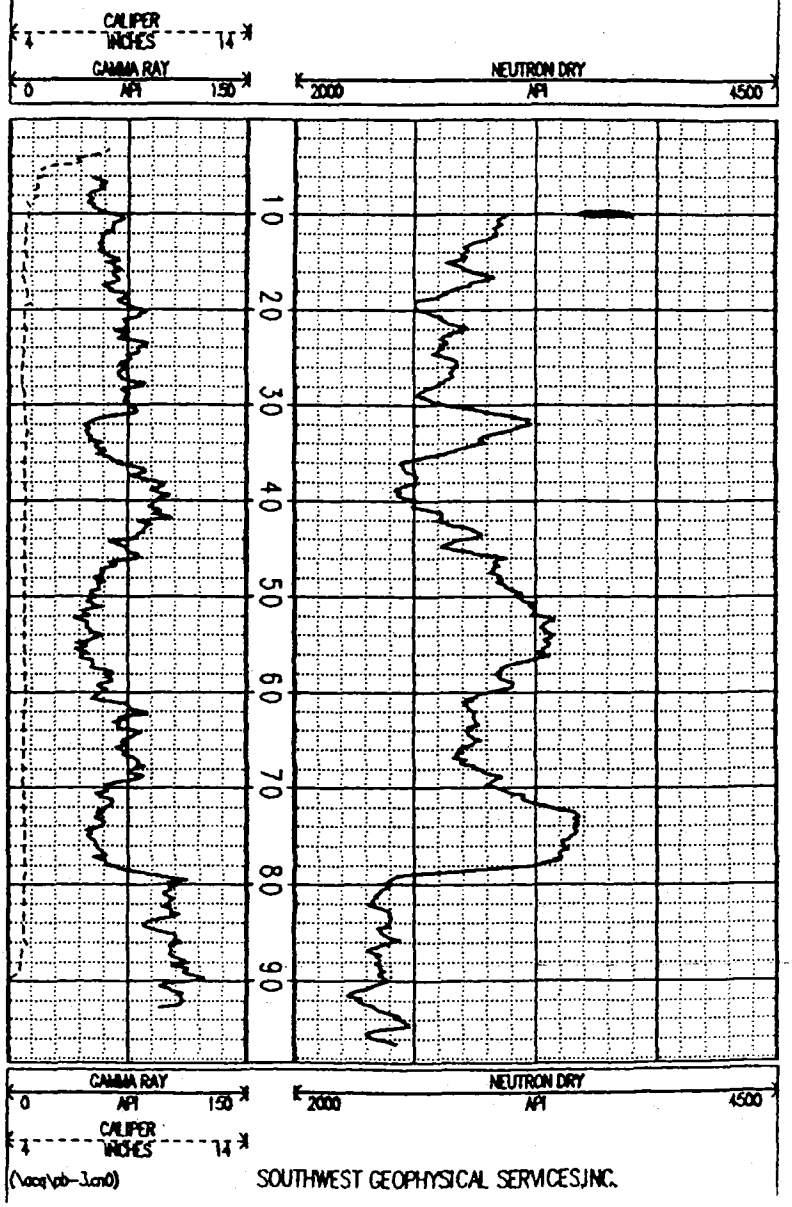
COMPANY GANDY CORPORATION
WELL: PB-3

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98.2 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.7 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-3.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



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This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-4

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

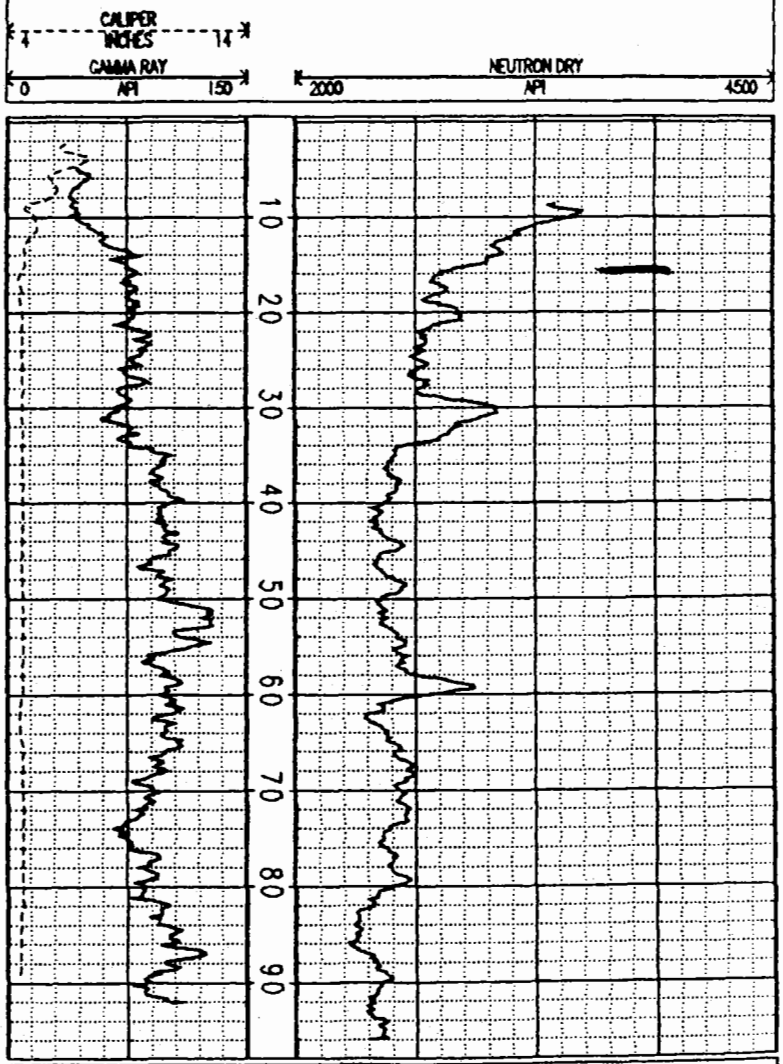
COMPANY GANDY CORPORATION
WELL: PB-4

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Corrbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-4.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



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all previous information

Southwest Geophysical Services, Inc.

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GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-5
LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

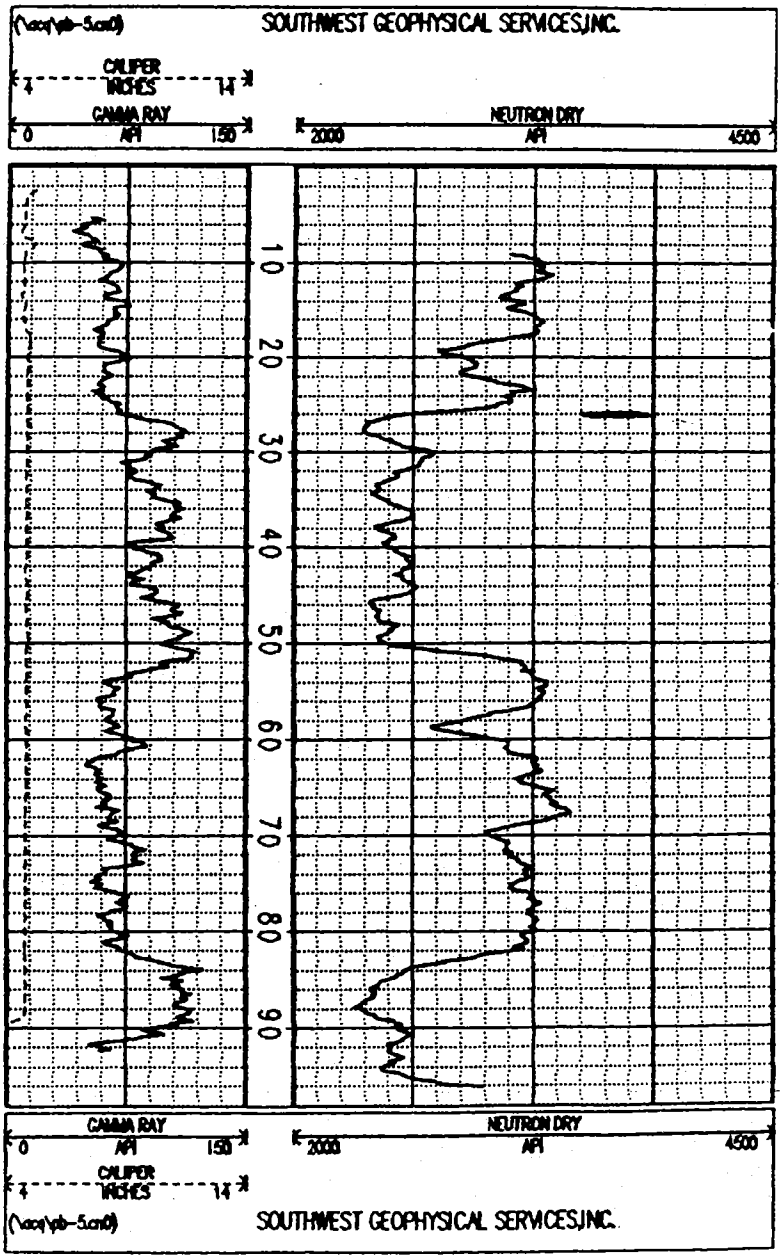
ELEVATION KB: DF: GL:

	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.7 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.2 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-5



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-6

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

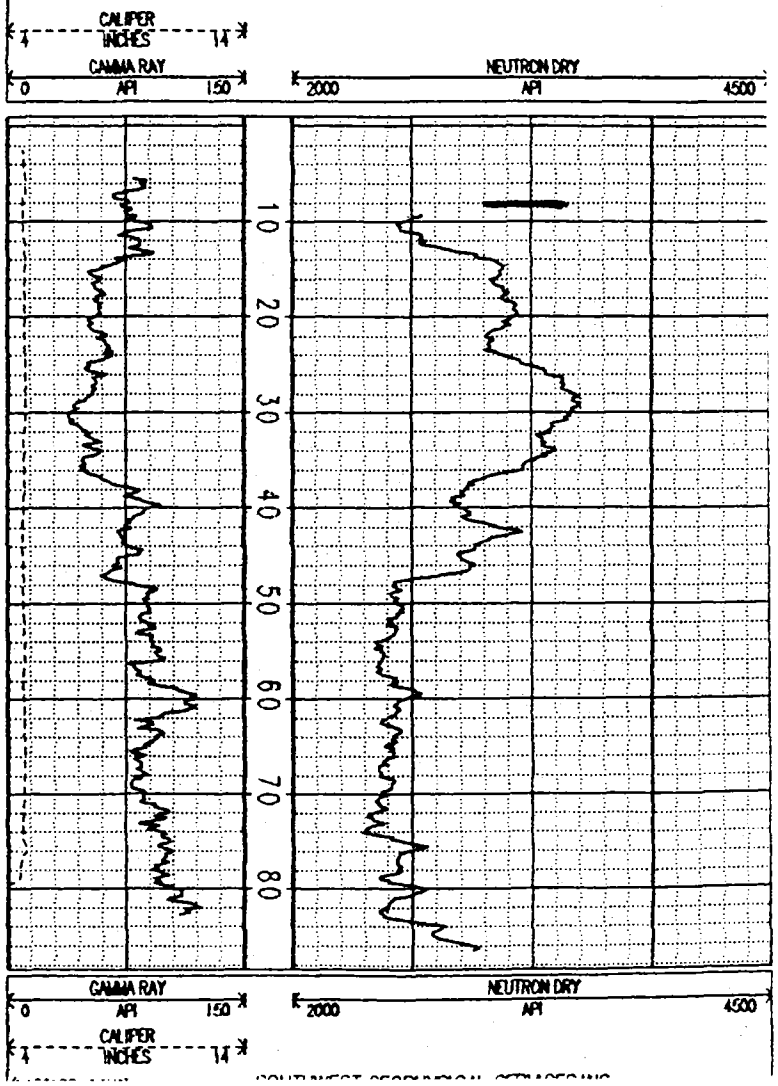
COMPANY GANDY CORPORATION
WELL: PB-6

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	88.2 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	88.7 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\ACD\PB-6.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-7

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

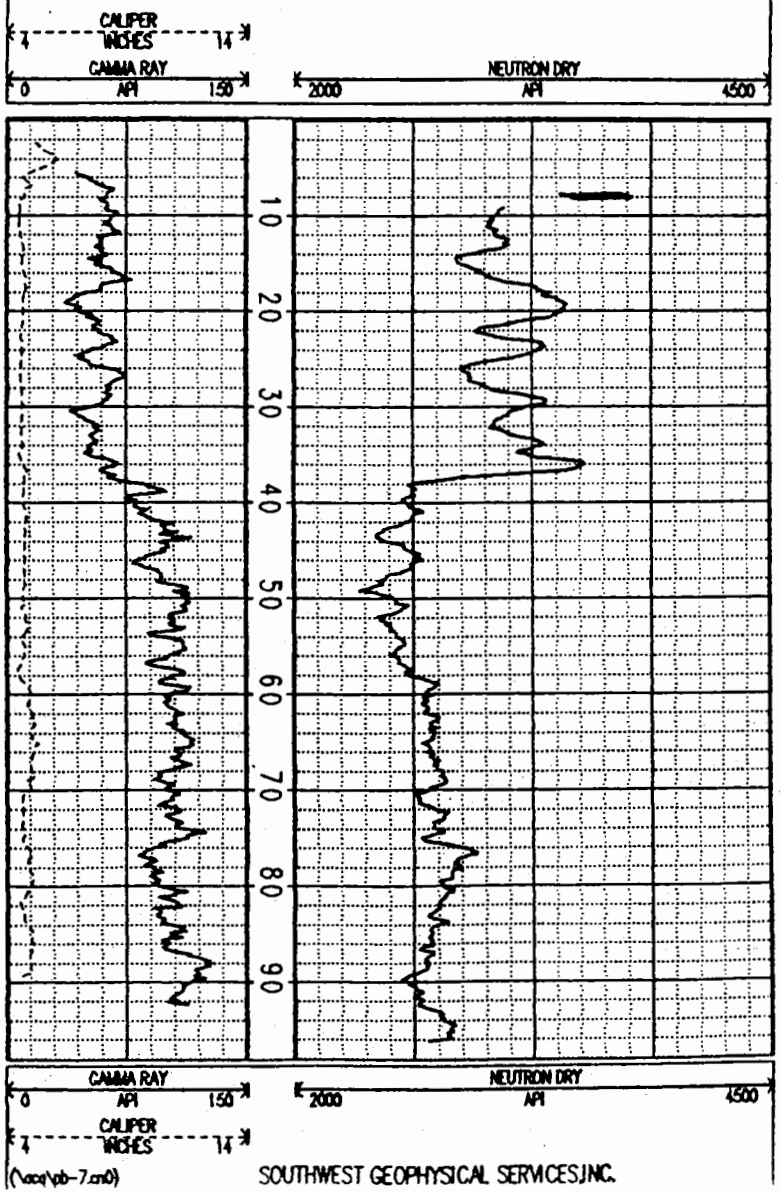
COMPANY GANDY CORPORATION
WELL: PB-7

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	96.2 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL	Carba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-7.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



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This revision supersedes
all previous information

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-8

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

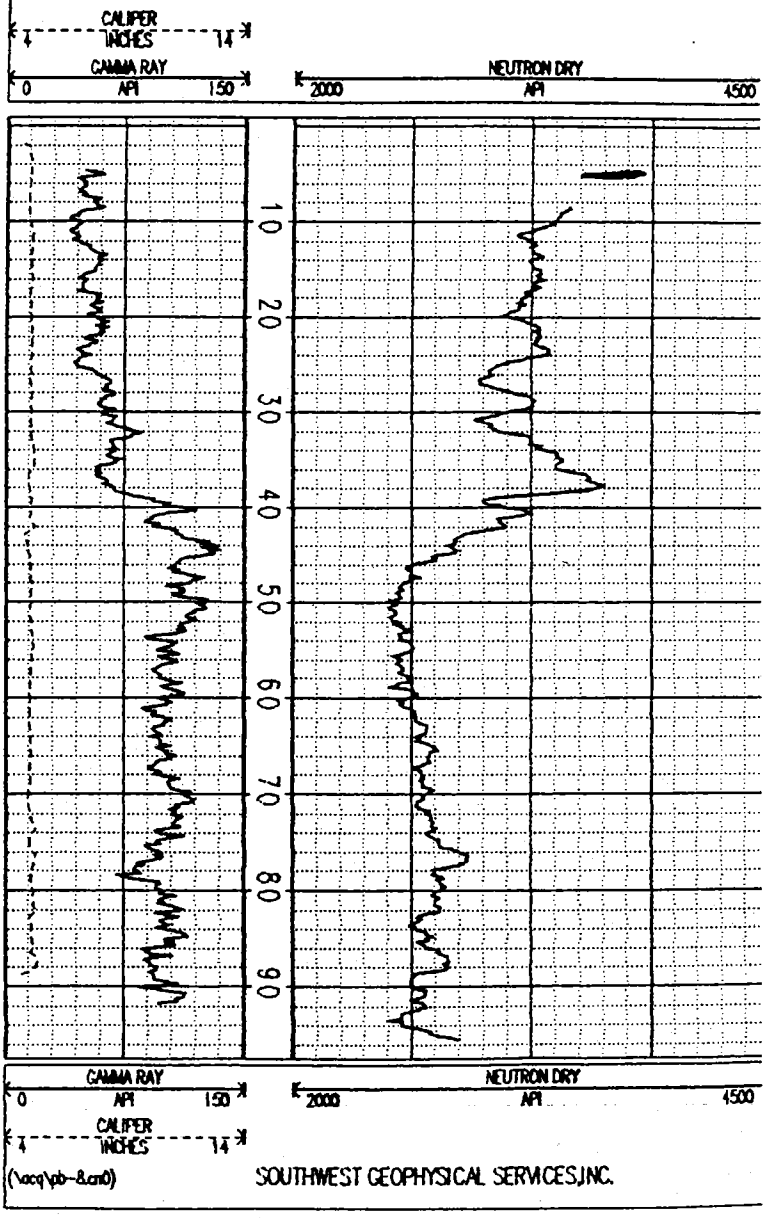
COMPANY GANDY CORPORATION
WELL: PB-8

	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Corrbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-8.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-8.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-9

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

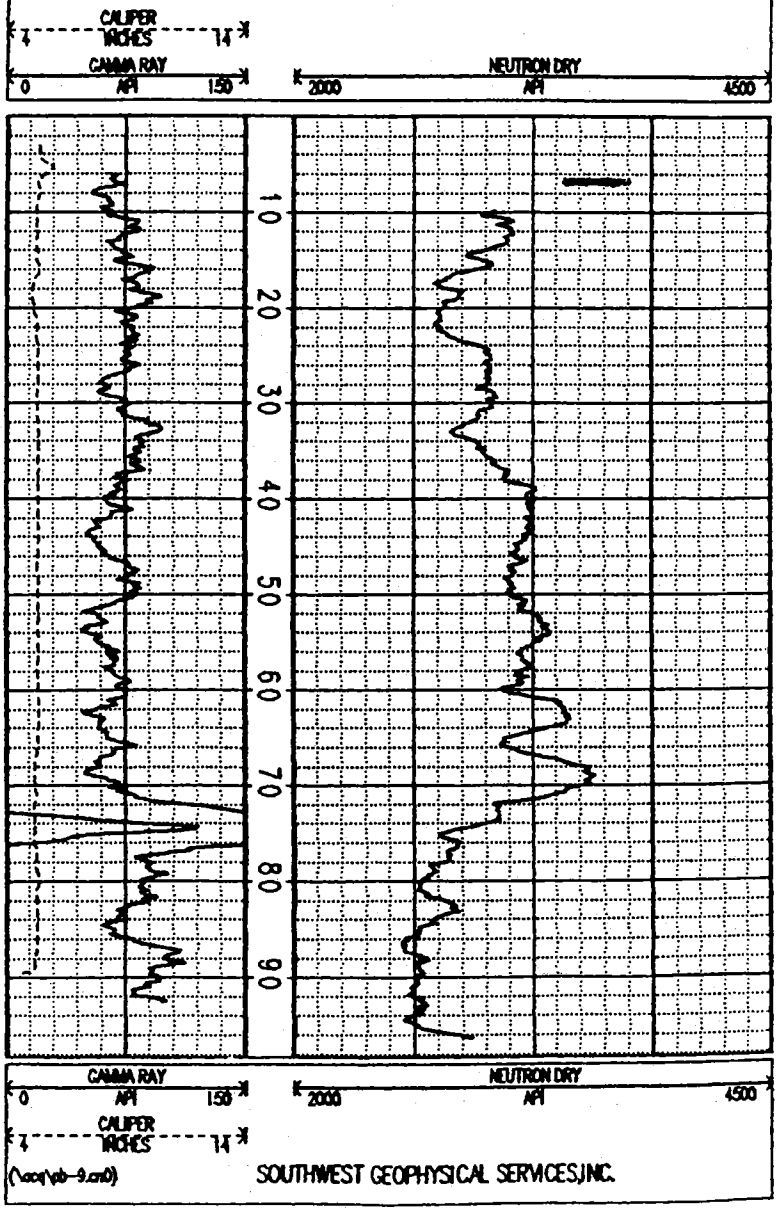
COMPANY GANDY CORPORATION
WELL: PB-9

	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.7 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.2 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Canba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\xcq\pb-9.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\xcq\pb-9.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-10

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

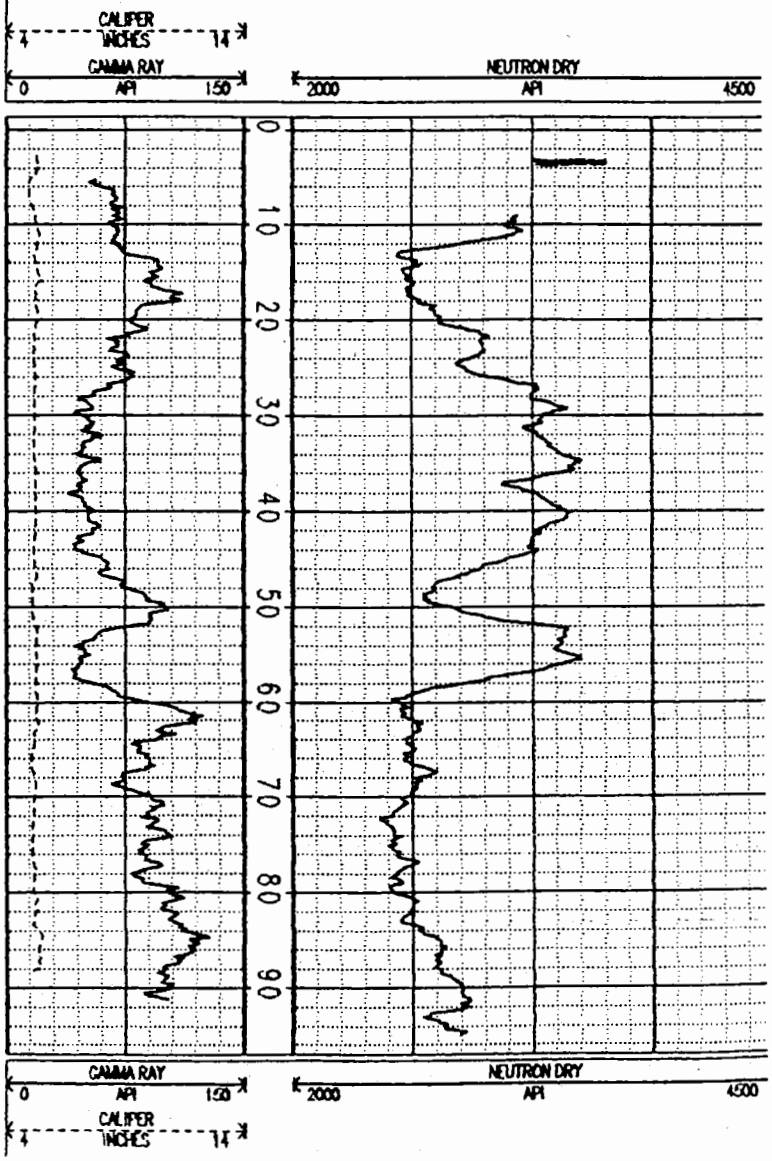
COMPANY GANDY CORPORATION
WELL: PB-10

	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	96.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-10.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-11

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

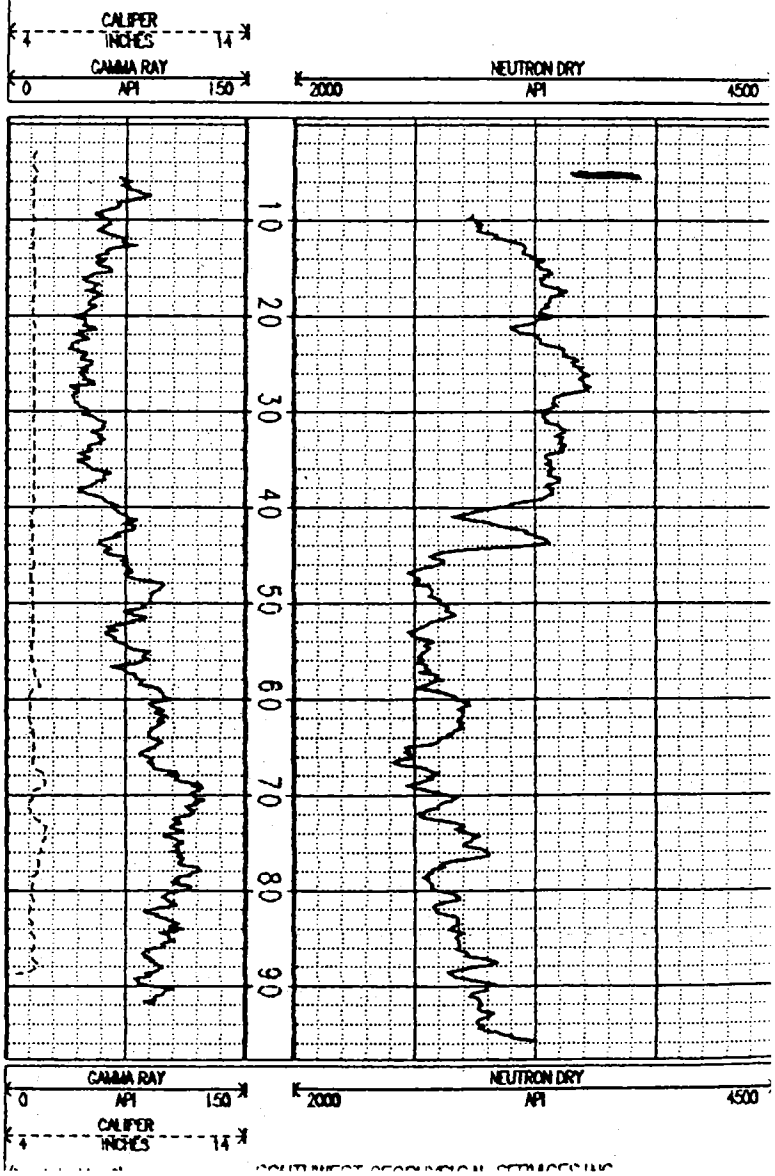
	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.3 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.8 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carrba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-11

(\acq\pb-11.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-12
LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

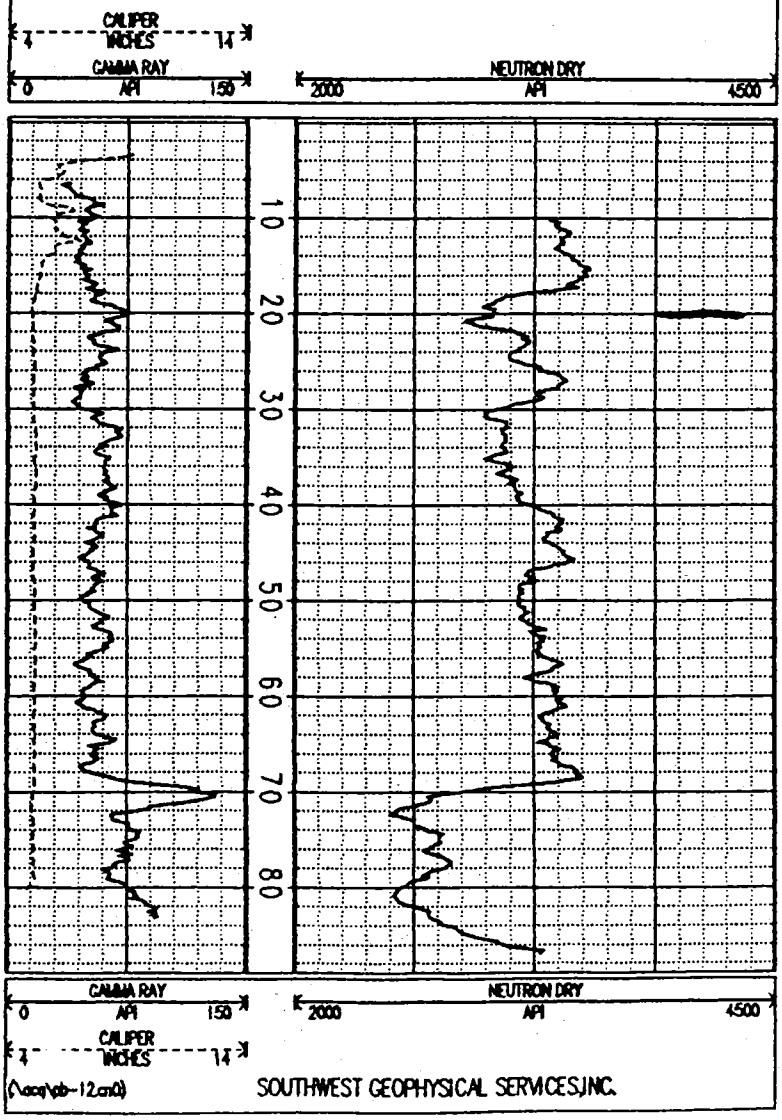
COMPANY GANDY CORPORATION
WELL: PB-12

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	88.2 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	88.7 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ BHT.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-12.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-12.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-13

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

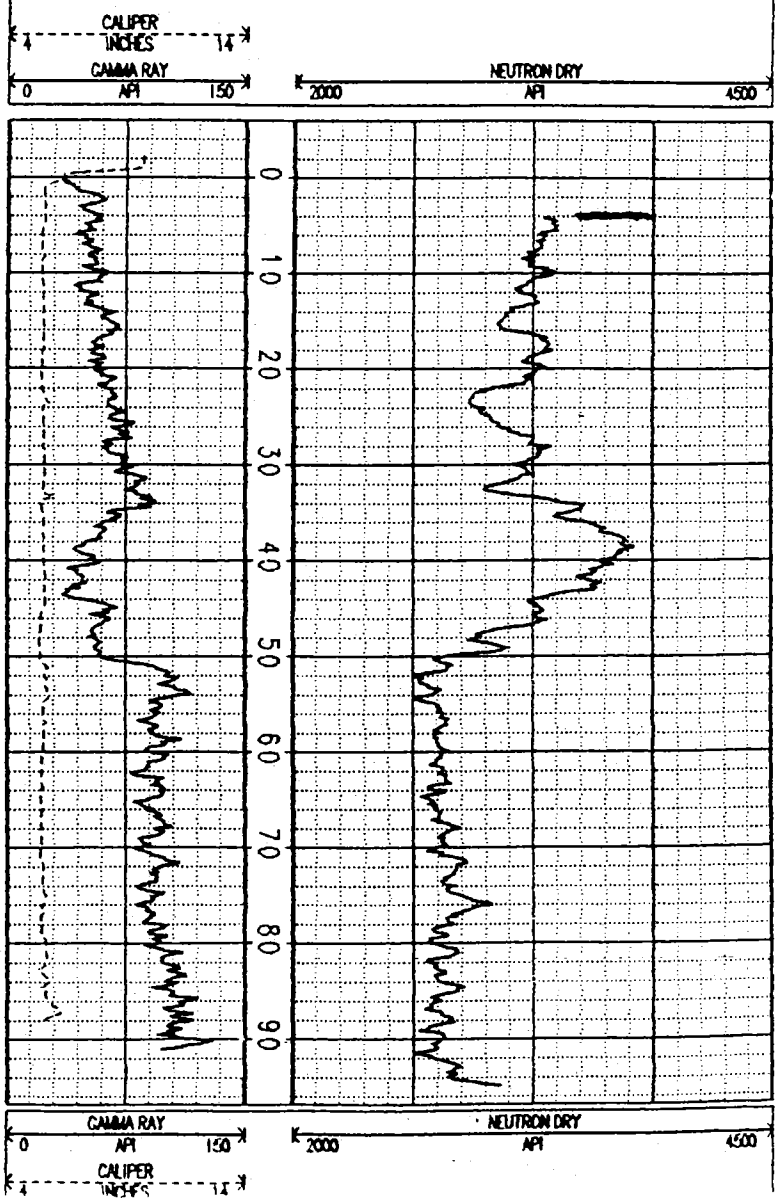
COMPANY GANDY CORPORATION
WELL: PB-13

	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-13.cnl) SOUTHWEST GEOPHYSICAL SERVICES,INC.



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: GL ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-14

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

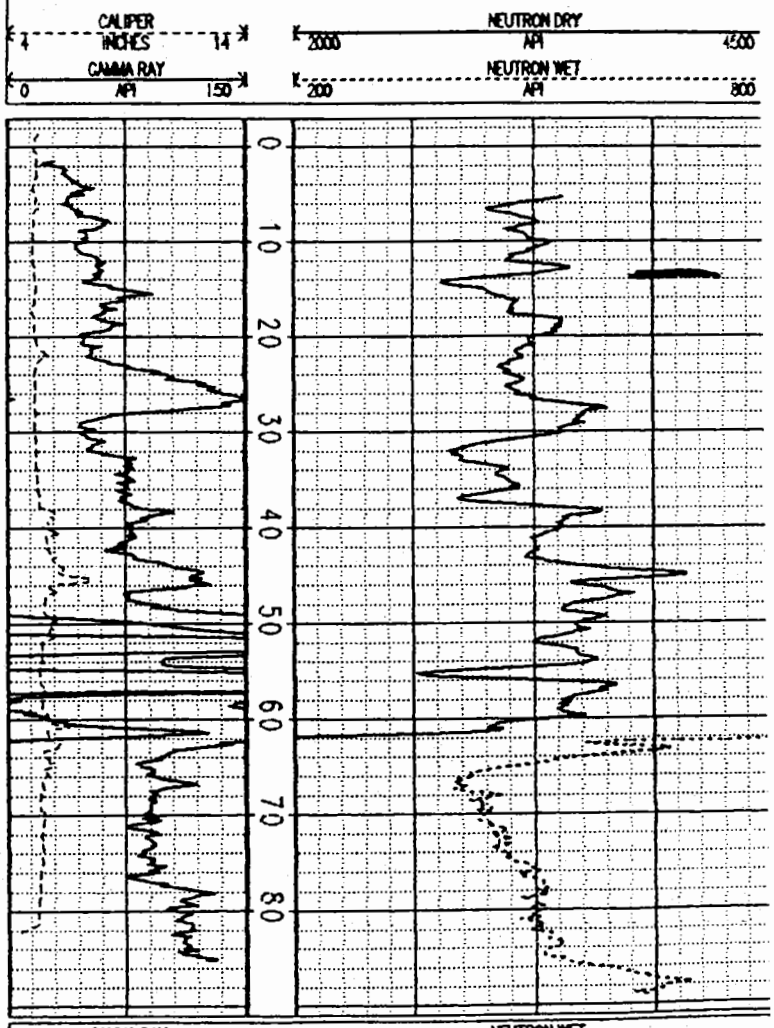
COMPANY GANDY CORPORATION
WELL: PB-14

	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	82 FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	NAT'L WATER
DEPTH LOGGER	90.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	88 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\ACO\PB-14.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\ACO\PB-14.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-14 OFFSET

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

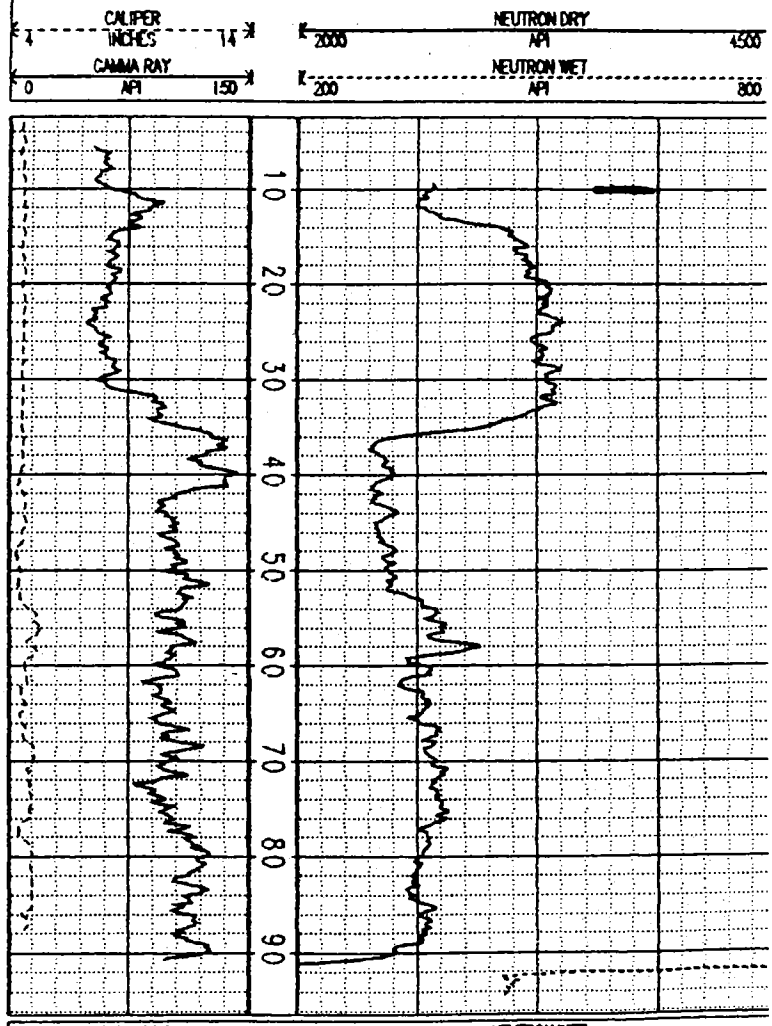
	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	94.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-14 OFFSET

(\ACQ\PB-14OFF.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\ACQ\PB-14OFF.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-15

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

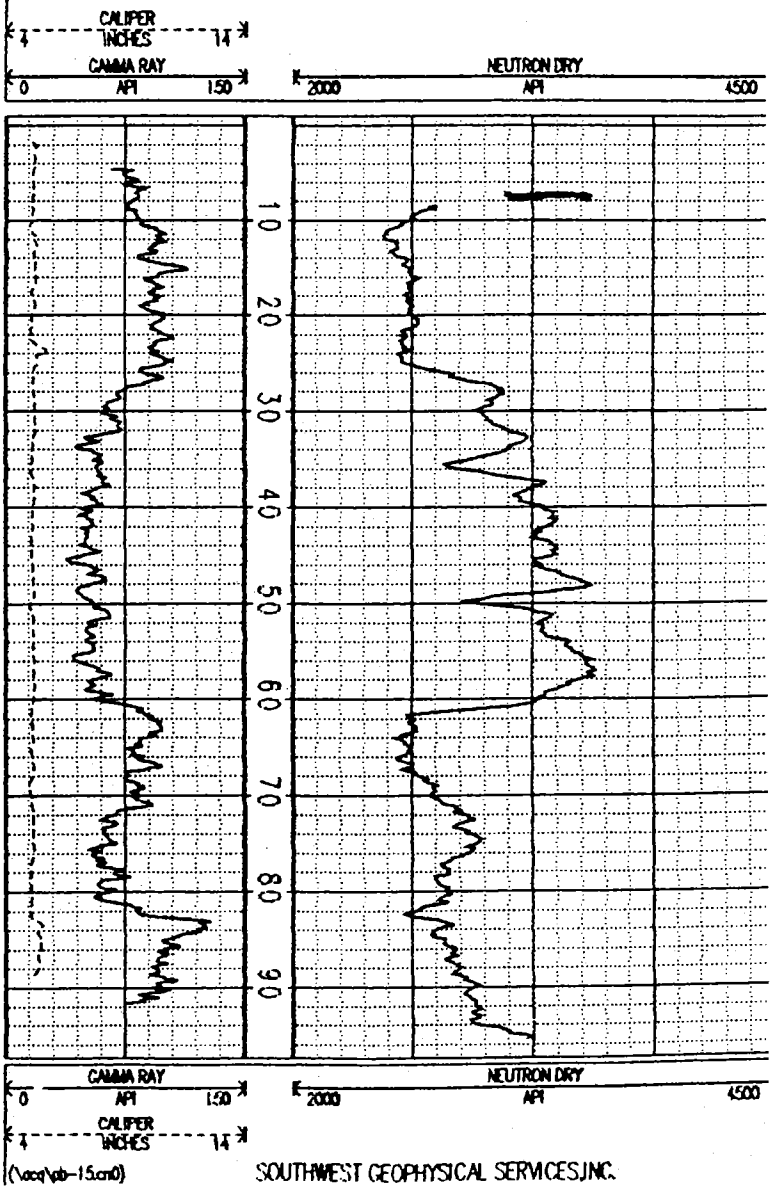
COMPANY GANDY CORPORATION
WELL: PB-15

	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-15.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-15.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-16

LOCATION SEC:18 T:11 S R:31 E
COUNTY: CHAVEZ STATE: NM

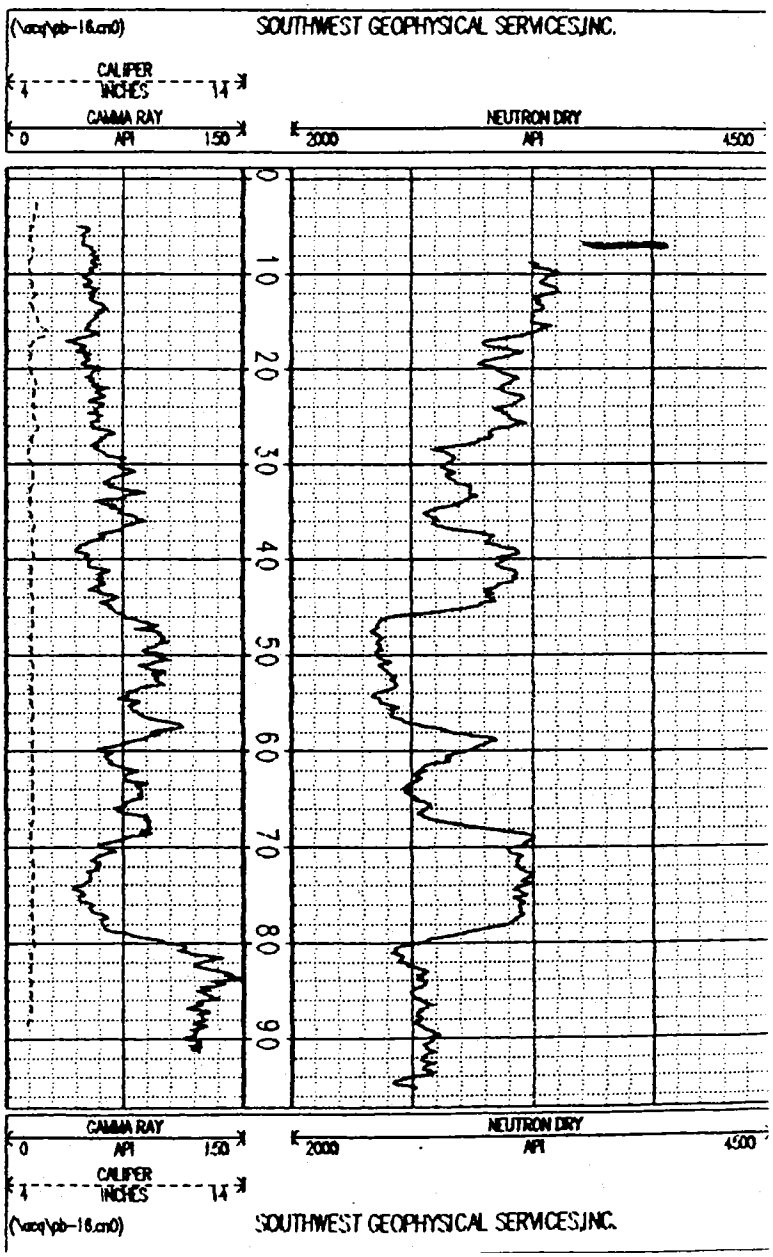
ELEVATION KB:
DF:
GL:

COMPANY GANDY CORPORATION
WELL: PB-16

	RUN NO. 1		RUN NO. 1
DATE	07/13/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-17

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

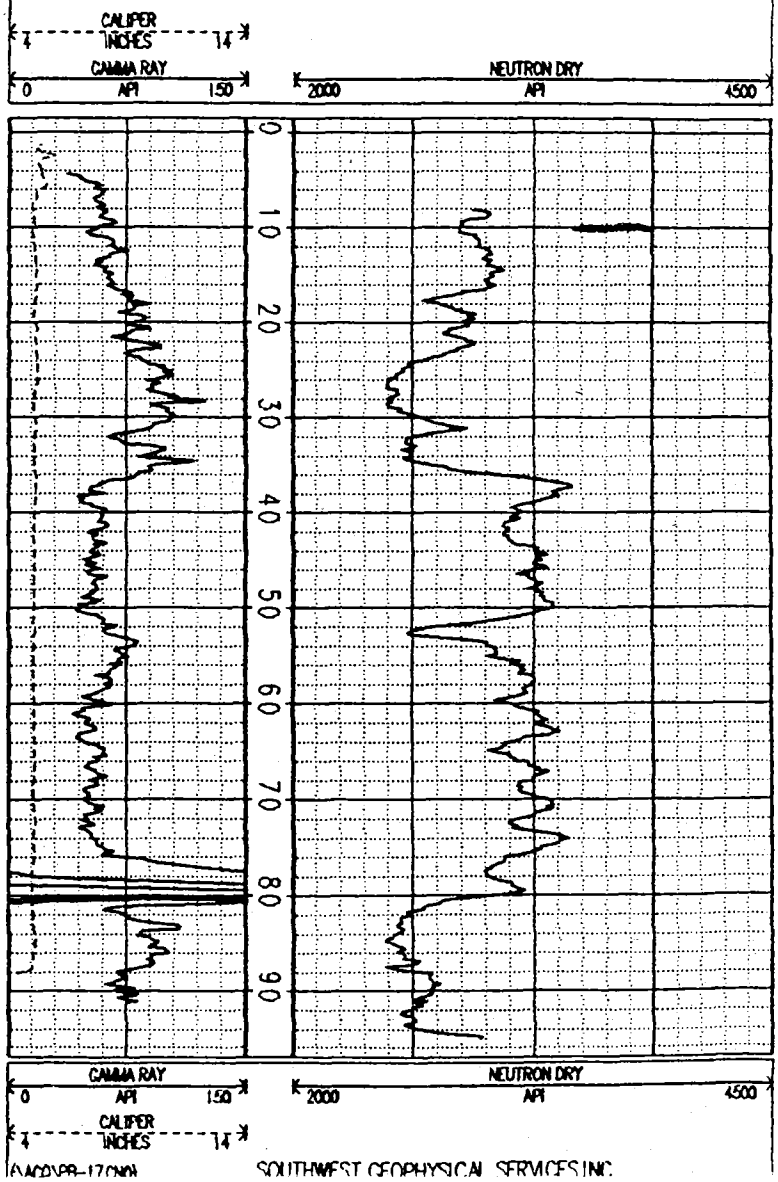
COMPANY GANDY CORPORATION
WELL: PB-17

	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	96.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\ACD\PB-17.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\ACD\PB-17.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-18

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

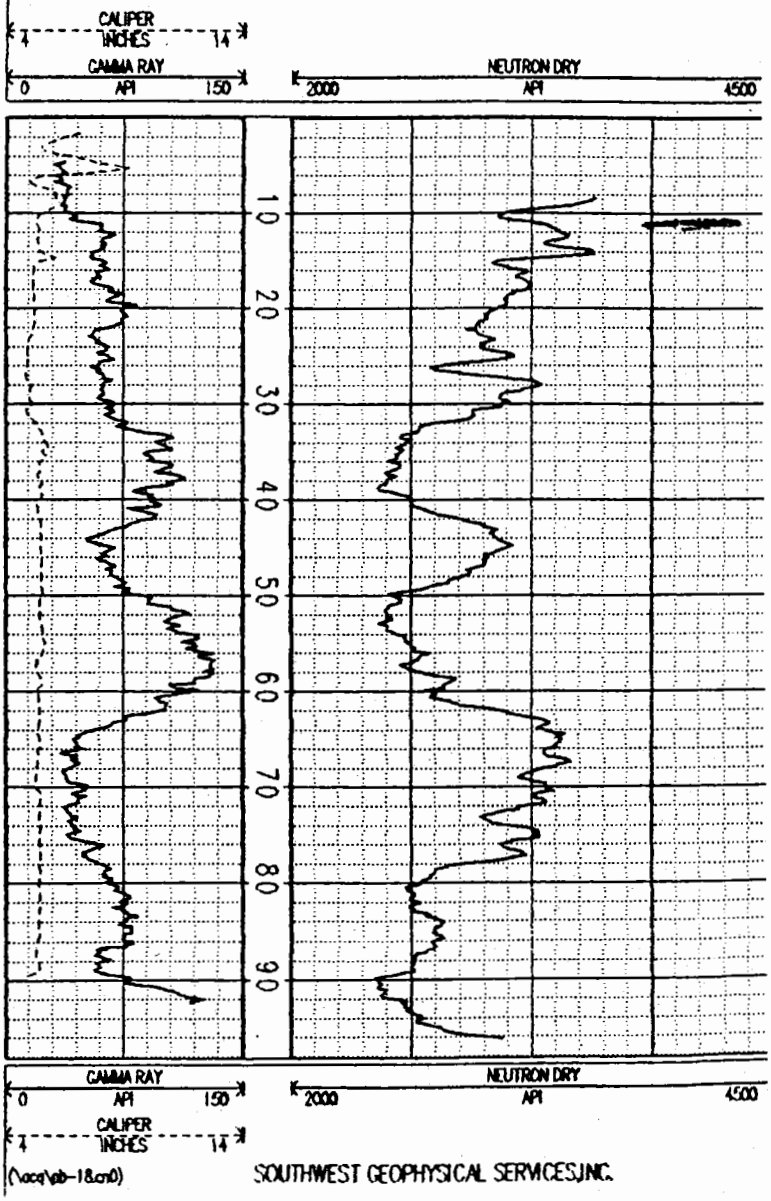
	RUN NO. 1		RUN NO. 1
DATE	07/15/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.8 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.3 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Corbu
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-18

(\acq\pb-18cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-18cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-19

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

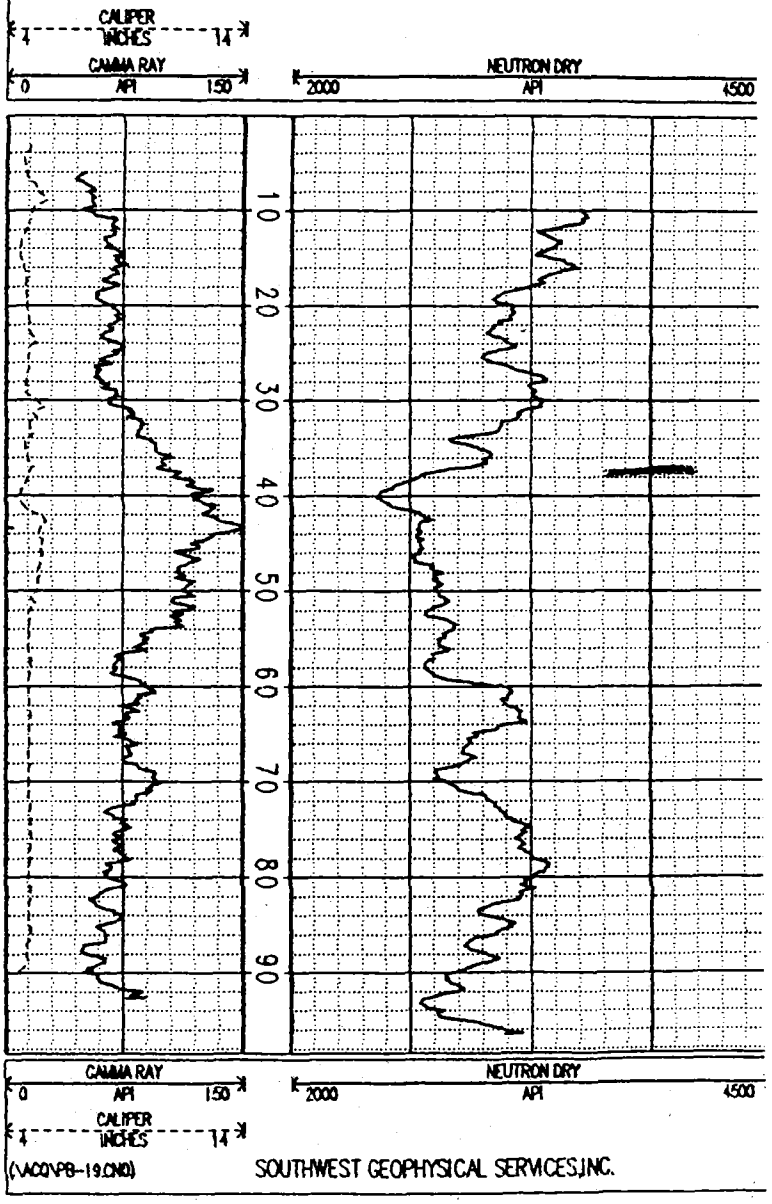
COMPANY GANDY CORPORATION
WELL: PB-19

	RUN NO. 1		RUN NO. 1
DATE	07/16/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	97 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\ACQ\PB-19.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\ACQ\PB-19.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: CANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-20
LOCATION SEC: 7 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

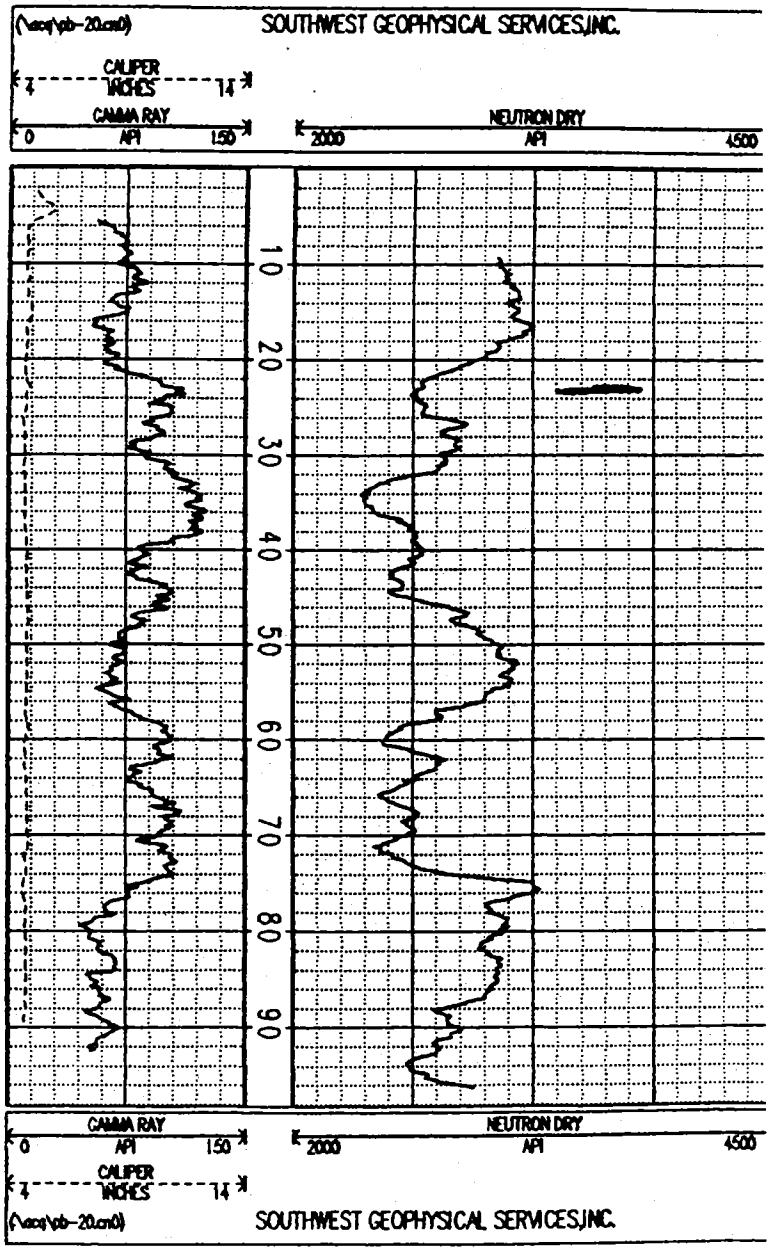
ELEVATION KB:
DF:
GL:

COMPANY CANDY CORPORATION
WELL: PB-20

	RUN NO. 1		RUN NO. 1
DATE	07/16/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	96.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-21
LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

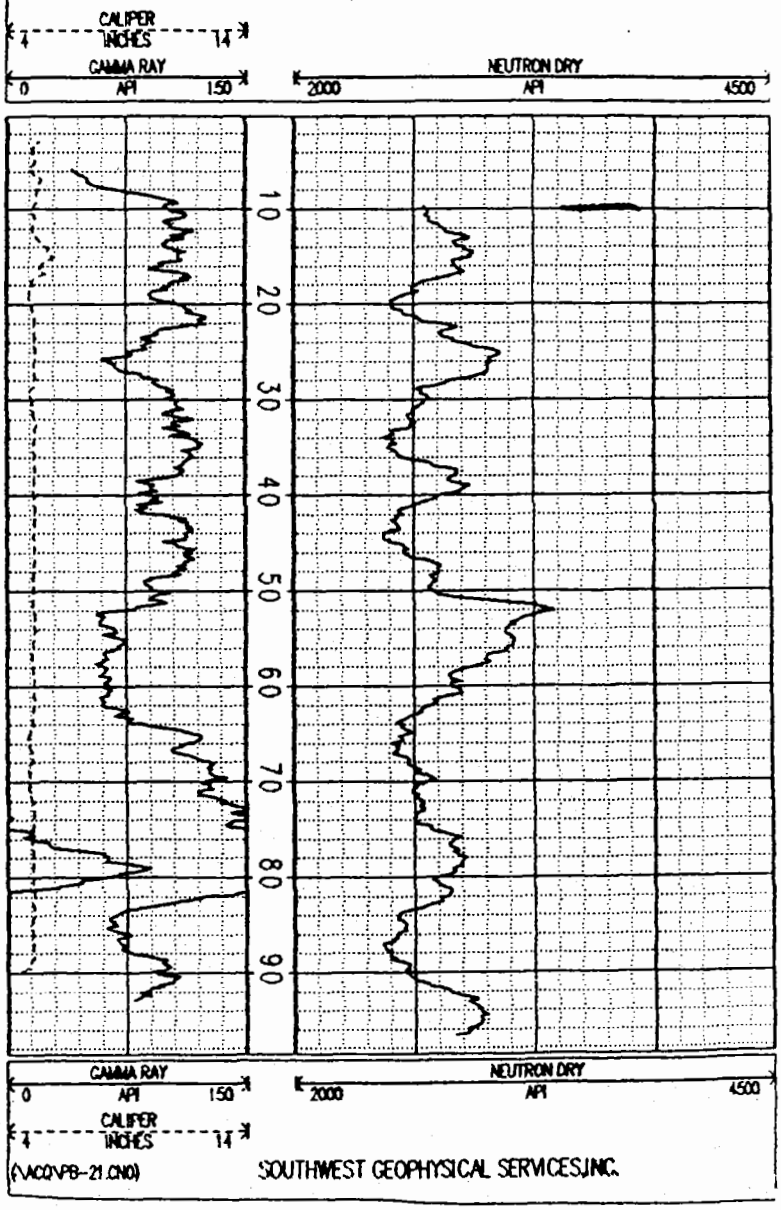
COMPANY GANDY CORPORATION
WELL: PB-21

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98.2 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.7 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Corrba
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\ACQ\PB-21.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\ACQ\PB-21.CND) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-22

LOCATION SEC:18 T:11 S R:31 E
COUNTY: CHAVEZ STATE: NM

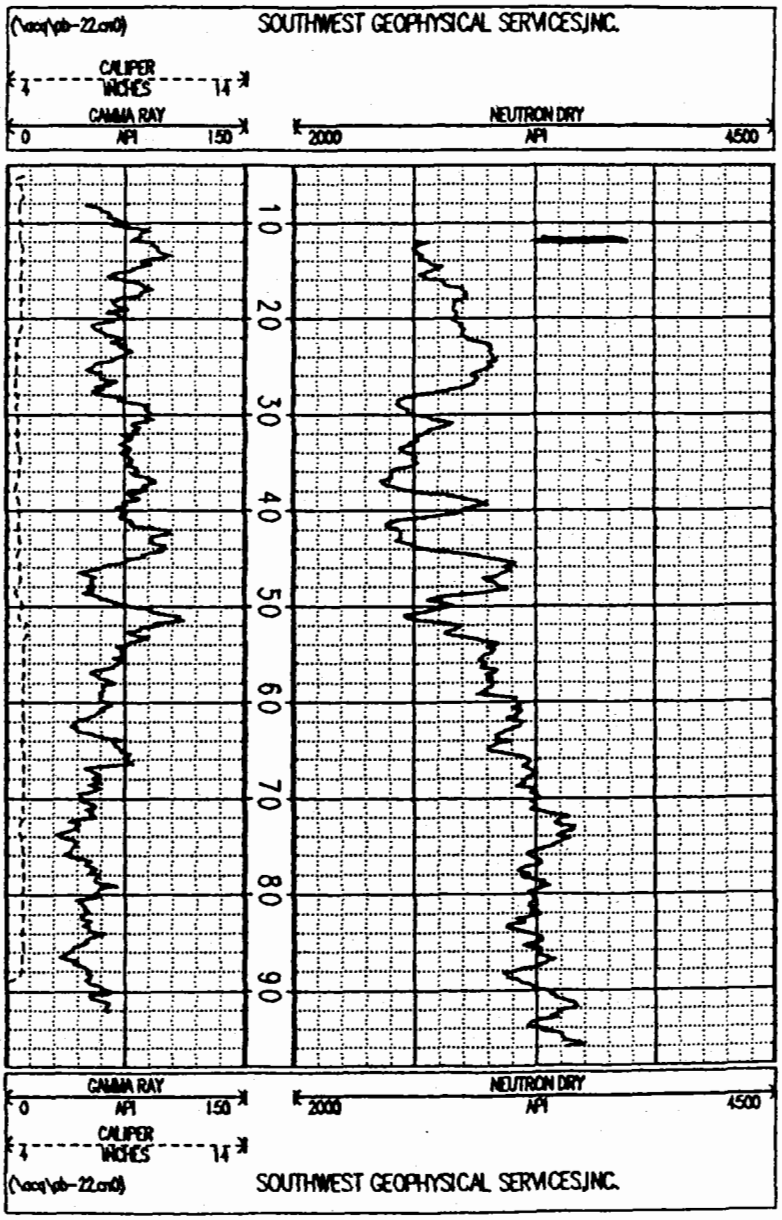
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Corbe
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-22



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-23

LOCATION SEC 17 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

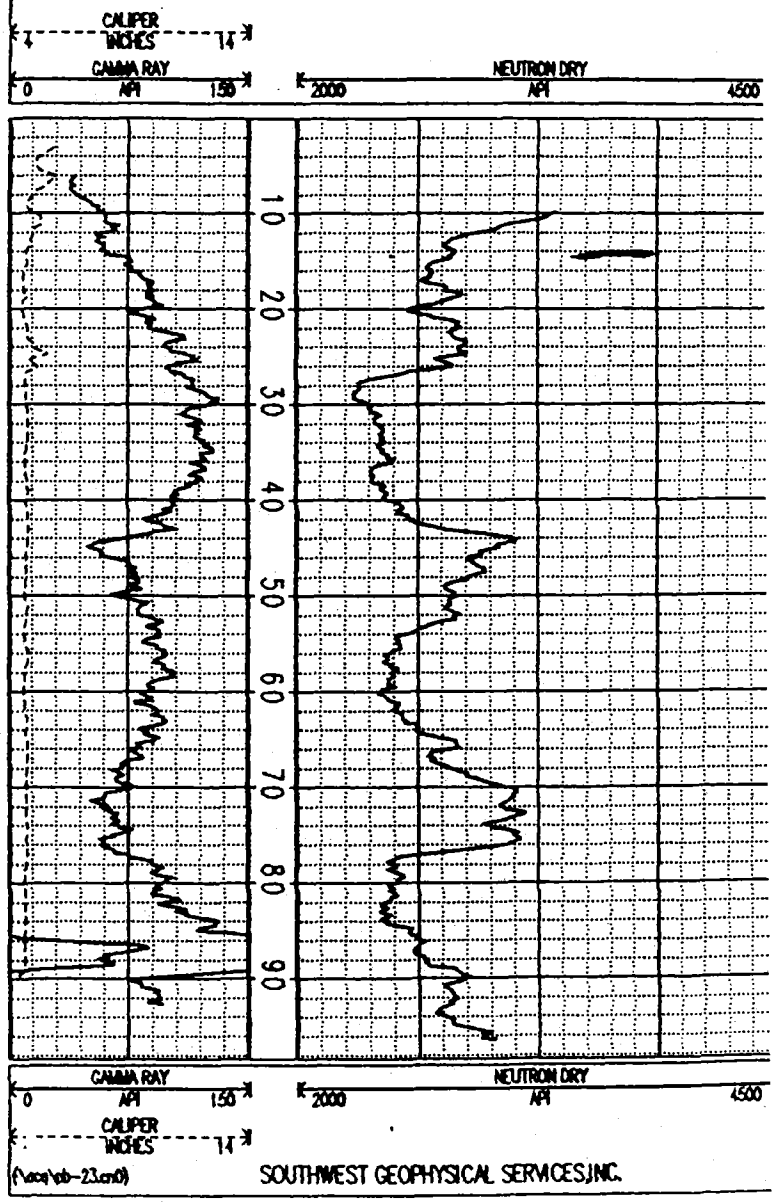
COMPANY GANDY CORPORATION
WELL: PB-23

	RUN NO. 1		RUN NO. 1
DATE	07/16/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-23.cnl) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-23.cnl) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-24
LOCATION SEC: 7 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

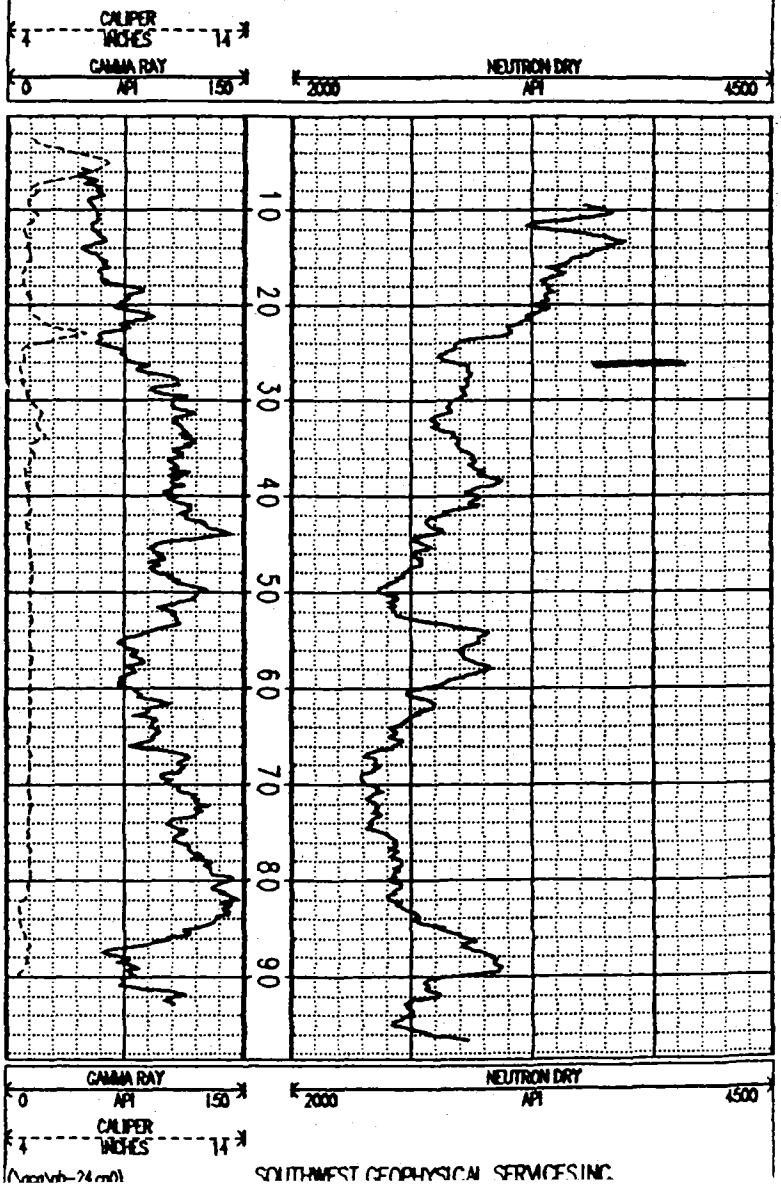
COMPANY GANDY CORPORATION
WELL: PB-24

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	96.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\ccq\pb-24.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\ccq\pb-24.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-25
LOCATION SEC: 17 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

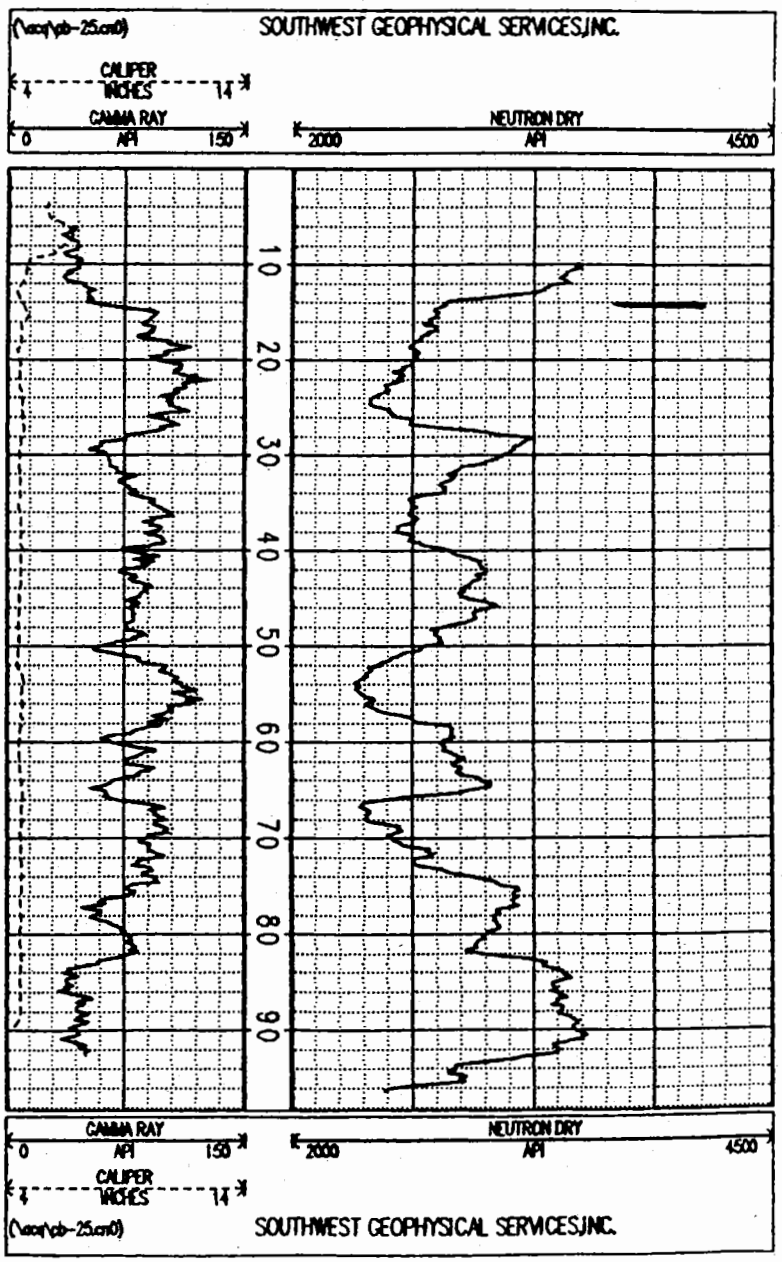
ELEVATION KB:
DF:
GL:

COMPANY GANDY CORPORATION
WELL: PB-25

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-26

LOCATION SEC: T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

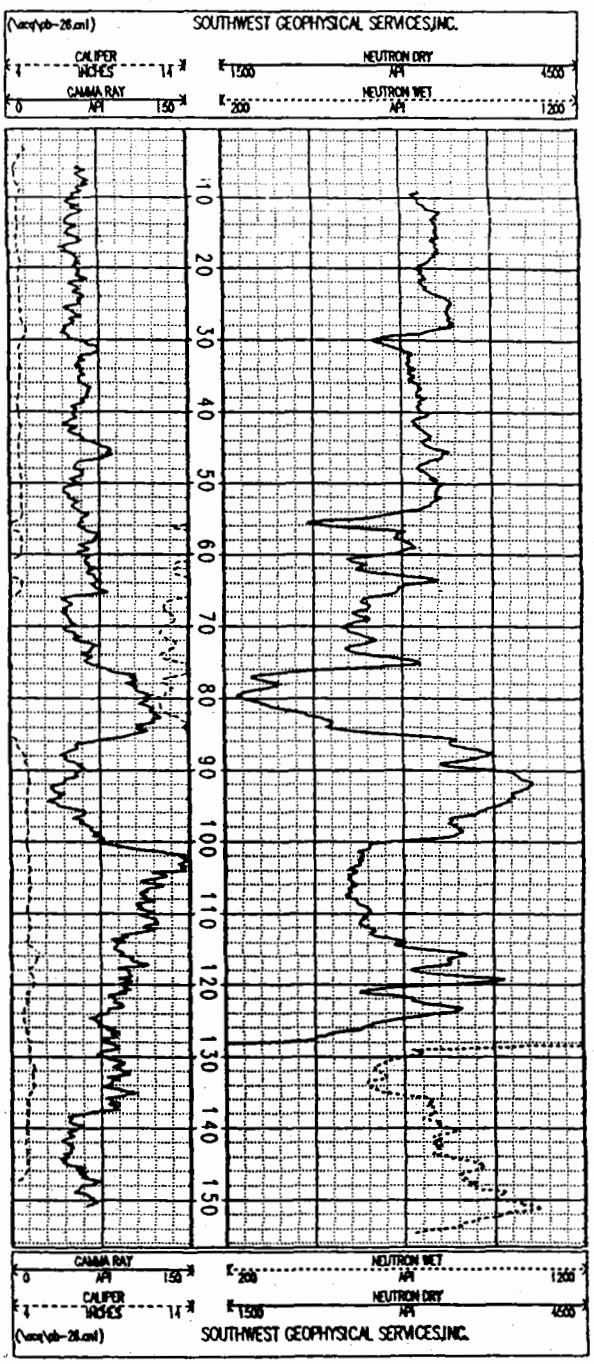
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	128 FT.
DEPTH DRILLER	180 FT.	FLUID NATURE	
DEPTH LOGGER	156 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	154.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JM BOHNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL PB-26



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY, NEUTRON, RESISTANCE, CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: GL. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RM
WELL: FB-27
LOCATION SEC: T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

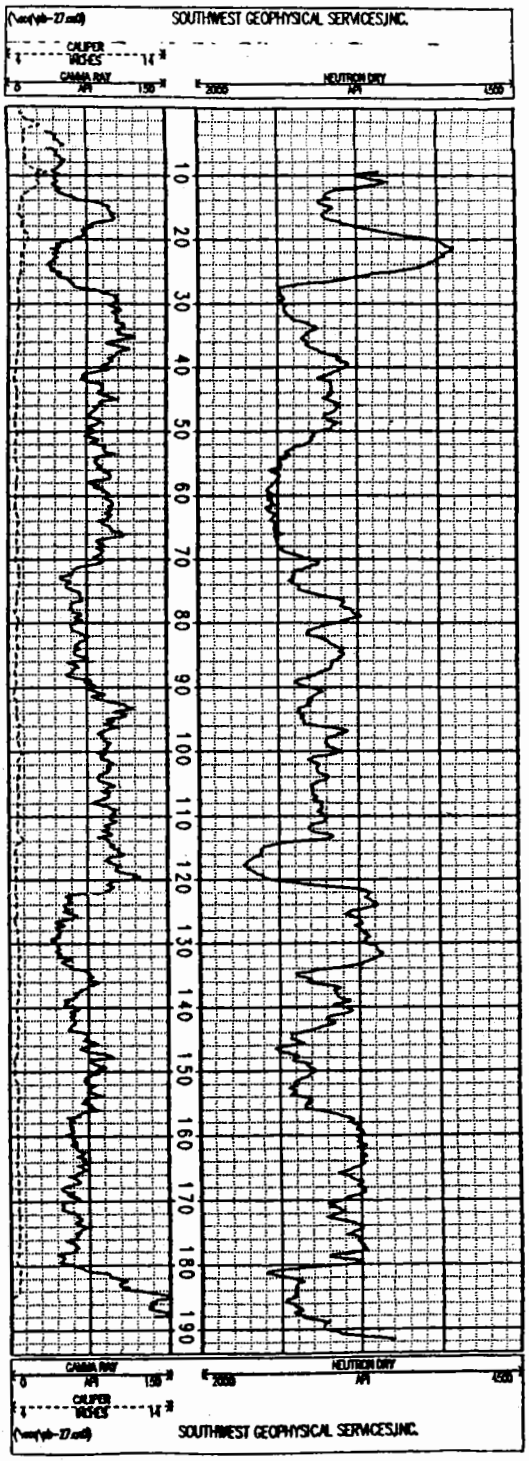
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	200 FT.	FLUID NATURE	
DEPTH LOGGER	193 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	184 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ BHT.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT. HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBEFIELD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL FB-27



This revision supersedes all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: FB-28
LOCATION SEC: 7 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Cavibe
BIT SIZE		LOGGED BY:	S.STURBENUD
		WITNESSED BY:	JIM BONNER

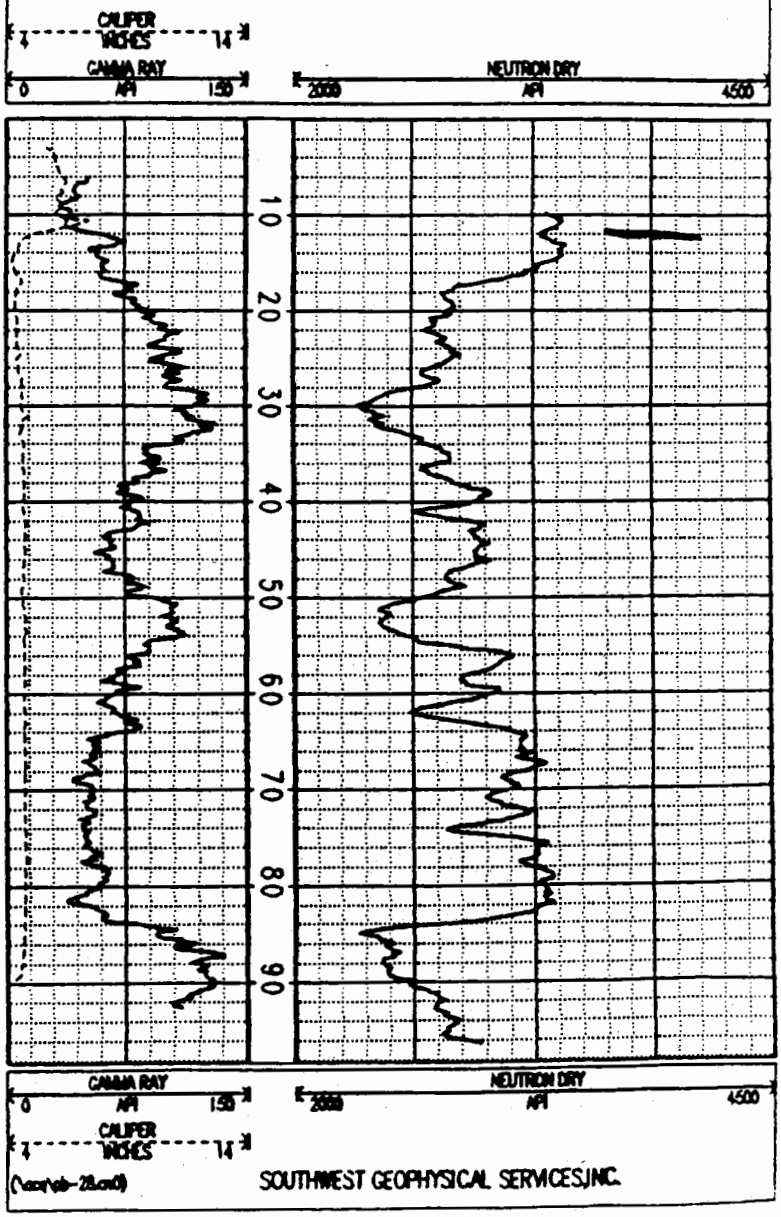
REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: FB-28

(\scr\fb-28.cal)

SOUTHWEST GEOPHYSICAL SERVICES,INC.



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SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-29

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

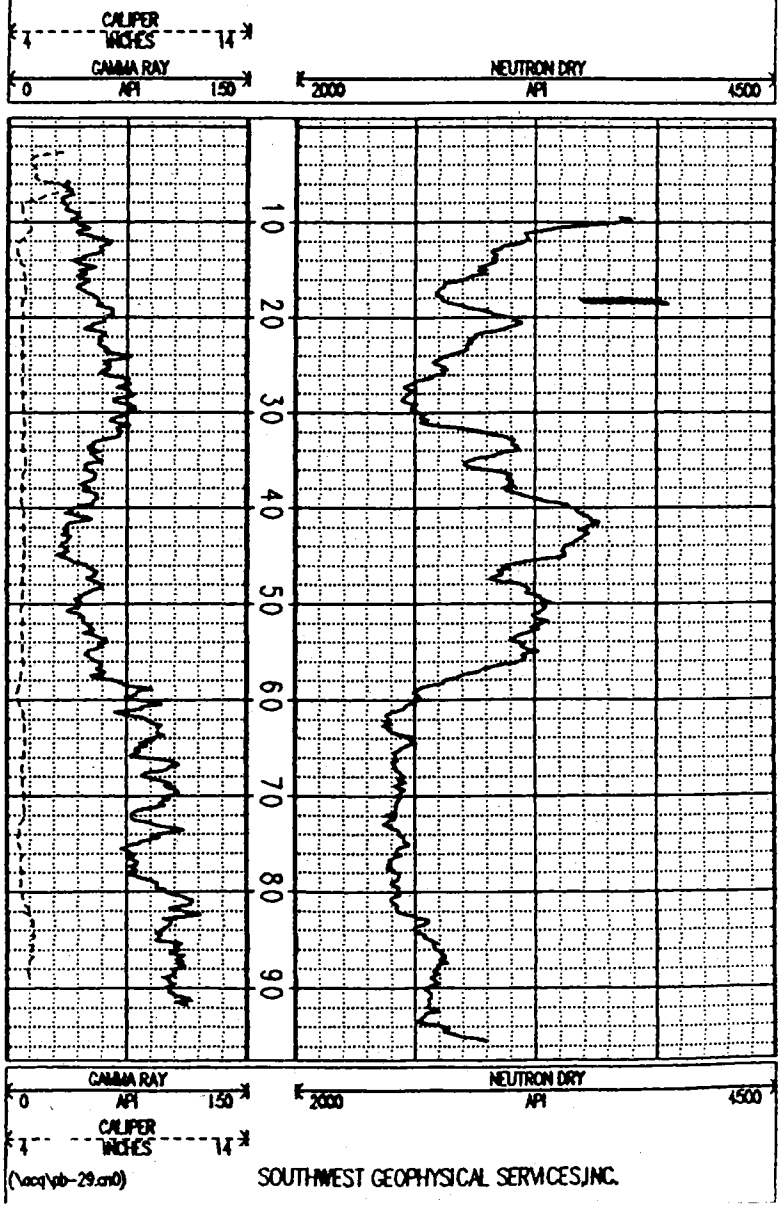
	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.2 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.7 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-29

(\acq\pb-29.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-29.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: CANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-30

LOCATION SEC: 7 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

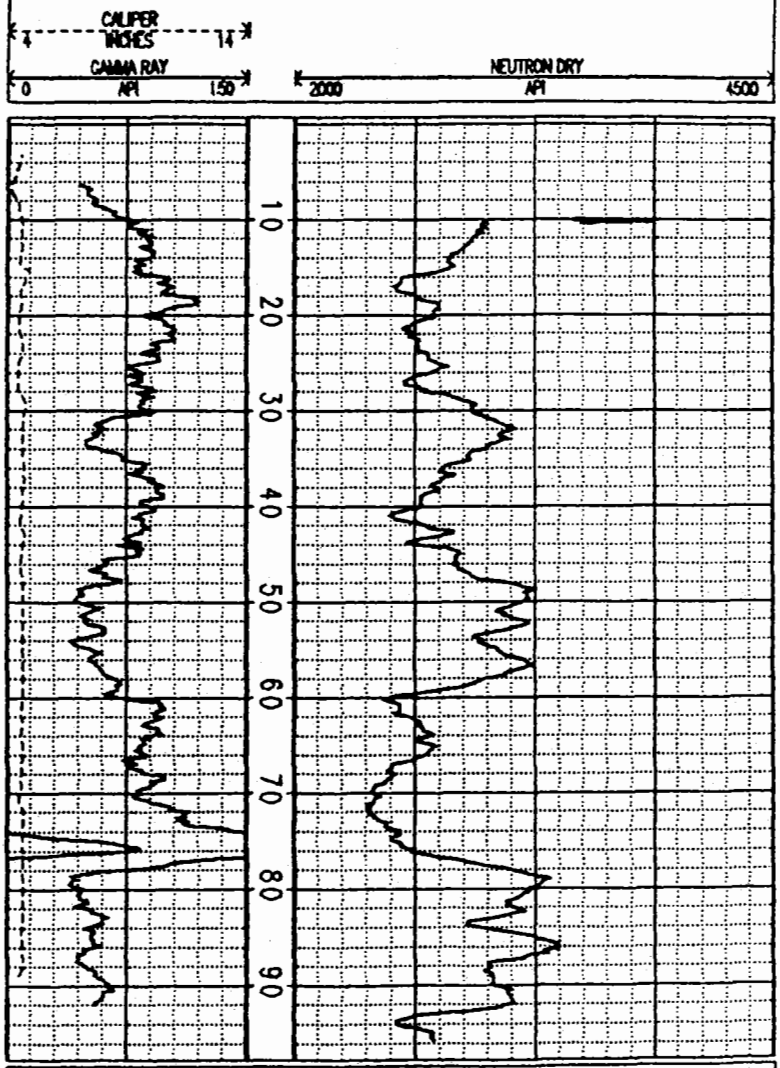
REMARKS:
LOCATION:

THANK YOU

COMPANY CANDY CORPORATION
WELL PB-30

(\acq\pb-30.cal)

SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-30.cal)

SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-31

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97.7 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	98.2 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

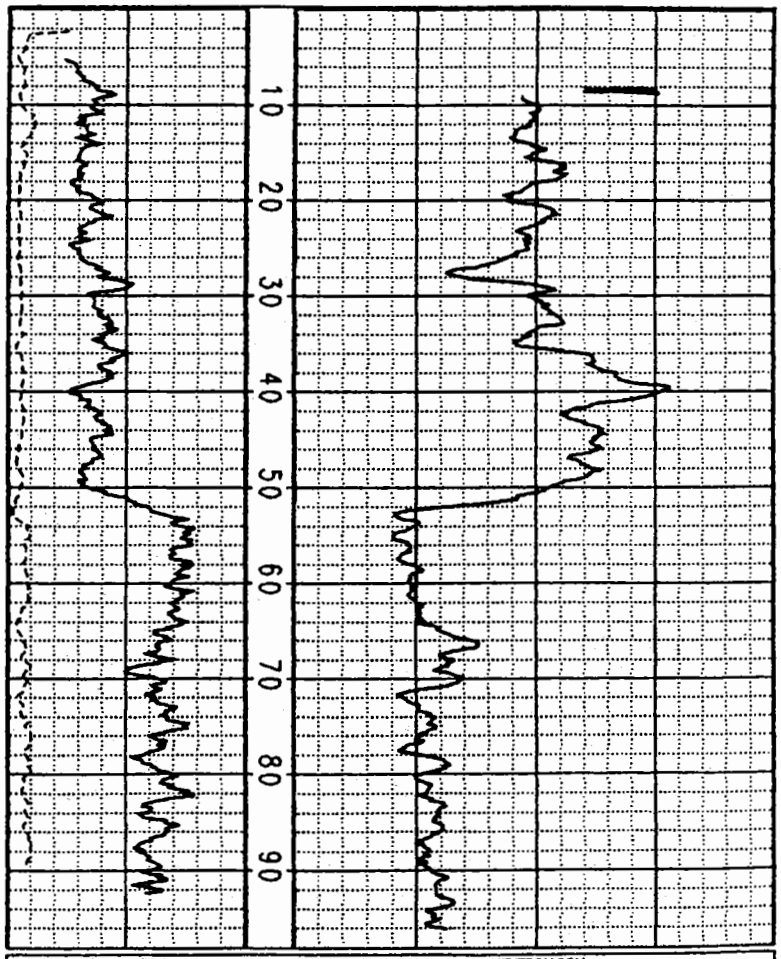
REMARKS:
LOCATION:

THANK YOU

COMPANY GANDY CORPORATION
WELL: PB-31

(\acq\pb-31.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

CALIPER INCHES 4 — 14
GAMMA RAY API 0 — 150
NEUTRON DRY API 2000 — 4500



GAMMA RAY API 0 — 150
NEUTRON DRY API 2000 — 4500
CALIPER INCHES 4 — 14

(\acq\pb-31.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-32

LOCATION SEC: 16 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

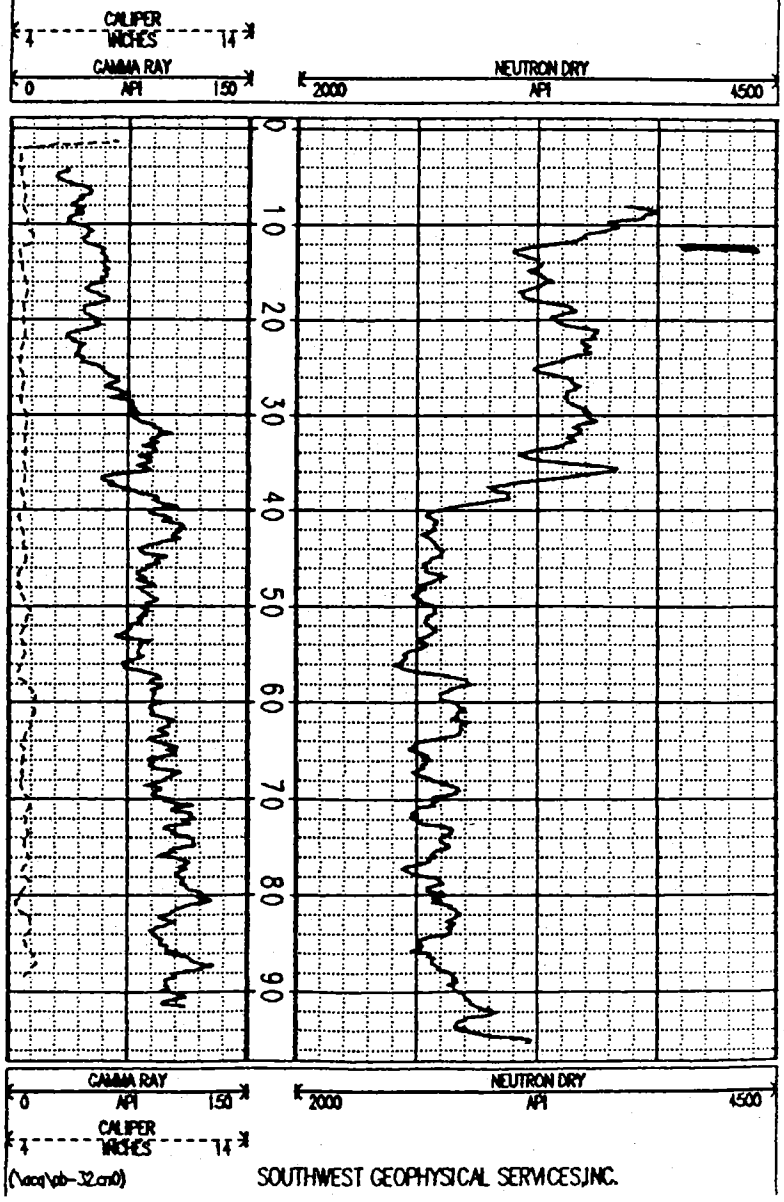
	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	98.8 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.3 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

WELL: PB-32 COMPANY GANDY CORPORATION

(\acq\pb-32.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-32.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-33

LOCATION SEC: 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

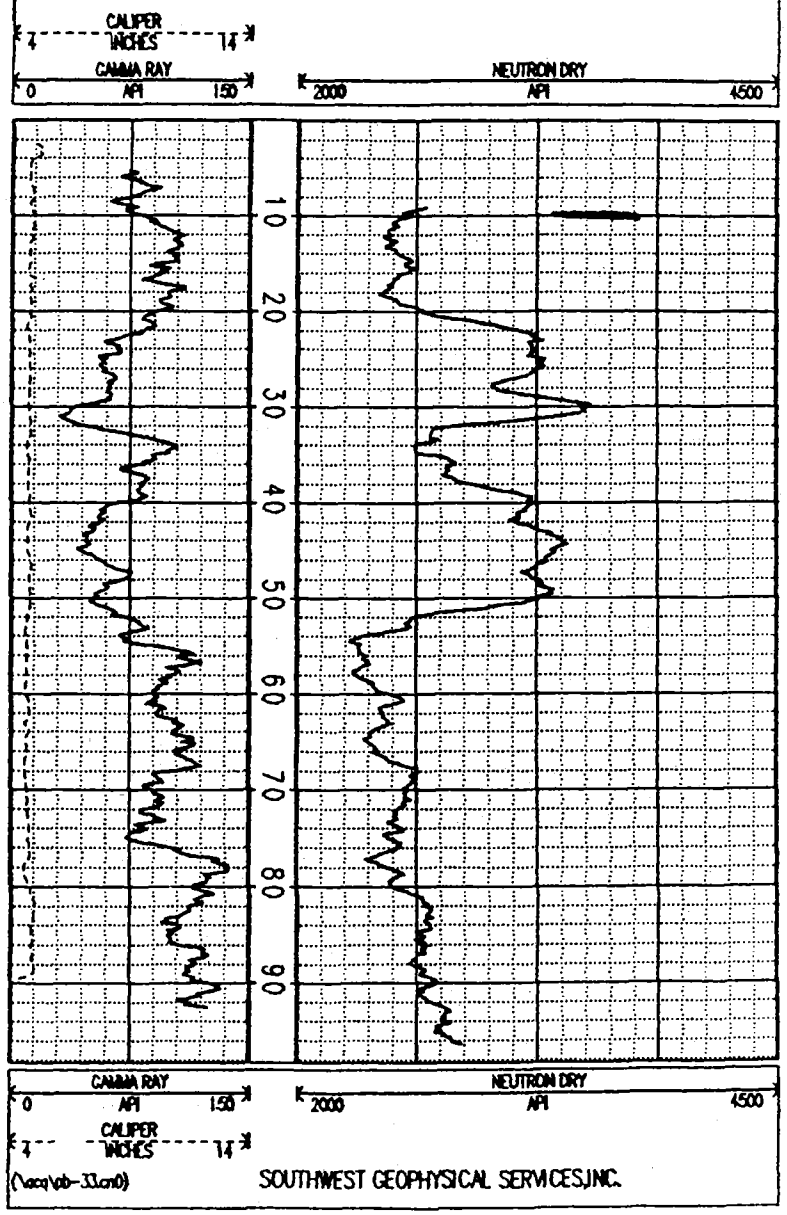
COMPANY GANDY CORPORATION
WELL: PB-33

	RUN NO. 1		RUN NO. 1
DATE	07/17/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	100 FT.	FLUID NATURE	
DEPTH LOGGER	97 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	95.5 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JIM BONNER

REMARKS:
LOCATION:

THANK YOU

(\acq\pb-33.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\acq\pb-33.cn0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: G.L. ELEVATION:	

COMPANY: CANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-34

LOCATION SEC:18 T:11 S R:31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB:
DF:
GL:

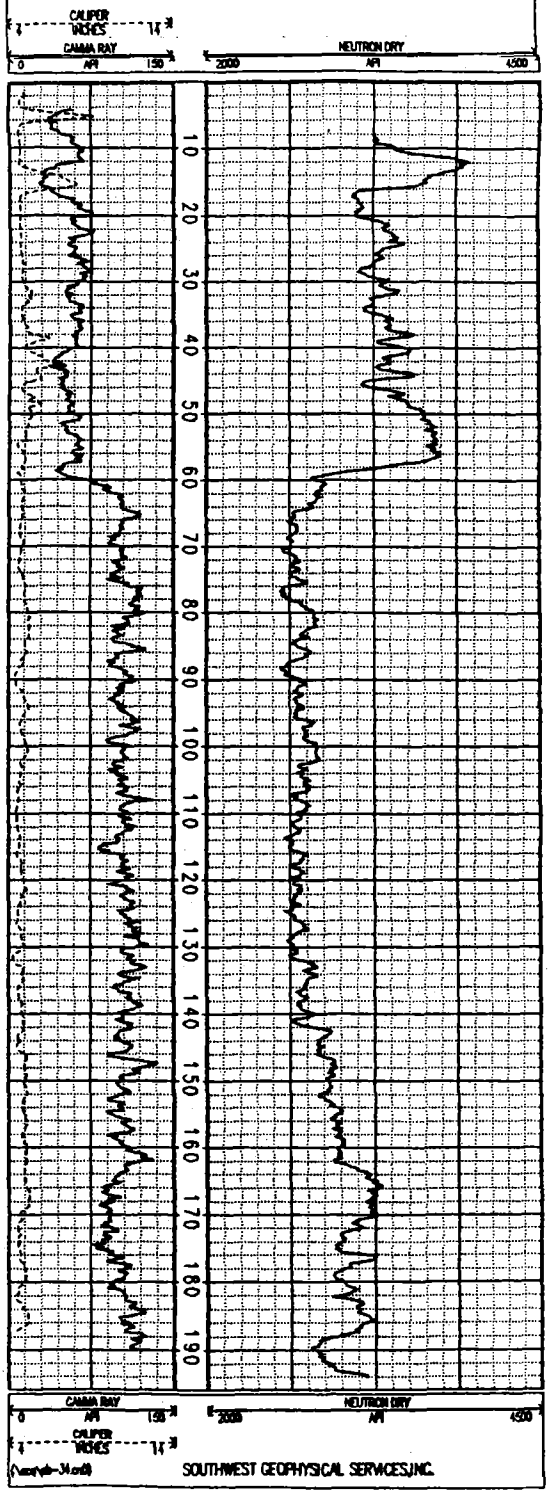
	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	200 FT.	FLUID NATURE	
DEPTH LOGGER	195.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	194 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S.STUBBENAUD
		WITNESSED BY:	JIM BOHNER

REMARKS:
LOCATION:

THANK YOU

COMPANY CANDY CORPORATION
WELL PB-34

(\sgs\pb-34.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.



(\sgs\pb-34.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: CANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-35
LOCATION SEC: 16 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

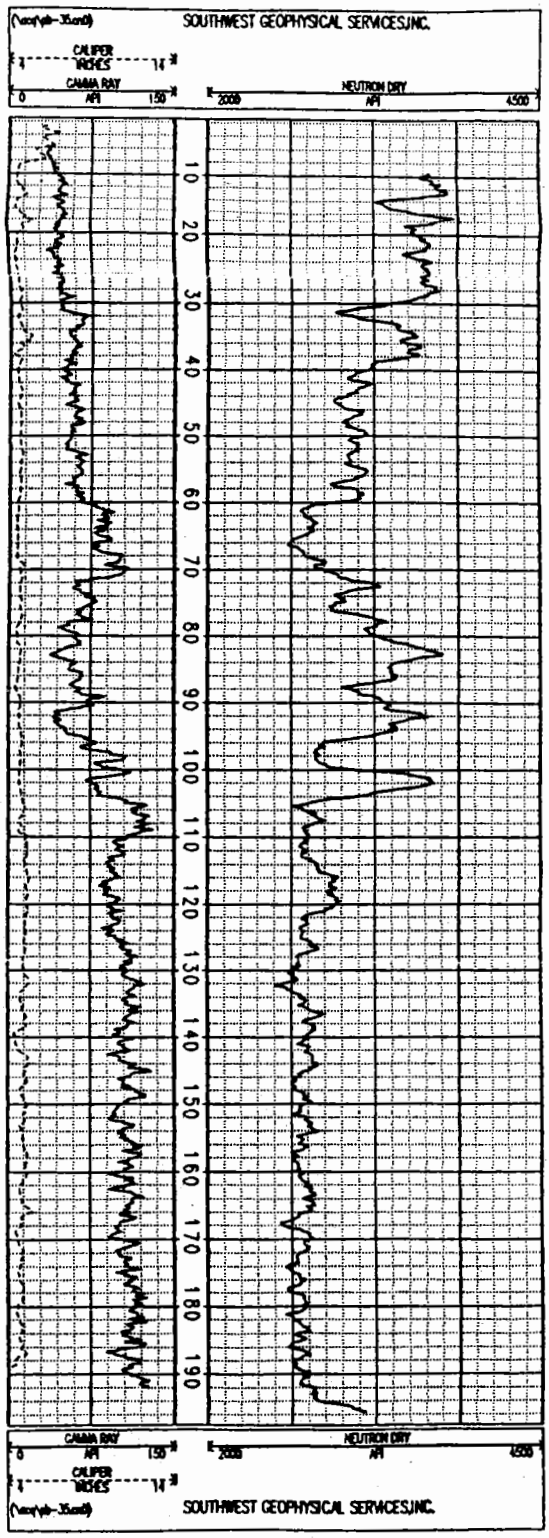
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	07/18/94	FLUID LEVEL	NONE FT.
DEPTH DRILLER	200 FT.	FLUID NATURE	
DEPTH LOGGER	197.2 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	193.7 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	NONE FT.	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Combo
BIT SIZE		LOGGED BY:	S.STUBBERUD
		WITNESSED BY:	JM BONNER

REMARKS:
LOCATION:

THANK YOU

WELL: PB-35
COMPANY: CANDY CORPORATION



This revision supersedes
all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY, NEUTRON, 3-ARM CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-36
LOCATION: SEC. 17 T: 11 S R: 31 E
NORTH/- EAST/-
COUNTY: CHAVES STATE: NEW MEXICO

ELEVATION: KB: DF: GL:

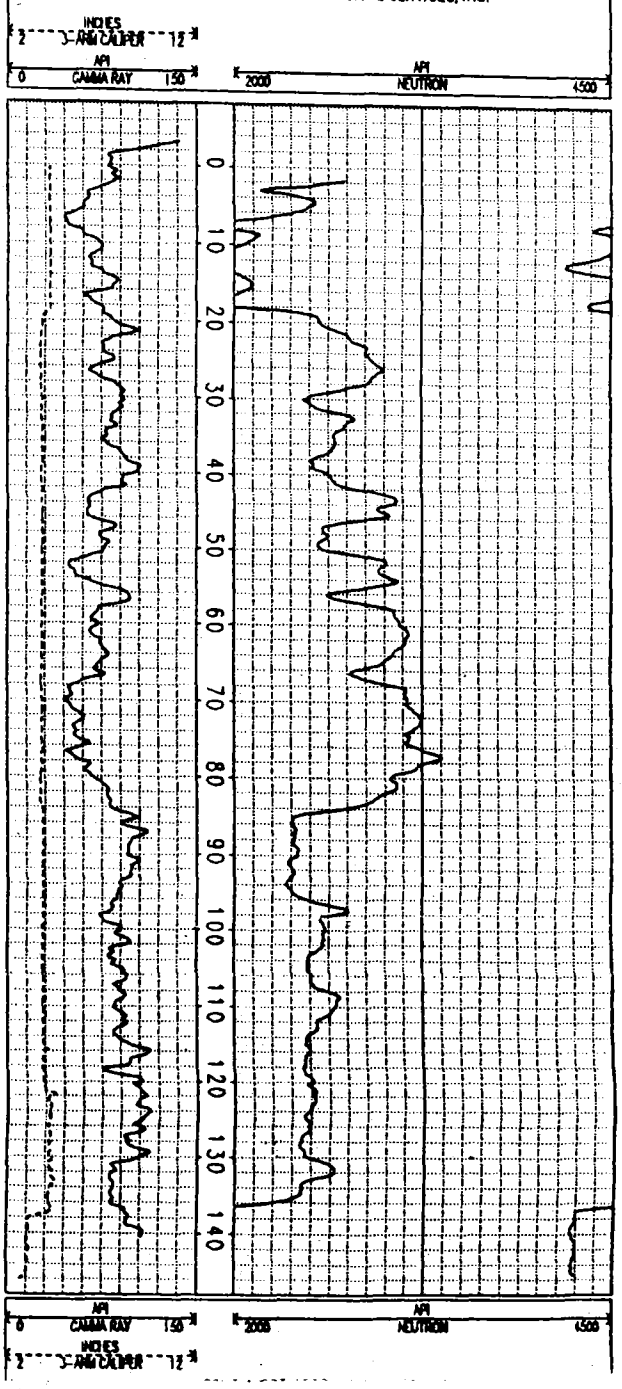
COMPANY: GANDY CORPORATION
WELL: PB-36

	RUN NO. 1		RUN NO. 1
DATE	7/25/95	FLUID LEVEL	NONE
DEPTH DRILLER	146 FT.	FLUID NATURE	
DEPTH LOGGER	146 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	146 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. REG. @ B.H.T.	
CASING LEVEL	18 FT.	CIRCULATION TEMP.	
CASING SIZE	4&1/4" AUGERS	BOT HOLE TEMP.	
CASING SIZE		TOOL #	1039
BIT SIZE	3&7/8"	LOGGED BY:	M.PETERSON
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS:
Hollow stem augers set at 18 ft. to stabilize hole.

THANK YOU

(\acq\pb-36.pg2) SOUTHWEST GEOPHYSICAL SERVICES, INC.



This revision supersedes all previous information

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON 3-ARM CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-37
LOCATION: SEC: 17 T: 11 S R: 31 E
NORTH= EAST=
COUNTY: CHAVES STATE: NEW MEXICO

ELEVATION KB:
DF:
GL:

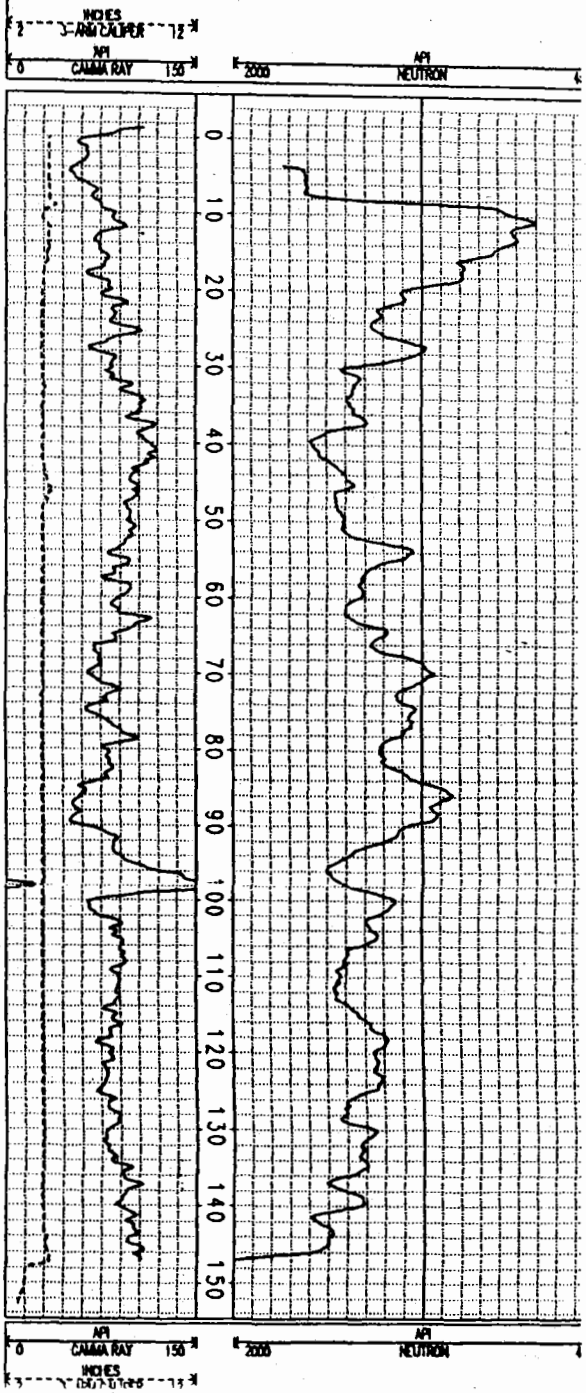
WELL: PB-37

	RUN NO. 1		RUN NO. 1
DATE	7/28/88	FLUID LEVEL	NONE
DEPTH DRILLER	155 FT.	FLUID NATURE	
DEPTH LOGGER	154 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	153 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	8 FT.	CIRCULATION TEMP.	
CASING SIZE	4&1/4" AUGERS	BOT HOLE TEMP.	
CASING SIZE		TOOL #	1038
BIT SIZE	3&7/8"	LOGGED BY:	M.PETERSON
BIT SIZE	3" CORE @ 148'	WITNESSED BY:	J.BONNER

REMARKS:
Hollow stem augers set at 8 ft. to stabilize hole.

THANK YOU

(\wcc\pb-37.pg0) SOUTHWEST GEOPHYSICAL SERVICES, INC.



This revision supersedes
all previous information

Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON 3-ARM CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: PB-38
LOCATION: SEC: 17 T: 11 S R: 31 E
NORTH- EAST-
COUNTY: CHAVES STATE: NEW MEXICO

ELEVATION KB: DF: GL:

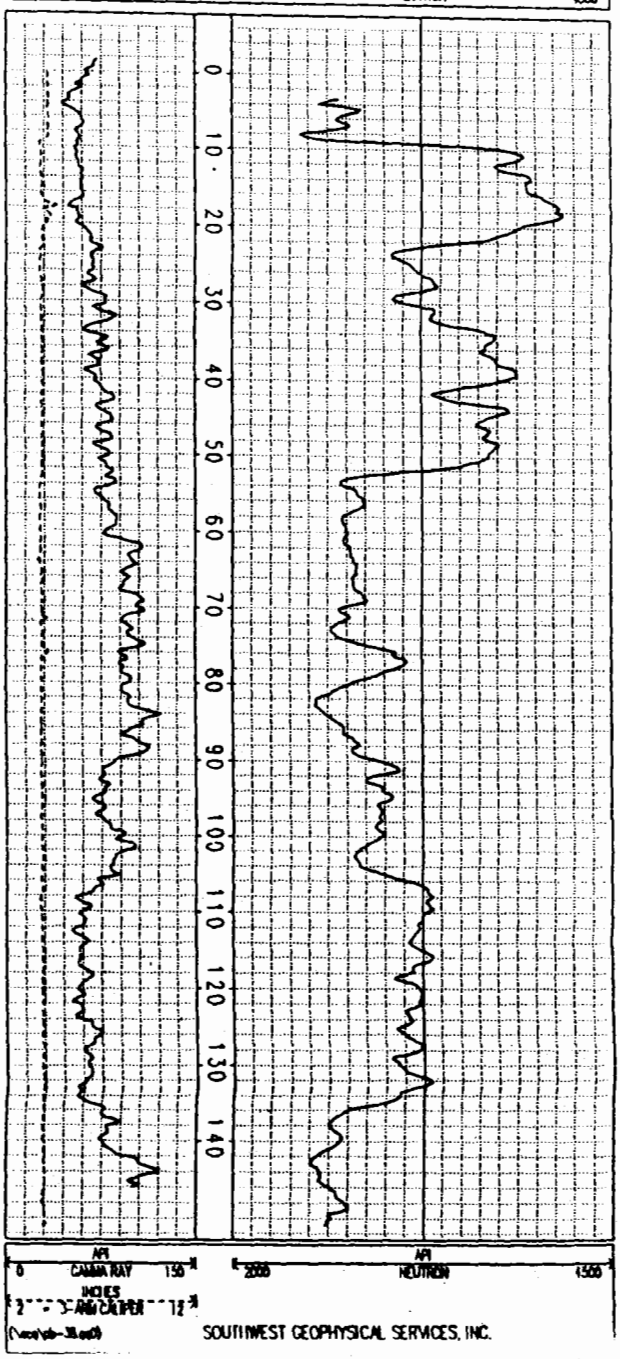
COMPANY: GANDY CORPORATION
WELL: PB-38

	RUN NO. 1		RUN NO. 1
DATE	7/25/95	FLUID LEVEL	NONE
DEPTH DRILLER	154 FT.	FLUID NATURE	
DEPTH LOGGER	152 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	151 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	8 FT.	CIRCULATION TEMP.	
CASING SIZE	4&1/4" AUGERS	BOT HOLE TEMP.	
CASING SIZE		TOOL #	1038
BIT SIZE	3&7/8"	LOGGED BY:	M.PETERSON
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS:
Hollow stem augers set at 8 ft. to stabilize hole.

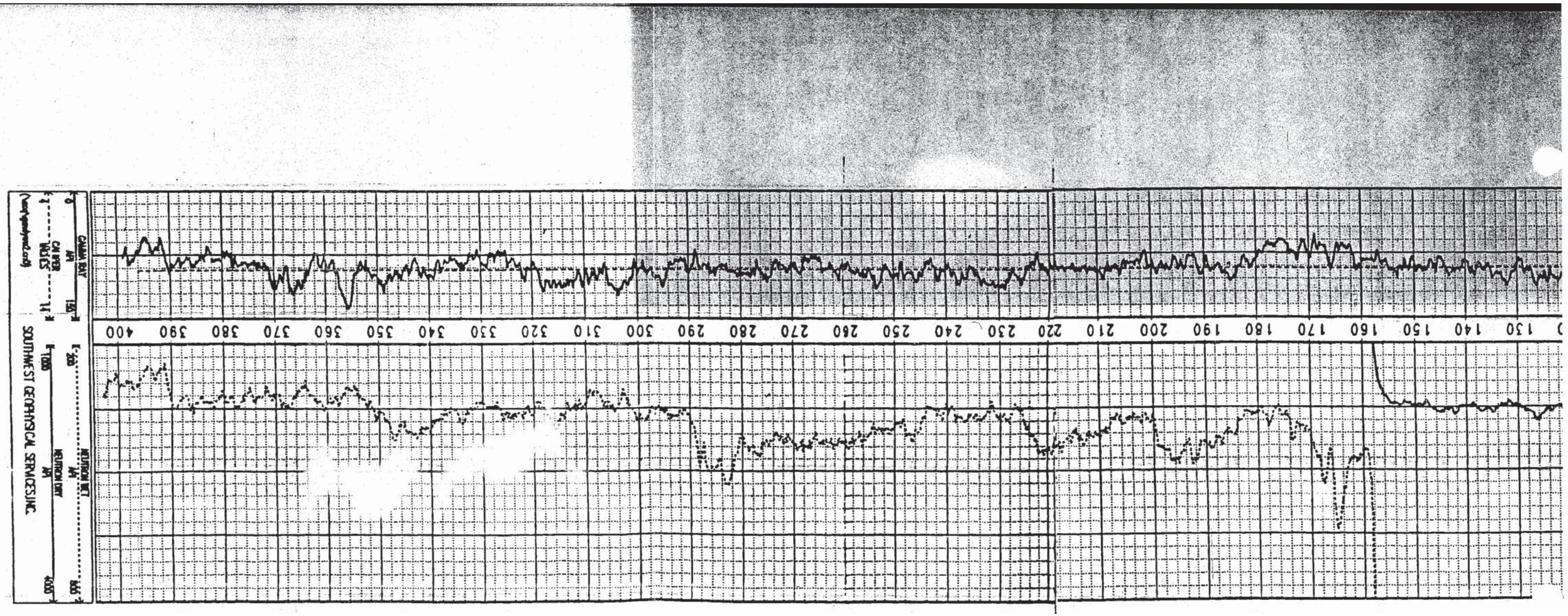
THANK YOU

(\acq\pb-38.gpl) SOUTHWEST GEOPHYSICAL SERVICES, INC.



This revision supersedes all previous information

(\acq\pb-38.gpl) SOUTHWEST GEOPHYSICAL SERVICES, INC.



This revision s
all previous in

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG: GAMMA RAY NEUTRON RESISTANCE CALIPER	PERM. DATUM: GROUND LEVEL LOG MEASURED FROM: G.L. ELEVATION:	OTHER SERVICES:

COMPANY: GANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: WW-2
LOCATION SEC. 18 T: 11 S R: 31 E
COUNTY: CHAVEZ STATE: NM

ELEVATION KB: DF: GL:

	RUN NO. 1		RUN NO. 1
DATE	07/16/94	FLUID LEVEL	186 FT.
DEPTH DRILLER	755 FT.	FLUID NATURE	
DEPTH LOGGER	404.5 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	403 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ B.H.T.	
CASING LEVEL	ALL FT.	CIRCULATION TEMP.	
CASING SIZE	3" PVC	BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL	Carlco
BIT SIZE		LOGGED BY:	S.STUBBERFIELD
		WITNESSED BY:	JIM BONNER

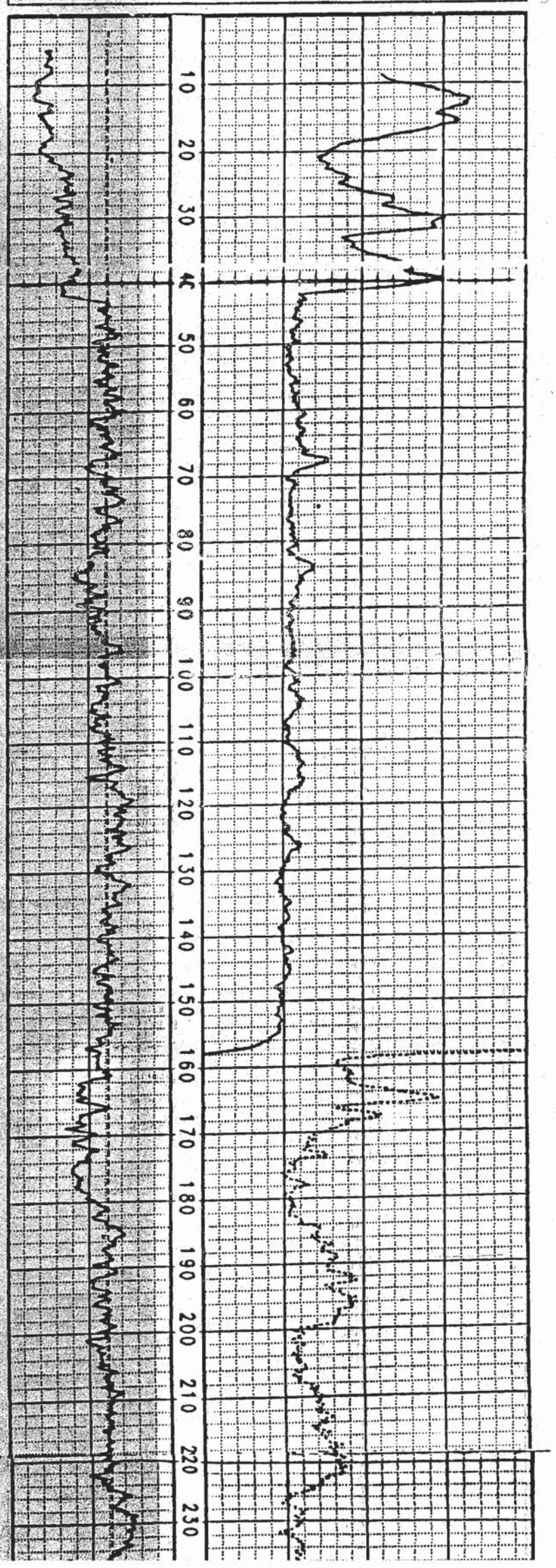
REMARKS:
LOCATION:

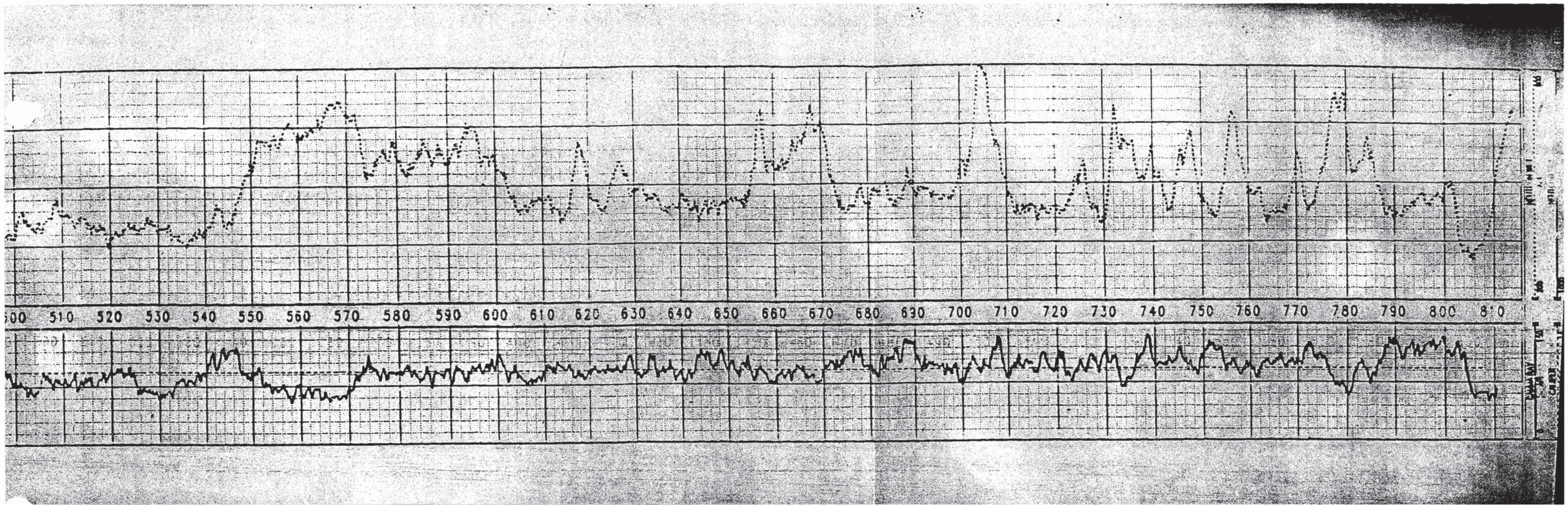
THANK YOU

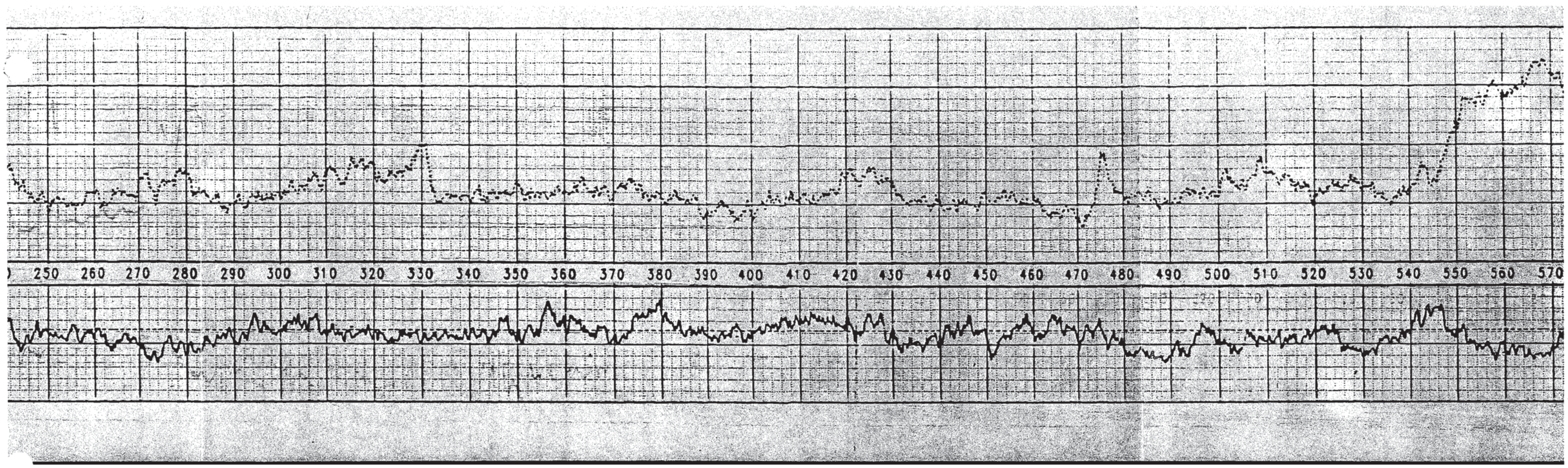
COMPANY GANDY CORPORATION
WELL WW-2

(\scg\gandyww2.cal) SOUTHWEST GEOPHYSICAL SERVICES,INC.

CALIPER INCHES 3 14
GAMMA RAY API 0 150
NEUTRON DRY API 1000 4000
NEUTRON WET API 200 800




500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800 810


250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570
250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570

Southwest Geophysic Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY NEUTRON RESISTANCE CALIPER	LOG MEASURED FROM: GL ELEVATION:	

COMPANY: CANDY CORPORATION
PROJECT/FIELD: MESCALERO RIM
WELL: WW-1
LOCATION: SEC. 17 T. 11 S. R. 26 E.
COUNTY: CHAVEZ STATE: NM
ELEVATION: KB: DF: GL:

COMPANY CANDY CORPORATION
WELL WW-1

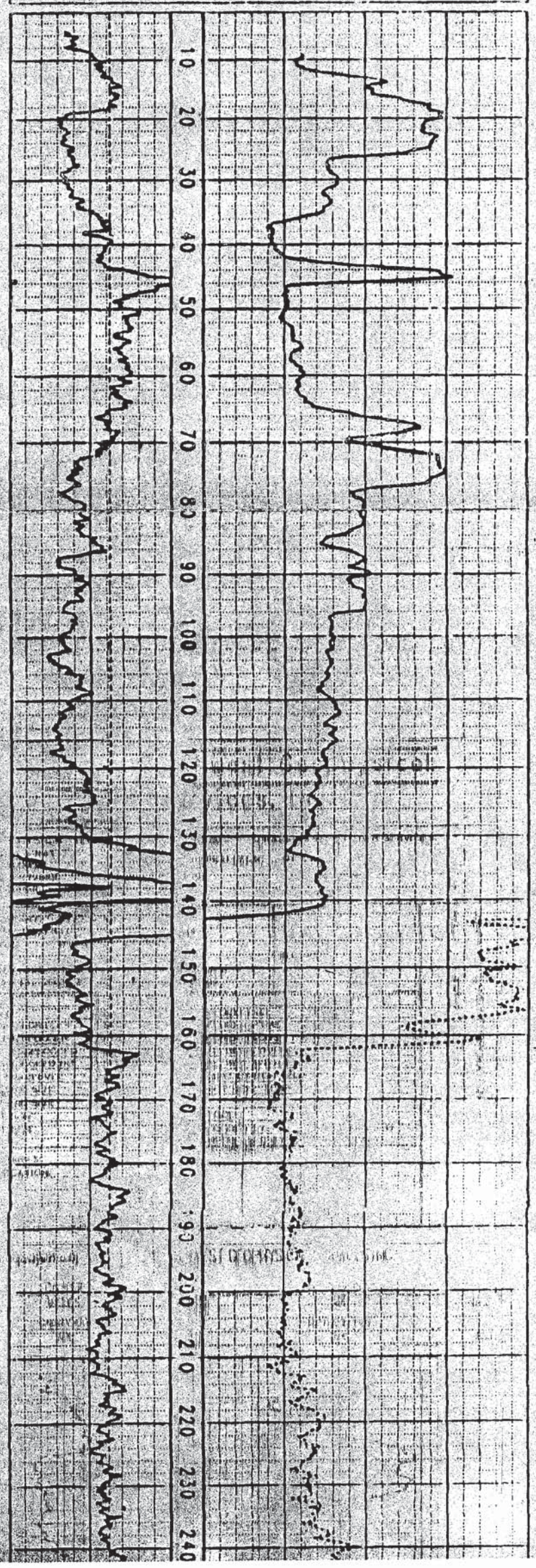
	RUN NO. 1		RUN NO. 1
DATE	07/16/94	FLUID LEVEL	142 FT
DEPTH DRILLER	820 FT.	FLUID NATURE	
DEPTH LOGGER	816 FT.	FLUID VISCOSITY	
BOTTOM LOGGED	813 FT.	FL. RESISTIVITY	
TOP LOGGED INT.	Surface	FL. RES. @ BHT.	
CASING LEVEL	ALL FT.	CIRCULATION TEMP.	
CASING SIZE	3" PVC	BOT HOLE TEMP	
CASING SIZE			
BIT SIZE	4 3/4"	TOOL #	Carbo
BIT SIZE		LOGGED BY:	S. SILLIMAN
		WITNESSED BY:	JIM KUNZ

REMARKS:
LOCATION

THANK YOU

SOUTHWEST GEOPHYSICAL SERVICES,INC.

CALIPER INCHES 7 — 14
NEUTRON DRY API 1000 — 4000
GAMMA RAY API 0 — 150
NEUTRON WET API 400 — 800



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY-MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB-39
LOCATION: SEC: T: R:
NORTH- EAST-
COUNTY: CHAVES STATE: NEW MEXICO

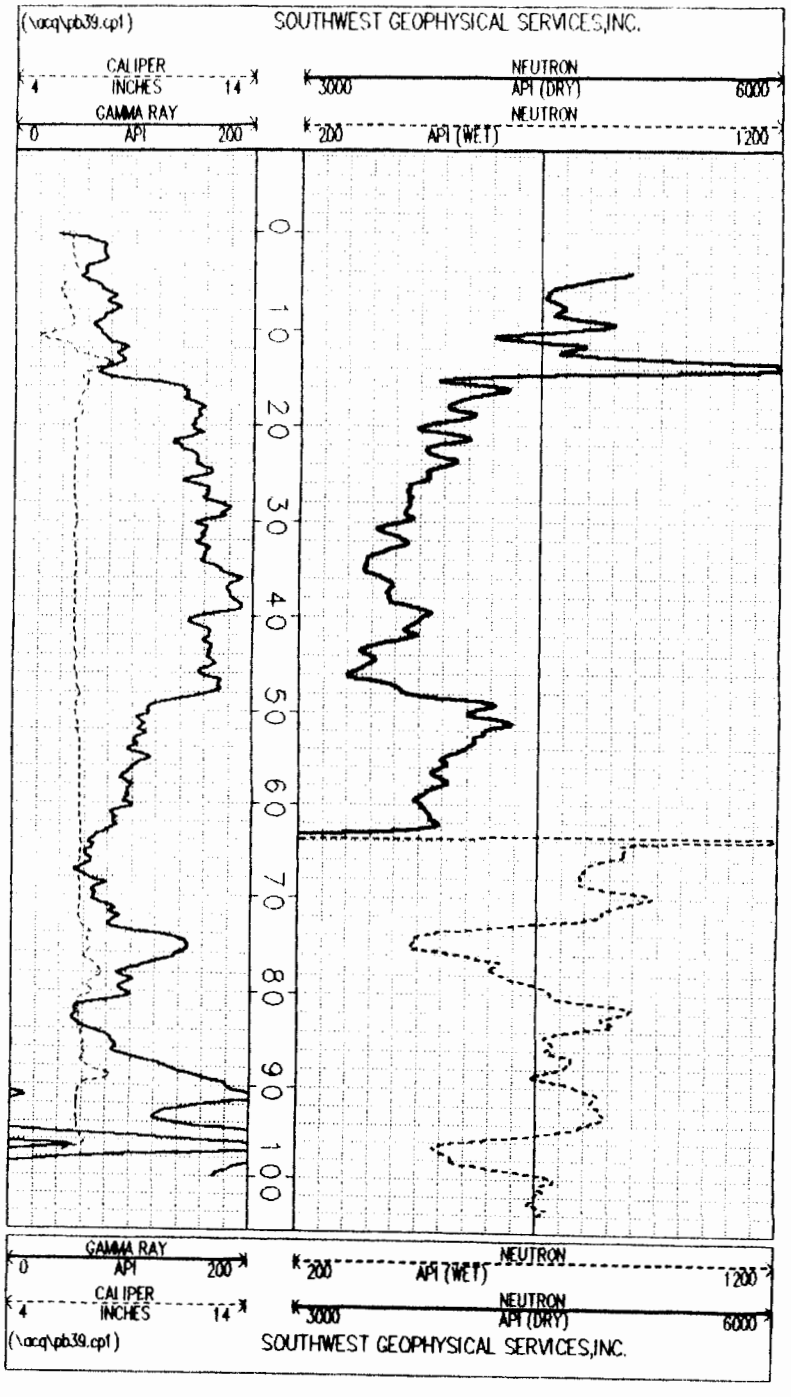
ELEVATION KB:
DF:
GL:

COMPANY: GANDY-MARLEY INC.
WELL: PB-39

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	64 FT.
DEPTH DRILLER	120 FT	FLUID NATURE	
DEPTH LOGGER	104 FT	FLUID VISCOSITY	
BOTTOM LOGGED	104 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY–MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB–40
LOCATION: SEC: T: R:
NORTH– EAST–
COUNTY: CHAVES STATE: NEW MEXICO

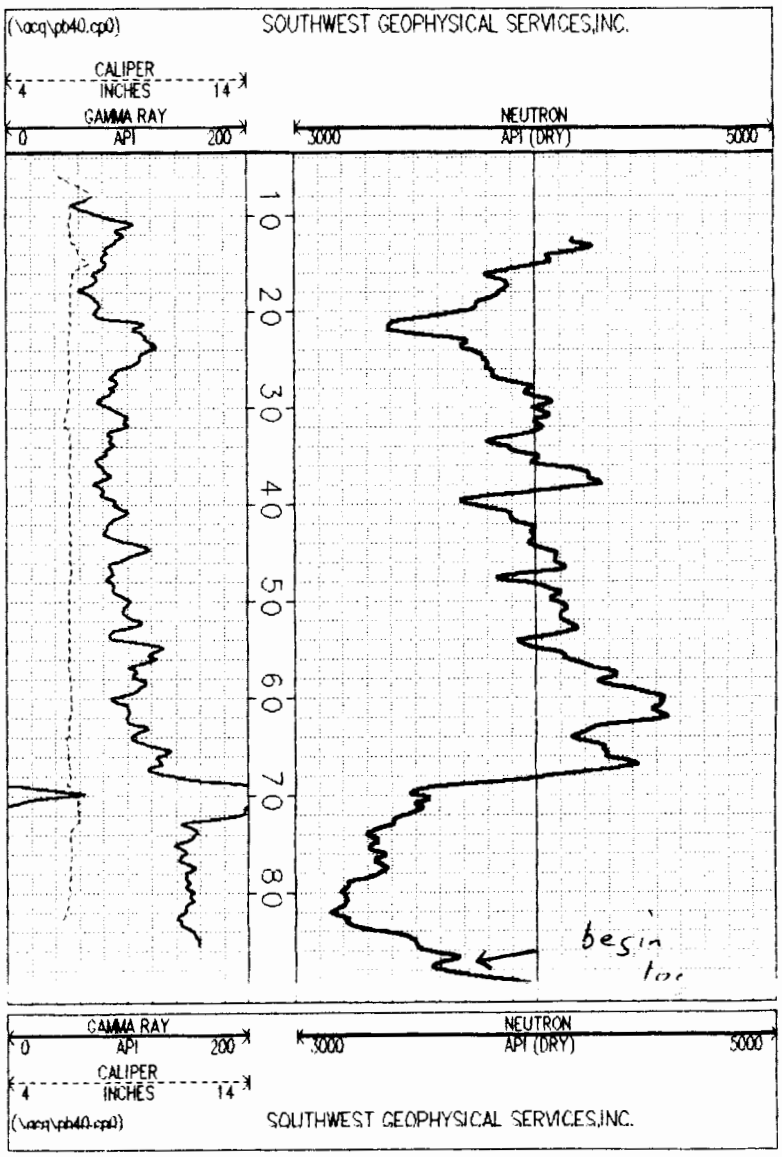
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	90 FT	FLUID NATURE	
DEPTH LOGGER	90 FT	FLUID VISCOSITY	
BOTTOM LOGGED	90 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY–MARLEY INC.
WELL: PB–40



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY–MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB–41
LOCATION: SEC: **T:** **R:**
NORTH– **EAST–**
COUNTY: CHAVES **STATE:** NEW MEXICO

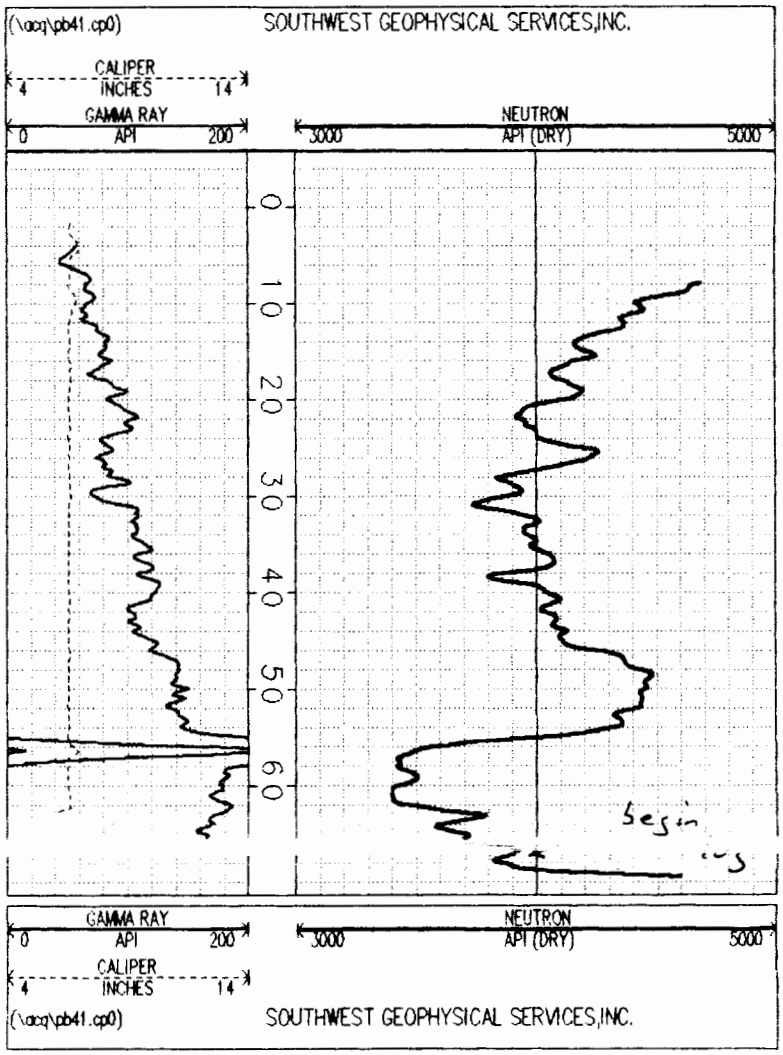
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	75 FT	FLUID NATURE	
DEPTH LOGGER	70 FT	FLUID VISCOSITY	
BOTTOM LOGGED	70 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY–MARLEY INC.
WELL: PB–41



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY-MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB-42
LOCATION: SEC: T: R:
NORTH- EAST-
COUNTY: CHAVES STATE: NEW MEXICO

ELEVATION KB:
DF:
GL:

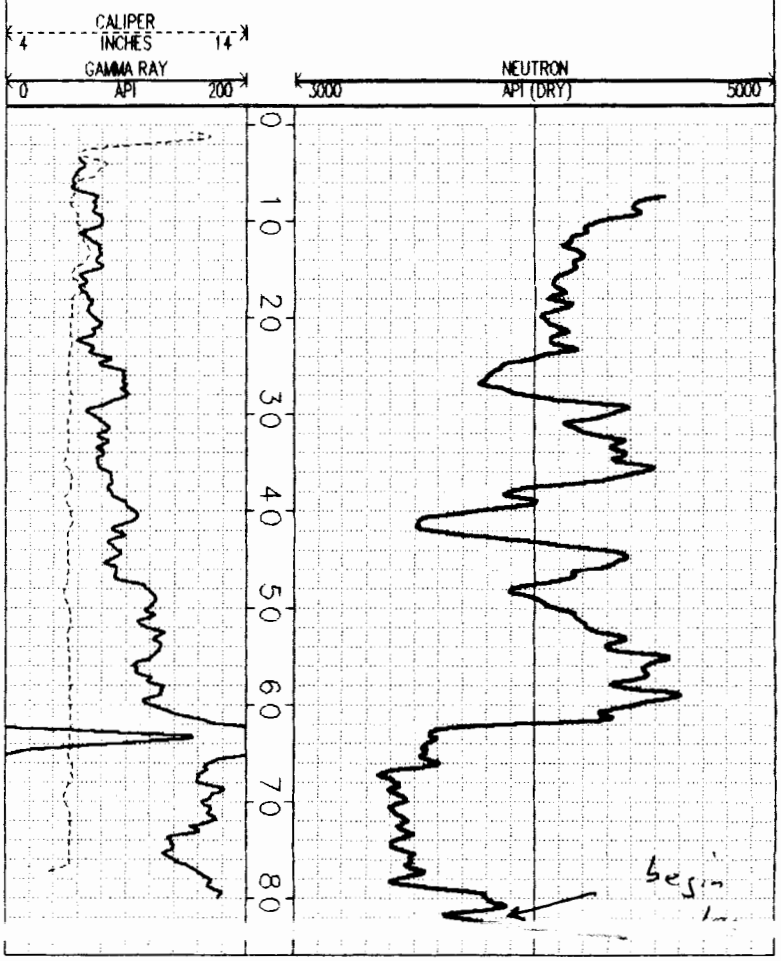
	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	85 FT	FLUID NATURE	
DEPTH LOGGER	84 FT	FLUID VISCOSITY	
BOTTOM LOGGED	84 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY-MARLEY INC.
WELL: PB-42

(\acq\pb42.cp0) SOUTHWEST GEOPHYSICAL SERVICES,INC.



GAMMA RAY
0 API 200
NEUTRON
3000 API (DRY) 5000
CALIPER
4 INCHES 14
(\acq\pb42.cp0) SOUTHWEST GEOPHYSICAL SERVICES,INC.

Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY–MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB–43
LOCATION: SEC: T: R:
NORTH– EAST–
COUNTY: CHAVES STATE: NEW MEXICO

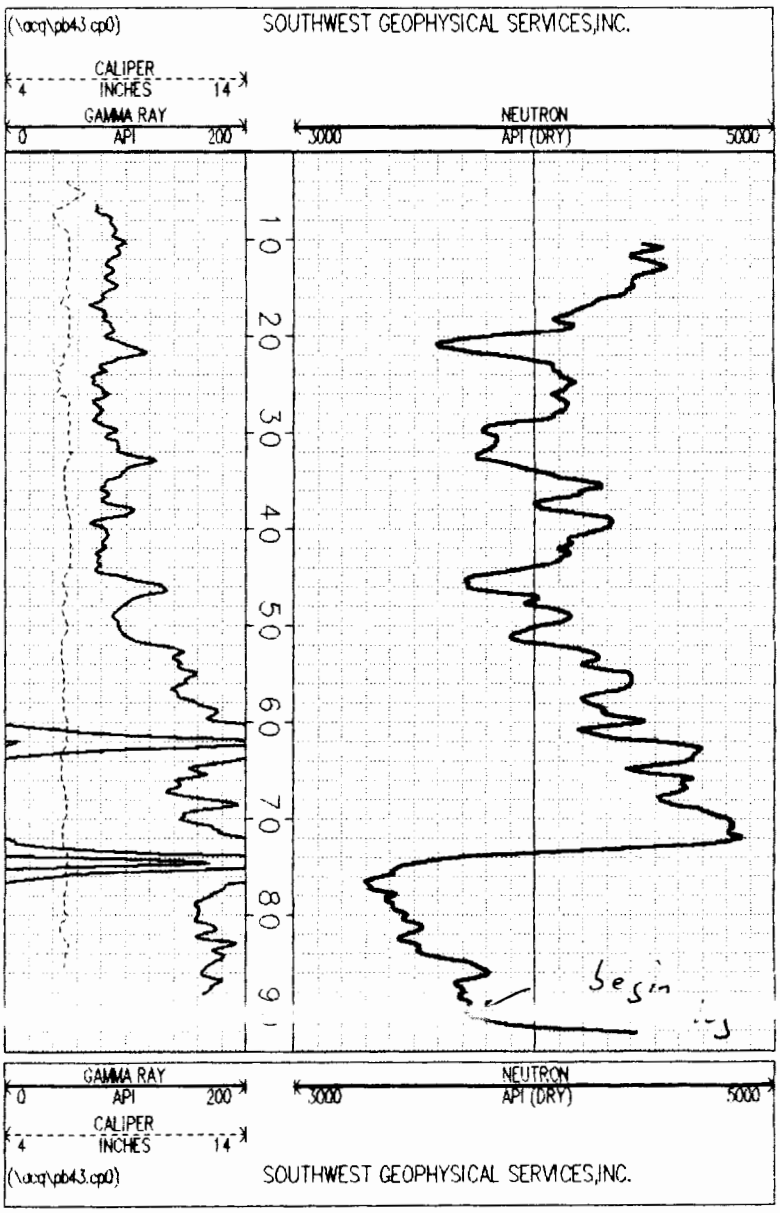
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	100 FT	FLUID NATURE	
DEPTH LOGGER	93 FT	FLUID VISCOSITY	
BOTTOM LOGGED	93 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY–MARLEY INC.
WELL: PB–43



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY–MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB–44
LOCATION: SEC: T: R:
NORTH– EAST–
COUNTY: CHAVES STATE: NEW MEXICO

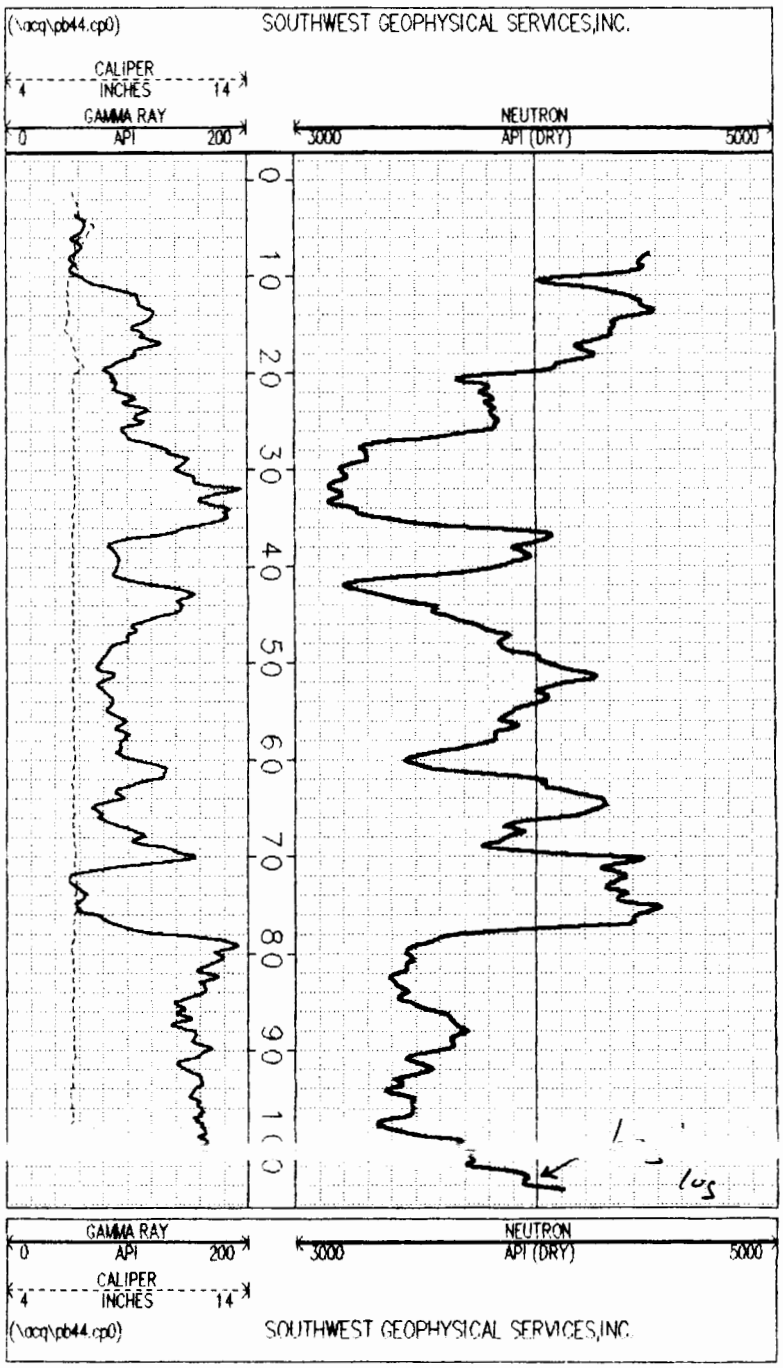
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	110 FT	FLUID NATURE	
DEPTH LOGGER	105 FT	FLUID VISCOSITY	
BOTTOM LOGGED	105 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY–MARLEY INC.
WELL: PB–44



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY-MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB-45
LOCATION: SEC: T: R:
NORTH- EAST-
COUNTY: CHAVES STATE: NEW MEXICO

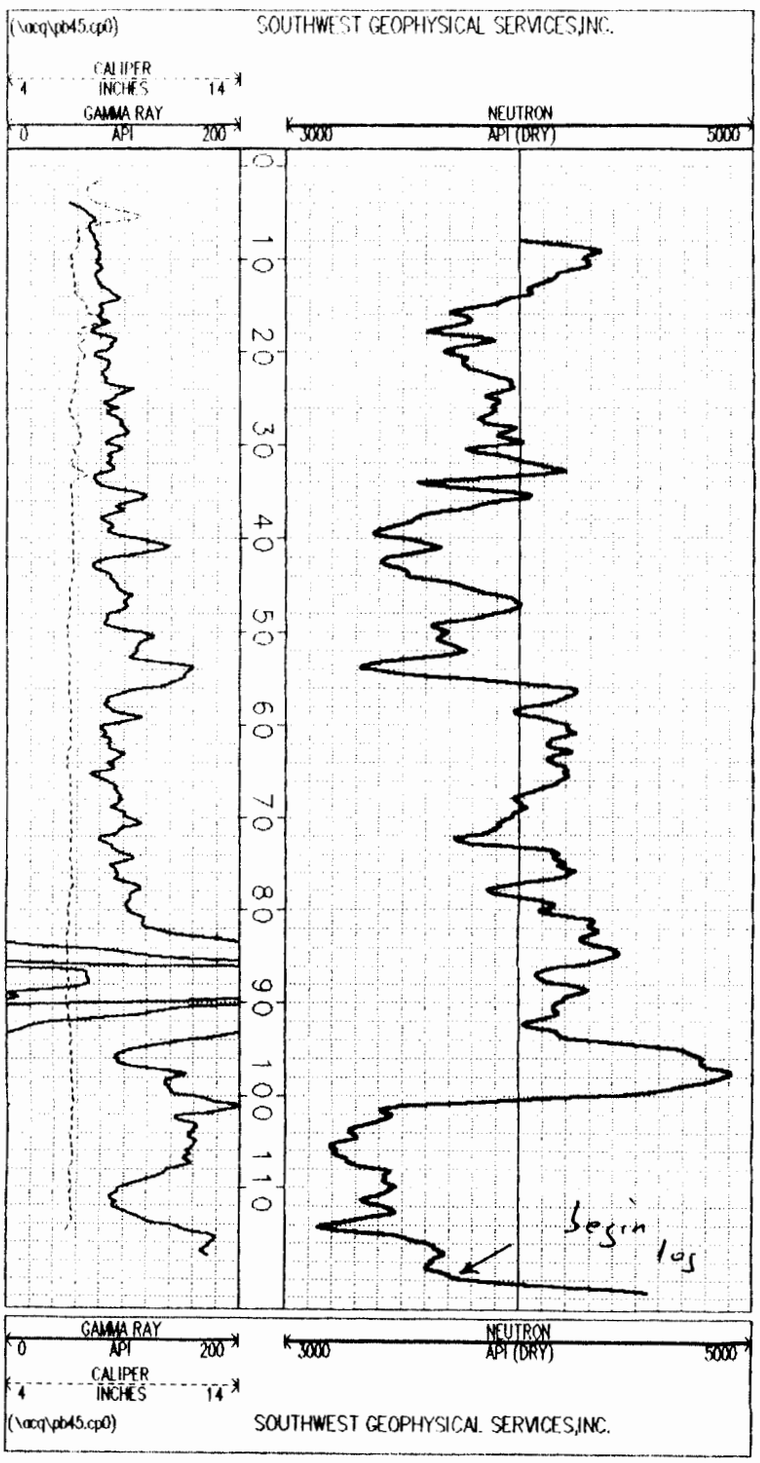
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	125 FT	FLUID NATURE	
DEPTH LOGGER	122 FT	FLUID VISCOSITY	
BOTTOM LOGGED	122 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY-MARLEY INC.
WELL: PB-45



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY-MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB-46
LOCATION: SEC: T: R:
NORTH— EAST—
COUNTY: CHAVES STATE: NEW MEXICO

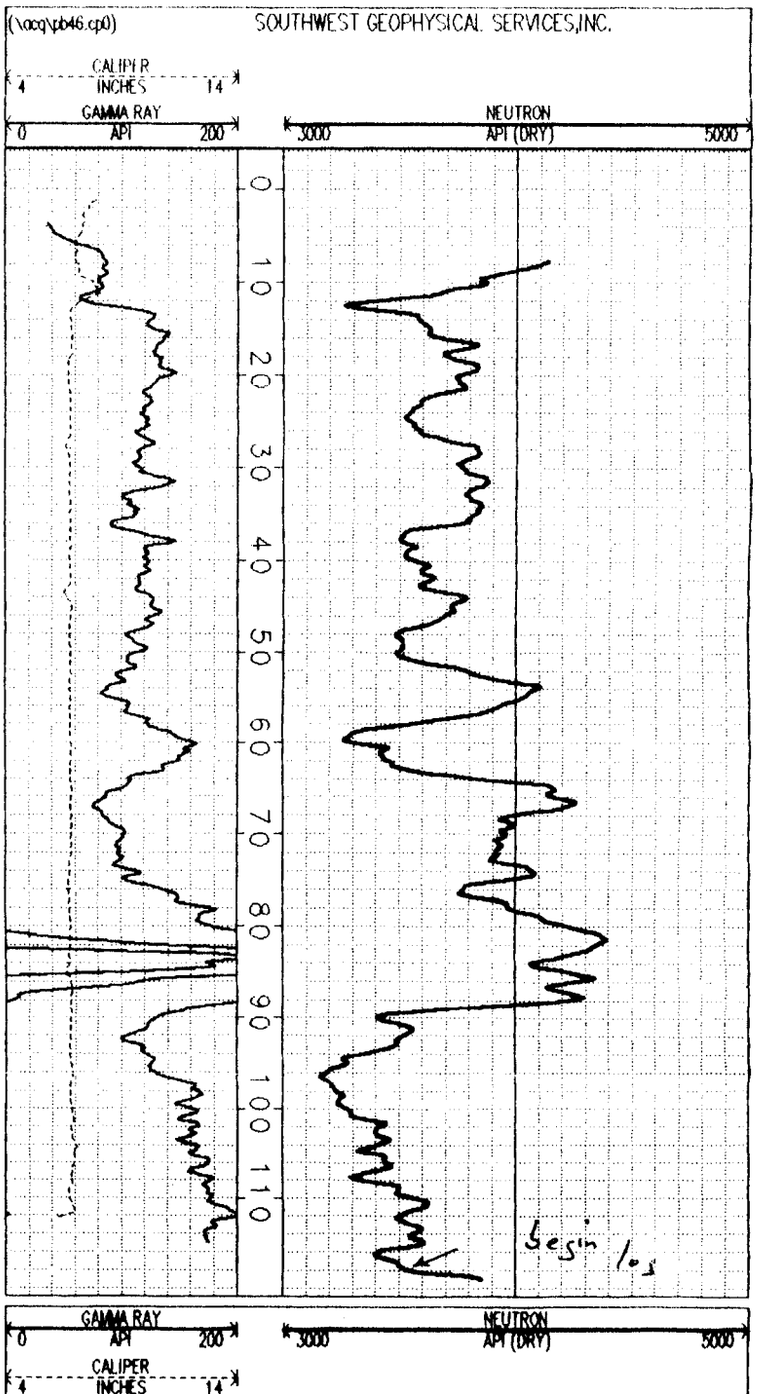
ELEVATION KB:
DF:
GL:

	RUN NO. 1		RUN NO. 1
DATE	8/4/99	FLUID LEVEL	NONE
DEPTH DRILLER	120 FT	FLUID NATURE	
DEPTH LOGGER	119 FT	FLUID VISCOSITY	
BOTTOM LOGGED	119 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU

COMPANY: GANDY-MARLEY INC.
WELL: PB-46



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY--MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB-47
LOCATION: SEC: T: R:
NORTH- EAST-
COUNTY: CHAVES STATE: NEW MEXICO

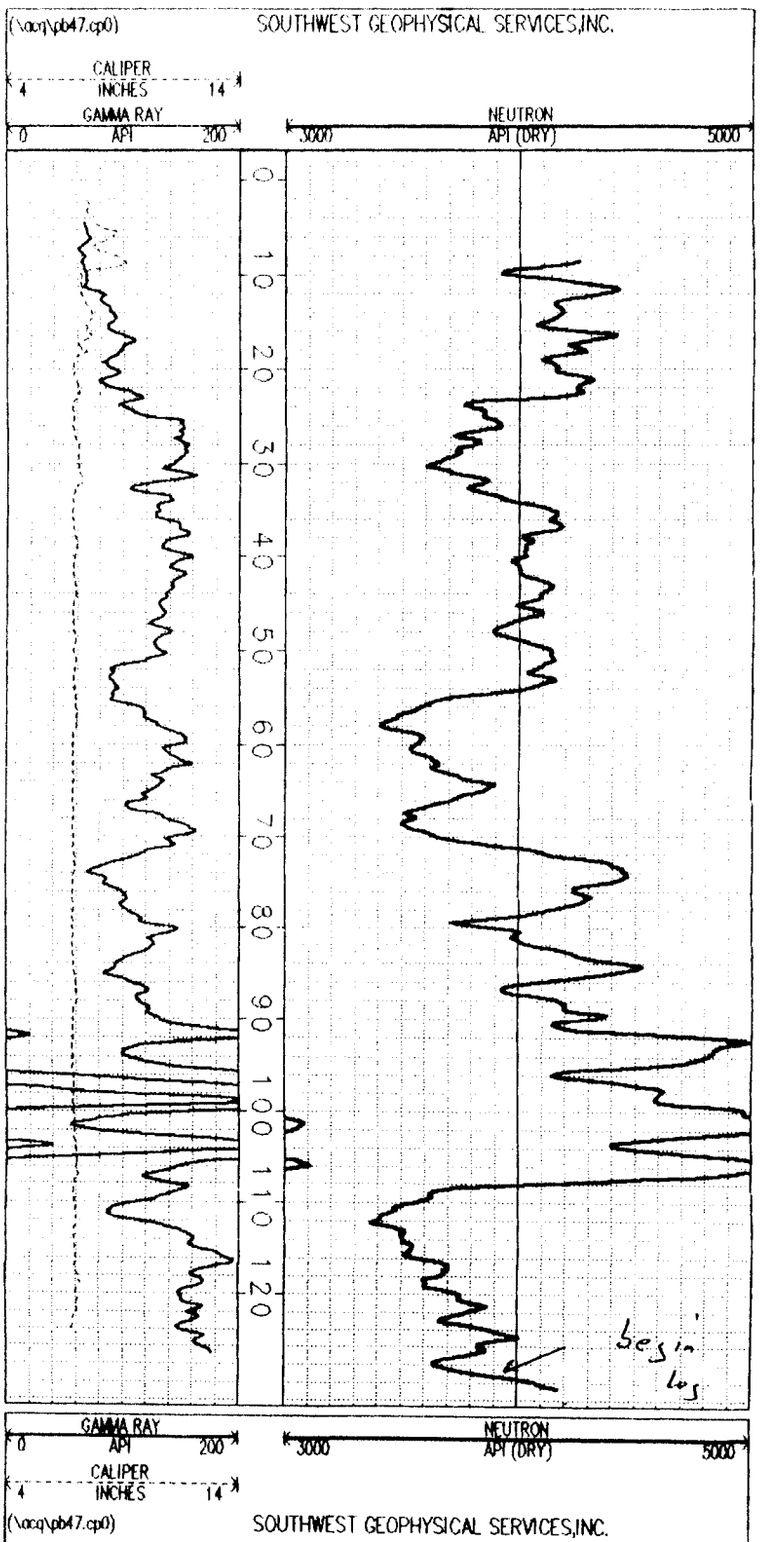
ELEVATION KB:
DF:
GL:

COMPANY: GANDY-MARLEY INC.
WELL: PB-47

	RUN NO. 1		RUN NO. 1
DATE	8/5/99	FLUID LEVEL	NONE
DEPTH DRILLER	130 FT	FLUID NATURE	
DEPTH LOGGER	131 FT	FLUID VISCOSITY	
BOTTOM LOGGED	131 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU



Southwest Geophysical Services, Inc.

GEOPHYSICAL WELL LOG:	PERM. DATUM: GROUND LEVEL	OTHER SERVICES:
GAMMA RAY CALIPER NEUTRON	LOG MEASURED FROM: G. L. ELEVATION:	NONE

COMPANY: GANDY–MARLEY INC.
PROJECT/FIELD: TRIASSIC PARK
WELL: PB–48
LOCATION: SEC: T: R:
NORTH– EAST–
COUNTY: CHAVES STATE: NEW MEXICO

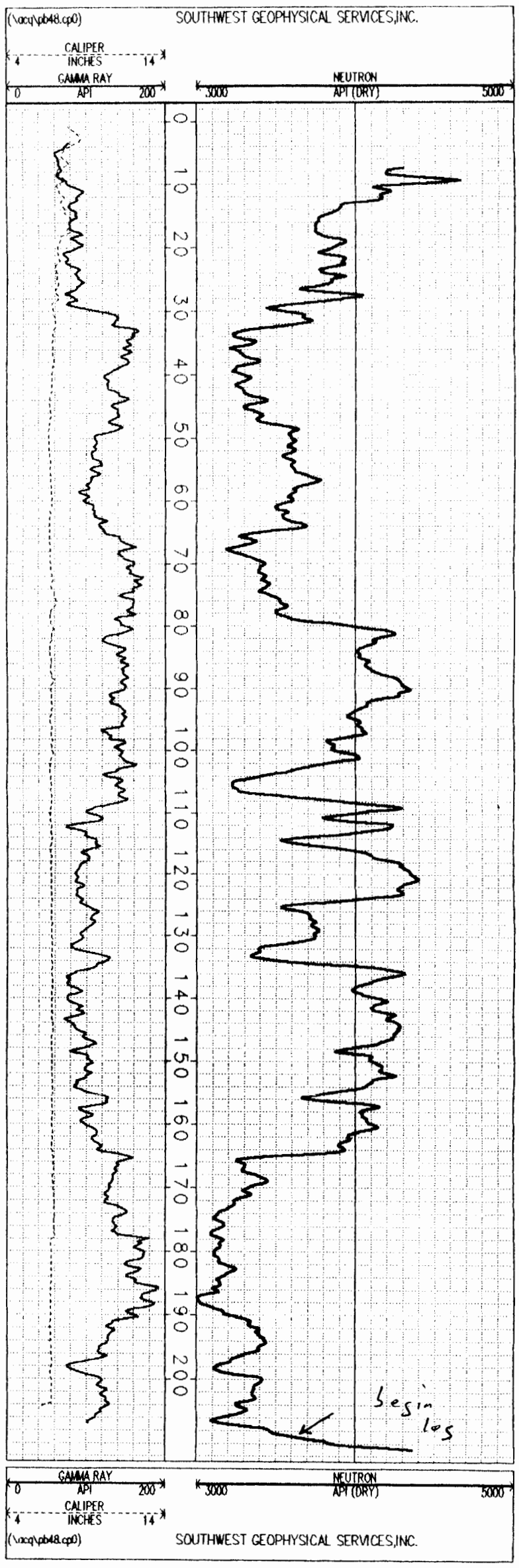
ELEVATION KB:
DF:
GL:

COMPANY: GANDY–MARLEY INC.
WELL: PB–48

	RUN NO. 1		RUN NO. 1
DATE	8/5/99	FLUID LEVEL	NONE
DEPTH DRILLER	210 FT	FLUID NATURE	
DEPTH LOGGER	211 FT	FLUID VISCOSITY	
BOTTOM LOGGED	211 FT	FL. RESISTIVITY	
TOP LOGGED INT.	SURFACE	FL. RES. @ B.H.T.	
CASING LEVEL	NONE	CIRCULATION TEMP.	
CASING SIZE		BOT HOLE TEMP.	
CASING SIZE		TOOL #	COMBO
BIT SIZE	7 IN.	LOGGED BY:	D.DUCOTE
BIT SIZE		WITNESSED BY:	J.BONNER

REMARKS: NONE

THANK YOU



Attachment W

Geotechnical Laboratory Results

TABULATION OF TEST RESULTS
BULK SAMPLES
Job No. C94-5318

Project Gandi Project (Part I)

Material Bulk Samples
Source Lab No. 7932

HOLE	LOCATION	DEPTH	UNIFIED CLASS	LL	PI	SIEVE ANALYSIS - ACCUM. % PASSING 200	100	40	10	4	3/8	1/2	3/4	1	1-1/2	MOIST.	LAB NO.
	PB-2		SC	36	21	41	61	98	99	100						7.6%	7932-2
	PB-4		SM	NV	NP	27	34	96	97	99	100					7.5%	7932-4
	PB-6		CL-ML	24	6	76	84	89	93	97	99	100				6.6%	7932-6
	PB-7		CL-ML	28	6	61	75	98	100	100						9.6%	7932-7
	PB-8		SC	28	9	48	65	96	98	99	100					6.4%	7932-8
	PB-9		SM	NV	NP	38	76	92	95	96	96	97	97	97	100	5.5%	7932-9
	PB-10		CL	30	13	56	80	95	99	100	99					6.5%	7932-10
	PB-11		CL	32	12	50	86	94	97	98	99	99	100			5.5%	7932-11
	PB-13		SM	NV	NP	21	36	75	99	100						4.4%	7932-13
	PB-14		SM	NV	NP	18	24	98	99	99	99	99	100			8.7%	7932-14
	PB-15		CL	32	9	56	77	90	98	100						6.6%	7932-15
	PB-21		SM	24	3	21	33	64	75	84	93	95	98	100		4.0%	7932-21
	PB-30		SC-SM	28	6	21	36	99	100							5.3%	7932-30
	PB-31		SM	NV	NP	21	31	97	99	99	100					5.4%	7932-31
	PB-33		CL-ML	24	4	68	77	91	96	97	99	100				7.5%	7932-33

This revision supersedes
all previous information

AGRA
Earth & Environmental

TABULATION OF TEST RESULTS
UNDISTURBED SAMPLES
LABORATORIES TESTS SUMMARY
Job No. C94-5318

Project Gandi Project (Part II)

Material Source Undisturbed Samples

SAMPLE NO.	DEPTH (ft)	LL	PI	% PASSING #200	UNIFIED CLASS	DRY DENSITY (PCF)	MOISTURE (%)	SPECIFIC GRAVITY	POROSITY (%)
PB-10	14-15	37	14	91	CL	121.7	7.5	2.676	27.1
PB-10	19-20	32	9	80	CL	129.5	7.4	2.660	22.0
PB-15	14-15	29	8	87	CL	106.0	7.1	2.696	37.0
PB-15	19-20	35	12	86	CL	109.4	7.5	2.692	34.9
PB-30	14-15	60	19	99	CH	100.4	20.8	2.656	39.4
PB-30	19-20	47	17	98	CL	89.3	6.6	2.690	46.8
PB-10	28-29	29	4	32	SM	130.9	5.9	2.640	20.5
PB-10	38-39	31	8	48	SM	133.8	6.9	2.663	19.5

This revision supersedes
all previous information

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Summary of Gandy Sample Permeability Test Results

Hole Number	Depth (ft)	Lithology	Confining Pressure (psi)	Initial Moisture Content (%)	Initial Dry Density (pcf)	Initial Void Ratio	B-Parameter after Saturation	Final Moisture Content (%)	Final Dry Density (pcf)	Least Hydraulic Gradient	Greatest Hydraulic Gradient	Coeficient of Permeability (cm/sec)
PB10	23.4 - 23.7	Siltstone	5.0	7.2	120	0.431	96	16.6	118	6.0	10.5	7.1E-05
			25.0					14.8	122	15.1	16.8	9.1E-07
	29.5 - 29.8	Sandy Silt	5.0	11.1	123	0.378	100	17.6	115	8.9	11.6	2.7E-05
			25.0					12.6	126	8.8	11.1	5.6E-06
PB15	11.5 - 14.0	Mudstone	5.0	5.6	143.2			9.9	143.3	2.421		2.0E-07
	26.5 - 29.0	Siltstone/ Sandy Silt	4.9	7.7	129.8			15.2	128.4	0.458		8.7E-07
PB30	19.9 - 20.2	Mudstone	5.0	6.4	117	0.470	98	14.3	124	17.8	18.4	3.9E-07
			25.0					12.7	128	16.9	18.0	1.9E-07
	30.9 - 31.1	Sandy Silt	5.0	5.6	118	0.425	96	12.2	127	10.3	19.1	8.8E-06
			25.0					12.1	127	15.0	17.2	3.1E-06
	37.3 - 37.6	Siltstone	5.0	13.2	105	0.594	100	17.3	114	1.8	5.1	1.5E-04
			25.0					17.3	114	3.3	8.2	1.3E-04
	40.5 - 40.8	Siltstone	5.0	9.9	121	0.425	98	16.8	118	8.7	12.3	3.1E-06
			25.0					15.4	121	12.8	14.1	9.2E-07

This revision supersedes
all previous information

SUMMARY OF GANDY SAMPLE ORGANIC CONTEST TEST RESULTS

Hole Number	Depth (feet)	Lithology	Organic Content (%)
PB10	21.5 - 24	Siltstone	1.14
	29 - 31.5	Sandy Silt	0.53
PB30	19 - 21.5	Mudstone	1.74
	29.5 - 31	Sandy Silt	0.77
	36.5 - 39	Siltstone	1.27
	39 - 41.5	Siltstone	0.76

This revision supersedes
all previous information

MAXIMUM DENSITIES SUMMARY
ASTM D-698

LOCATION	MAXIMUM DENSITY (PCF)	OPTIMUM MOISTURE (%)
PB-2	116.6	12.6
PB-4	112.4	14.1
PB-6	122.1	12.8
PB-7	112.6	13.7
PB-8	117.2	13.6
PB-9	114.7	12.2
PB-10	113.6	16.7
PB-11	119.9	12.9
PB-13	116.7	12.2
PB-14	110.6	14.9
PB-15	116.9	15.5
PB-21	122.6	10.4
PB-30	112.5	14.9
PB-31	117.2	12.4
PB-33	117.8	12.5

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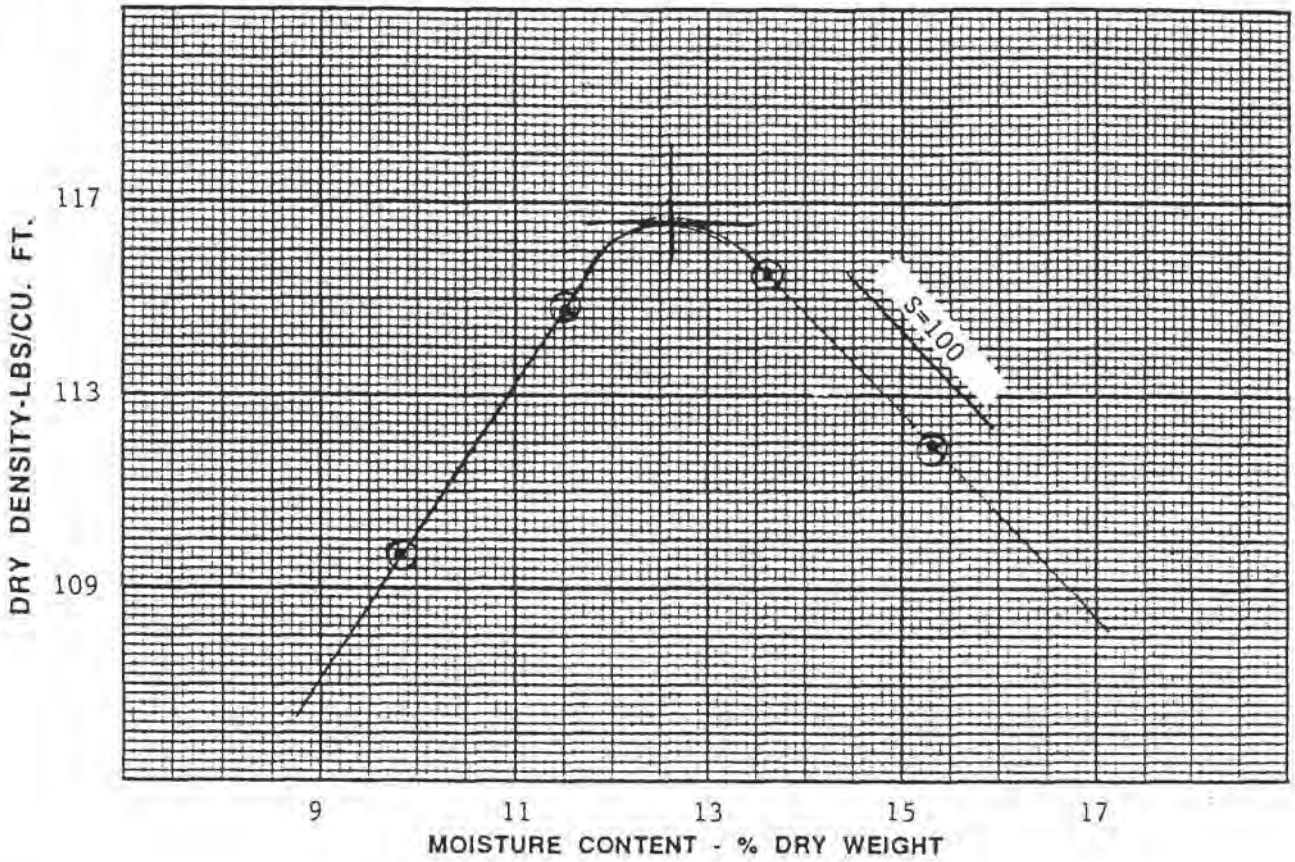
This revision supersedes
all previous information

PROCTORS

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT JOB NO. C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-2	16.6	116.6	ASTM D-698	A	7932-2

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

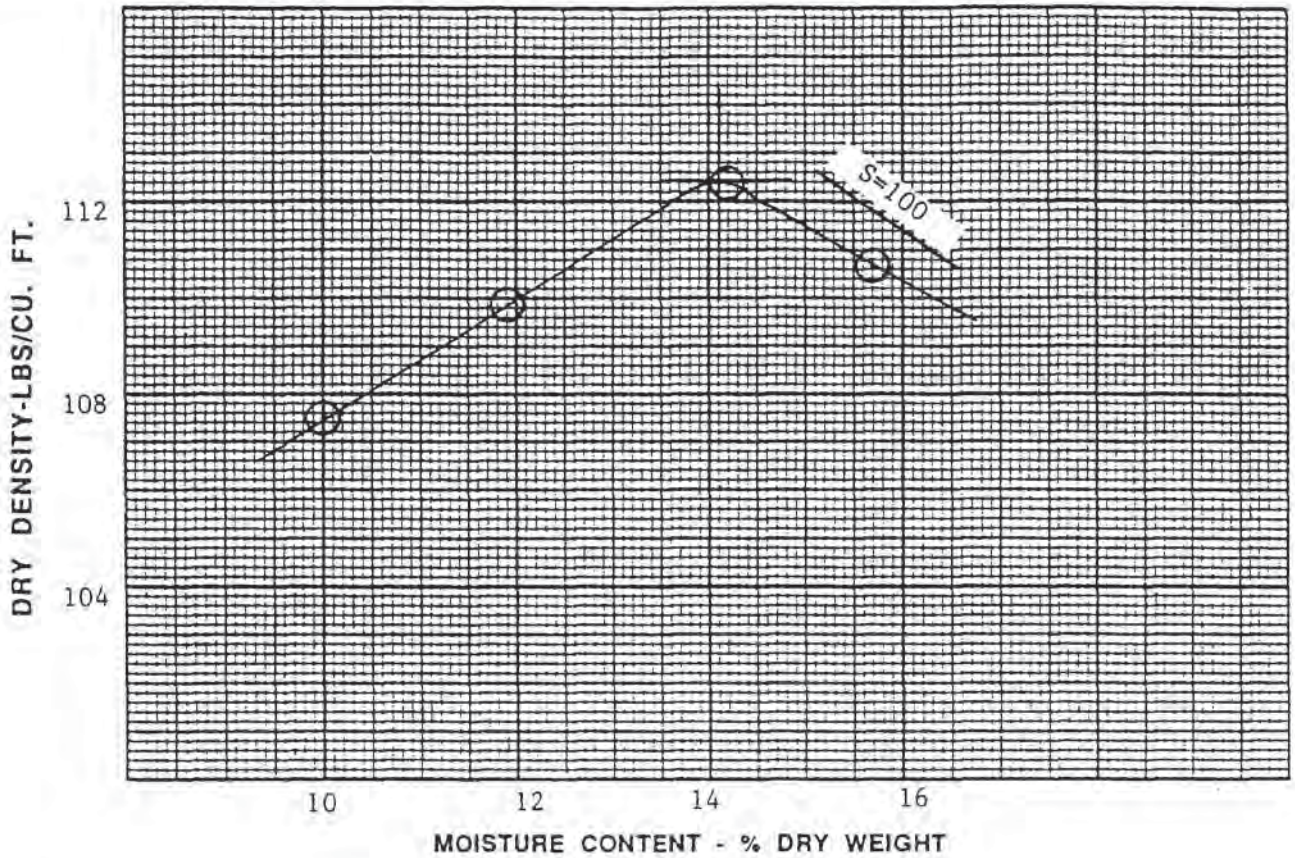
METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

This revision supersedes
all previous information

AGRA
Earth & Environmental

SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-4	14.1	112.4	ASTM D698	A	7932-4

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

This revision supersedes all previous information

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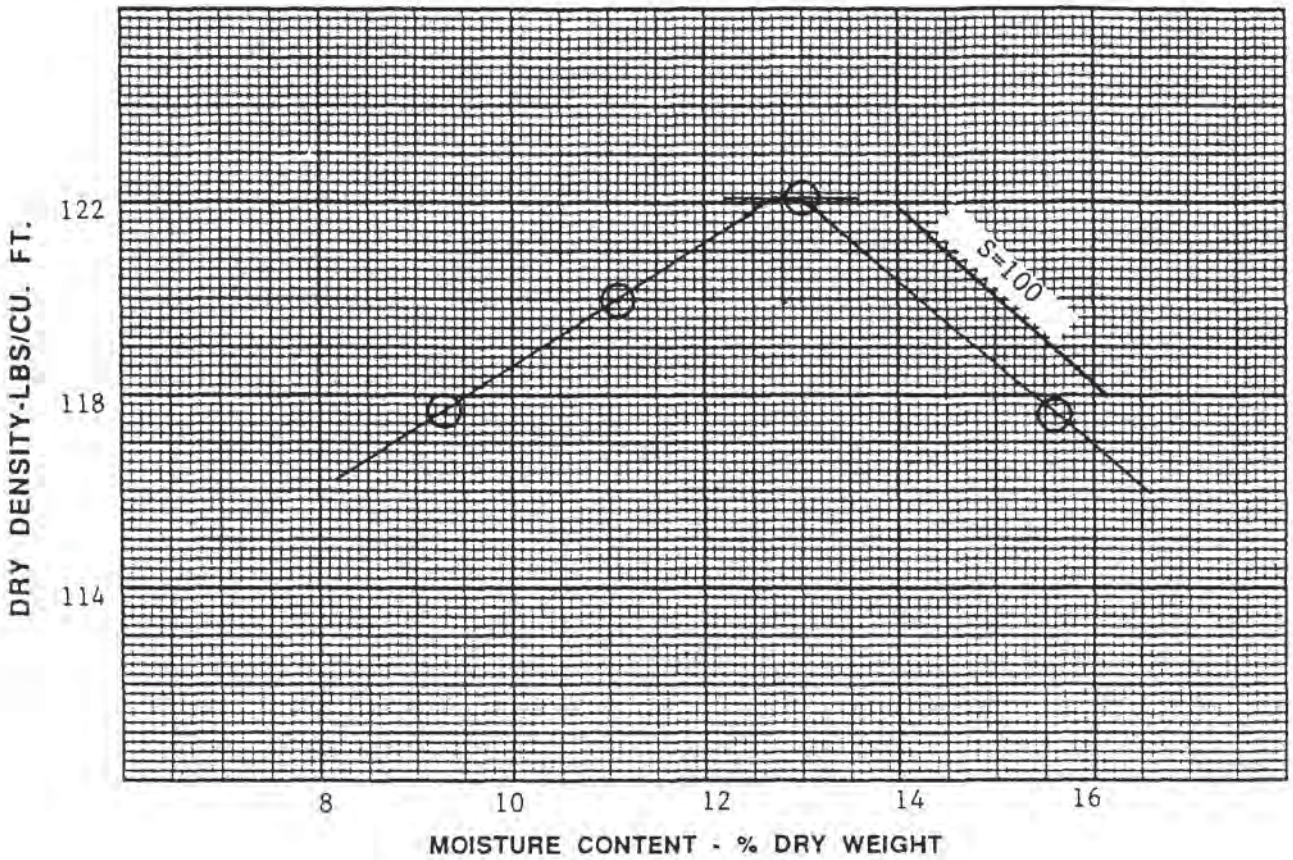
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-6	12.8	122.1	ASTM D698	A	7932-6

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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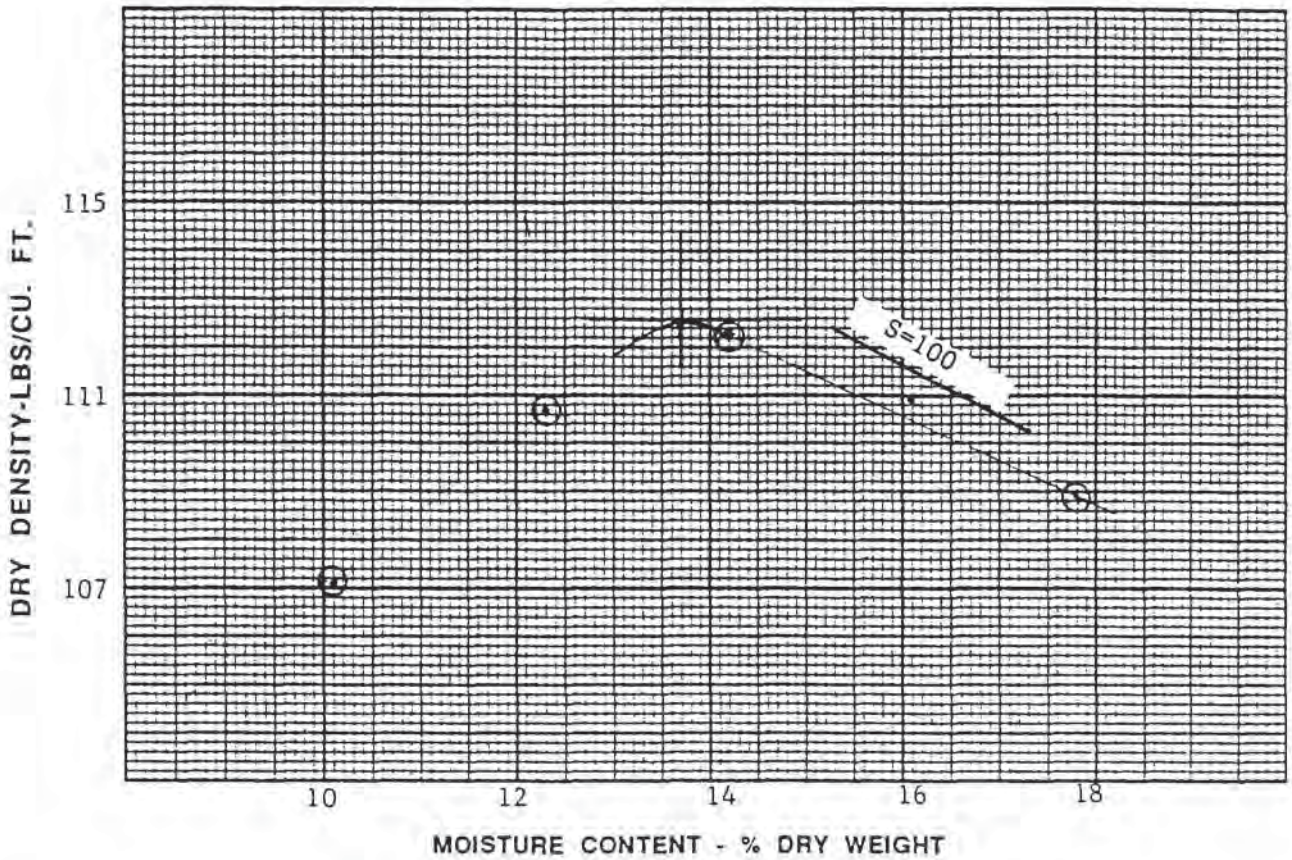
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT JOB NO. C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-7	13.7	112.6	ASTM D698	A	7932-7

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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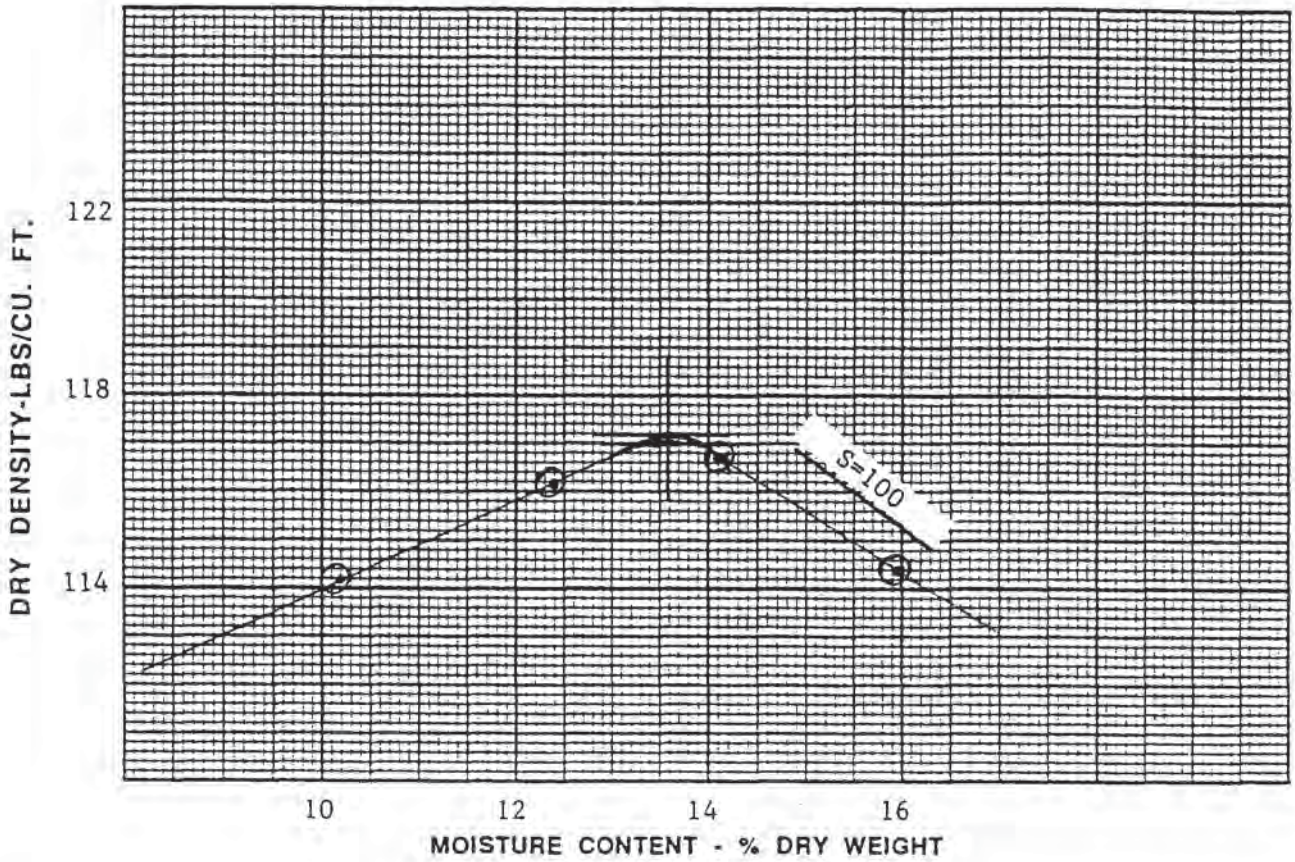
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT JOB NO. C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-8	13.6	117.2	ASTM D698	A	7932-8

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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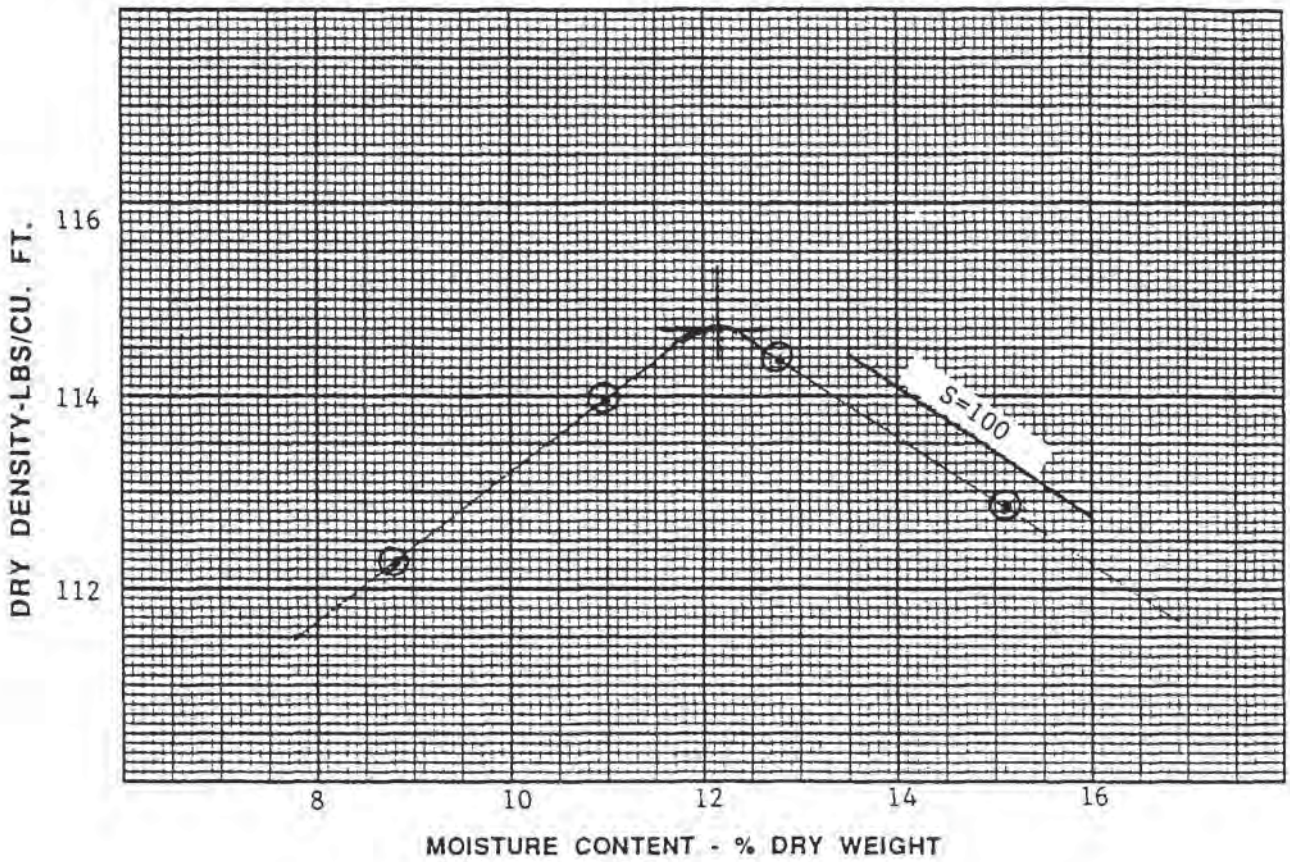
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-9	12.2	114.7	ASTM D698	A	7932-9

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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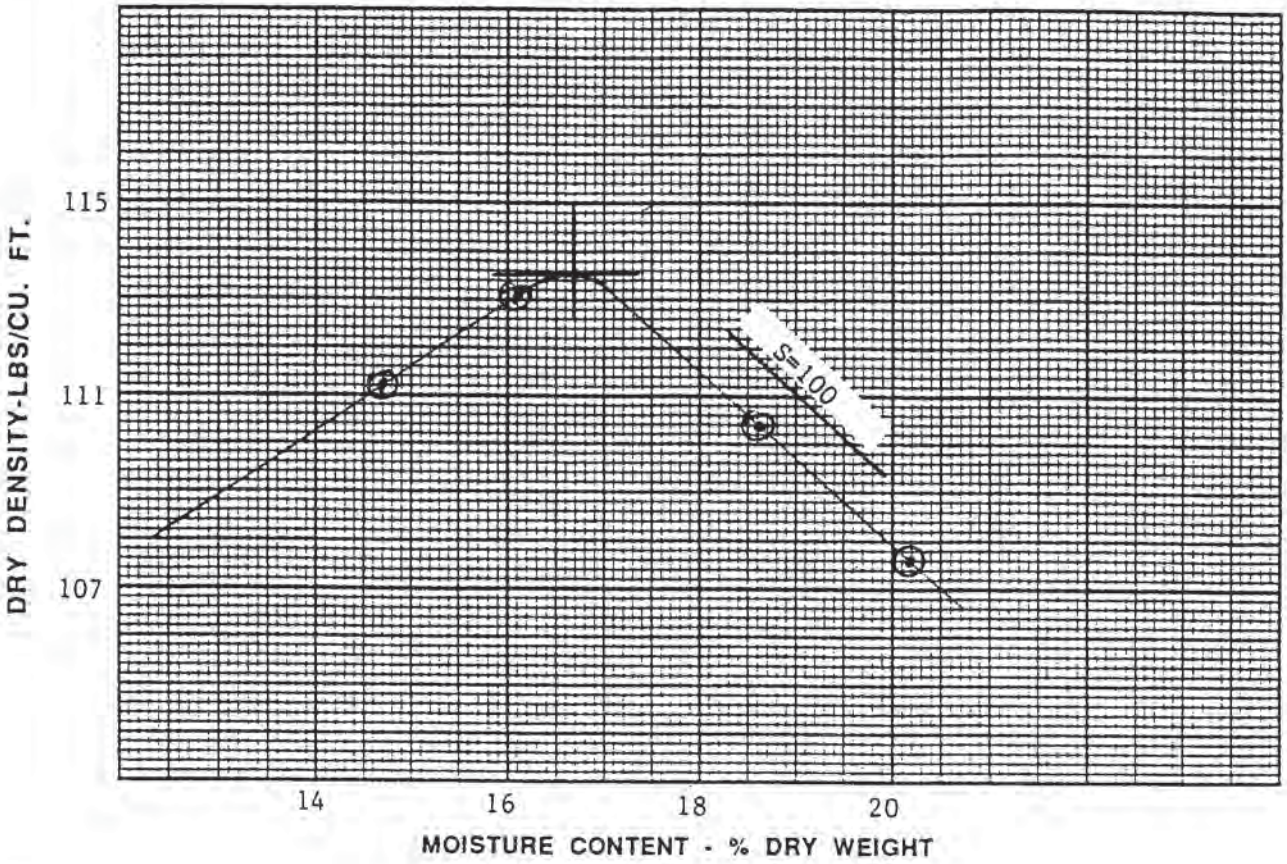
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-10	16.7	113.6	ASTM D698	A	7932-10

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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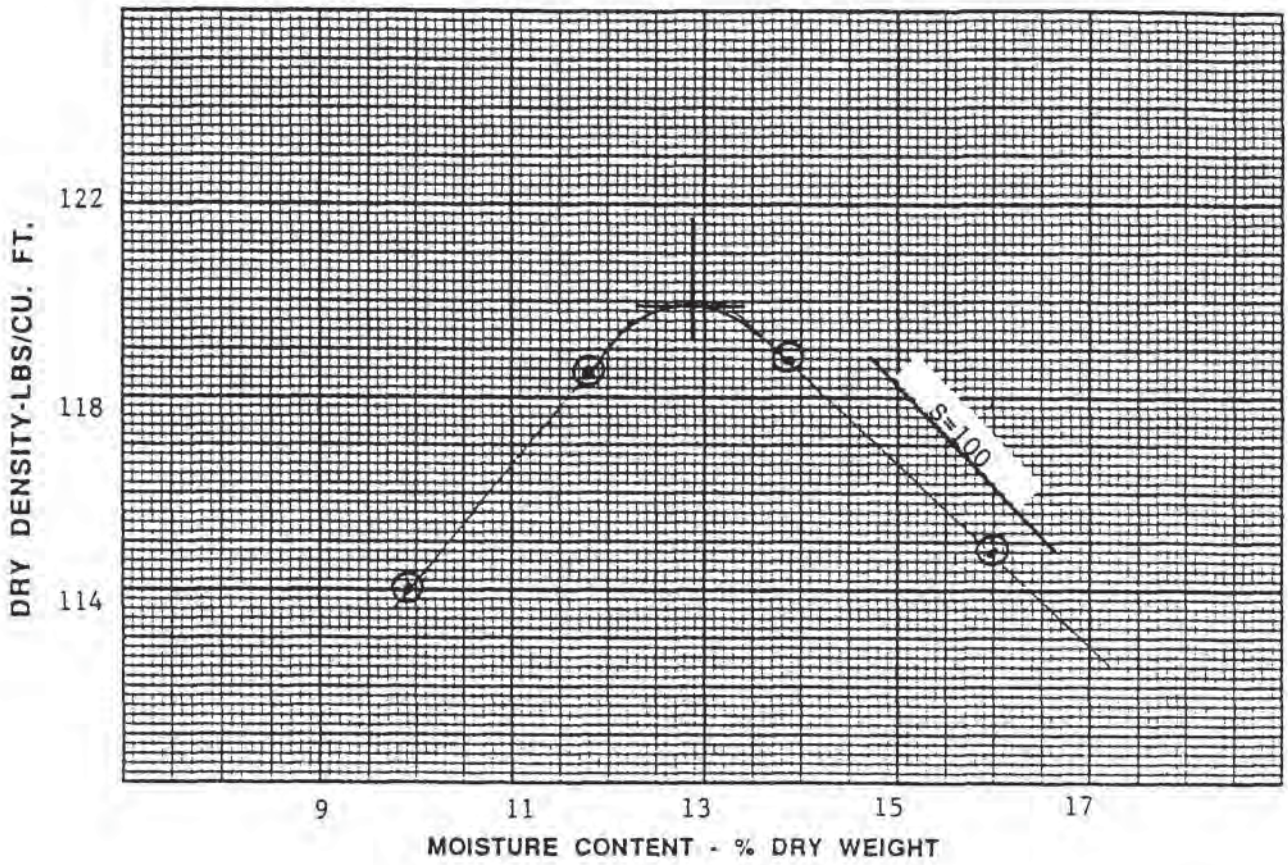
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-11	12.9	119.9	ASTM D698	A	7932-11

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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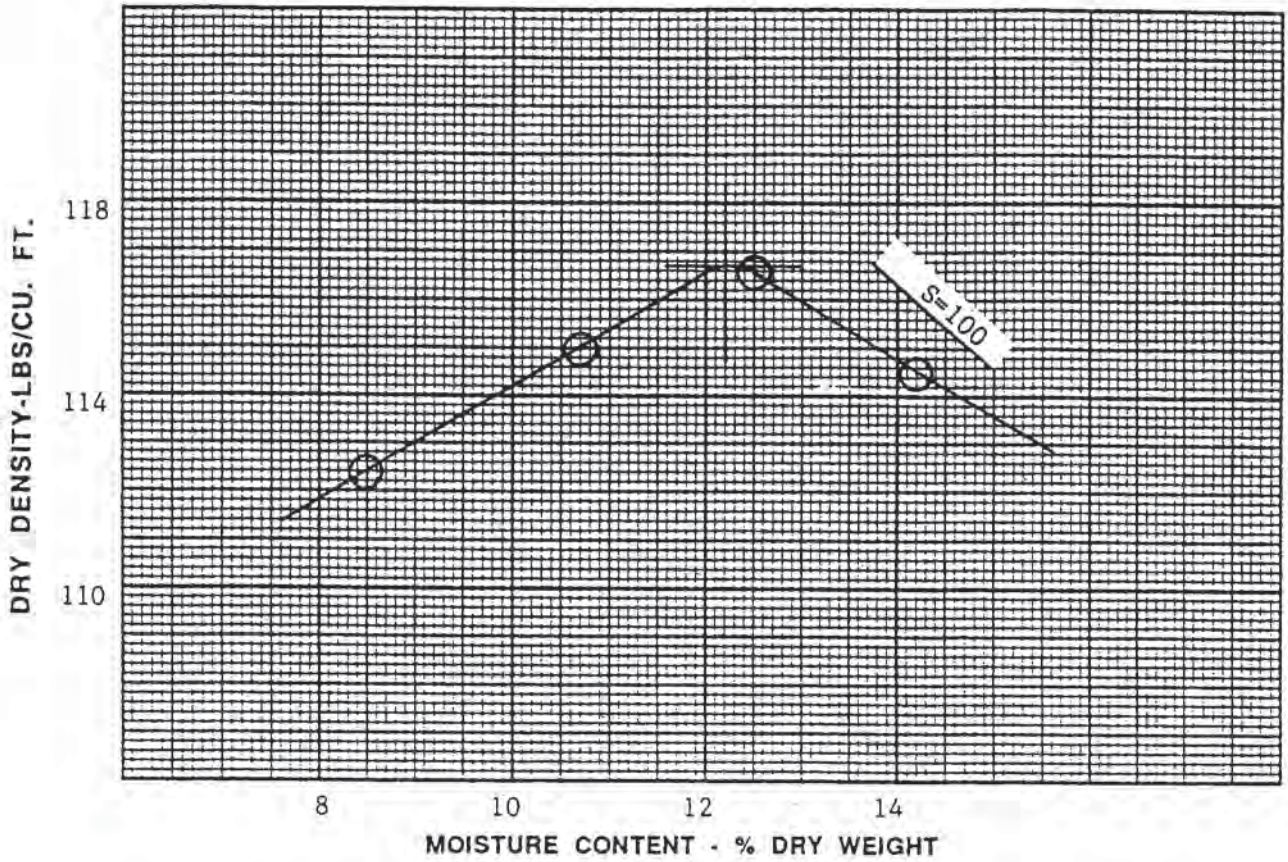
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT JOB NO. C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-13	12.2	116.7	ASTM D698	A	7932-13

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD DIAMETER	MOLD HEIGHT	NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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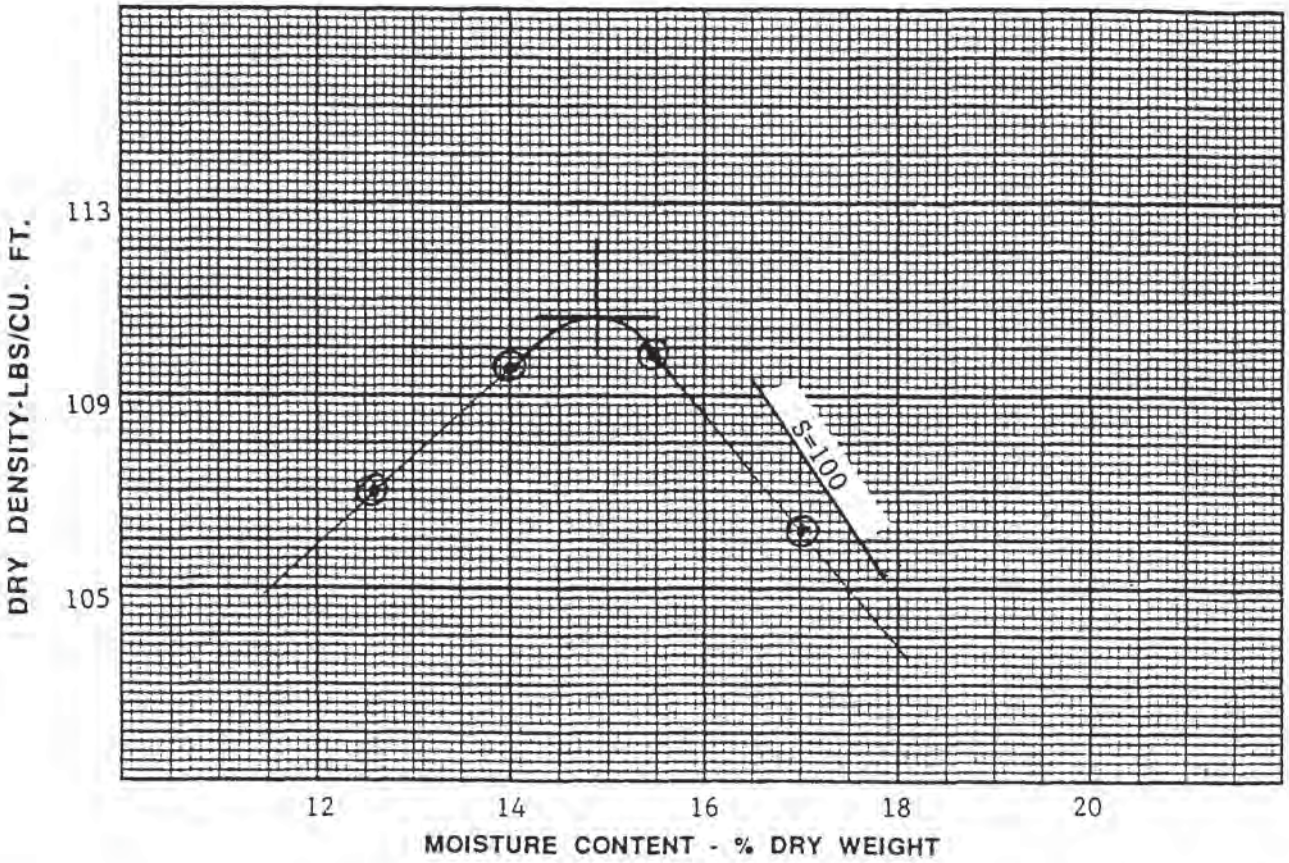
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-14	14.9	110.6	ASTM D698	A	7932-14

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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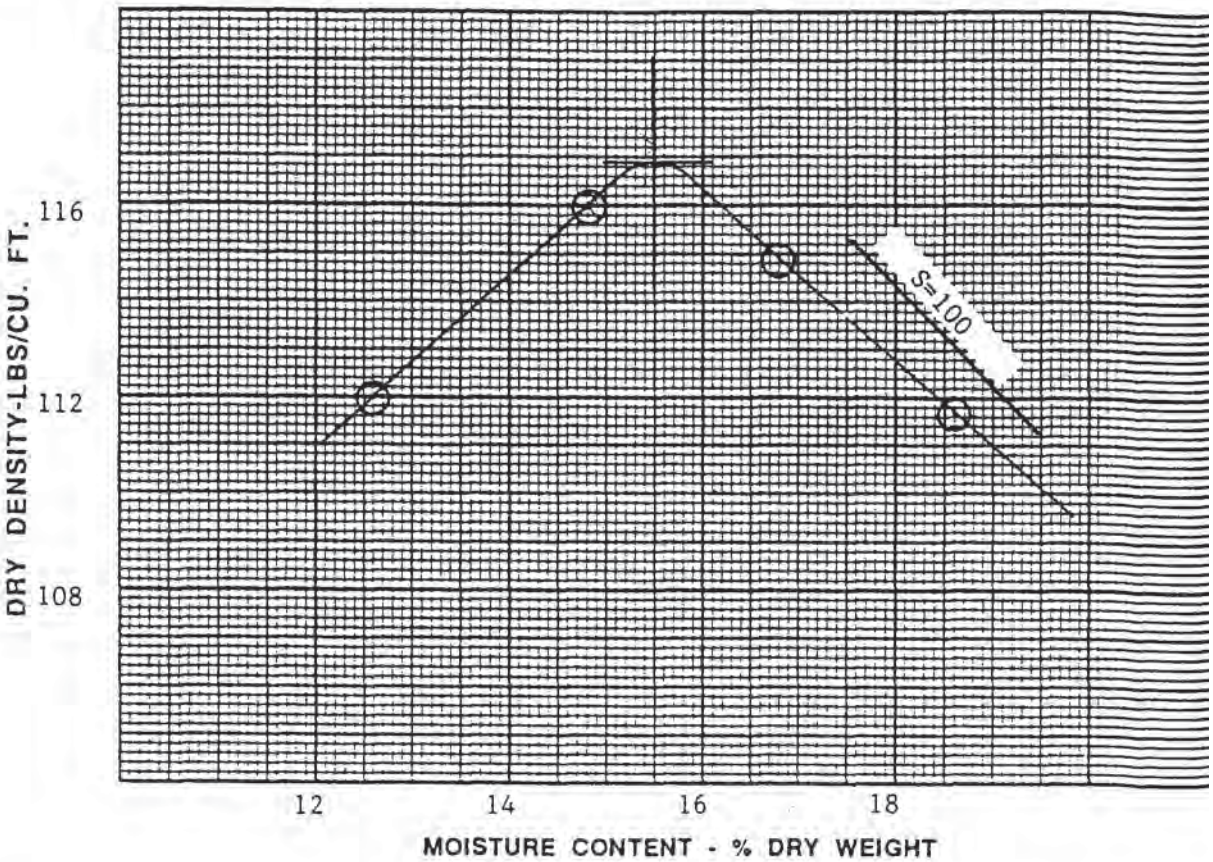
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	
PB-15	15.5	116.9	ASTM D698	A	

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIV[illegible] FT. LBS.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12.[illegible]
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12.
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIV[illegible] FT. LBS.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56.[illegible]
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55.-
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55.-

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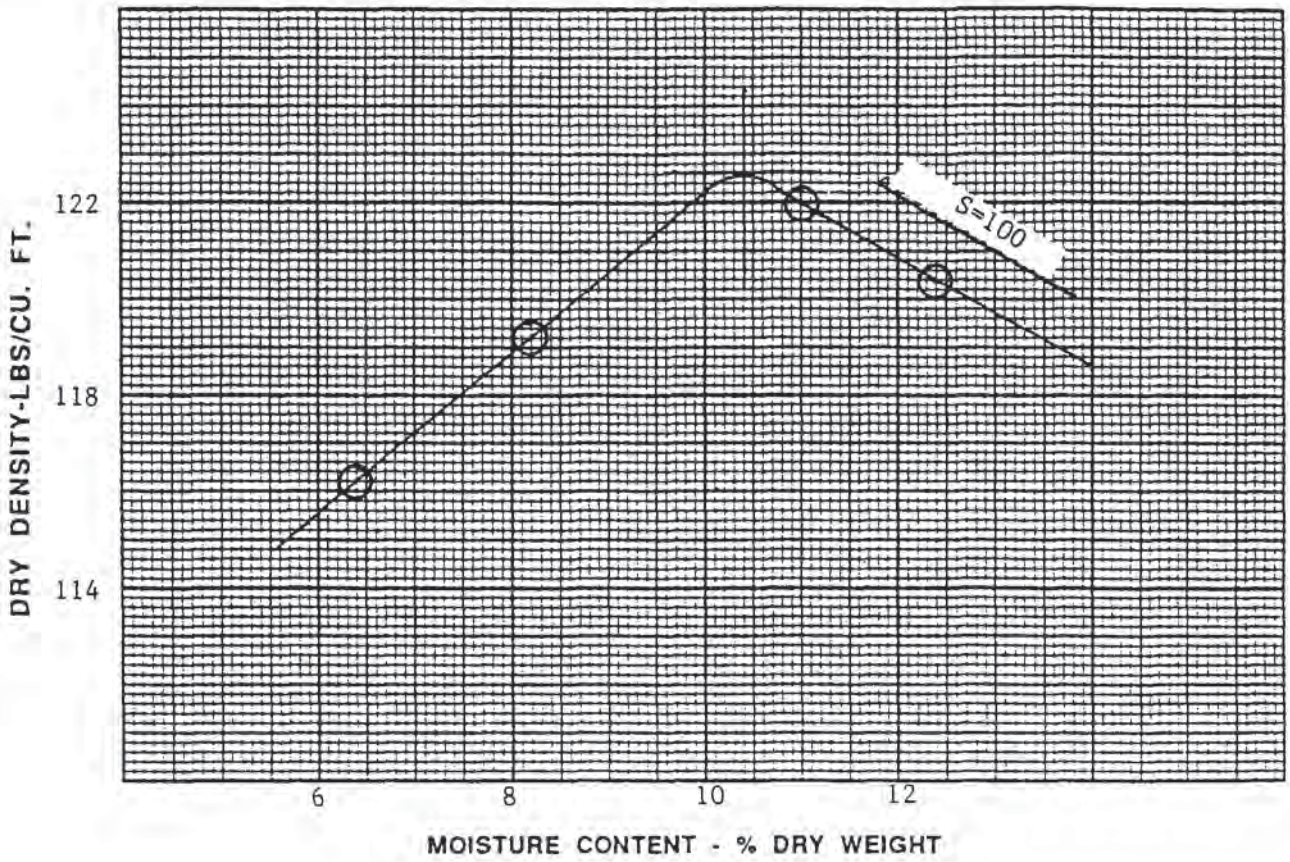
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-21	10.4	122.6	ASTM D698	A	7932-21

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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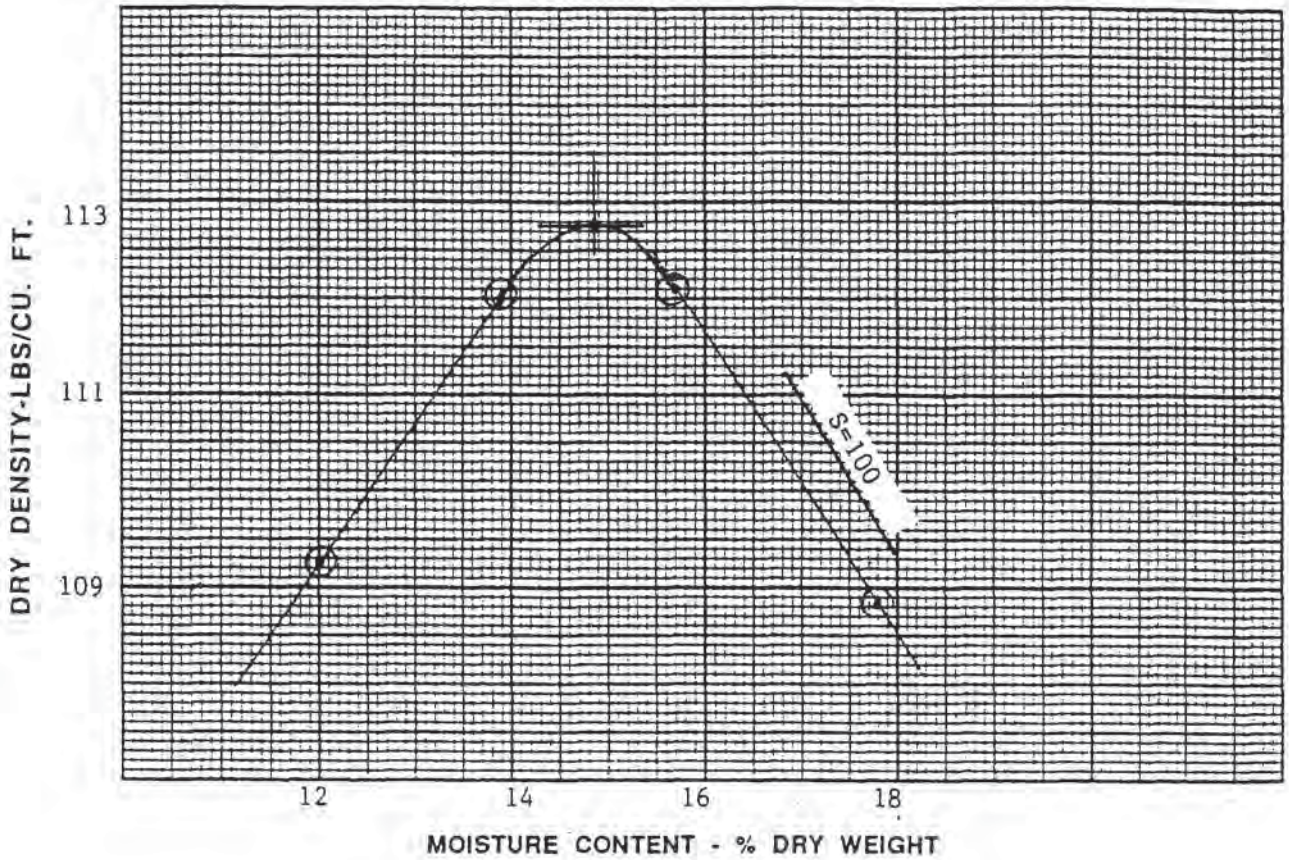
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT JOB NO. C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-30	14.9	112.5	ASTM D698	A	7932-30

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-3/4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-3/4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-3/4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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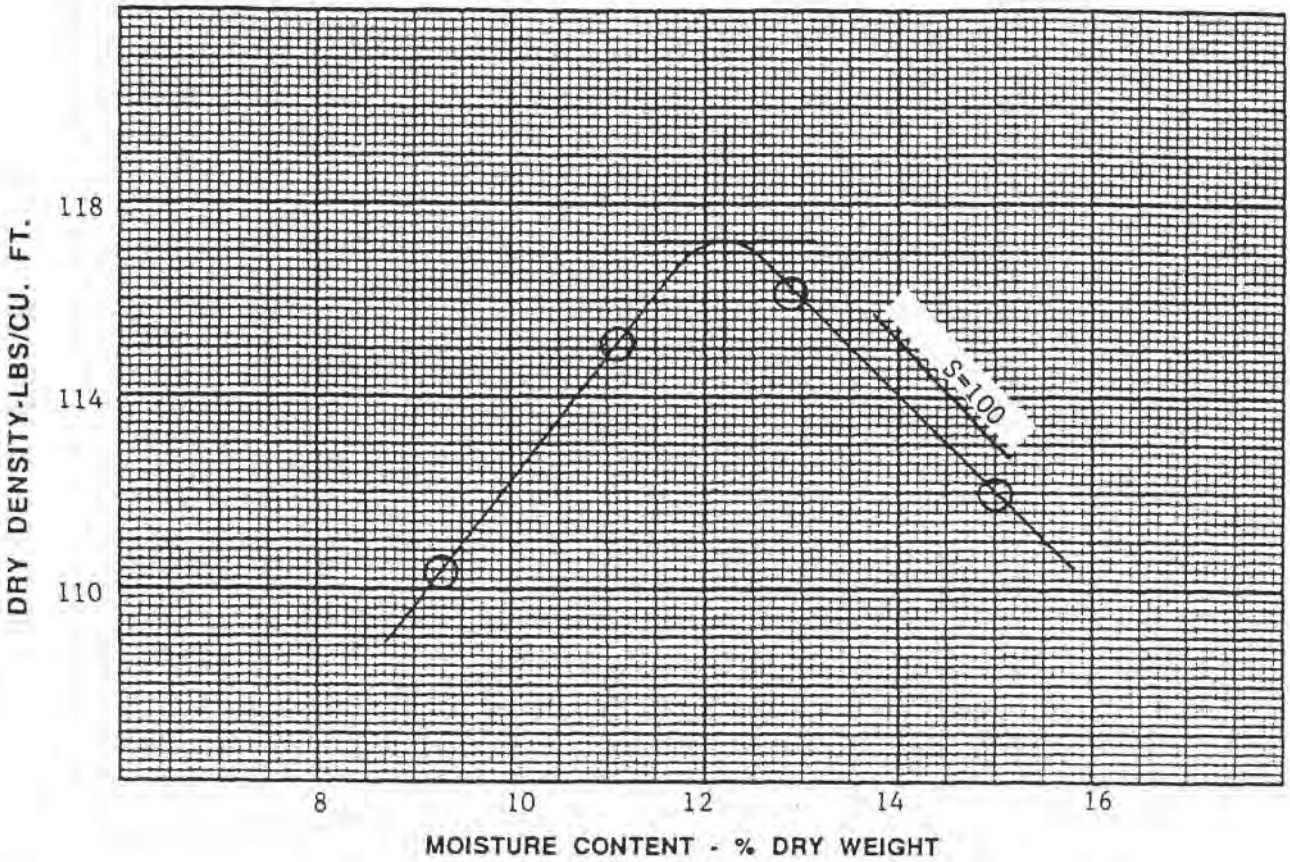
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-31	12.4	117.2	ASTM D698	A	7932-31

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

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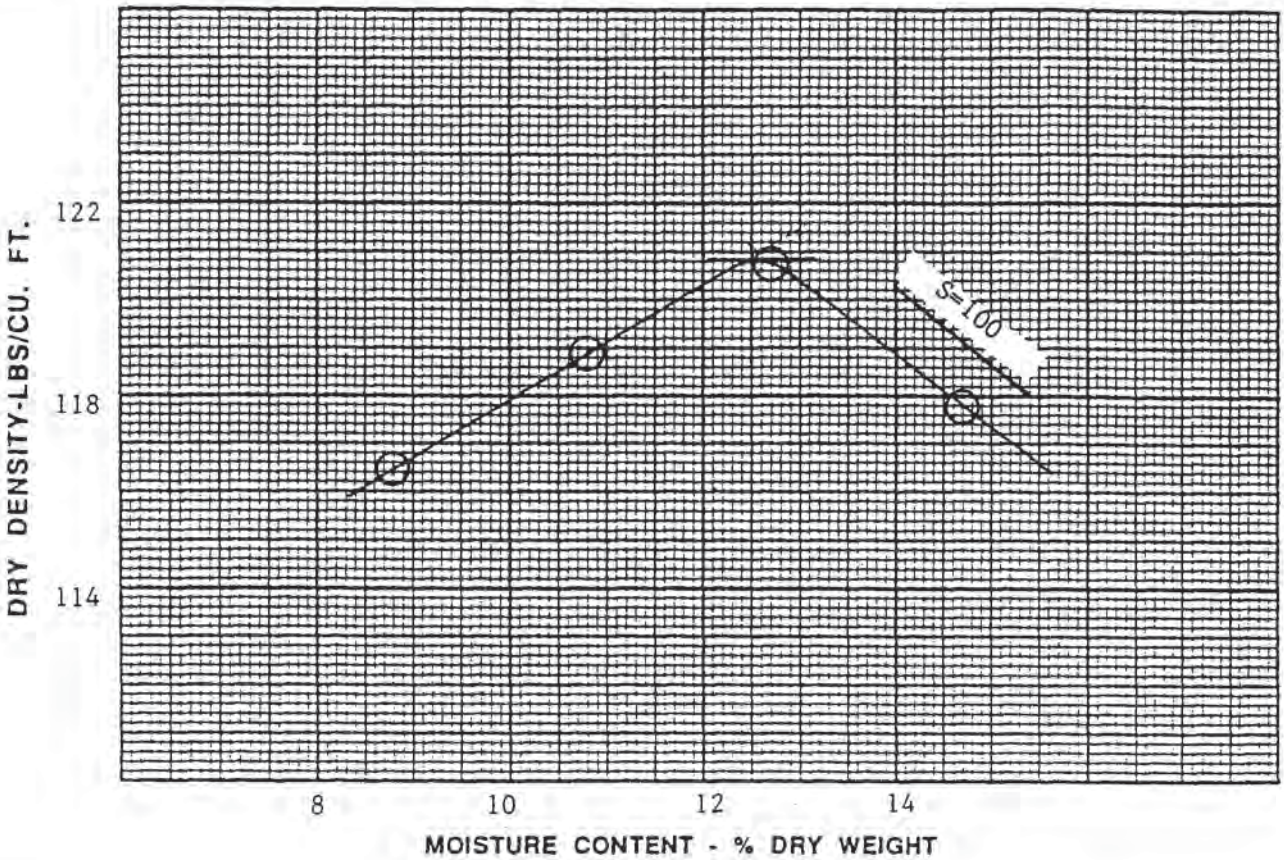
SUMMARY OF MOISTURE DENSITY RELATIONSHIP TESTS

PROJECT GANDI PROJECT **JOB NO.** C94-5318



SOURCE	OPTIMUM MOISTURE CONTENT % DRY WT.	MAXIMUM DRY DENSITY LBS/CU. FT.	TEST DESIGNATION	TEST METHOD	LAB NO.
PB-33	12.5	117.8	ASTM D698	A	7932-33

MOISTURE-DENSITY RELATIONSHIP TEST METHOD DATA

ASTM D698 (Standard Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,375
B	-#4	4"	4.58"	3	25	5.5 lbs	12"	12,317
C	-3/4	6"	4.58"	3	56	5.5 lbs	12"	12,317

ASTM D1557 (Modified Proctor)

METHOD	MATERIAL	MOLD		NO. OF LAYERS	BLOWS PER LAYER	HAMMER WEIGHT	HEIGHT OF FALL	COMPACTIVE EFFORT FT. LBS./CU. FT.
		DIAMETER	HEIGHT					
A	-#4	4"	4.58"	5	25	10.0 lbs	18"	56,250
B	-3/8	4"	4.58"	5	25	10.0 lbs	18"	55,986
C	-3/4	6"	4.58"	5	56	10.0 lbs	18"	55,986

This revision supersedes
all previous information

AGRA
Earth & Environmental

HYDROMETER

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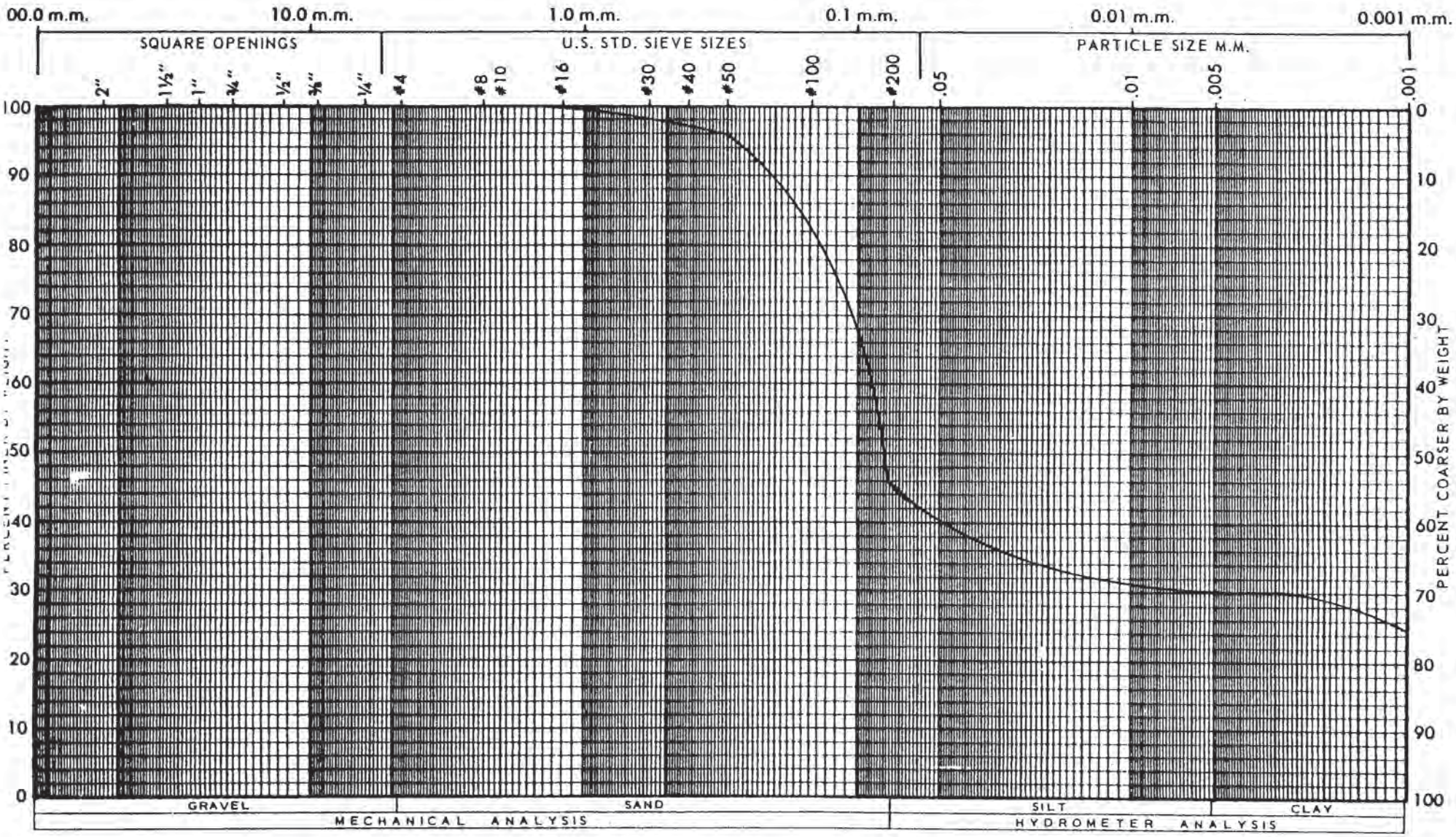
PARTICLE SIZE .RIBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-2	36	31		SC	7932-2

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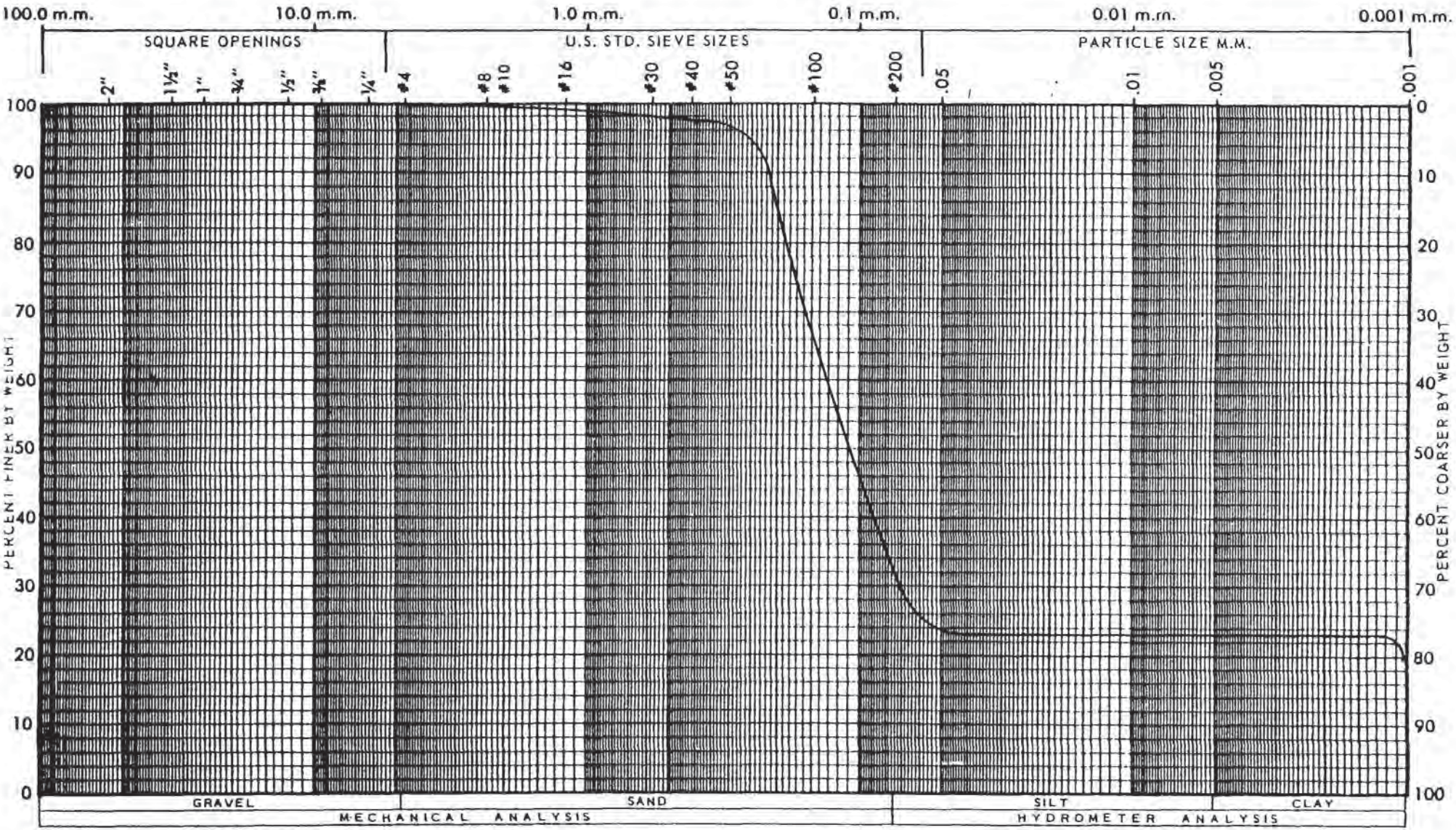
JOB NO. ( )

PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT **LOCATION** ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-4	NV	NP		SM	7932-4

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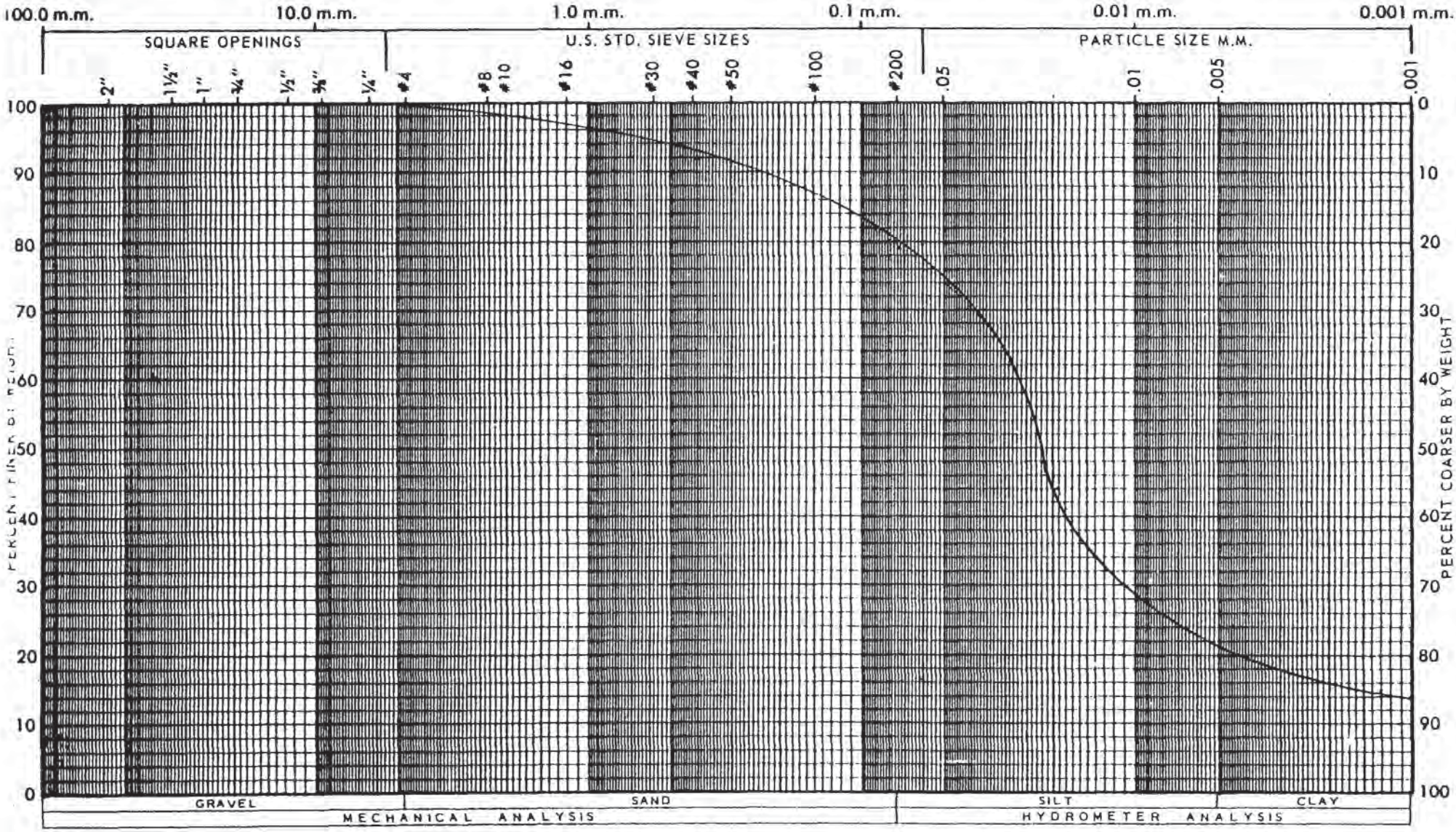
PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-6	24	6		CL-ML	7932-6

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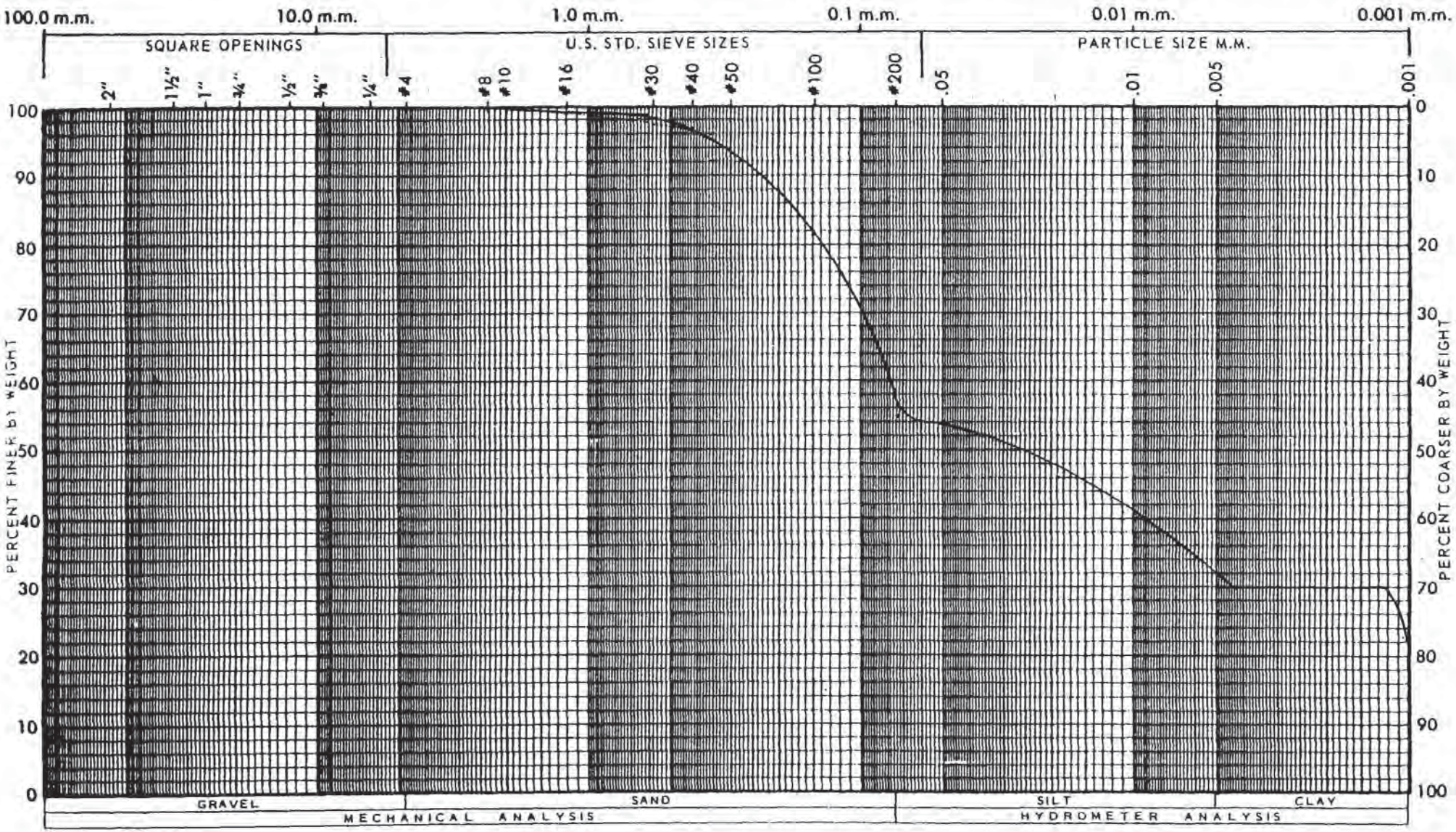
JOB NO. [illegible]

PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-7	28	6		CL-ML	7932-7

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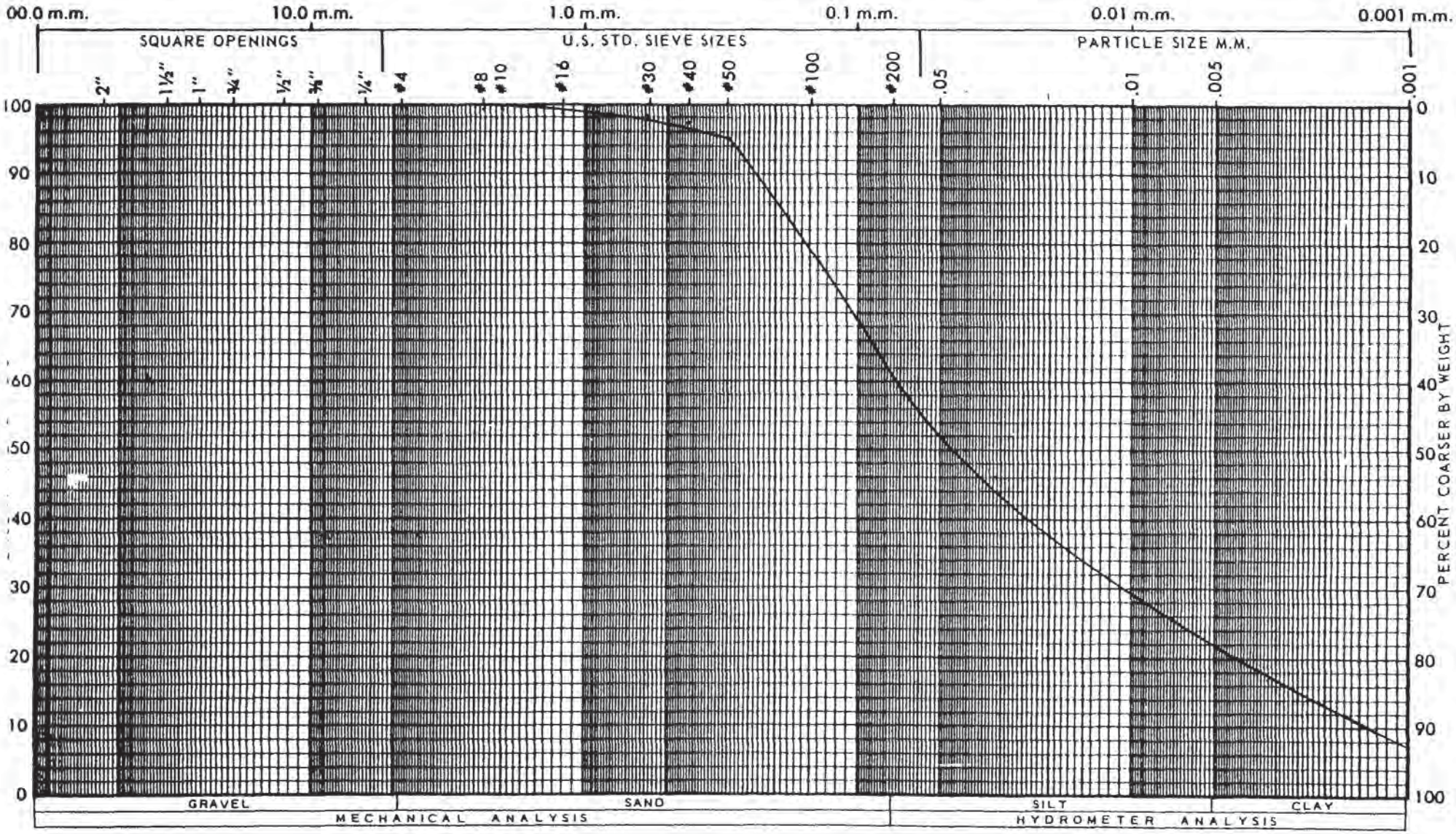
JOB NO. [illegible]

PARTICLE SIZE [illegible]RIBUTION CURVE

PROJECT GANDI PROJECT **LOCATION** ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-8	28	9		SC	7932-8

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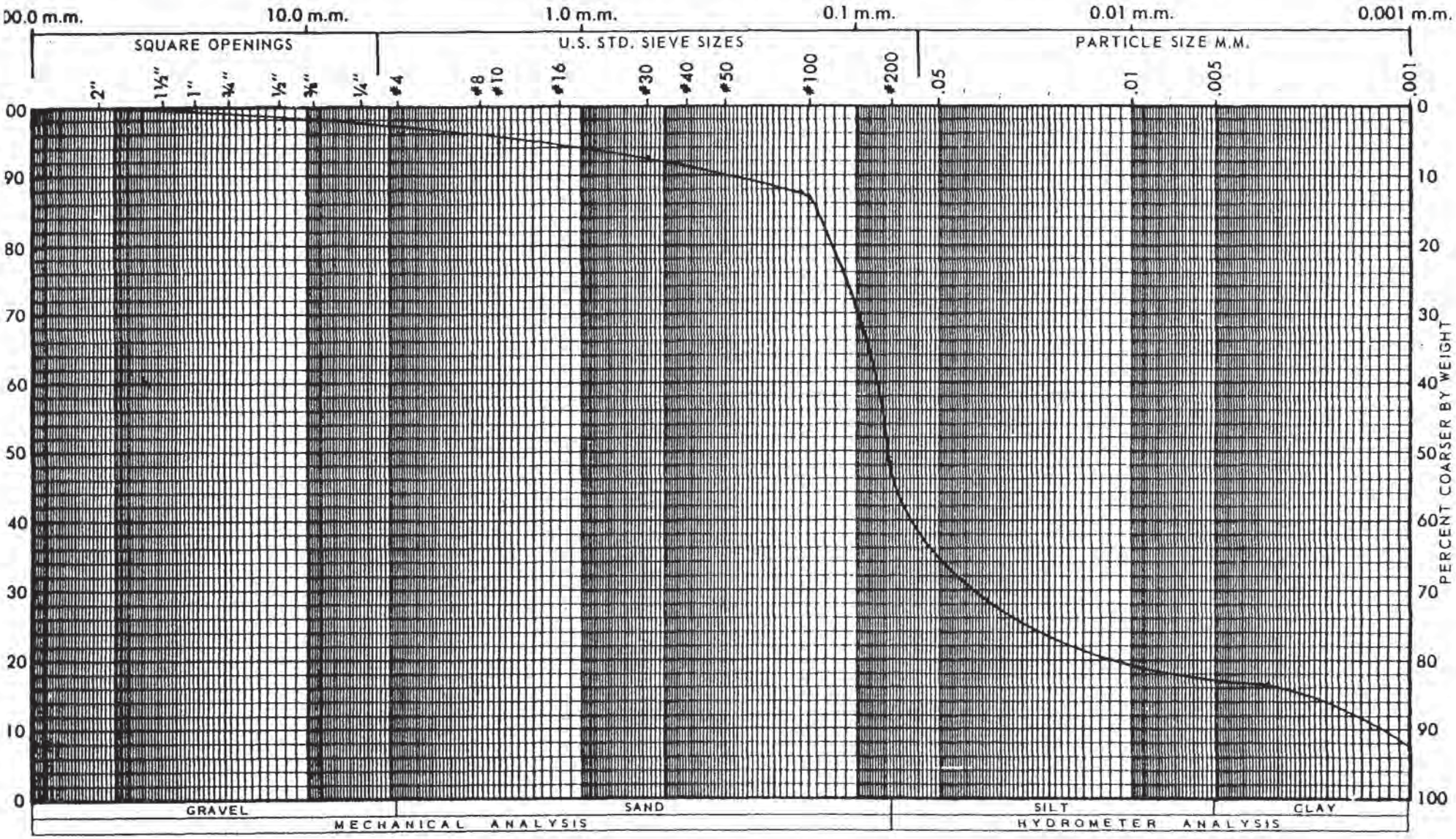
PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



This revision supersedes all previous information

CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-9	NV	NP		SM	7932-9

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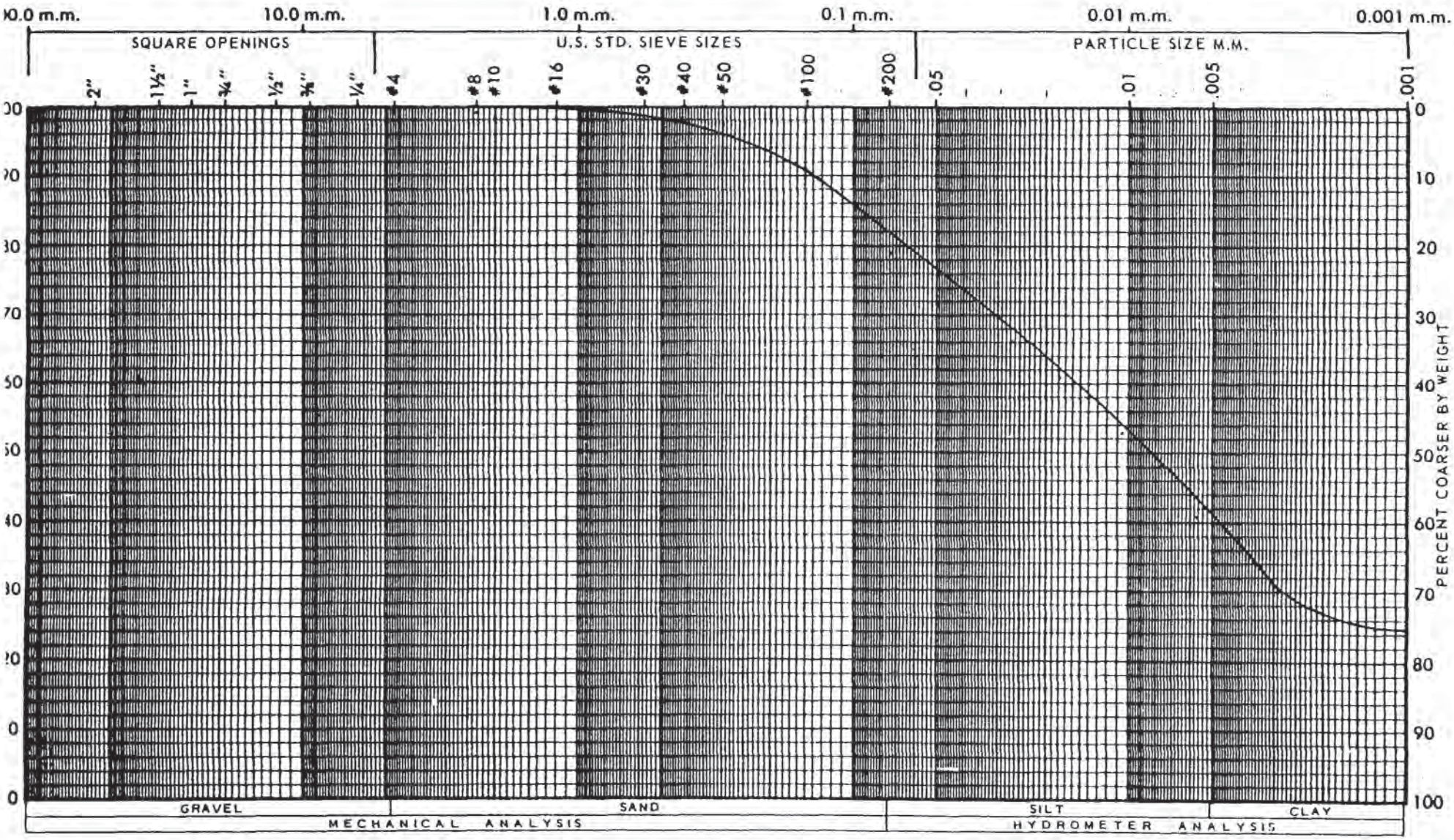
PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT **LOCATION** ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-10	30	13		CL	7932-10

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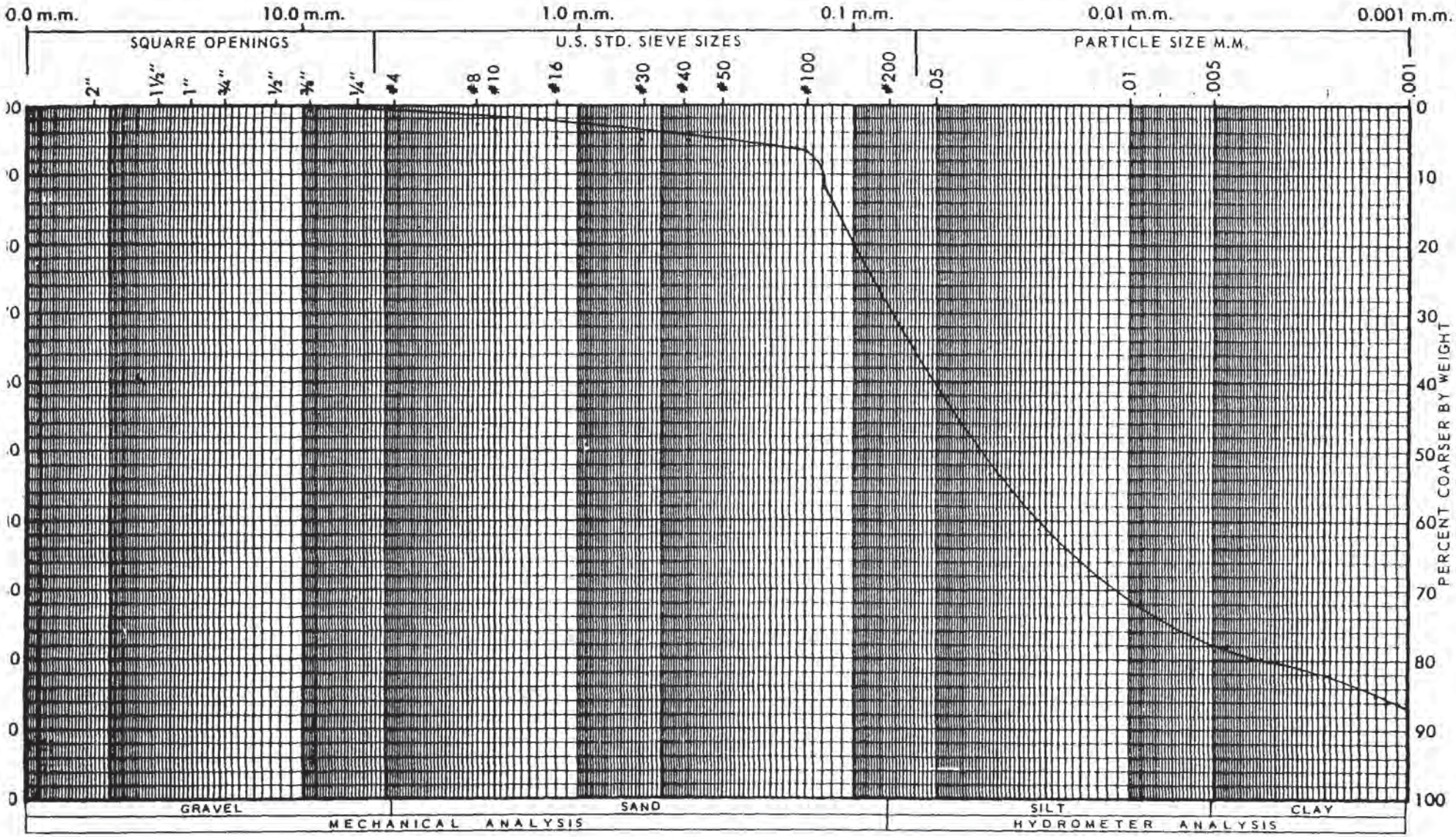
PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT **LOCATION** ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-11	32	12		CL	7932-11

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JOB NO. [illegible]

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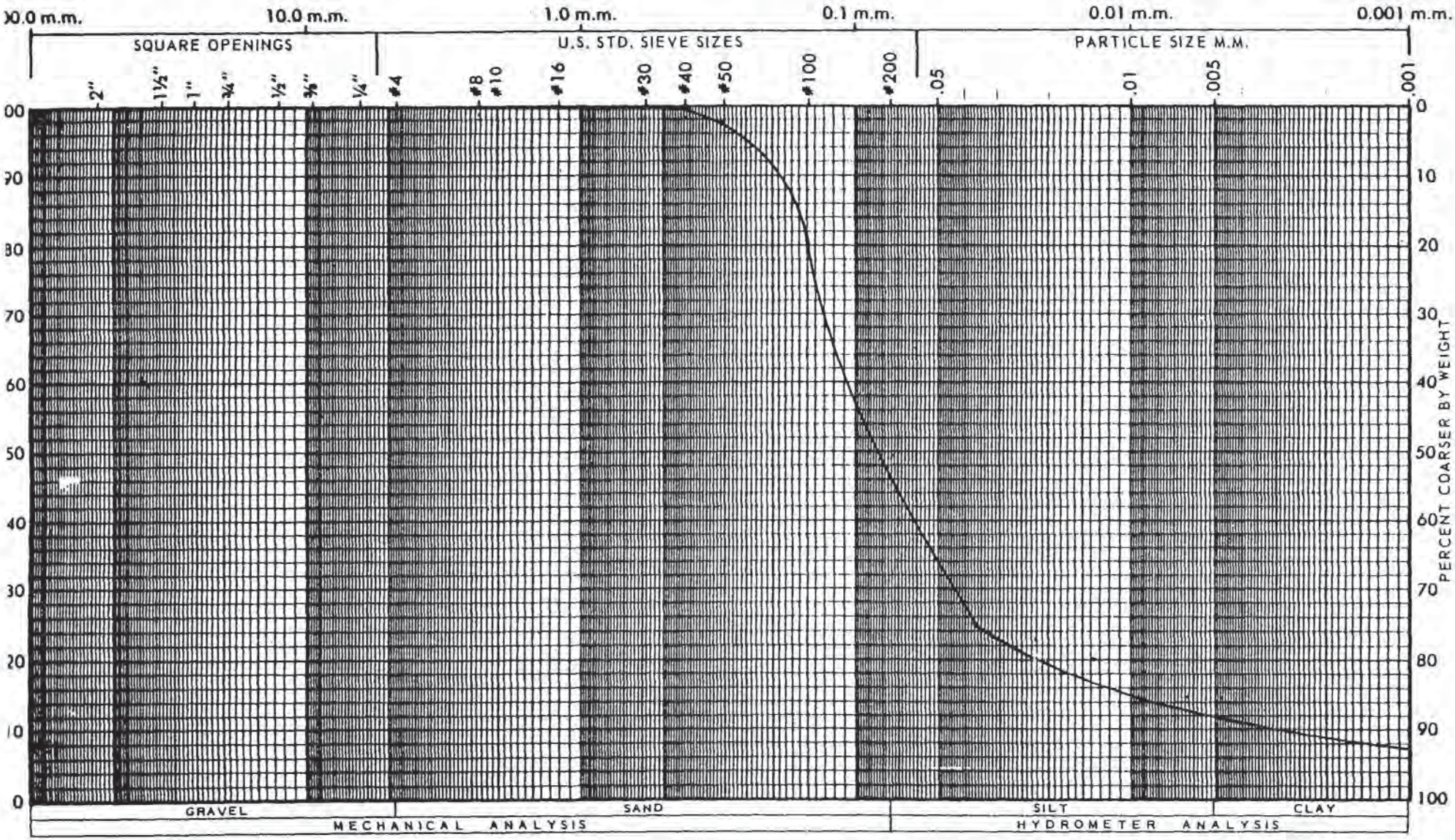
PROJECT GANDI PROJECT **LOCATION** ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-13	NV	NP		SM	7932-13

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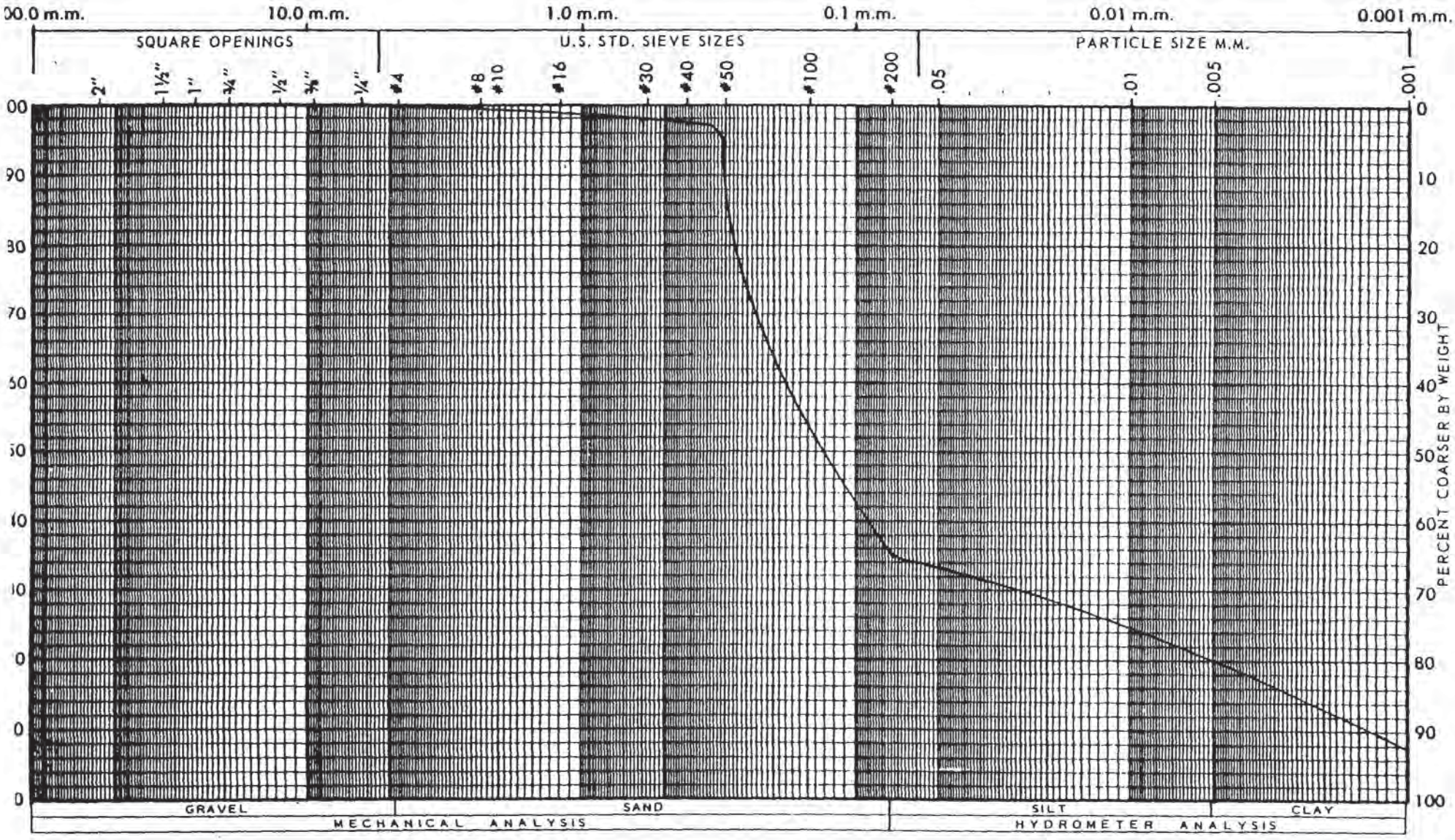
PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-14	NV	NP		SM	7932-14

This revision supersedes all previous information

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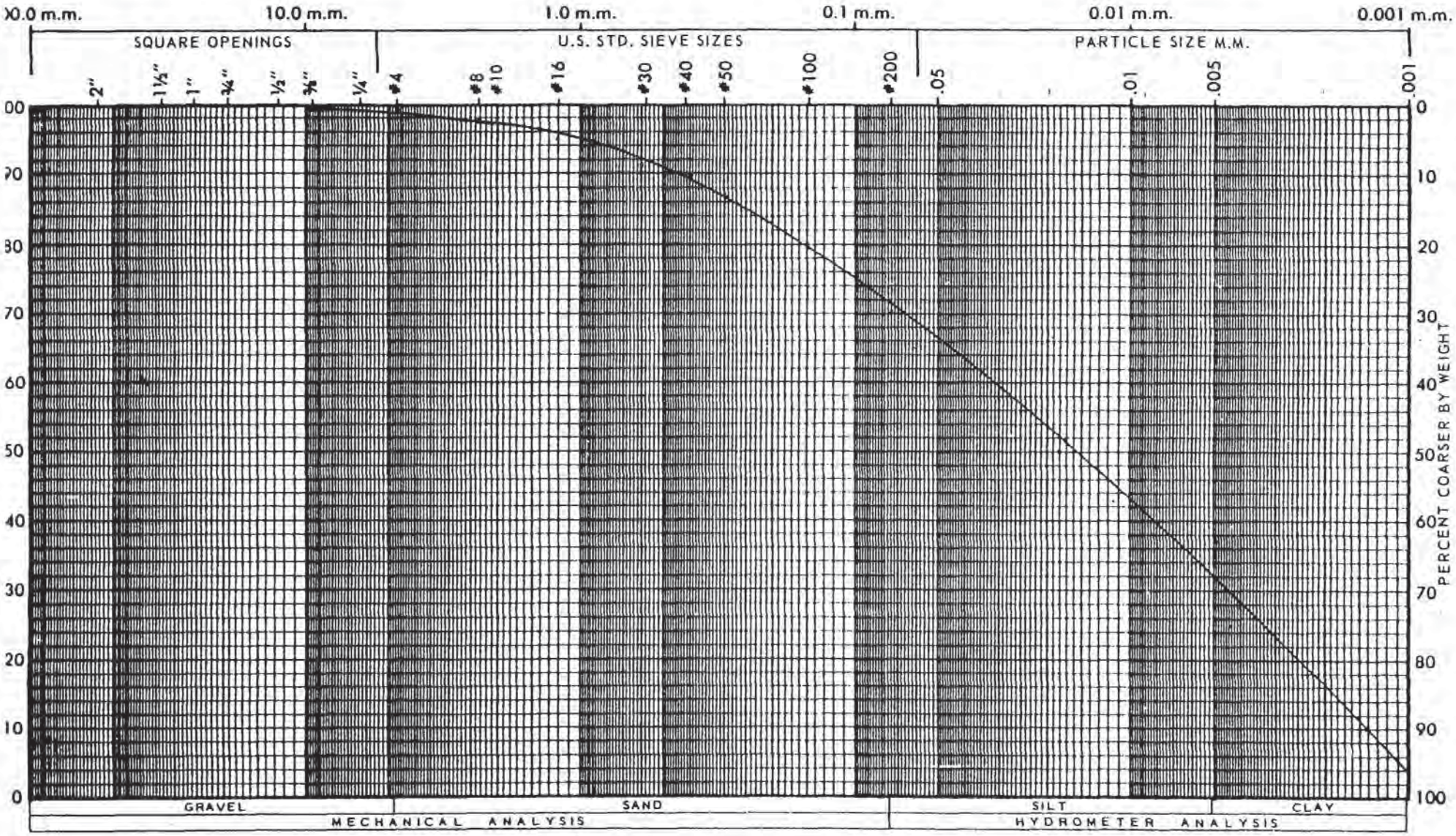
PARTICLE SIZE RIBUTION CURVE

PROJECT CANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-15	32	9		CL	7932-15

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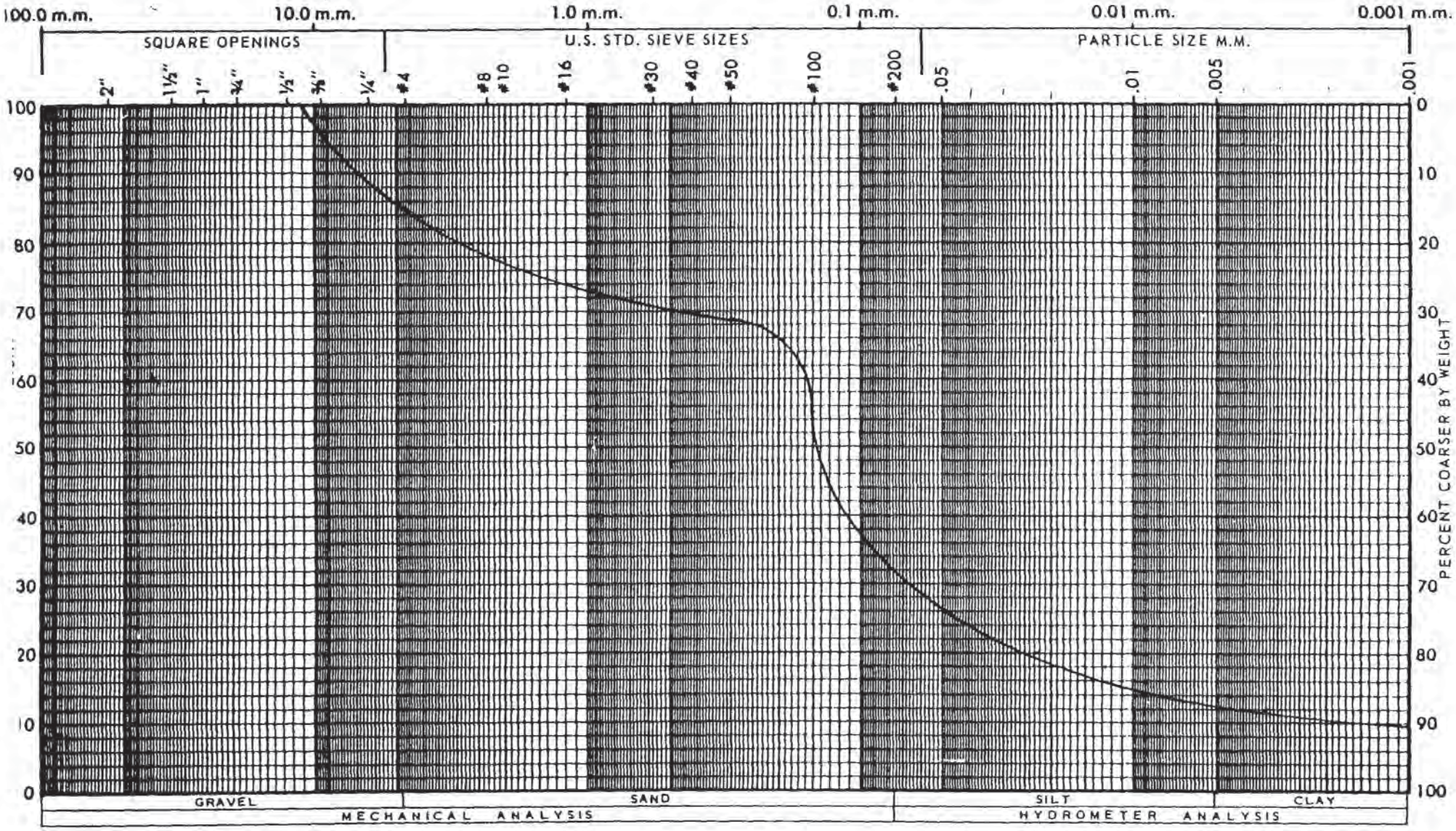
PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-21	24	3		SM	7932-21

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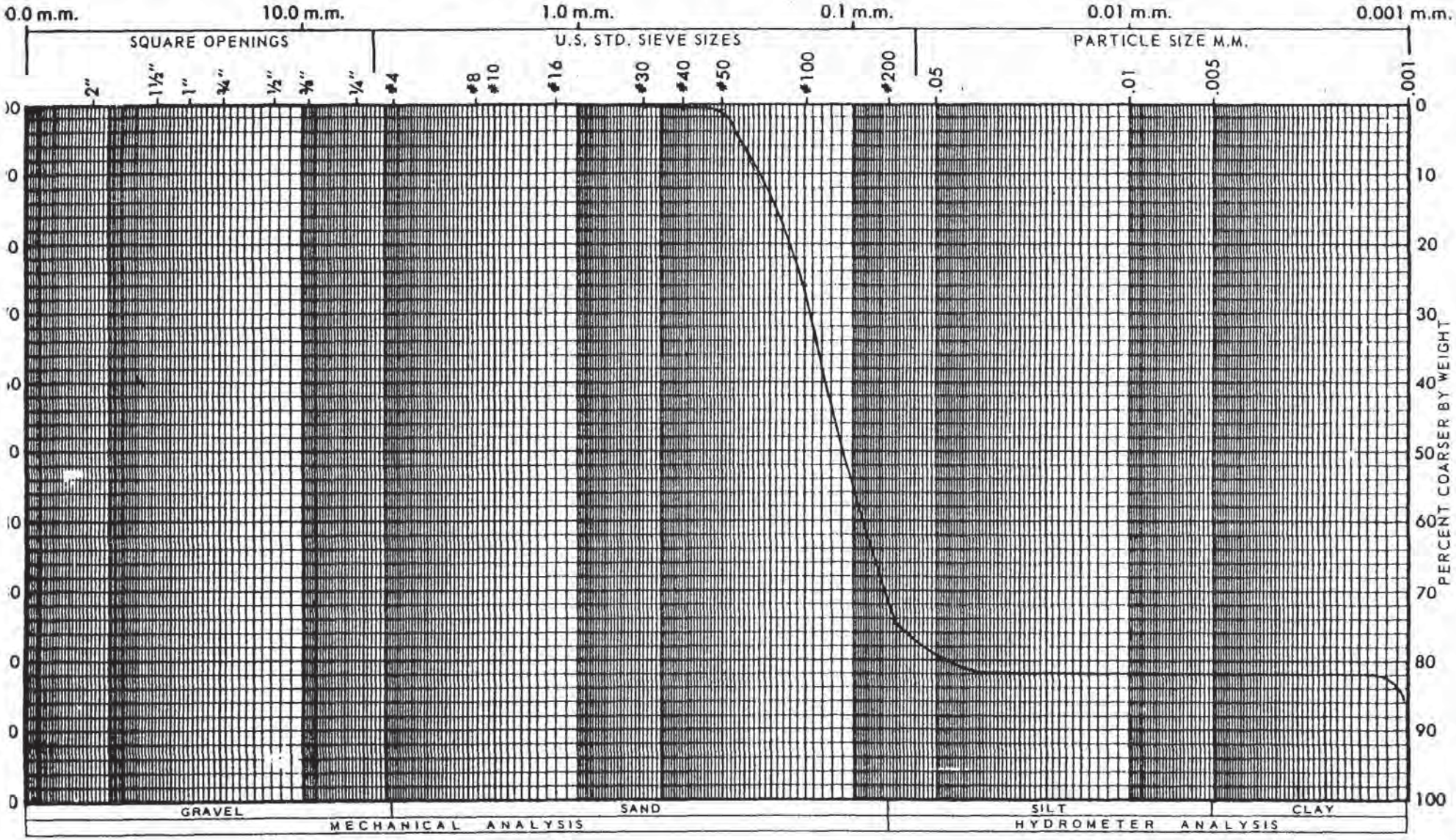
JOB NO. 6-24-5

PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-30	28	6		SC-SM	7932-30

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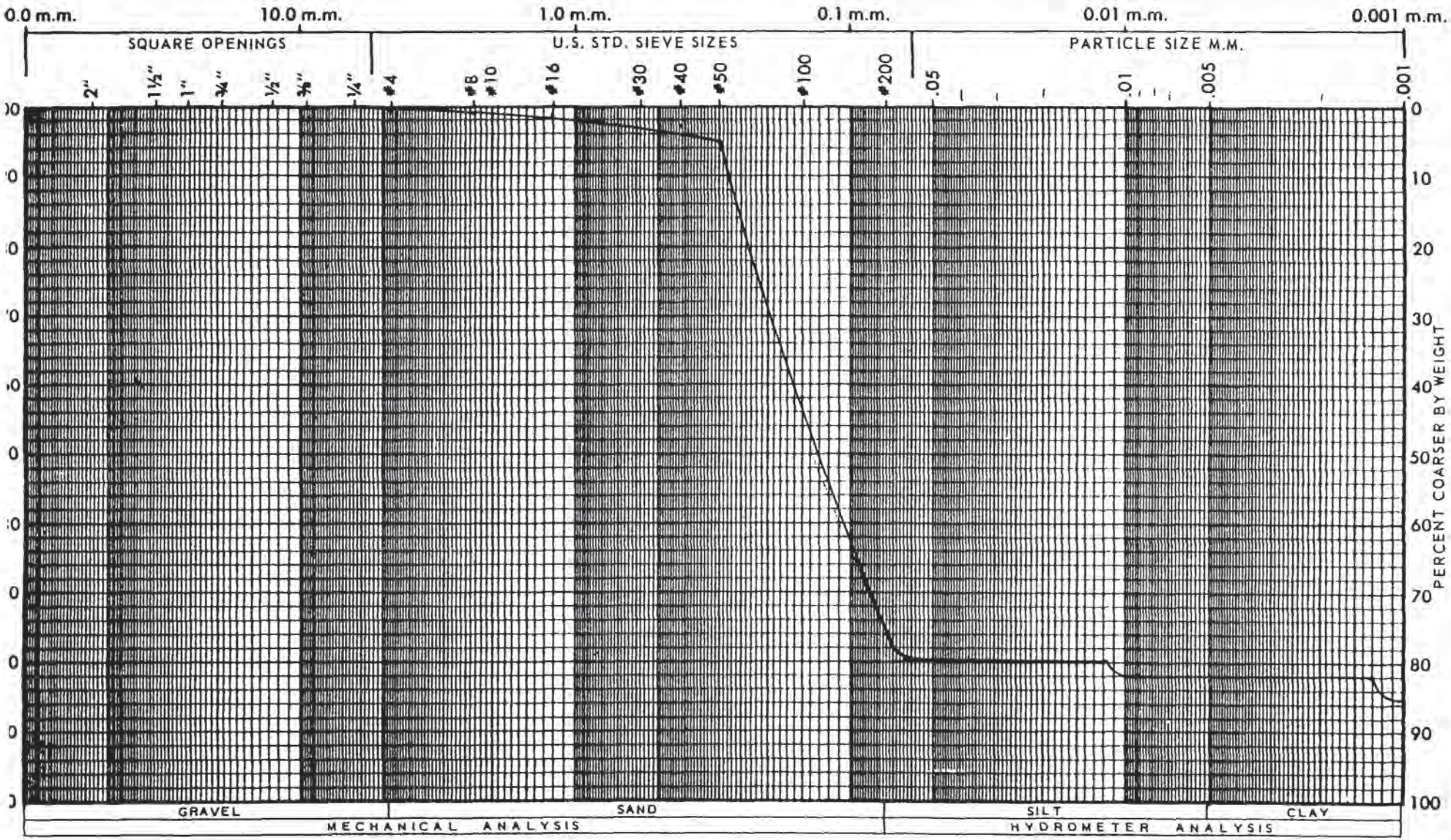
JOB NO. [illegible]

PARTICLE SIZE RIBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-31	NV	NP		SM	7932-31

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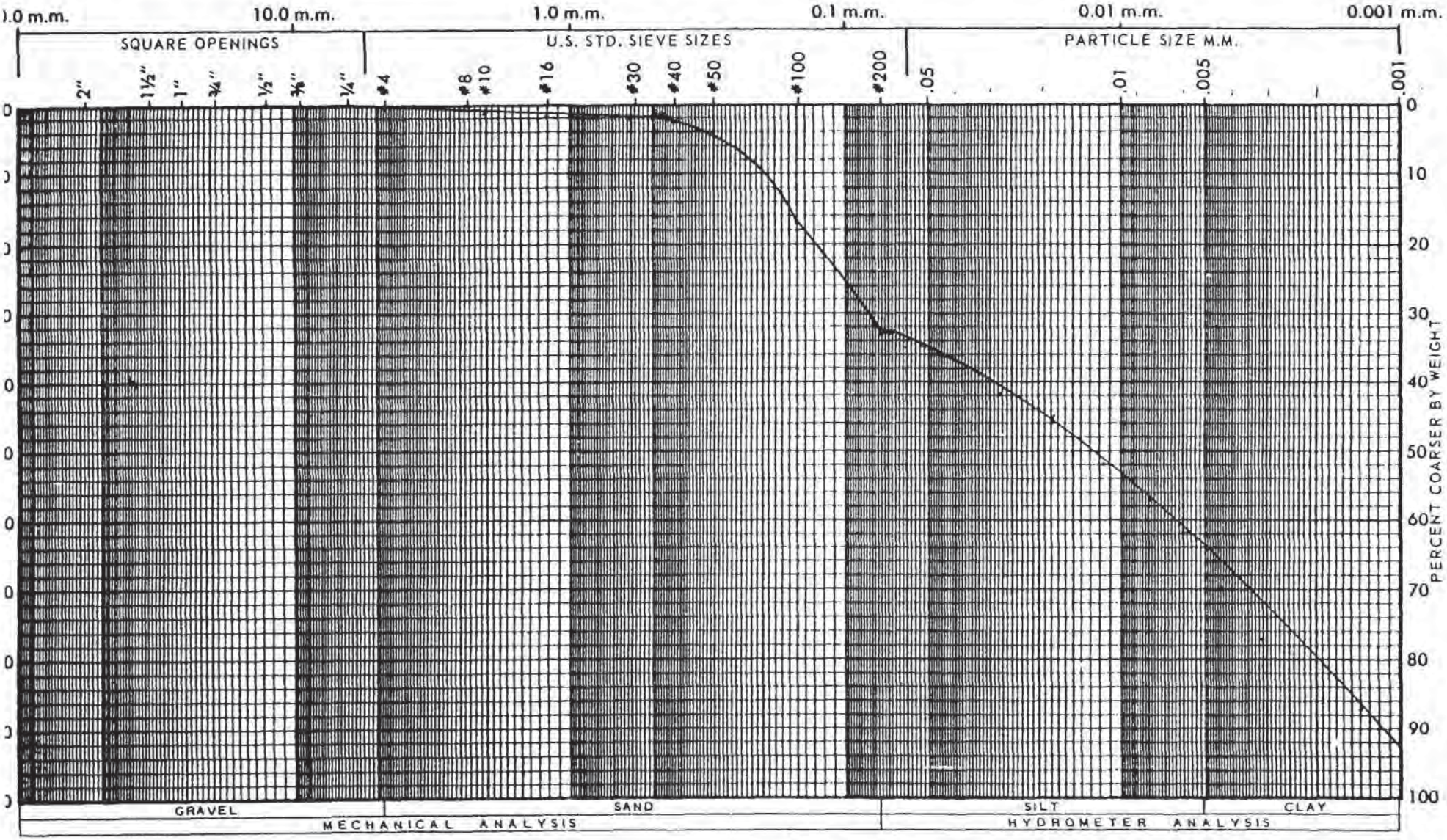
JOB NO.

PARTICLE SIZE IBUTION CURVE

PROJECT GANDI PROJECT LOCATION ROSWELL, NEW MEXICO



CURVE	SAMPLE	LIQUID LIMIT	PLASTICITY INDEX	ACTIVITY	UNIFIED SOIL CLASSIFICATION	LAB NO.
	PB-33	24	4		CL-ML	7932-33

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Attachment X

Grain Size Analyses

Grain-size Analysis Procedure

The following methodology is adapted from Jackson (1979). The samples were dry to the touch upon arrival; thus, no initial drying was performed.

1) Entire samples from the five foot core intervals were split until a 10 to 20 gram subsample was obtained.

2) Given that the material was not completely disaggregated, the subsample was crushed with a mortar and pestle to disaggregate coarse-grained clumps of rock.

3) The subsample was weighed on a Fisher-Scientific model 300-D balance. The accuracy of the balance is ± 0.02 gr for weights greater than 10 grams and ± 0.002 gr for weights less than 10 gr.

4) The subsample was split into two 50 ml centrifuge tubes, to which 30 ml of deionized water and 5 ml of 1% sodium-pyrophosphate solution (a de-flocculant) were added.

5) The centrifuge tubes were stopped and shaken vigorously for one minute. A sonic dismembrator was used to further disaggregate a few samples, but was found to have little effect.

6) The centrifuge tubes were placed in an IEC Centra-7 high-speed centrifuge for 6 minutes at 600 rpm to separate the silt and sand fraction from the clay.

7) Five ml of clay solution was extracted from each tube and placed in pre-weighed foil trays.

8) The trays were placed in an oven at 100°C for at least two hours (or until completely dry). The trays were weighed immediately after removal from the oven.

9) After subtracting the weight of the foil tray, the weight of the dried clay solution was multiplied by seven to obtain the weight of clay in the subsample.

10) The remaining material in the centrifuge tube is passed through a wet sieve in order to separate the sand and silt fractions.

11) The sand fraction was directed from the sieve into either a pre-weighed 100 ml beaker or petri dish.

12) The beakers or petri dishes were placed in an oven at 100°C for at least 2 hours (or until completely dry). The beakers or petri dishes were weighed after cooling to room temperature.

13) The weight of sand was obtained by subtracting the weight of the beaker or petri dish from the sand + glassware weight.

14) The weight percent of the sand and clay fractions were obtained by computing the ratio of size fraction weight to the total sample weight and multiplying by 100. The weight percent silt was obtained from the difference of the measured weight fractions and 100 percent.

Other:

- A blank was prepared to assess the contribution of sodium pyrophosphate to the clay weight.

- Replicates (both intentional and blind) were completed in order to assess the reproducibility of the results.

- The progress of the separation procedure was tracked in a lab notebook and written in indelible black ink.

Jackson, M.L., 1979, Soil Chemical Analysis--Advanced Course, 2nd edition, 11th printing. Published by the author, Madison, WI 53705.

Contract Samples for Jim Bonner, Stroller Corp.								
Borehole WW-2								
Sample #	Spl. wt.	tray wt.	cl. + tray	beaker wt.	sd + beak.	wt. % clay	wt. % silt	wt. % sand
48-55	10.99	1.51	1.69	45.27	49.56	11	50	39
55-60	12.41	1.52	1.65	47.09	50.60	8	64	28
60-65	10.40	1.55	1.74	36.58	38.04	13	73	14
65-70(av.)						15	55	30
70-75	12.43	1.64	1.85	27.47	28.67	12	79	10
75-80	21.32	1.54	2.03	46.17	48.05	16	75	9
80-85	9.95	1.56	1.76	49.96	50.64	14	79	7
85-90	11.42	1.57	1.80	36.10	38.33	14	66	20
90-95	17.71	1.51	2.04	34.16	38.33	21	55	24
95-100	18.22	1.50	1.95	45.24	46.57	17	75	7
105-110	9.61	1.52	1.74	43.80	45.16	16	70	14
110-115	14.94	1.60	1.89	48.54	52.24	14	61	25
115-120	13.14	1.49	1.71	50.16	52.92	12	67	21
120-125	12.66	1.53	1.77	50.18	51.19	13	79	8
125-130	14.99	1.57	1.80	40.82	41.99	11	82	8
130-135	10.99	1.60	1.78	35.02	36.40	11	76	13
135-140	13.99	1.55	1.83	50.53	51.58	14	78	8
140-145	10.81	1.52	1.76	27.51	29.78	16	63	21
145-150	16.22	1.58	1.88	46.92	49.10	13	74	13
150-155	29.35	1.53	2.22	44.70	49.60	17	67	17
155-160	14.42	1.55	1.84	49.84	51.70	14	73	13
160-165	6.45	1.56	1.64	44.78	45.01	9	88	4
165-170	28.54	1.58	2.19	50.11	55.06	15	68	17
170-175	13.11	1.61	1.86	38.47	40.89	13	68	18
175-180	12.06	1.58	1.85	38.46	41.49	16	59	25
180-185	14.30	1.56	1.85	36.29	40.42	14	57	29
185-190	8.42	1.54	1.66	50.76	51.80	10	78	12
190-195	15.84	1.60	1.93	47.12	50.72	15	63	23
195-200	11.70	1.51	1.71	40.35	42.42	12	71	18
200-205	8.55	1.53	1.72	47.98	49.93	16	61	23
205-210	8.01	1.58	1.74	40.85	42.71	14	63	23
210-215	8.13	1.51	1.73	44.72	46.26	19	62	19
215-220	6.86	1.51	1.67	35.31	36.83	16	62	22
220-225	9.24	1.53	1.65	47.46	48.75	9	76	14
225-230	5.85	1.55	1.68	45.80	47.41	16	57	28
230*								
235-240	13.28	1.50	1.76	45.55	48.75	14	62	24
240-245	14.14	1.54	1.82	34.18	38.39	14	56	30
245-250	15.21	1.57	1.97	40.96	45.24	19	53	28
250-255	10.61	1.60	1.82	36.60	38.01	14	73	13
255-260	10.19	1.59	1.69	45.48	47.86	7	69	23
260-265	16.46	1.54	1.87	46.22	52.28	14	49	37
265-270	19.97	1.54	2.00	27.50	32.47	16	59	25
270-275	14.45	1.58	1.85	47.10	52.16	13	52	35
275-280	6.04	1.57	1.67	47.45	48.52	11	71	18
280-285	12.18	1.51	1.70	38.45	41.43	11	64	24
285-290	17.22	1.54	1.84	50.47	54.93	12	62	26
290-295	15.47	1.56	1.83	50.19	54.08	12	63	25

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all previous information

295-300	12.08	1.53	1.74	50.11	52.09	12	71	16
300-305	10.51	1.56	1.80	48.56	50.96	16	62	23
305-310	22.28	1.55	2.11	36.10	42.03	18	56	27
310-315	8.84	1.53	1.67	40.95	41.87	11	78	10
315-320	10.05	1.57	1.81	37.02	37.81	17	75	8
320-325	10.06	1.55	1.72	46.89	50.02	12	57	31
325-330	14.45	1.53	1.78	44.73	49.16	12	58	31
330-335	12.30	1.57	1.82	46.88	52.91	14	37	49
335*								
340*								
345-350	7.47	1.53	1.62	49.79	51.12	8	74	18
350-355	12.28	1.57	1.78	50.15	52.18	12	71	17
355-360	11.06	1.51	1.70	44.80	47.31	12	66	23
360-365	8.98	1.52	1.65	45.48	45.91	10	85	5
365-370	13.63	1.59	1.84	45.28	48.86	13	61	26
370-375	5.84	1.53	1.60	35.28	35.75	8	84	8
375-380	11.58	1.52	1.76	50.12	52.04	15	69	17
380-385	8.80	1.54	1.72	44.17	46.74	14	57	29
385-390	21.13	1.54	2.06	45.79	52.11	17	53	30
390-395	12.80	1.53	1.79	44.15	45.44	14	76	10
395-400	8.60	1.57	1.71	45.78	46.37	11	82	7
400-405 ave.						15	76	9
405-410	8.43	1.52	1.64	50.17	51.07	10	80	11
410-415	18.01	1.52	1.85	50.21	52.34	13	75	12
415-420	13.57	1.56	1.83	49.93	51.88	14	72	14
420-425	18.60	1.54	1.85	44.82	48.68	12	67	21
425-430	16.81	1.59	1.85	40.41	43.25	11	72	17
430-435	14.50	1.51	1.81	50.14	53.39	15	63	22
435-440	16.00	1.53	1.92	50.06	51.76	17	72	11
440-445	12.71	1.51	1.86	50.24	51.26	19	73	8
445-450	27.89	1.56	2.35	50.18	54.56	20	64	16
450-455	13.73	1.54	1.79	46.91	49.12	13	71	16
455-460	17.21	1.64	1.98	36.13	37.11	14	81	6
465-470	15.26	1.54	1.76	49.81	53.18	10	67	22
470-475	23.75	1.62	1.98	50.00	54.64	11	70	20
475-480	8.36	1.55	1.69	50.79	51.80	12	76	12
480-485	10.60	1.53	1.70	50.44	53.61	11	59	30
*485-490								
490-495	9.96	1.51	1.76	50.58	52.28	18	65	17
495-500	17.81	1.53	1.99	48.56	50.07	18	73	8
500-505	18.96	1.53	1.83	46.97	51.60	11	65	24
505-510	19.79	1.57	1.88	50.16	54.62	11	66	23
510-515	10.34	1.57	1.75	50.04	53.20	12	57	31
515-520	7.85	1.60	1.77	45.82	46.45	15	77	8
520-525	14.57	1.58	1.91	48.55	50.51	16	71	13
525-530	27.57	1.56	2.11	35.30	45.75	14	48	38
530-535	21.96	1.60	1.81	49.91	55.41	7	68	25
535-540	13.51	1.61	1.86	40.38	45.30	13	50	36
540-545	18.88	1.54	1.95	40.84	46.86	15	53	32
545-550	11.38	1.51	1.67	50.54	54.23	10	58	32
550-555	13.94	1.57	1.76	43.81	46.91	9	68	22

This revision supersedes
all previous information

555-560	6.92	1.56	1.69	27.52	28.12	13	78	9	
560-565	14.90	1.51	1.82	40.86	44.81	14	59	27	
565-570	8.78	1.57	1.75	35.32	37.33	14	63	23	
570-575	8.75	1.54	1.72	43.83	45.23	14	70	16	
575-580	14.67	1.55	1.76	34.21	37.71	10	66	24	
580-585	11.83	1.51	1.72	35.06	36.30	12	77	10	
585-590	13.46	1.56	1.84	44.74	47.49	14	65	20	
590-595	12.42	1.52	1.72	50.57	51.63	12	80	9	
* - missing samples									
Effect of sonication									
615-620A	13.18	1.54	1.77	36.31	37.30	12	81	8	sonication
615-620B	13.22	1.55	1.76	48.02	48.89	11	82	7	no sonic.
blank	0.00	1.52	1.52	50.14	50.10	0.04 gr.	0 D.L.	0.00	gr.
Replicates									
65-70B	11.37	1.52	1.77	35.06	38.36	16	55	29	
65-70C	16.35	1.51	1.82	46.90	52.12	13	55	32	
65-70A	10.41	1.53	1.77	46.94	50.01	16	54	29	
					average	14.94	54.91	30.15	
					1 S.D.	1.65	0.49	1.56	
Blind Replicates									
400-405	16.05	1.48	1.89	45.29	47.59	18	68	14	
400-405	9.17	1.48	1.64	36.99	37.29	12	85	3	
					average	14.90	76.30	8.80	

This revision supersedes all previous information

MONTGOMERY WATSON

Calculation Cover Sheet

Appendix F1

Project Title: Triassic Park Waste Disposal Facility

Project No.: 602-0200

Calculation Title: Sediment Demonstration

	Name	Date
Prepared By:	Dan Gleason	11/15/97
Checked By:	Tom Leidich	11/15/97
Reviewed By:		

Revisions	Date	By	Checked By	Reviewed By

SOIL LOSS CALCULATIONS FOR TRIASSIC PARK LANDFILL COVER

1.0 EROSION CALCULATIONS

In order to evaluate the cover effectiveness for the Triassic Park Landfill an erosion analysis was performed. Calculated gross erosion effects on the existing surface slope were evaluated in comparison to State regulations. The equations and input parameters used to determine the gross annual sediment yield for the Triassic Park Landfill are presented in the following sections.

The Revised Universal Soil Loss Equation (RUSLE) was used to estimate the annual sediment yield (Barfield et al, 1981):

$$Y = R \bullet K \bullet L \bullet S \bullet C \bullet P$$

Where:

Y =	Sediment yield (tons per acre-year)
R =	Rainfall factor
K =	Soil erodibility factor
L =	Length factor
S =	Slope factor
C =	Control factor
P =	Practice factor

1.1 AVERAGE ANNUAL RAINFALL FACTOR, R_{annual}

The average annual rainfall factor was obtained for the following equation: $R = 27(P_{2.6})^{2.2}$ (Barfield et al, 1981). A value of 98 was used for the Triassic Park Landfill Cover Analysis.

1.2 SOIL ERODIBILITY FACTOR, K

The soil erodibility factor for the subject site was assumed based on site specific Soil Conservation data. The following soil erodibility factor was used for the Triassic Park Landfill analysis.

TABLE 1
SOIL ERODIBILITY FACTOR

Dominant Soil Type	Soil Texture	Soil Erodibility Factor (K)
Roswell - Faskin- Jalmer Association	Sand to sandy loam	0.30

1.3 LENGTH FACTOR, L

The length factor for the sediment yield equation was determined based on the following equation (Renard et al, 1996):

$$L = \left(\frac{\lambda}{72.6}\right)^m$$

Where:

λ =	Representative slope length (ft)
m =	Variable slope length exponent

The representative slope length was measured directly from topographic maps of the subject site. The slope length is defined as the distance from the point of origin of overland flow to the point where the slope decreases such that significant deposition occurs or the flow enters a defined channel.

The slope length exponent is related to the ratio β of rill erosion (caused by flow) to interill erosion (principally caused by raindrop impact) by the following equation (Renard et al, 1996):

$$m = \frac{\beta}{(1+\beta)}$$

$$\beta = \frac{\frac{\sin\theta}{0.0896}}{(3.0 \bullet (\sin\theta)^{0.8} + 0.56)}$$

Where: θ = Slope angle

1.4 SLOPE FACTOR, S

The slope factor is representative of the typical slope length found on the subject site and calculated as follows:

$S = 10.8 \bullet \sin(\theta) + 0.03$ for slopes < 9%

$S = 16.8 \bullet \sin(\theta) - 0.50$ for slopes ≥ 9%

Slope angles were determined from topographic maps or from design slope information.

1.5 CONTROL FACTOR, C

The control factor is used to account for vegetative or mulch cover. The following values were utilized:

TABLE 2
CONTROL FACTOR

Surface	Vegetation	Control Factor (C)
Vegetated Conditions	No appreciable canopy, 60 % herbaceous cover	0.042

1.6 PRACTICE FACTOR, P

The practice factor is used to account for soil surface conditions, such as contour furrow ditches. The following values were utilized:

TABLE 3
PRACTICE FACTOR

Surface	Practice	Practice Factor (P)
Vegetated Conditions	None	0.80

2.0 RESULTS

Based on the attached spreadsheet calculations a maximum slop length of 650 feet adequately meets the maximum allowable gross erosion rate of 2 tons per acre-year for 6 % slope and 30 feet.

3.0 REFERENCES

Barfield, Warner, and Haan, 1981. *Applied Hydrology and Sedimentology for Disturbed Areas.* Oklahoma Technical Press, Stillwater, Oklahoma

Renard, K.G., Foster, G.R. Weesies G.A., McCool D.K., Yoder D.C., coordinators, 1996. *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal soil Loss Equation (RUSLE).* Agriculture Handbook No. 703. U.S. Department of Agriculture

FINAL COVER

SOIL ERODIBILITY FACTOR:

Soil Type	Soil Group	Erodibility Factor, K
Final Cover	B	0.3

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
30	7.5	25.0%	0.6	14.0	2.10

The LS Factor was calculated by:

LS = (Slope Length/72.6)^m(10.8*sin(slope angle) + 0.03) for Slopes < 9%*

LS = (Slope Length/72.6)^m(16.8*sin(slope angle) - 0.5) for Slopes > or = 9%*

Where:

Slope < or = 3%	*m = 0.3*
Slope = 4%	*m = 0.4*
5% > Slope < 10%	*m = 0.5*
Slope > 10%	*m = 0.6*

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Control Factor, C	Practice Factor, P
Final Cover	60%	0%	0.042	0.80

RAINFALL FACTOR:

R = 98

TRIASSIC PARK LANDFILL
CALCULATED SEDIMENT YIELD

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yield is determined according to the Revised Universal Soil Loss Equation.

PARAMETER DESCRIPTION	VALUE	
Annual Rainfall Factor	98.00	
Soil Erodibility Factor	0.30	
Length Slope Factor	2.10	
Control Factor	0.04	
Practice Factor	0.80	
Gross Annual Sediment Yield	2.08	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0010	acre-feet/acre/year
Sediment Delivery Ratio	90%	
Estimated Annual Sediment Yield	0.0009	acre-feet/acre/year
Watershed Area	0	acres
Watershed Annual Sediment Yield	0.0000	acre-feet/year
Number of years	1	years
Required Pond Sediment Storage	0.000	acre-feet

TRIASSIC PARK LANDFILL
CALCULATED SEDIMENTOLOGY DATA

FINAL COVER

SOIL ERODIBILITY FACTOR:

Soil Type	Soil Group	Erodibility Factor, K
Final Cover	B	0.3

SLOPE FACTOR:

Length (ft)	Elevation Change (ft)	Slope (%)	m	Slope Angle (deg)	LS Factor
650	39	6.0%	0.5	3.4	2.03

The LS Factor was calculated by:

LS = (Slope Length/72.6)^m(10.8*sin(slope angle) + 0.03) for Slopes < 9%*

LS = (Slope Length/72.6)^m(16.8*sin(slope angle) - 0.5) for Slopes > or = 9%*

Where:

Slope < or = 3%	*m = 0.3*
Slope = 4%	*m = 0.4*
5% > Slope < 10%	*m = 0.5*
Slope > 10%	*m = 0.6*

COVER AND PRACTICE FACTORS:

Cover Type	Cover (%)	Canopy (%)	Control Factor, C	Practice Factor, P
Final Cover	60%	0%	0.042	0.80

RAINFALL FACTOR: R = 98

CALCULATED SEDIMENT YIELD

The following spreadsheet calculates the predicted sediment yield for the project area. The gross sediment yield is determined according to the Revised Universal Soil Loss Equation.

PARAMETER DESCRIPTION	VALUE	
Annual Rainfall Factor	98.00	
Soil Erodibility Factor	0.30	
Length Slope Factor	2.03	
Control Factor	0.04	
Practice Factor	0.80	
Gross Annual Sediment Yield	2.00	tons/acre/year
Sediment Density	94.00	pcf
Gross Annual Sediment Yield	0.0010	acre-feet/acre/year
Sediment Delivery Ratio	90%	
Estimated Annual Sediment Yield	0.0009	acre-feet/acre/year
Watershed Area	0	acres
Watershed Annual Sediment Yield	0.0000	acre-feet/year
Number of years	1	years
Required Pond Sediment Storage	0.000	acre-feet

APPENDIX F

SURFACE WATER CONTROL SYSTEM DESIGN

1.0 INTRODUCTION

This appendix contains the methodology, assumptions, and calculation for the proposed channels, culverts and ponds.

2.0 HYDROLOGY

The hydrologic calculations used to evaluate the Triassic Park Landfill surface water control system were performed utilizing the SEDCAD+ computer model developed by Civil Software Design.

SEDCAD+ is a hydrologic, hydraulic, and sediment calculation model designed for use on computer systems. The SEDCAD+ hydrologic model calculates runoff volume, and peak flow via a numerical modeling technique based on user inputs of a design storm event, (i.e., precipitation frequency data, selection of rainfall distribution, and convolution increment). Hydrographs are developed on a subwatershed basis with the input of area, time of concentration, SCS curve number, and the selection of a hydrograph shape. Routing of hydrographs is accomplished by the Muskingum Method.

Inputs to the hydrology component of the SEDCAD+ computer model include:

- Precipitation Distribution
- Storm Duration
- Return Period/Precipitation
- Hydrograph Response Shape
- Drainage Basin Area
- Time of Concentration
- Muskingum Routing Parameters
- Curve Number

Input values used in this model, are shown on the SEDCAD+ printouts in Attachment 1, and are explained in the following text.

2.1 Precipitation Distribution

A precipitation distribution is input to model the runoff hydrograph. SEDCAD+ allows the user to choose between the SCS Type I and Type II Storms. The SCS Type II distribution was input as a geographical estimation of the area storms.

2.2 Storm Duration

A storm duration of 24 hours was used for the design and evaluation of the stormwater control system and represents the largest peak flow condition.

2.3 Return Period/Precipitation

A precipitation amount is required for the appropriate return period. As required by current regulations for the Triassic Park Landfill, the following precipitation amount was used for the design and evaluation of the stormwater control system (National Oceanic and Atmospheric Administration, 1973)

2-year, 24-hour event	2.1 inches
25-year, 24-hour event	4.3 inches
100-year, 24-hour event	5.3 inches

2.4 Hydrograph Response Shape

A unit hydrograph is chosen for each drainage area or sub-area model to predict the runoff response. The hydrograph responses available in the SEDCAD+ model are slow, medium, and fast. A slow response corresponds to a forested area or an area with a number of obstructions. A fast response corresponds to an unvegetated or poorly protected area. Medium hydrograph responses were chosen for disturbed and undisturbed areas.

The internal convolution increment is 0.05 hours and values are saved at the user specified interval of 0.1 hours or greater. A convolution increment of 0.1 was specified for the Triassic Park Landfill Area.

2.5 Drainage Basin Area

The drainage areas were determined by direct measurement from the U.S. Geological Survey, Mescalero Point quadrangle map, and a 1"=100' scale ariel survey topography map of the site. All basin areas are shown on the SEDCAD+ computer printouts in Attachment 1.

2.6 Time of Concentration, T_c

The time of concentration was calculated using the SCS upland method (a utility of SEDCAD+). All hydraulic lengths, drainage heights and slopes were measured directly from the above mentioned map and drawing. The calculated values for each structure are shown on the SEDCAD+ printouts in Attachment 1.

2.7 Muskingum Routing Parameters, K, X

The Muskingum Routing Parameters were also calculated using the SCS upland method. All hydraulic lengths, drainage heights and slopes were measured directly from the appropriate maps and drawings. The values calculated between each junction and/or subwatershed are shown on the SEDCAD+ printouts in Attachment 1.

2.8 Curve Number, CN

The run-off curve number is a factor relating the amount of rainfall to the amount of run-off for a given area. Curve numbers (CN) were evaluated based on vegetation and soil type for the given watershed. Vegetation was assumed based on anticipated cover vegetation. Indigenous surface soils types were obtained from the county Soil Conservation Service. The following curve numbers, presented in Table A-1, were assigned to area watersheds (U.S. Department of Commerce, 1986):

TABLE A-1 CURVE NUMBERS			
Area Type	Hydrologic Soil Group	Vegetation	Curve Number
Final Cover	B	Herbaceous (Fair)	71
Facilities Disturbed	B	Newly Graded	86
Waste	C	Newly Graded	91
Landfill Disturbed	D	Newly Graded	94
Undisturbed	B	Herbaceous (Fair)	71

3.0 CHANNEL DESIGNS

The surface water diversion dimensions were determined using Mannings Equation for open channel flow Channels with flow velocities less than 5 fps from a 25-year event will not require erosion protection. Channels with peak flow velocities greater than 5 fps from a 25-year event but less than 5 fps from and average storm (2-year event) will also not utilize erosion protection. During average storm events these channels should be stable, however, during major storm events the channels may show signs of erosion in some areas. These areas will be repaired as required following all major storm events. Channels with peak flow velocities greater than 5 fps from and average storm will be lined with gravel or riprap size particles if required. To minimize sediment transport to receiving streams the East Channel and Final Cover Roadside Ditch will be lined with gravel.

Riprap and gravel sizes were determined using the SEDCAD+ subroutine for designing riprap lined channels, utilizing the PADER Method

All inputs and results are shown on the SEDCAD channel design computer printouts in Attachment 2.

A riprap apron will be constructed at the end of the East channel to dissipate the flow before entering the natural channel to help reduces erosion. The apron size and riprap requirement was designed using design curves relating culvert size, peak flow and taiwater conditions. The design calculations are shown in Attachment 3

All inputs and results are shown on the SEDCAD channel design computer printouts

4.0 CULVERT DESIGNS

The culverts were sized using the U.S. Bureau of Public Roads nomograph using a headwater/ diameter ratio of 1.5. The culvert design inputs and results are shown in Attachment 4 along with the nomographs.

5.0 PONDS

All three surface water detention basins are designed to contain the storm water discharge from the entire active site area given flows from a 25-year, 24-hour storm event. The total run-off for each basin was determined using SEDCAD+. All inputs and results are shown on the SEDCAD+ computer printouts in Attachment 1. The pond volumes were determine by determining the areas of the stages for every two foot elevation and developing a stage storage table. The stage storage tables for each pond are shown in Attachment 5.

6.0 REFERENCES

Barfield, B.J., Warner, R.C., Haan, C.T., 1981, *Applied Hydrology and Sedimentology for Disturbed Areas.*

Warner, R.C., Schwab, P.J, 1992, *SEDCAD + Version 3.*

Urban Hydrology For Small Watersheds, TR-55, 1986, Soil Conservation Service, USDA

TRIASSIC PARK LANDFILL

CHANNEL DESIGNS

Ditch	25-yr,24-hr Flow Q (cfs)	Slope (%)	Bottom Width (ft)	Side Slope (H:1V)	Depth of Flow (ft)	Velocity (fps)	Freeboard (ft)	~~Minimum~~ Maximum Total Depth (ft)	Erosion Protection	2 -yr,24-hr Flow Q (cfs)	Velocity (fps)
1	34.2	0.5-2.0	0	2	2.1	6.7	~~0.3~~ 1	~~2.4~~ 3.1	None	4.8	~~4.7~~ 4.1
2	62.2	0.5-1.0	0	2	2.6	6.0	~~0.3~~ 1	~~2.9~~ 3.6	None	8.3	3.6
3	126.6	0.5-1	5	3	2.4	5.75	~~0.3~~ 1	~~2.7~~ 3.4	None	40	4.8
		1.1-2	5	3	2.1	6.6	~~0.3~~ 1	~~2.3~~ 3.1	Riprap D50=6"	(4)	(4)
4	6.8	0.5-1.0	0	2	1.1	3.5	~~0.3~~ 1	~~1.4~~ 2.1	None	(4)	(4)
5	217.3	0.5-1.0	10	~~2.3~~	2.3	7.3	~~0.3~~ 1	~~2.6~~ 3.3	None	53.6	~~5.0~~ 4.8
6	30.1	0.5-1	0	2	2.0	5.0	~~0.3~~ 1	~~2.3~~ 3	None	(4)	(4)
7 Lower	7.3	1	0	1.5	0.9	6.0	~~0.3~~ 1	~~1.2~~ 1.9	HDPE	(4)	(4)
7 Upper	7.3	10	0	1.5	0.6	14.2	~~0.3~~ 1	~~0.9~~ 1.6	HDPE	(4)	(4)
8 Lower	19.3	1	0	1.5	1.3	7.6	~~0.3~~ 1	~~1.6~~ 2.3	HDPE	(4)	(4)
8 Upper	19.3	10	0	1.5	0.8	18	~~0.3~~ 1	~~1.1~~ 1.8	HDPE	(4)	(4)
East	272.8	0.5-0.8	16	3	~~2.3~~ 2.5	~~6.0~~ 5.5	~~0.3~~ 1	~~2.6~~ 3.5	Gravel D50=3"	(4)	(4)
Final Cover Road Side	31.5	0.5-2.4	0	3	1.8	~~5.7~~ 5	~~0.3~~ 1	~~2.1~~ 2.8	Gravel D50=3"	(4)	(4)
Spillway	358	0.5	20	3	~~2.4~~ 2.6	5.4	1.0	~~3.4~~ 3.6	Gravel D50=3"	(4)	(4)
9	90.9	0.5	3	3	2.1	4.7	1	3.1	none	(4)	(4)
10	90.4	0.5	3	3	2.1	4.7	1	3.1	none	(4)	(4)

Notes:

(1) Maximum allowable velocity for channels without erosion protection 5 fps.

(2) Channels with velocities greater than 5 fps for the 25-year event and less than 5 fps for the 2 year storm will not be lined. These channels will be repaired after major storm events.

(3) Maximum allowable velocity for gravel lined channels is 6 fps

(4) * THE VELOCITY CALCULATIONS WERE NOT REQUIRED FOR THE 2-YEAR STORM BECAUSE THE 24-YEAR ~~STORM~~ RAIN EVENT FLOW VELOCITY WAS LESS THAN 5 fps, SO THE 2-YEAR, 24-HOUR RAIN EVENT FLOW VELOCITY WOULD ~~NEEDED~~ BE LESS THAN 5 fps, OR [illegible] CALCULATION THAT IT WAS NEEDED IS UNNECESSARY.

ATTACHMENT 1
SEDCAD+ COMPUTER PRINTOUTS

ATTACHMENT 1
SEDCAD+ COMPUTER PRINTOUTS

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\FACPOND

Date: 11-13-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\FACPOND User: TEL
Date: 11-13-1997 Time: 16:28:43
TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

TBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	32.80	71	M	0.348	0.000	0.000	0.0	4.38	34
		Type: Null			Label: DITCH 1					
111	Structure	32.80							4.38	
111	Total IN/OUT	32.80							4.38	34
121	1	77.80	71	M	0.595	0.000	0.000	0.0	10.39	62
		Type: Null			Label: DITCH 2					
121	Structure	77.80							10.39	
21	Total IN/OUT	77.80							10.39	62
211	1	104.10	86	M	0.852	0.000	0.000	0.0	24.46	126
		Type: Null			Label: DITCH 3					
211	Structure	104.10							39.24	
211	Total IN/OUT	214.70							39.24	210
111 to 211 Routing						0.009	0.277			
221	1	4.40	86	M	0.563	0.000	0.000	0.0	1.03	6
		Type: Null			Label: DITCH 4					
221	Structure	4.40							1.03	
221	Total IN/OUT	4.40							1.03	6
311	1	4.50	86	M	0.099	0.000	0.000	0.0	1.06	12
		Type: Null			Label: DITCH 5					
311	Structure	4.50							41.33	
311	Total IN/OUT	223.60							41.33	217
211 to 311 Routing						0.078	0.277			
321	1	15.60	86	M	0.330	0.000	0.000	0.0	3.67	30
		Type: Null			Label: DITCH 6					
21	Structure	15.60							3.67	
321	Total IN/OUT	15.60							3.67	30

411	1	8.30	86	M	0.166	0.000	0.000	0.0	1.95	19.
411	2	8.20	71	M	0.561	0.000	0.000	0.0	1.10	6.
411	3	9.80	98	F	0.001	0.000	0.000	0.0	3.32	32.
		Type: Null			Label: STORMWATER POND					
'11 Structure		26.30							51.36	
.11 Total IN/OUT		265.50							51.36	254.
311 to 411 Routing						0.000	0.486			

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\FACPOND

Date: 11-13-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\FACPOND User: TEL
Date: 11-13-1997 Time: 16:28:50
TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
Storm: 5.30 inches, 100 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pe Disc (c
111	1	32.80	71	M	0.348	0.000	0.000	0.0	6.41	5
		Type: Null			Label: DITCH 1					
111	Structure	32.80							6.41	
111	Total IN/OUT	32.80							6.41	5
121	1	77.80	71	M	0.595	0.000	0.000	0.0	15.21	9
		Type: Null			Label: DITCH 2					
121	Structure	77.80							15.21	
121	Total IN/OUT	77.80							15.21	9
211	1	104.10	86	M	0.852	0.000	0.000	0.0	32.51	16
		Type: Null			Label: DITCH 3					
211	Structure	104.10							54.13	
211	Total IN/OUT	214.70							54.13	29
111 to 211 Routing						0.009	0.277			
221	1	4.40	86	M	0.563	0.000	0.000	0.0	1.37	
		Type: Null			Label: DITCH 4					
221	Structure	4.40							1.37	
221	Total IN/OUT	4.40							1.37	
311	1	4.50	86	M	0.099	0.000	0.000	0.0	1.41	1
		Type: Null			Label: DITCH 5					
311	Structure	4.50							56.91	
311	Total IN/OUT	223.60							56.91	30
211 to 311 Routing						0.078	0.277			
321	1	15.60	86	M	0.330	0.000	0.000	0.0	4.87	3
		Type: Null			Label: DITCH 6					
321	Structure	15.60							4.87	
321	Total IN/OUT	15.60							4.87	3

411	1	8.30	86	M	0.166	0.000	0.000	0.0	2.59	25
411	2	8.20	71	M	0.561	0.000	0.000	0.0	1.60	10
411	3	9.80	98	F	0.001	0.000	0.000	0.0	4.13	39
		Type: Null			Label: STORMWATER POND					
411 Structure		26.30							70.12	
411 Total IN/OUT		265.50							70.12	357
311 to 411 Routing						0.000	0.486			

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\FACPOND

Date: 11-14-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\FACPOND User: TEL
Date: 11-14-1997 Time: 09:55:46
TRIASSIC PARK LANDFILL: FACILITIES DITCHES AND POND
Storm: 2.10 inches, 2 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	32.80	71	M	0.348	0.000	0.000	0.0	0.84	4
		Type: Null			Label: DITCH 1					
111	Structure	32.80							0.84	
111	Total IN/OUT	32.80							0.84	4
121	1	77.80	71	M	0.595	0.000	0.000	0.0	1.99	8
		Type: Null			Label: DITCH 2					
121	Structure	77.80							1.99	
21	Total IN/OUT	77.80							1.99	8
211	1	104.10	86	M	0.852	0.000	0.000	0.0	8.03	40
		Type: Null			Label: DITCH 3					
211	Structure	104.10							10.85	
211	Total IN/OUT	214.70							10.85	51
111 to 211 Routing						0.009	0.277			
221	1	4.40	86	M	0.563	0.000	0.000	0.0	0.34	2
		Type: Null			Label: DITCH 4					
221	Structure	4.40							0.34	
221	Total IN/OUT	4.40							0.34	2
311	1	4.50	86	M	0.099	0.000	0.000	0.0	0.35	4
		Type: Null			Label: DITCH 5					
311	Structure	4.50							11.54	
311	Total IN/OUT	223.60							11.54	53
211 to 311 Routing						0.078	0.277			
321	1	15.60	86	M	0.330	0.000	0.000	0.0	1.20	9
		Type: Null			Label: DITCH 6					
21	Structure	15.60							1.20	
321	Total IN/OUT	15.60							1.20	9

411 1	8.30	86	M	0.166	0.000	0.000	0.0	0.64	6
411 2	8.20	71	M	0.561	0.000	0.000	0.0	0.21	0
411 3	9.80	98	F	0.001	0.000	0.000	0.0	1.53	19
	Type: Null			Label: STORMWATER POND					
411 Structure	26.30							15.12	
411 Total IN/OUT	265.50							15.12	64
311 to 411 Routing					0.000	0.486			

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

TRIASSIC PARK LANDFILL: RAMP DITCHES & CLAENWATER COLLECTION POND

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\COLBASIN

Date: 11-14-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\COLBASIN User: TEL
Date: 11-14-1997 Time: 13:22:41
TRIASSIC PARK LANDFILL: RAMP DITCHES & CLAENWATER COLLECTION POND
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	2.30	94	F	0.026	0.000	0.000	0.0	0.69	7
		Type: Null			Label: DITCH 7					
111	Structure	2.30							0.69	
111	Total IN/OUT	2.30							0.69	7
121	1	6.10	94	F	0.071	0.000	0.000	0.0	1.84	19
		Type: Null			Label: DITCH 8					
121	Structure	6.10							1.84	
1	Total IN/OUT	6.10							1.84	19
211	1	6.60	94	F	0.046	0.000	0.000	0.0	1.99	20
		Type: Null			Label: COLLECTION POND					
211	Structure	6.60							4.52	
211	Total IN/OUT	15.00							4.52	47
111 to 211 Routing						0.000	0.486			

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

GANDY TRIASSIC PARK LANDFILL : SITE PERIMETER DITCH

by

Name: DGG

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\OFFSITE

Date: 11-08-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\OFFSITE User: DGG
Date: 11-08-1997 Time: 13:07:58
GANDY TRIASSIC PARK LANDFILL : SITE PERIMETER DITCH
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	377.80	71	M	0.709	0.000	0.000	0.0	50.47	272
		Type: Null			Label: EAST DITCH					
111	Structure	377.80							50.47	
111	Total IN/OUT	377.80							50.47	272

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

GANDY TRIASSIC PARK LANDFILL : FINAL COVER ROADSIDE DITCH

by

Name: DGG

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\ROADSIDE

Date: 11-07-1997

Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\ROADSIDE User: DGG
Date: 11-07-1997 Time: 15:14:00
GANDY TRIASSIC PARK LANDFILL : FINAL COVER ROADSIDE DITCH
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Peak Discha (cfs
111	1	27.00	71	M	0.258	0.000	0.000	0.0	3.61	31
		Type: Null			Label: ROADSIDE DITCH					
111	Structure	27.00							3.61	
111	Total IN/OUT	27.00							3.61	31

CIVIL SOFTWARE DESIGN

SEDCAD+ Version 3

GANDY : LANDFILL PHASE 1 RUN-OFF

by

Name: TEL

Company Name: ACZ, INC.
File Name: J:\602\SEDCAD\LANDFILL

Date: 11-08-1997

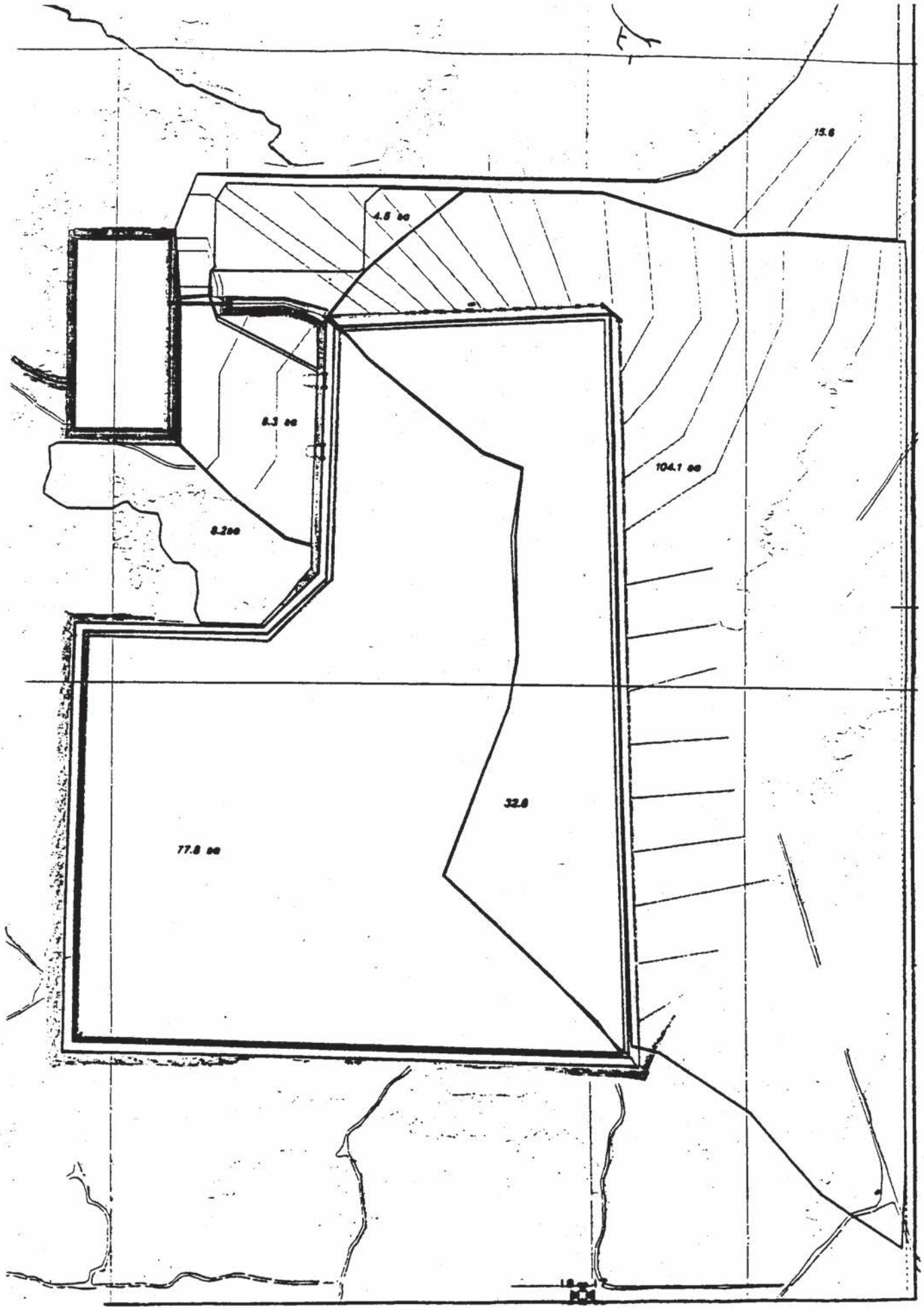
Civil Software Design -- SEDCAD+ Version 3.1
Copyright (C) 1987-1992. Pamela J. Schwab. All rights reserved.

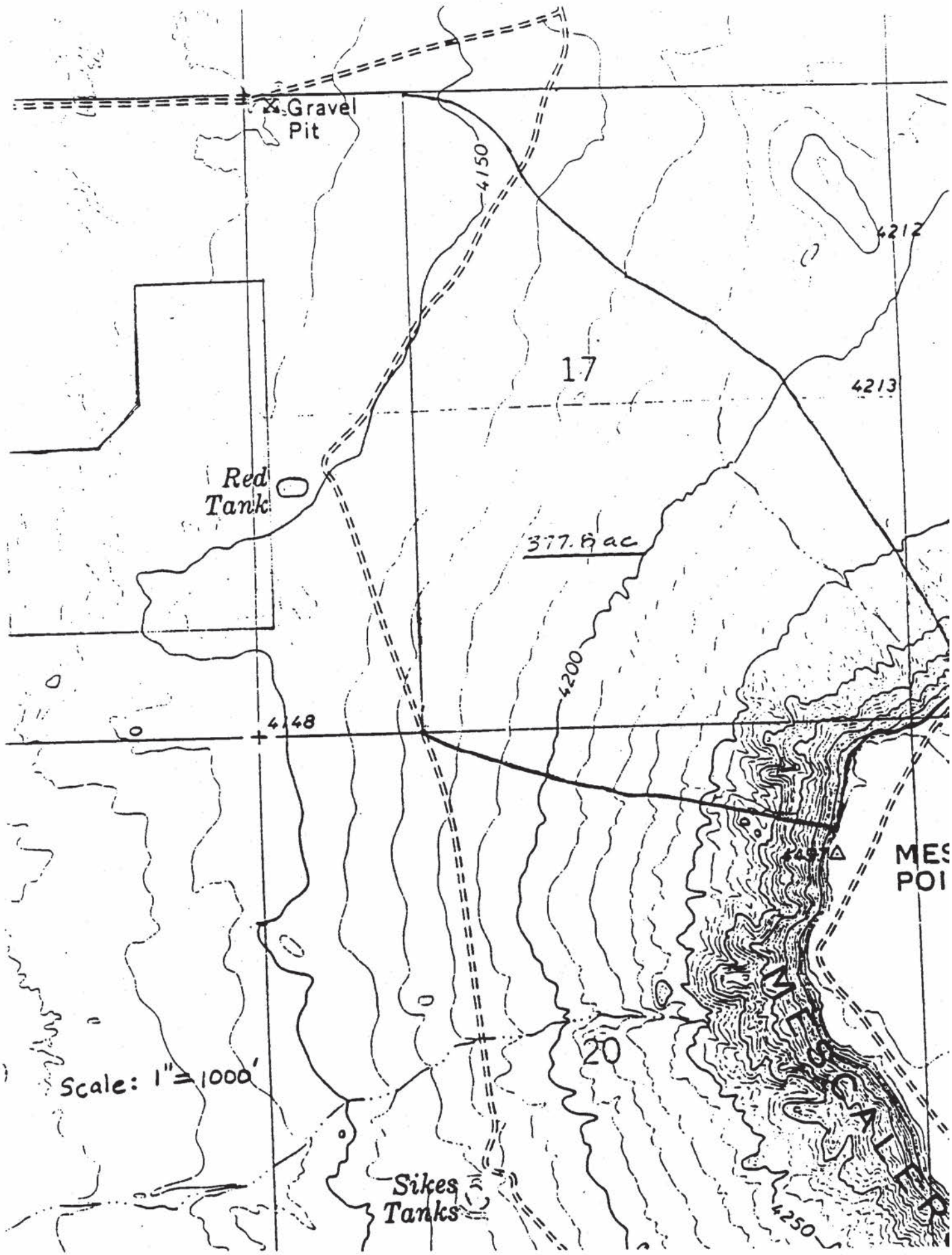
Company Name: ACZ, INC.
Filename: J:\602\SEDCAD\LANDFILL User: TEL
Date: 11-08-1997 Time: 16:23:38
GANDY : LANDFILL PHASE 1 RUN-OFF
Storm: 4.30 inches, 25 year-24 hour, SCS Type II
Hydrograph Convolution Interval: 0.1 hr

SUBWATERSHED/STRUCTURE INPUT/OUTPUT TABLE

-Hydrology-

JBS	SWS	Area (ac)	CN	UHS	Tc (hrs)	K (hrs)	X	Base-Flow (cfs)	Runoff Volume (ac-ft)	Pea Disch (cf
111	1	15.60	91	M	0.070	0.000	0.000	0.0	4.30	47
		Type: Null			Label: PHASE 1 LANDFILL					
111	Structure	15.60							4.30	
111	Total IN/OUT	15.60	-						4.30	47


15.6
4.6 ac
6.3 ac
104.1 ac
8.2ac
32.8
77.8 ac


Gravel Pit
4150
4212
17
4213
Red Tank
377.8 ac
4200
4148
MES
POI
20
Scale: 1" = 1000'
Sikes Tanks
4250

ATTACHMENT 2
CHANNEL DESIGNS

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 1

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	34.20 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.07 ft
with Freeboard	2.37 ft
Top Width	8.27 ft
with Freeboard	9.47 ft
Velocity	4.00 fps
Cross Sectional Area	8.55 sq ft
Hydraulic Radius	0.92 ft
Froude Number	0.69

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 1

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	34.20 cfs	
Slope	2.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.59 ft
with Freeboard	1.89 ft
Top Width	6.38 ft
with Freeboard	7.58 ft
Velocity	6.73 fps
Cross Sectional Area	5.08 sq ft
Hydraulic Radius	0.71 ft
Froude Number	1.33

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 1

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	4.80 cfs	
Slope	2.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	0.76 ft
with Freeboard	1.06 ft
Top Width	3.05 ft
with Freeboard	4.25 ft
Velocity	4.12 fps
Cross Sectional Area	1.17 sq ft
Hydraulic Radius	0.34 ft
Froude Number	1.17

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 2

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	62.20 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.59 ft
with Freeboard	2.89 ft
Top Width	10.35 ft
with Freeboard	11.55 ft
Velocity	4.65 fps
Cross Sectional Area	13.39 sq ft
Hydraulic Radius	1.16 ft
Froude Number	0.72

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 2

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	62.20 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.27 ft
with Freeboard	2.57 ft
Top Width	9.09 ft
with Freeboard	10.29 ft
Velocity	6.02 fps
Cross Sectional Area	10.33 sq ft
Hydraulic Radius	1.02 ft
Froude Number	1.00

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 2

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	8.30 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.07 ft
with Freeboard	1.37 ft
Top Width	4.27 ft
with Freeboard	5.47 ft
Velocity	3.64 fps
Cross Sectional Area	2.28 sq ft
Hydraulic Radius	0.48 ft
Froude Number	0.88

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	126.60 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.030	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.36 ft
with Freeboard	2.66 ft
Top Width	19.13 ft
with Freeboard	20.93 ft
Velocity	4.45 fps
Cross Sectional Area	28.42 sq ft
Hydraulic Radius	1.43 ft
Froude Number	0.64

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	126.60 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.030	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.00 ft
with Freeboard	2.30 ft
Top Width	17.00 ft
with Freeboard	18.80 ft
Velocity	5.75 fps
Cross Sectional Area	22.01 sq ft
Hydraulic Radius	1.25 ft
Froude Number	0.89

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	40.00 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.03 ft
with Freeboard	1.33 ft
Top Width	11.18 ft
with Freeboard	12.98 ft
Velocity	4.80 fps
Cross Sectional Area	8.33 sq ft
Hydraulic Radius	0.72 ft
Froude Number	0.98

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	126.60 cfs	
Slope	1.10 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	5.00 ft	
Manning's n	0.035	
Material	6" RIPRAP	
Freeboard	.3 ft	

RESULTS:

Depth	2.10 ft
with Freeboard	2.40 ft
Top Width	17.62 ft
with Freeboard	19.42 ft
Velocity	5.32 fps
Cross Sectional Area	23.80 sq ft
Hydraulic Radius	1.30 ft
Froude Number	0.81

SEDCAD+ RIPRAP CHANNEL DESIGN

DITCH 3

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	126.60 cfs	
Slope	2.00 %	
Sideslopes (L and R)	3.00:1	3.00:1
Bottom Width	5.00 feet	
Freeboard	.3 ft	

RESULTS:

Steep Slope Design - PADER Method

Depth	1.82 ft
with Freeboard	2.12 ft
Top Width	15.94 ft
with Freeboard	17.74 ft
Velocity	6.63 fps
Cross Sectional Area	19.10 sq ft
Hydraulic Radius	1.16 ft
Manning's n	0.035
Froude Number	1.07
Dmax	0.625 ft (7.50 in)
D50	0.500 ft (6.00 in)
D10	0.167 ft (2.00 in)

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 4

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.80 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.13 ft
with Freeboard	1.43 ft
Top Width	4.51 ft
with Freeboard	5.71 ft
Velocity	2.67 fps
Cross Sectional Area	2.55 sq ft
Hydraulic Radius	0.50 ft
Froude Number	0.63

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 4

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	6.80 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	.STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	0.99 ft
with Freeboard	1.29 ft
Top Width	3.96 ft
with Freeboard	5.16 ft
Velocity	3.46 fps
Cross Sectional Area	1.96 sq ft
Hydraulic Radius	0.44 ft
Froude Number	0.87

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 5

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	217.30 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.025	
Material	.STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	2.27 ft
with Freeboard	2.57 ft
Top Width	23.63 ft
with Freeboard	25.43 ft
Velocity	5.69 fps
Cross Sectional Area	38.21 sq ft
Hydraulic Radius	1.57 ft
Froude Number	0.79

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 5

INPUT VALUES:

Shape	TRAPEZOIDAL	
Discharge	217.30 cfs	
Slope	1.00 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Bottom Width	10.00 ft	
Manning's n	0.025	
Material	.STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.90 ft
with Freeboard	2.20 ft
Top Width	21.39 ft
with Freeboard	23.19 ft
Velocity	7.29 fps
Cross Sectional Area	29.79 sq ft
Hydraulic Radius	1.35 ft
Froude Number	1.09

Material:

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
10.00	3.0:1	3.0:1	1.0	0.0250			

	w/o Freeboard	w/ Freeboard
Design Discharge:	53.60 cfs	
Depth:	0.89 ft	
Top Width:	15.31 ft	
Velocity:	4.78 fps	
X-Section Area:	11.21 sq ft	
Hydraulic Radius:	0.719	
Froude Number:	0.98	

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 6

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	30.10 cfs	
Slope	0.50 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.97 ft
with Freeboard	2.27 ft
Top Width	7.88 ft
with Freeboard	9.08 ft
Velocity	3.87 fps
Cross Sectional Area	7.77 sq ft
Hydraulic Radius	0.88 ft
Froude Number	0.69

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 6

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	30.10 cfs	
Slope	1.00 %	
Sideslopes	2.00:1 (L)	2.00:1 (R)
Manning's n	0.025	
Material	STIFF CLAY	
Freeboard	.3 ft	

RESULTS:

Depth	1.73 ft
with Freeboard	2.03 ft
Top Width	6.92 ft
with Freeboard	8.12 ft
Velocity	5.02 fps
Cross Sectional Area	5.99 sq ft
Hydraulic Radius	0.77 ft
Froude Number	0.95

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 7 LOWER

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	7.30 cfs	
Slope	1.00 %	
Sideslopes	1.50:1 (L)	1.50:1 (R)
Manning's n	0.013	
Material	HDPE	
Freeboard	.3 ft	

RESULTS:

Depth	0.90 ft
with Freeboard	1.20 ft
Top Width	2.71 ft
with Freeboard	3.61 ft
Velocity	5.97 fps
Cross Sectional Area	1.22 sq ft
Hydraulic Radius	0.38 ft
Froude Number	1.57

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 7 UPPER

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	7.30 cfs	
Slope	10.00 %	
Sideslopes	1.50:1 (L)	1.50:1 (R)
Manning's n	0.013	
Material	HDPE	
Freeboard	.3 ft	

RESULTS:

Depth	0.59 ft
with Freeboard	0.89 ft
Top Width	1.76 ft
with Freeboard	2.66 ft
Velocity	14.15 fps
Cross Sectional Area	0.52 sq ft
Hydraulic Radius	0.24 ft
Froude Number	4.61

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 8 LOWER

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	19.30 cfs	
Slope	1.00 %	
Sideslopes	1.50:1 (L)	1.50:1 (R)
Manning's n	0.013	
Material	HDPE	
Freeboard	.3 ft	

RESULTS:

Depth	1.30 ft
with Freeboard	1.60 ft
Top Width	3.90 ft
with Freeboard	4.80 ft
Velocity	7.61 fps
Cross Sectional Area	2.54 sq ft
Hydraulic Radius	0.54 ft
Froude Number	1.66

SEDCAD+ NONERODIBLE CHANNEL DESIGN

DITCH 8 UPPER

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	19.30 cfs	
Slope	10.00 %	
Sideslopes	1.50:1 (L)	1.50:1 (R)
Manning's n	0.013	
Material	HDPE	
Freeboard	.3 ft	

RESULTS:

Depth	0.84 ft
with Freeboard	1.14 ft
Top Width	2.53 ft
with Freeboard	3.43 ft
Velocity	18.04 fps
Cross Sectional Area	1.07 sq ft
Hydraulic Radius	0.35 ft
Froude Number	4.89

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	0.8			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	272.80 cfs	
Depth:	2.20 ft	
Top Width:	29.18 ft	
Velocity:	5.50 fps	
X-Section Area:	49.64 sq ft	
Hydraulic Radius:	1.660	
Froude Number:	0.74	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

EAST
CHANNEL

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
16.00	3.0:1	3.0:1	0.5			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	272.80 cfs	
Depth:	2.49 ft	
Top Width:	30.96 ft	
Velocity:	4.66 fps	
X-Section Area:	58.56 sq ft	
Hydraulic Radius:	1.843	
Froude Number:	0.60	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

SEDCAD+ NONERODIBLE CHANNEL DESIGN

FINAL COVER ROAD SIDE DITCH

INPUT VALUES:

Shape	TRIANGULAR	
Discharge	31.50 cfs	
Slope	0.50 %	
Sideslopes	3.00:1 (L)	3.00:1 (R)
Manning's n	0.030	
Material	GRAVEL	
Freeboard	.3 ft	

RESULTS:

Depth	1.82 ft
with Freeboard	2.12 ft
Top Width	10.90 ft
with Freeboard	12.70 ft
Velocity	3.18 fps
Cross Sectional Area	9.90 sq ft
Hydraulic Radius	0.86 ft
Froude Number	0.59

Material: Riprap

Triangular Channel

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.0:1	3.0:1	2.4			

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	31.50 cfs	
Depth:	1.45 ft	
Top Width:	8.70 ft	
Velocity:	5.00 fps	
X-Section Area:	6.31 sq ft	
Hydraulic Radius:	0.688	
Froude Number:	1.03	
Manning's n:	0.0360	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Material: Riprap

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
20.00	3.0:1	3.0:1	0.5			

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	358.00 cfs	
Depth:	2.62 ft	
Top Width:	35.71 ft	
Velocity:	4.91 fps	
X-Section Area:	72.91 sq ft	
Hydraulic Radius:	1.995	
Froude Number:	0.61	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Triassic Park

Evaporation Pond
Diversion Ditch Design

Jorge C. Troncoso

Montgomery Watson Americas, Inc.
165 S. Union Blvd.
Suite 410
Lakewood, CO 80228

Phone: (303) 763-5140
Email: jorge.t.troncoso@mw.com

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	4.300 inches

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Null	#1	==>	End	0.000	0.000	Diversion Ditch

#1
Null

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)
#1	35.700	35.700	90.44	7.32

Structure Detail:

Structure #1 (Null)

Diversion Ditch

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	35.700	0.373	0.000	0.000	82.000	TR55	90.44	7.323
	$\sum$	**35.700**						**90.44**	**7.323**

Subwatershed Time of Concentration Details:

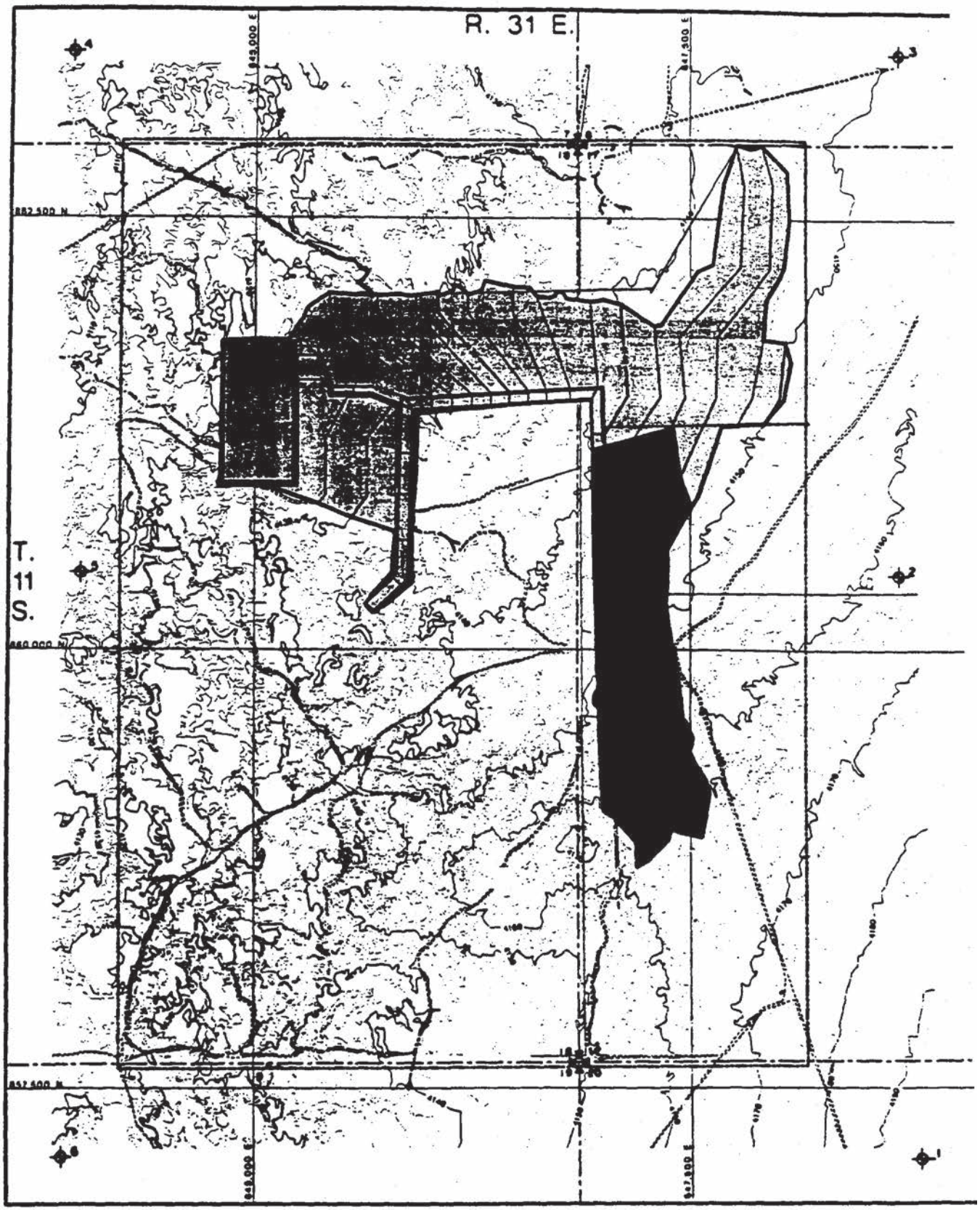
Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	7. Paved area and small upland gullies	1.25	26.00	2,080.00	2.250	0.256
		7. Paved area and small upland gullies	0.50	3.00	600.00	1.420	0.117
#1	**1**	**Time of Concentration:**					**0.373**

Material: Stiff clay very colloidal

Trapezoidal Channel

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Manning's n	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.00	3.0:1	3.0:1	0.5	0.0250				3.8

	w/o Freeboard	w/ Freeboard
Design Discharge:	90.44 cfs	
Depth:	2.07 ft	
Top Width:	15.45 ft	
Velocity:	4.73 fps	
X-Section Area:	19.14 sq ft	
Hydraulic Radius:	1.187	
Froude Number:	0.75	


R. 31 E.
T.
11
S.
882 500 N
860 000 N
857 500 N
843 000 E
847 300 E
847 800 E

ATTACHMENT 3
APRON DESIGN

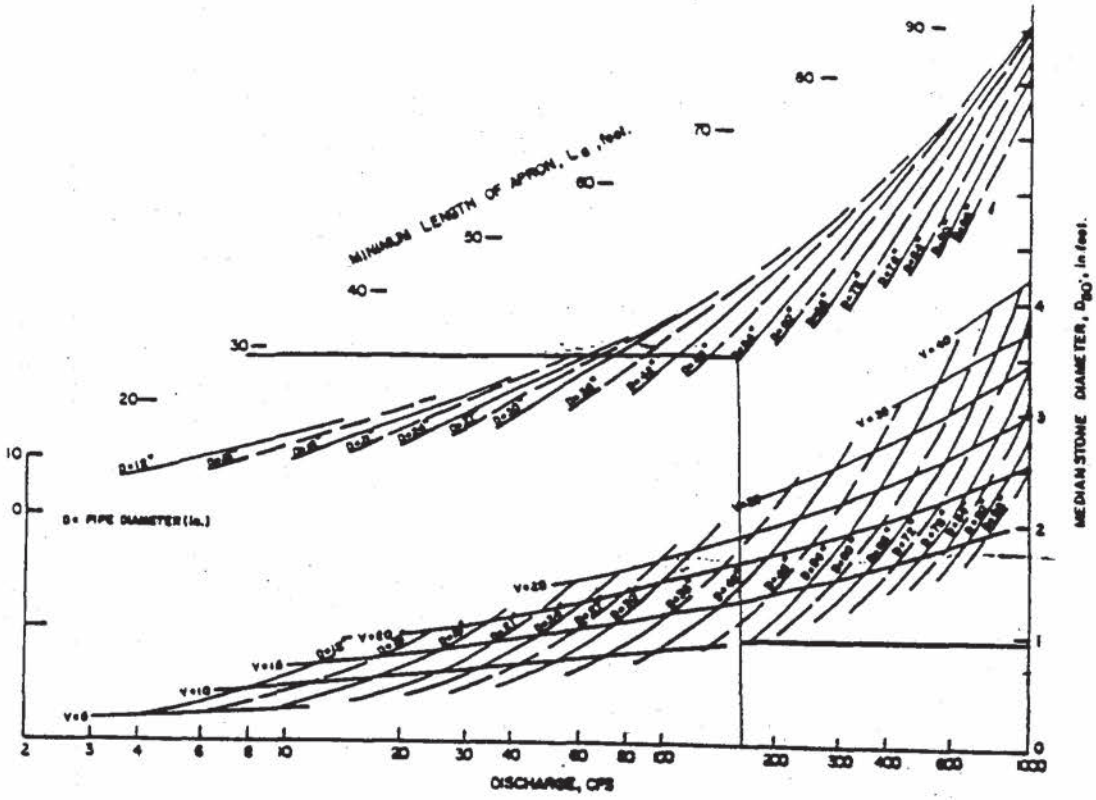
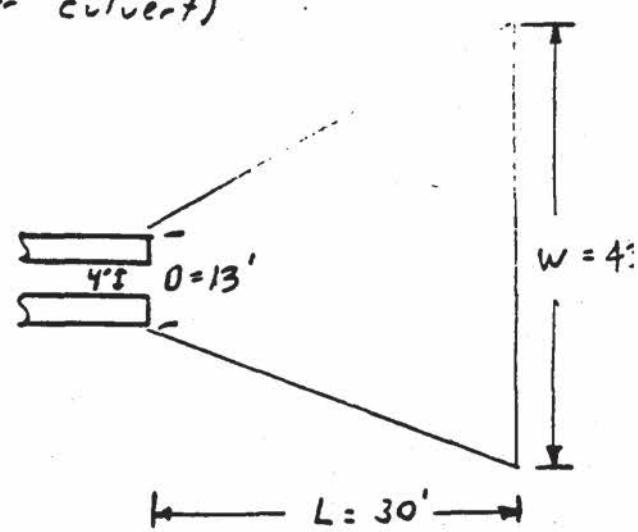


Figure 7.25. Design of outlet protection - minimum tailwater condition, $T_w < 0.5D$. (U.S. EPA, 1976)

Apron Calculation East Ditch

Flow 272 cfs (136 cfs per culvert)
Culverts 2 - 54 "ϕ

$D_{50} = 1'$
Apron Length L = 30'
Apron Width = W = D + L
= 13 + 30
= 43'



FROM BARFIELD ET AL. (1981)

ATTACHMENT 4
CULVERT DESIGNS

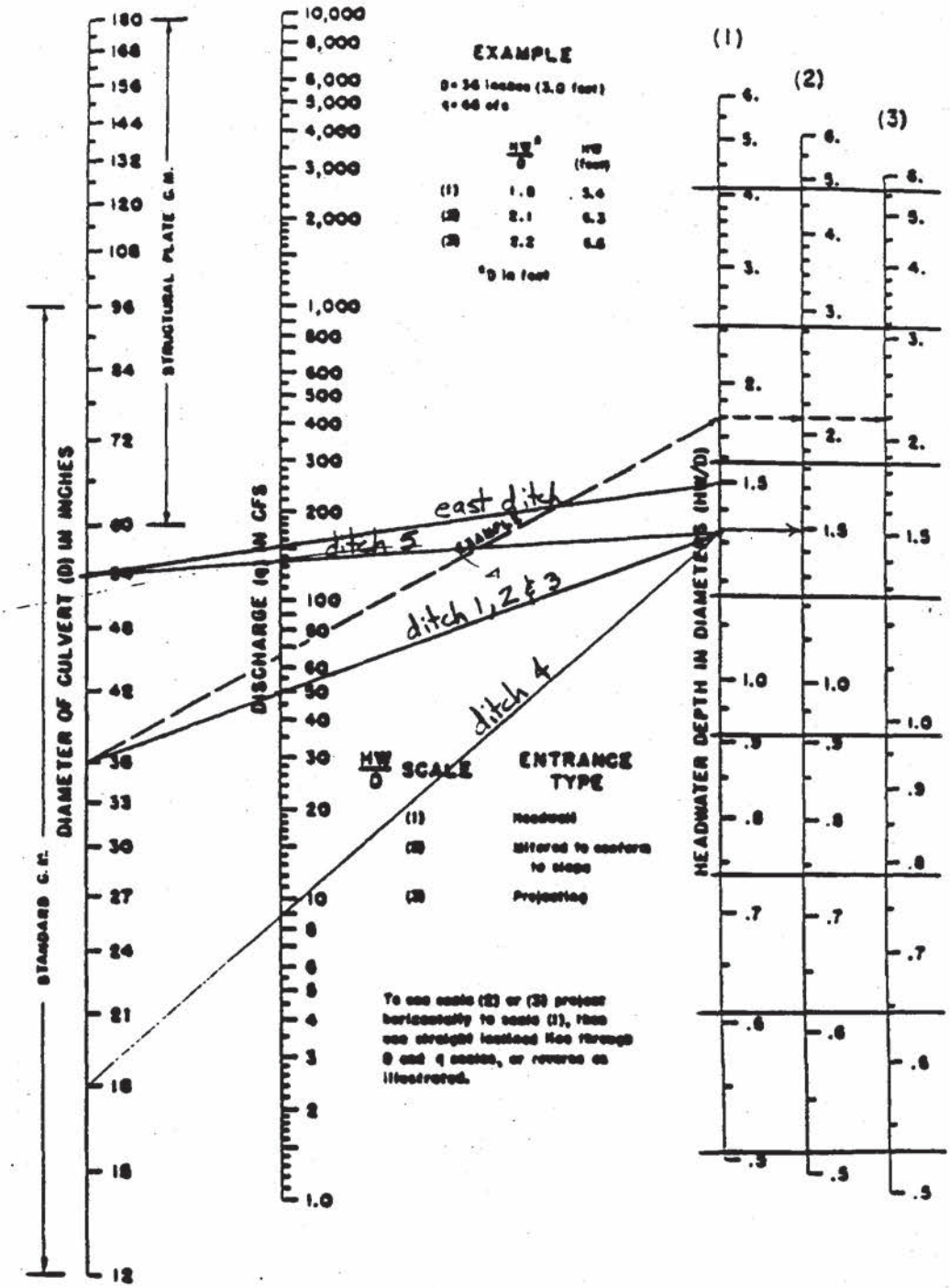
CULVERT SUMMARY

Project: Triassic Park Landfill
Project Number: 602
Prepared by: D. Gleason

Channel	Flow Q (cfs)	Culvert Capacity (cfs)	No. of Culverts (1)	Culvert Dia. (in.)	Total Capacity (cfs)
East Ditch	272.8	155	2	54	310
Ditch 1 and 2	96.4	50	2	36	100
Ditch 3	126.6	50	3	36	150
Ditch 4	6.8	9	1	18	9
Ditch 5	217.3	135	2	54	270

Note:
(1) Represents the number of culverts needed at each road crossing.

Ditch 8	19.3	50	1	36	50
Ditch 9 and 10	90.4	50	2	36	100



BUREAU OF PUBLIC ROADS JAN. 1963

Exhibit 14-9. Headwater depth for C. M. pipe culverts with inlet control.

NEH Notice 4-102, August 1972

ATTACHMENT 5
POND STAGE STORAGE TABLES

Facilities Retention Basin

Elev.	Area	Area	Avg.Area	Depth	Volume	Cul. Vol.
4106	254327	5.8385				
4108	267492	6.1408	5.9897	2	11.9793	11.9793
4110	280944	6.4496	6.2952	2	12.5904	24.5697
4112	294685	6.7650	6.6073	2	13.2146	37.7843
4114	308713	7.0871	6.9261	2	13.8521	51.6364
4116	323030	7.4157	7.2514	2	14.5028	66.1392

Phase 1 Liner Basin

Elev.	Area	Area	Avg.Area	Depth	Volume	Cul. Vol.
4050	7000	0.1607				
4052	31400	0.7208	0.4408	2	0.8815	0.8815
4054	59500	1.3659	1.0434	2	2.0868	2.9683
4056	83300	1.9123	1.6391	2	3.2782	6.2466
4058	96096	2.2061	2.0592	2	4.1184	10.3649
4060	106300	2.4403	2.3232	2	4.6464	15.0113

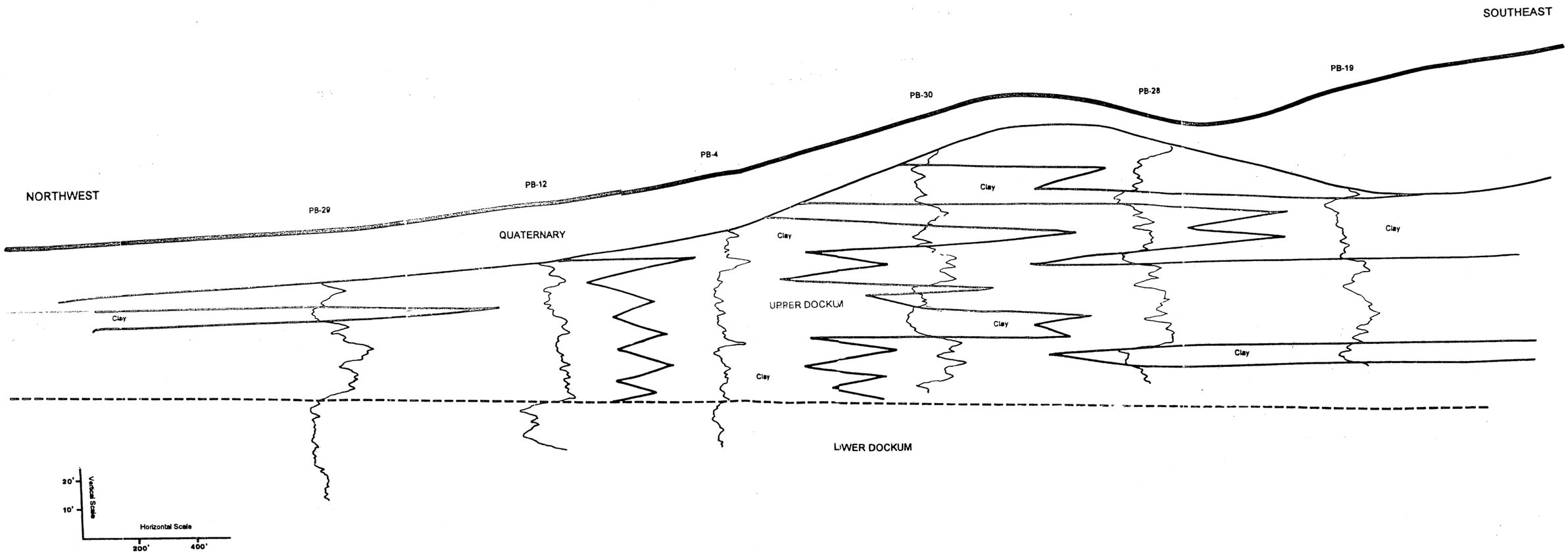
Collection Basin

Elev.	Area	Area	Avg.Area	Depth	Volume	Cul. Vol.
4050	125	0.0029				
4052	13787	0.3165	0.1597	2	0.3194	0.3194
4054	27405	0.6291	0.4728	2	0.9456	1.2650
4056	42342	0.9720	0.8006	2	1.6012	2.8662
4058	58600	1.3453	1.1587	2	2.3173	5.1835
4060	69100	1.5863	1.4658	2	2.9316	8.1151

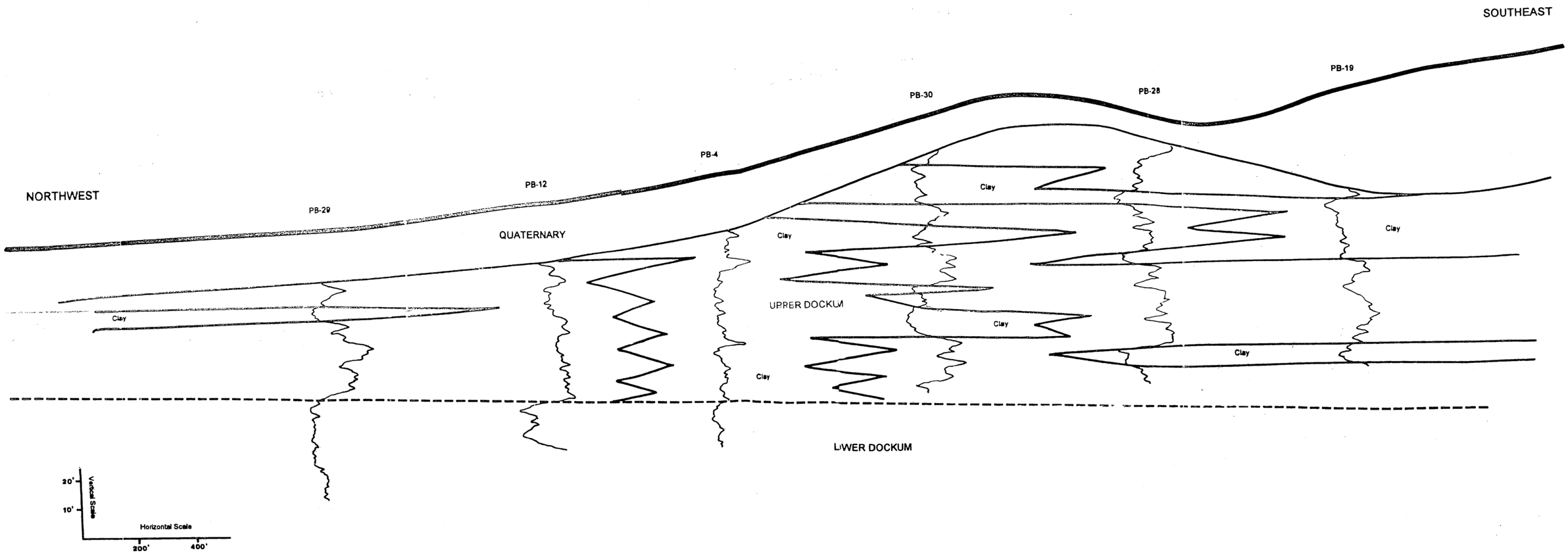
Attachment Y

Cross Sections

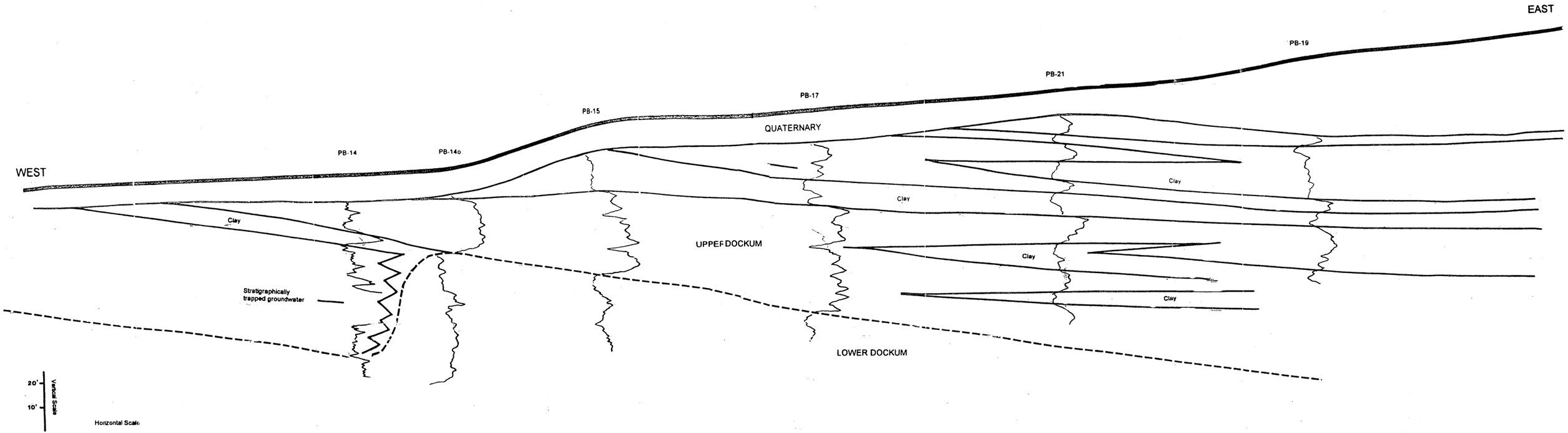
CROSS SECTION 3-1
GANDY MARLEY PROJECT



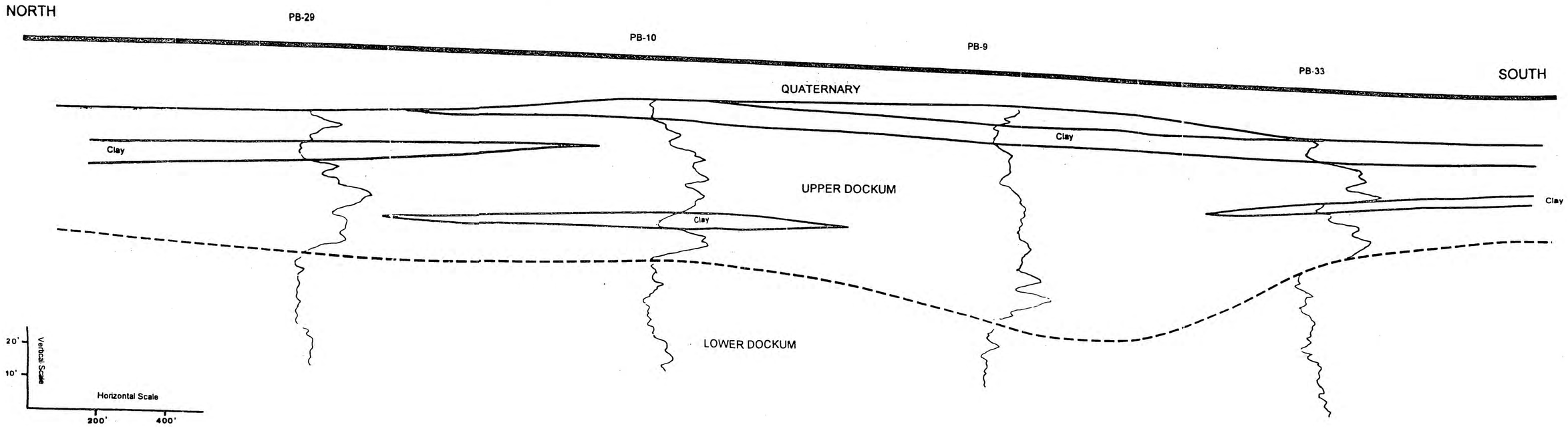
CROSS SECTION 3-2
GANDY MARLEY PROJECT



DIP CROSS SECTION 3-3
GANDY MARLEY PROJECT



STRIKE CROSS SECTION 3-4
GANDY MARLEY PROJECT



DIP CROSS SECTION 3-5
GANDY MARLEY PROJECT

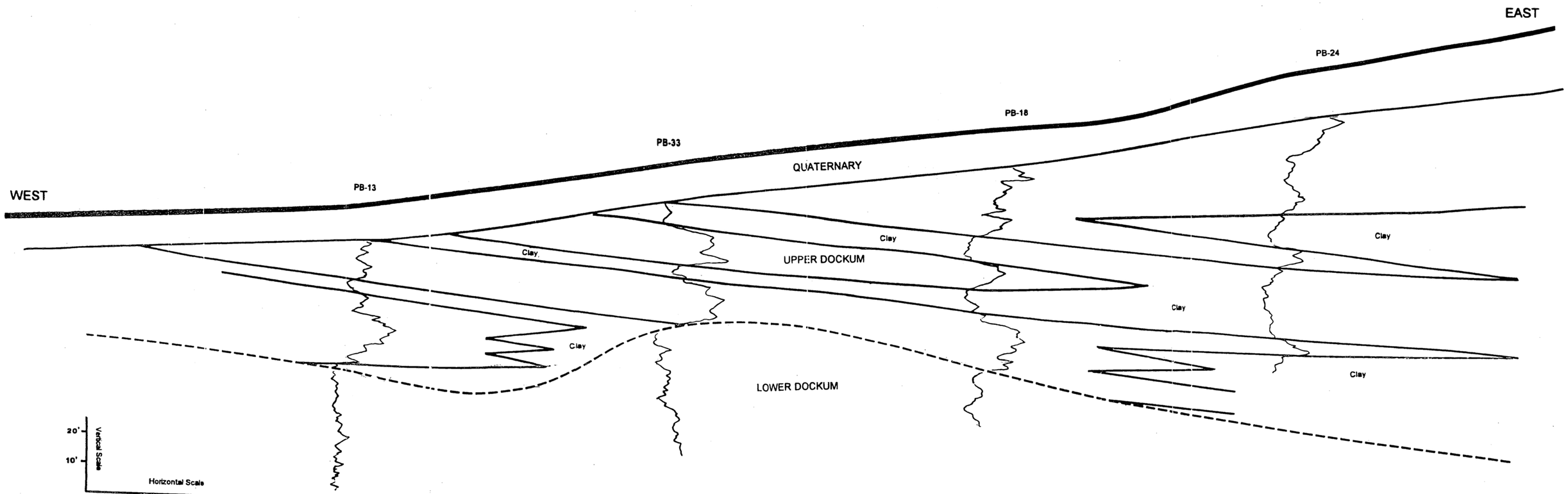
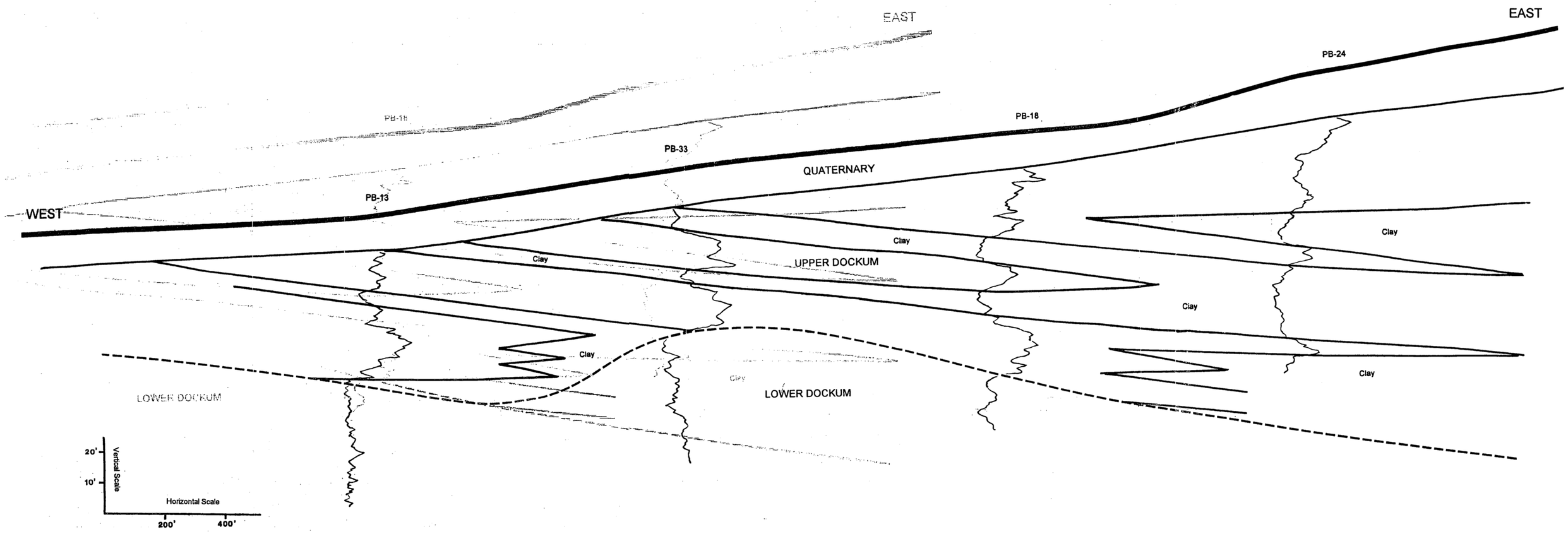


PLATE 3-6
DIP CROSS SECTION
GANDY MARLEY PROJECT



Attachment Z

Construction Specifications

NEW MEXICO ENVIRONMENTAL DEPARTMENT
RCRA PART B PERMIT APPLICATION

SPECIFICATIONS FOR LANDFILL, SURFACE IMPOUNDMENT AND ASSOCIATED FACILITIES LINER AND COVER SYSTEM CONSTRUCTION

FINAL

TRIASSIC PARK HAZARDOUS WASTE FACILITY
CHAVES COUNTY, NEW MEXICO

EPA IDENTIFICATION NUMBER NM0001002484

December 1997
(Revised October 2000)

PATRICK G. CORSER
NEW MEXICO
12236
REGISTERED PROFESSIONAL ENGINEER

Patrick Corser, P.E., New Mexico Registration 12236

NOTE: This document contains construction specifications for various elements of the Triassic Park Hazardous Waste Facility landfill, landfill cover, surface impoundment, and Associated Facilities. Modifications to the plan may be required prior to construction. Any revisions required will be submitted to NMED for approval prior to construction.

TABLE OF CONTENTS

Section No. Page No.

SECTION 01010 GENERAL REQUIREMENTS 01010-1

SECTION 02110 SITE PREPARATION AND EARTHWORK 02110-1

SECTION 02119 PREPARED SUBGRADE 02119-1

SECTION 02221 CLAY LINER 02221-1

SECTION 02224 DRAINAGE GRAVEL 02224-1

SECTION 02225 ROAD BASE 02225-1

SECTION 02227 VEGETATIVE COVER 02227-1

SECTION 02228 PIPE BEDDING 02228-1

SECTION 02229 SELECT SUBBASE 02229-1

SECTION 02230 SUBBASE 02230-1

SECTION 02231 FOUNDATION SAND 02231-1

SECTION 02232 PROTECTIVE SOIL LAYER 02232-1

SECTION 02710 GEOCOMPOSITE 02710-1

SECTION 02712 GEONET 02712-1

SECTION 02714 FILTER AND CUSHION GEOTEXTILE 02714-1

SECTION 02718 POLYETHYLENE PIPE AND FITTINGS 02718-1

SECTION 02720 ADS N-12 PIPE 02720-1

SECTION 02730 ADS SLOTTED CPT 02730-1

SECTION 02740 CORRUGATED METAL PIPE 02740-1

SECTION 02775 GEOMEMBRANE LINERS 02775-1

SECTION 02780 GEOSYNTHETIC CLAY LINERS 02780-1

SECTION 02900 VEGETATION AND SEEDING 02900-1

SECTION 03100 CONCRETE FORMWORK 03100-1

TABLE OF CONTENTS

Section No.	Page No.
SECTION 03200 REINFORCEMENT STEEL	03200-1
SECTION 03290 JOINTS IN CONCRETE	03290-1
SECTION 03300 CAST-IN-PLACE CONCRETE	03300-1
SECTION 03410 STRUCTURAL PRECAST CONCRETE	03410-1
SECTION 05100 STRUCTURAL STEEL FRAMING	05100-1
SECTION 05500 MISCELLANEOUS METALWORK	05500-1
SECTION 07920 SEALANTS AND CAULKING	07920-1
SECTION 11210 LEACHATE PUMPS	11210-1
SECTION 13205 POLYETHYLENE TANK	13205-1
SECTION 15600 CARBON STEEL PIPE	15600-1
SECTION 15700 STAINLESS STEEL PIPE	15700-1

SECTION 01010
GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary to construct the landfill or surface impoundment liner or cover systems at the Triassic Park hazardous waste treatment, storage, and disposal facility (TSDF) in Chaves County, New Mexico.

B. The work shall include those items identified in the Contract Documents which may include site preparation and earthwork, clay liner construction, geosynthetic clay liner installation, geomembrane liner/cover installation, drainage layer and drainage pipe installation, protective soil layer placement, quality control, surveying, and related work.

1.02 DEFINITIONS

A. The following list of definitions is provided for reference.

1. *Atterberg Limits*: The liquid limit, plastic limit, and shrinkage limit for soils as defined by (ASTM D 4318).

2. *NMED*: New Mexico Environmental Department (NMED)

3. *NMED and RCRA Part B Permit (Part B Permit):* New Mexico Environmental Department and Resource Conservation and Recovery Act (RCRA) Part B Permit for the Triassic Park Facility.

4. *Compaction*: The process of increasing the unit weight of soil by rolling, tamping, vibrating, or other mechanical means. As a result of compaction, the hydraulic conductivity of the soil may be decreased.

5. *Construction Drawings*: Design plans used to construct a facility; the plans must be signed and sealed by a Professional Engineer registered in the State of New Mexico.

6. *Construction Quality Assurance (CQA)*: A planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements.

7. *CQA Engineer*: The individual, firm or corporation, independent from the Owner, Contractor, Supplier, or Manufacturer, that is responsible for observing, testing, and documenting construction activities under the terms of the contract. Provided that the Design Engineer and the Owner are not the same party, the CQA Engineer may be the same as the Design Engineer. The CQA Engineer will provide a Construction Quality Assurance Resident Engineer (CQA Resident Engineer). The CQA Engineer is responsible for

certification of landfill construction according to the specifications contained herein and will be a Professional Engineer registered in the State of New Mexico.

8. *CQA Plan*: Site-specific document which addresses the following: (i) CQA personnel responsibilities, authorities, and qualifications; (ii) inspection, monitoring, and testing activities necessary to ensure that the facility is constructed to meet or exceed design criteria, plans, and specifications; and (iii) CQA documentation requirements.

9. *Contract Documents*: The contract documents for construction of the landfill or surface impoundment including the General Specifications, the Construction Drawings, the CQA Plan, any supplemental requirements, and the General Agreement.

10. *Contractor*: The individual, firm, or corporation undertaking the execution of the work under the terms of the contract.

11. *Design Engineer*: The individual, firm or corporation having direct responsibility for the design of the landfill or surface impoundment structure. The Design Engineer must provide a Professional Engineer registered in the State of New Mexico. The Design Engineer may be the same as the Owner.

12. *Dewatering*: Process of lowering ground water level(s) or removing storm water to permit construction activities to be made "in the dry" (not drying of fill material).

13. *General Specifications*: Specifications written which apply to the construction of all landfills and surface impoundments.

14. *Geocomposite*: A planar, polymeric drainage material consisting of a polyethylene geonet core and geotextile filter layers that have been heat-bonded to the top and bottom surfaces of the geonet.

15. *Geomembrane*: A nonporous polymeric membrane liner or barrier used in civil engineering projects.

16. *Geonet*: A net consisting of two sets of transverse polymeric strands which create high in-plane flow capacity; used as a drainage medium in civil engineering projects.

17. *Geosynthetics*: Polymeric materials used to perform various functions in construction projects (i.e., geomembranes, geonets, geocomposites, geotextiles, etc.).

18. *Geosynthetic Clay Liner (GCL)*: A factory manufactured, hydraulic barrier typically consisting of bentonite clay or other very low permeability material, supported by geotextiles and/or geomembranes which are held together by needling, stitching, or chemical adhesives.

19. *Geotextile:* A permeable textile material used with foundation, soil, rock, earth, or any other geotechnical engineering-related material that is an integral part of a man-made project, structure, or system.

20. *Gandy-Marley, Inc.*: owner and operator of the hazardous waste treatment, storage, and disposal facility under construction; referred to as the Owner.

21. *Hydraulic Conductivity:* The rate at which a fluid flows through a porous medium. It is a function of the physical characteristics of both the porous medium and the fluid.

22. *In-situ:* "As is", or as it exists in place naturally.

23. *Laboratory:* The individual, firm, or corporation, independent from the Owner, Manufacturer, Supplier, or Contractor, responsible for conducting tests on construction materials to assure conformance with the General Specifications.

24. *Leachate Collection System:* The drainage layer above the primary composite liner of the landfill and associated piping, risers, etc. that enable collection and removal of leachate from the landfill.

25. *Leak Detection System:* The drainage layer sandwiched between the primary and secondary liners of the landfill or surface impoundment and associated piping, risers, etc., that enable detection, collection, and removal of leachate, if any, that leaks through the primary liner.

26. *Liner System:* The system of natural and synthetic liners and drainage layers beneath the landfill or surface impoundment, used to contain leachate while allowing its collection and removal.

27. *Manufacturer:* The individual, firm, or corporation responsible for manufacturing a specific component (e.g., a geomembrane liner) used in surface impoundment or landfill construction.

28. *Moisture Content:* Ratio of quantity of water in the soil (by weight) to the weight of the soil solids (dry soil), expressed in percentage; also referred to as water content.

29. *Optimum Moisture Content (OMC):* Moisture content corresponding to maximum dry unit weight as determined in the standard Proctor or modified Proctor compaction test (i.e., ASTM D 698 or D 1557).

30. *Owner:* The party known as Gandy-Marley, Inc., a New Mexico Corporation, and the operator of the hazardous waste treatment storage and disposal facility under construction. The Owner shall hire the Contractor(s) to execute the work under the terms of the General Agreement. The activities of the Owner in the General Specifications, any supplemental requirements, and CQA Plan may be performed by the Owner or other party representing the Owner such as, but not limited to, a representative of Triassic Park Hazardous Waste Facility, the Design Engineer, or CQA Engineer.

31. *Particle-Size Distribution*: Distribution of particle sizes within a soil; determined using ASTM D 422.

32. *Permanent Sump*: The drainage layer beneath the sump area of the secondary liner of the landfill that enables the detection, collection, and removal of leachate if any, that leaks through the secondary liner in that area.

33. *Permeability*: Ability of pore fluid to travel through a soil mass via interconnected voids. "High" permeability indicates relatively rapid flow, and vice versa. Rates of permeability are generally reported in centimeters per second.

34. *Plasticity*: Ability of soil mass to flow or be remolded without raveling or breaking apart. Generally that range of soil water content between the liquid and plastic limit.

35. *Primary Composite Liner*: Top composite liner in a double-liner system consisting of two or more low-permeability components of different materials in contact with each other.

36. *Primary Geomembrane Liner*: Top geomembrane liner in a double-liner system.

37. *Primary Soil Liner*: Top soil liner in a double-liner system.

38. *RCRA*: Resource Conservation and Recovery Act; Federal hazardous waste regulations.

39. *Secondary Composite Liner*: Bottom composite liner in a double-liner system consisting of two or more low-permeability components of different materials in contact with each other.

40. *Secondary Geomembrane Liner*: Bottom geomembrane liner in a double-liner system.

41. *Secondary Soil Liner*: Bottom soil liner in a double-liner system.

42. *Secondary Structure*: The macrostructure of a geologic stratum. Structural features in a soil or rock deposit which can be seen with little or no magnification, to include, but not be limited to, pockets, lenses, layers, seams, or partings of varying soil types, slickensided fissures, laminated structure, bedding planes, and/or mineral concretions or staining.

43. *Landfill Phase*: A discrete landfill cell designed and constructed to store industrial and/or hazardous wastes in an environmentally safe manner and in accordance with Federal, State, and local regulations.

44. *Sieve (200 Mesh)*: Refers to the soil particle size that passes (smaller than or equal to) the U.S. Sieve No. 200 (ASTM Specification E-11) which has a 75 micrometer (0.00295 inch) opening.

45. *Specifications*: Detailed descriptions of requirements, dimensions, materials, construction methods, etc., necessary for the construction of a landfill or surface impoundment.

46. *Subcontractor:* The individual, firm, or corporation that contracts to perform some service or provide some material necessary for the performance of another's contract.

47. *Supplier:* The individual, firm, or corporation responsible for supplying a contractor or a manufacturer with a specific material (e.g., gravel, granular material, resin, etc.) required for construction of a manufactured product or for the construction of the landfill or surface impoundment.

48. *Surface Impoundment:* A discrete impoundment designed and constructed to hold an accumulation of potentially contaminated rainwater and runoff from processing, hauling, or waste handling operations or designed and operated to contain hazardous waste during treatment of the waste.

49. *TSDF*: treatment, storage, and disposal facility.

50. *Unified Soil Classification System:* Soil classification system in accordance with ASTM D 2487.

51. *Unit Weight*: Weight of soil per unit volume; usually reported in pounds per cubic foot.

52. *"Walking Out"*: Continually rising effect experienced by a sheepsfoot roller during compaction of soil; an indication that the soil is approaching the proper degree of compaction.

PART 2: CONTRACT DOCUMENTS

2.01 INCLUDED DOCUMENTS

A. The Contract Documents for construction of the landfill or surface impoundment shall include, as applicable: (i) General Specifications, (ii) Supplemental Specifications; (iii) CQA Plan; (iv) Construction Drawings; and (v) General Agreement.

2.02 GENERAL SPECIFICATIONS

A. The landfill or surface impoundment shall be constructed in accordance with these General Specifications and other applicable Contract Documents.

2.03 SUPPLEMENTAL SPECIFICATION

A. The supplemental specifications provide additional requirements for construction of a specific landfill liner or cover or surface impoundment that relate to construction contractual considerations, and are not permit-related.

2.04 CQA PLAN

A. The materials, procedures, and test methods and frequencies used in the construction quality assurance of the landfill or surface impoundment construction shall conform to the requirements of the CQA Plan.

2.05 CONSTRUCTION DRAWINGS

A. The landfill or surface impoundment shall be constructed not only in accordance with the General Specifications but also in accordance with the Construction Drawings for the specific structure.

2.06 GENERAL AGREEMENT

A. The contractual agreement, and all terms and conditions thereof, between the Owner and the Contractor.

PART 3: PROJECT ORGANIZATION AND CONTROL

3.01 ORGANIZATION CHART

A. The project organization chart for the parties involved in construction of the landfill and surface impoundment is provided in Figure 01010-1.

3.02 RESPONSIBILITIES OF PARTIES

A. *Owner:* The Owner is the facility manager, responsible for facility administration, regulatory oversight, health and safety, accounting, purchasing, etc. The Owner has direct authority over the Contractor, CQA Engineer, and Design Engineer and coordinates activities by these parties.

B. *Contractor:* The Contractor is responsible for constructing various elements of the facility in accordance with the General Specifications, other applicable contract documents, Construction Drawings and CQA Plan. The Contractor may be responsible for earthwork, geosynthetics, and other components of landfill or surface impoundment construction. The contracting and administration of contract requirements for landfill or surface impoundment construction shall be the responsibility of the Owner. Different contractors may be used to construct different components of the landfill or surface impoundment.

C. *CQA Engineer:* The CQA Engineer is responsible for monitoring construction activities on-site and certifying that the facility is constructed in accordance with the plans and specifications. The CQA Engineer provides information, reports, test results, and observations to the Owner. The CQA Engineer may communicate directly with the Contractor and Design Engineer to coordinate activities and receive information. The CQA Engineer provides an on-site CQA Resident Engineer.

D. *Design Engineer:* The Design Engineer is responsible for the design of the landfill or surface impoundment. The Design Engineer reports to the Owner. The Design Engineer may communicate directly with the Contractor and CQA Engineer.

PART 4: SEQUENCE OF CONSTRUCTION

4.01 OVERALL SEQUENCE

A. The overall sequence of construction for a specific facility element shall be as described in the Construction Drawings for the specific structure and in accordance with the Contract Documents.

PART 5: REFERENCE STANDARDS

5.01 APPLICABLE ORGANIZATIONS

A. Organizations whose standards are referenced herein are as follows:

1. ASTM - American Society for Testing and Materials
2. New Mexico State Highway and Transportation Department (Standard Specifications for Highway and Bridge Construction)
3. GRI - Geosynthetics Research Institute
4. OSHA - Occupational Safety and Health Administration
5. USEPA - United States Environmental Protection Agency

5.02 APPLICABLE STANDARDS

A. Any reference to standards of any society, institute, association, or government agency shall be the edition in effect as of the date of the contract, unless stated otherwise.

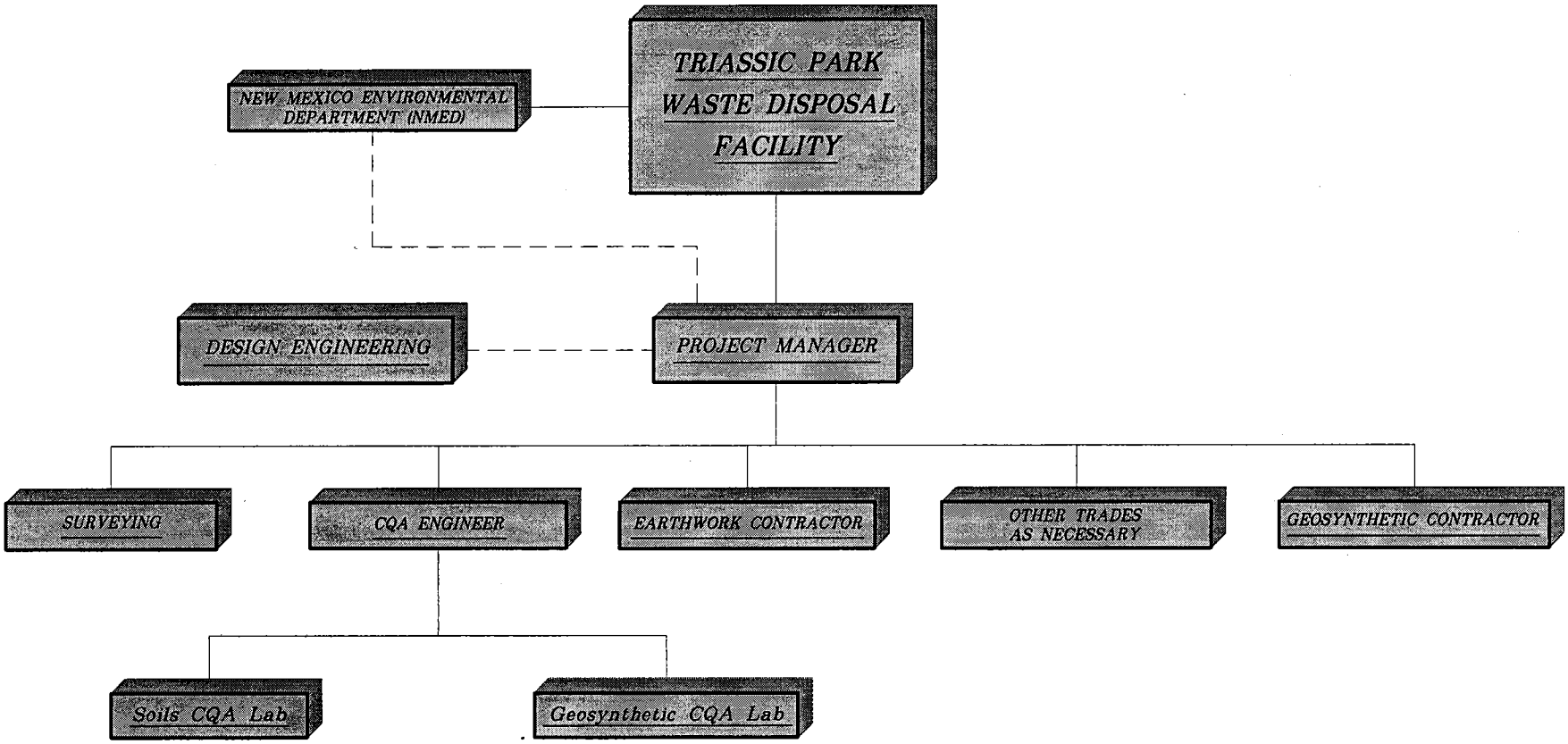
5.03 SPECIFIC STANDARDS

A. Specific test standards cited in the General Specifications are given in Table 01010-1.

PART 6: GENERAL REQUIREMENTS

A. *Reference Points*: Construction reference monuments and benchmarks have been established by the Owner for use in controlling the construction work. All work shall be constructed based on and in relation to these reference points. The Contractor shall be responsible for re-establishing any reference points disturbed during construction. Disturbed or destroyed points shall be re-established at the Contractor's expense, as directed by the Owner.

B. *Soils Investigation*: Site soil investigations will be performed by the Owner. Soil investigation reports will be available for the Contractor's use. The Contractor shall not assume that information within these reports accurately reflects the soil conditions at all locations within the project area, but that they only depict soil conditions at specific points where samples were taken.



REV. No.	REVISIONS	DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	TECH LAW REVIEW COPY	4/24/00	J.Pellicer	J.Bever	J.Pellicer

TerraMatrix
MONTGOMERY WATSON
Mining Group

PROJECT No.: 602-0200
AutoCAD FILE: TPORG.DWG
SCALE: Not to Scale
FIGURE No: 01010-1

Triassic Park Waste Disposal Facility

TYPICAL PROJECT ORGANIZATION

C. *Surveying:* The Contractor shall perform all surveying required to lay out and control the work. Surveying shall be conducted such that all applicable standards required by the State of New Mexico are followed. Required Record Drawings shall be as specified in these General Specifications. All surveying shall be performed under the direction of a surveyor licensed to perform such work in the State of New Mexico. All Record Drawings shall be signed and sealed by the licensed surveyor who directed the survey work. Record drawings shall be at a scale not smaller than 1 inch = 50 feet. The required surveying of liner system elevations shall be carried out on a grid; approximately 50-foot square on slopes of 25 percent or less and 100-foot square on slopes greater than 25 percent. The survey locations shall be close enough to define the following features in the landfill or surface impoundment: toe of slope, crest of slope, anchor trench, leachate collection sump, leak detection sump, permanent sump, and perimeter drainage ditch. All surveys shall be referenced to the Owner's site coordinate grid system.

D. *Construction Tolerances:* Unless otherwise stated herein and where practical, construction tolerances shall be " 0.2 feet horizontally, and, provided that minimum thickness requirements are met, " 0.1 feet vertically. All surfaces shall be reasonably free from irregularities with slopes or grades within " 10 percent of their nominal values. All liner and cover surfaces shall be free-draining with no standing water except at low points designated on the Construction Drawings.

E. *Permits:* The Contractor shall not be required to obtain any environmental or general construction permits applying to the general design of the facility. The Contractor shall be required to obtain permits, such as over-size haul permits, related to specific construction equipment or techniques he intends to employ to accomplish the work.

F. *Sedimentation, Erosion Control, and Dewatering:* Contractor shall comply with all requirements of the New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction for controlling erosion, water pollution, and dust emissions resulting from construction activities; the Contractor shall be responsible for any fines imposed due to noncompliance. Within the disturbed areas in which the Contractor is working, the Contractor shall seal-roll disturbed surfaces when required and maintain temporary grades and ditches to promote water drainage and prevent infiltration. The Contractor shall provide all equipment necessary to dewater excavations within 12 hours after a storm event.

G. *Work Limits*: All clearing, stripping, excavation, backfill and surfacing shall be done to the lines, grades, and dimensions called for on the Construction Drawings and General Specifications unless directed otherwise by the Owner. All work done beyond designated limits without prior approval shall be corrected to the Owner's satisfaction, at no additional cost to the Owner.

H. *Protection of Existing Services and Wells*: The Contractor shall exercise care to avoid disturbing or damaging existing monitor wells, electrical poles and lines, permanent below-ground utilities, permanent drainage structures, temporary utilities and structures, or items which the Owner has marked with red flagging. If the Contractor encounters any unexpected underground utilities during the course of the work, the Contractor shall immediately inform the Owner who will determine whether or not the utility is active. When the work requires the Contractor to be near or cross known utilities, the Contractor shall carefully uncover, support and protect these utilities and shall not cut, damage, or otherwise disturb them without prior

authorization from the Owner. All utilities, wells, or other items damaged by the Contractor shall be immediately repaired or replaced by the Contractor to the satisfaction of the Owner at no additional cost to the Owner.

I. *Explosives*: The use of explosives for demolition or excavation is not expected to be required and will not be permitted without prior written approval of the Owner.

J. *Burning*: The use of open fires on site for any reason is prohibited.

K. *Temporary Roads*: The Contractor shall be responsible for constructing and maintaining all temporary roads and laydown areas which the Contractor may require in the execution of his work.

L. *Construction Water*: The quality of construction water used to accomplish construction work is crucial due to the nature of the facilities being constructed. The Owner will provide water for construction and dust control and will specify the source and periodically obtain water quality samples. The Contractor shall not add substances to construction water without the express written consent of the Owner. The Contractor shall utilize measuring devices that allow him to measure and record the volume of water used. Such usage records shall be maintained by the Contractor and provided to the Owner.

M. *Cooperation*: The Contractor shall cooperate with all other parties engaged in project-related activities to the greatest extent possible. Disputes or problems shall be referred to the Owner for resolution.

N. *Familiarization*: The Contractor is responsible for becoming familiar with all aspects of work prior to performing the work.

O. *Safeguards*: The Contractor shall provide and use all personnel safety equipment, barricades, guardrails, signs, lights, flares, and flagmen as required by OSHA, state, or local codes and ordinances. No excavations deeper than 4 feet with side slopes steeper than 2:1 (horizontal:vertical) shall be made without the prior approval of the Owner. When shoring is required, the design and inspection of such shoring shall be the Contractor's responsibility and subject to the review of the Owner prior to use. No personnel shall work within or next to an excavation requiring shoring until such shoring has been installed, inspected, and approved by an Engineer registered in the State of New Mexico provided by the Contractor. The Contractor shall be responsible for any fines imposed due to violation of any laws and regulations relating to the safety of the Contractor's personnel.

P *Construction Access Plan*: Prior to mobilization to the site, the Contractor shall submit a plan to the Owner showing where he intends to place staging areas, stockpile areas, temporary on-site access roads, temporary erosion control structures, etc. This plan must be approved by the Owner prior to mobilization.

Q. *Clean-up*: The Contractor shall be responsible for general house-keeping during construction. Upon completion of work, the Contractor shall remove all of his equipment, facilities, construction materials, and trash. All disturbed areas shall be revegetated or otherwise put into a condition satisfactory to the Owner. Revegetation shall be carried out in accordance with the requirements in Section 02900.

R. *Security*: The Contractor is responsible for the safety and condition of all of his tools and equipment. The Owner will not be responsible for lost or stolen materials or equipment.

S. *Acceptance of Work*: Except as otherwise provided within the General Conditions, the Contractor shall retain ownership and responsibility for all work until accepted by Owner. The Owner will accept ownership and responsibility for the liner system: (i) when all work is completed; (ii) after the Contractor has submitted all required documentation, including manufacturing quality control documentation, manufacturing certifications, and Record Drawings signed and sealed by a Professional Land Surveyor licensed in the State of New Mexico (if required by Owner); and (iii) after the CQA Engineer has submitted the Final CQA Report which certifies that the liner has been constructed in accordance with the Construction Drawings and these Specifications and Record Drawings signed and sealed by a Professional Engineer registered in the State of New Mexico.

T. *Health and Safety Training*: The Contractor shall provide necessary health and safety training for all of the Contractor's on-site personnel in accordance with the Site Health and Safety Plan. The Owner may require evidence of health and safety training at any time for any of the Contractor's personnel working on site.

U. *Exclusion Areas*: The Contractor's personnel shall not enter any areas on-site identified with signs as exclusion areas without approval of the Owner, and without proper personal protective equipment. The Contractor shall confine activities to the work limits shown on the Construction Drawings.

V. *Hazardous Waste Management Operations*: The Contractor shall not enter areas where active hazardous waste management operations are being performed.

W. *CQA Activities*: The Owner will utilize an independent CQA Engineer to perform CQA activities. The Contractor shall be aware of all CQA activities and shall allow sufficient time in his construction schedule to accommodate CQA activities. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of CQA activities.

X. All quality control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

TABLE 01010-1
TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN

AMERICAN SOCIETY OF TESTING AND MATERIALS	
1. ASTM A 307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
2. ASTM A 726	Standard Specification for Cold-Rolled Carbon Steel Sheet, Magnetic Laminated Quality, Types 1, 2, and 2S.
3. ASTM C 88	Soundness of Aggregate by use of Sodium Sulfate or Magnesium Sulfate
4. ASTM C 131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
5. ASTM C 535	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
6. ASTM D 422	Standard Method for Particle-Size Analysis of Soils.
7. ASTM D 570	Standard Test Method for Water Absorption of Plastics.
8. ASTM D 638	Standard Test Method for Tensile Properties of Plastics.
9. ASTM D 698	Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.
10. ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
11. ASTM D 751	Standard Methods of Testing Coated Fabrics.
12. ASTM D 792	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
13. ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
14. ASTM D 1004	Standard Test Method of Initial Tear Resistance of Plastic Film and Sheeting.
15. ASTM D 1204	Standard Plastics Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
16. ASTM D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
17. ASTM D 1248	Standard Specification for Polyethylene Plastic Molding and Extrusion Metals.
18. ASTM D 1505	Standard Test Methods for Density of Plastics by Density-Gradient Technique.
19. ASTM D 1556	Standard Test Method for Density of Soil In Place by the Sand-Cone Method.
20. ASTM D 1593	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting.
21. ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics.
22. ASTM D 2167	Standard Test Method for Density and Unit Weight of Soils in Place by the Rubber Balloon Method.
23. ASTM D 2216 or D 4643	Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
24. ASTM D 2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
25. ASTM D 2487	Standard Test Method for Classification of Soils for Engineering Purposes.
26. ASTM D 2657	Standard Practice for Heat-Joining for Polyolefin Pipe and Fittings.
27. ASTM D 2663	Carbon-Black Dispersion in Rubber.
28. ASTM D 2837	Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
29. ASTM D 2922	Standard Test Method for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth).
30. ASTM D 3015	Recommended Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
31. ASTM D 3017	Standard Test Method for Moisture Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth).
32. ASTM D 3083	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining.
33. ASTM D 3350	Standard Specifications for Polyethylene Plastic Pipe and Fittings Materials.
34. ASTM D 3776	Mass Per Unit Area (Weight) of Woven Fabric.

TABLE 01010-1 TEST METHODS CITED IN GENERAL SPECIFICATIONS AND CQA PLAN	
35. ASTM D 4253	Standard Test Method for Maximum Index Density of Soils Using a Vibratory Table
36. ASTM D 4254	Standard Test Method for Minimum Index Density of Soils and Calculations of Relative Density.
37. ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
38. ASTM D 4373	Standard Test Method for Calcium Carbonate Content of Soils.
39. ASTM D 4437	Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Geomembranes.
40. ASTM D 4491	Standard Test Method for Water Permeability of Geotextiles by the Permittivity Method.
41. ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
42. ASTM D 4632	Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Elongation Method and Peel Strength).
43. ASTM D 4643	Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
44. ASTM D 4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
45. ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
46. ASTM D 4716	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
47. ASTM D 4833	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
48. ASTM D 5261	Measuring mass per unit area of geotextile.
49. ASTM D 5321	Coefficient of soil and geosynthetics or geosynthetics and geosynthetics friction by direct shear.
50. ASTM D 5890	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
51. ASTM D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
52. ASTM E 11	Specification for Wire-Cloth Sieves for Testing Purposes.
53. ASTM F 714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
54. ASTM C 31	Making and Curing Concrete Test Specimen in the Field.
55. ASTM C 39	Compressive Strength of Cylindrical Concrete Specimens.
56. ASTM C 143	Test Method for Slump of Hydraulic Cement Concrete.
57. ASTM C 173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
58. ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	
1. USEPA Method 9090	Compatibility Test for Wastes and Membrane Liners.

[END OF SECTION]

SECTION 02110
SITE PREPARATION AND EARTHWORK

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary to perform all site preparation, excavation, backfilling, and grading required to construct the landfill or surface impoundment. The work shall be carried out in accordance with this General Specification, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02119 - Prepared Subgrade
B. Section 02221 - Clay Liner

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling and shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities, except when specifically not required by the General Specifications.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

A. Fill materials shall be obtained from the excavation of the landfill or surface impoundment, from the excavation of diversion ditches, or from borrow sources identified by the Owner.

B. Soil shall be classified as one of the following: (i) structural fill; (ii) clay liner material; (iii) topsoil; (iv) protective soil layer material; (v) cover soil; (vi) vegetative cover; (vii) pipe bedding; (viii) subbase; or (ix) spoil.

1. Soil that is classified according to the Unified Soil Classification System (USCS) as SM, CL, ML, SC or GM or GC (ASTM D 2487) and has a maximum particle size of 4 inches; or other material approved by the Owner, may be used as structural fill. Structural fill shall be placed at the locations shown on the Construction Drawings and in all areas requiring fill that are within 50 feet of the landfill or surface impoundment liner system. Beyond the 50 foot requirement structural fill material characteristics may be modified with the approval of the Owner.

2. Soil that meets the requirements of Section 02221 of these General Specifications may be used as clay liner material.

3. Soil classified as topsoil may be used for revegetation of disturbed areas or for other purposes shown on the Construction Drawings. All revegetation activities shall be carried out in accordance with this Section and Section 02900.

4. Soil that meets the requirements of Section 02716 of these General Specifications may be used as protective soil layer material.

5. Soil that meets the requirements of Section 02226 of these General Specifications may be used a cover soil.

6. Soil that meets the requirements of Section 02227 of these General Specifications may be used as vegetative cover material.

7. Soil that meets the requirements of Section 02228 of these General Specifications may be used as pipe bedding.

8. Soil that meets the requirements of Section 02230 of these General Specifications may be used as subbase.

9. Soil not classified as structural fill, clay liner material, protective soil layer material, cover soil, vegetative cover, or topsoil shall be classified as spoil material. Spoil may be used for purposes specified in the Construction Drawings or by the Owner, or it may be disposed of on site in a manner approved by the Owner.

PART 3: EXECUTION

3.01 SITE PREPARATION

A. The Contractor shall develop access to the construction area in accordance with the requirements of the Construction Drawings.

B. The Contractor shall install silt fences immediately down-slope of each area to be disturbed prior to the beginning of work in that area. The Contractor shall maintain the silt fences for the duration of construction. Accumulated sediment behind the silt fences shall be disposed of on-site by the Contractor in a manner approved by the Owner. The area around the top of landfills and surface impoundments shall be graded to direct surface water away from the structure, wherever possible.

C. All brush, vegetation, rubbish, and other objectionable material shall be removed from the construction area and disposed of in an area designated by the Owner.

D. All topsoil shall be removed from the construction area and stockpiled in areas designated by the Owner for subsequent use on site.

E. A 30-foot wide work area shall be maintained clear of objectionable materials around the edge of the landfill or surface impoundment construction area.

F. Diversion ditches, either permanent or temporary, shall be constructed in accordance with the Construction Drawings or as approved by the Owner. The Contractor shall be responsible for constructing diversion ditches as required to divert run-on around the construction area. The construction of temporary ditches not shown on the Construction Drawings shall not be undertaken until the Contractor's plan for constructing the ditches is approved by the Owner.

G. Temporary access roads to the construction area shall be constructed in accordance with the Construction Drawings or as approved by the Owner.

3.02 STOCKPILING

A. Prior to the start of excavation and if required by the Owner, the Contractor shall prepare a written excavation plan. The plan shall indicate the areas and sequence of excavation, and the anticipated classification of the excavated material (e.g., structural fill, clay liner material). This excavation plan must be reviewed and approved by the

Owner. The Contractor shall take into account that the stockpiling portion of the excavation plan may be modified during construction based on the results of any conformance testing of the excavated material required by the CQA Plan.

B. Excavated fill materials (i.e., clay liner, cover soil, etc.) shall be stockpiled in designated areas free of incompatible soil, clearing debris, or other objectionable materials. Stockpile areas will be shown on the Construction Drawings or designated by the Owner.

C. Excavated material classified as spoil shall be segregated from fill and stockpiled or disposed of in the manner shown on the Construction Drawings or as specified by the Owner.

D. The CQA Engineer shall assist in the determination of what excavation material is select fill or spoil material.

E. Stockpiles of fill or spoil shall be no steeper than 3:1 (horizontal:vertical) or other slope approved by the Owner, graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the Owner, and dressed daily during periods of active placement of fill taken from the stockpile. The Contractor may cover fill stockpiles with plastic sheeting or other material approved by the Owner in order to preserve the moisture content of the fill.

F. Stockpiles that will remain out of active use for a period greater than seven months shall either be covered as described in this section or stabilized by revegetation in accordance with the requirements for revegetation given in Section 02900.

G. The Contractor shall not remove fill material from the project site without the prior written approval of the Owner.

3.03 EXCAVATION

A. Upon completion of site preparation, the landfill or surface impoundment shall be excavated to the elevations and grades for the subgrade shown on the Construction Drawings. The excavation shall include provisions for any leakage detection system sump or permanent sump shown on the Construction Drawings. All excavation work shall be carried out in compliance with all applicable OSHA regulations.

B. During construction of the landfill or surface impoundment, the Contractor shall make excavations, as necessary, to ensure the drainage of water to a single area (i.e., a sump) to facilitate water collection and removal. A pump shall be provided for removing water from the sump. The pump shall have a capacity sufficient to meet the requirements of Section 01010 of these General Specifications. Water that accumulates in the sump shall be pumped to the on-site construction water tank or to such other location as designated by the Owner. The Contractor shall maintain the landfill or surface impoundment excavation in a dry and workable condition. Damaged work or delays caused by water from any source shall be the responsibility of the Contractor.

C. For subgrades on slopes steeper than 5:1 (horizontal:vertical) which will serve as foundations for structural fill, the subgrade shall be terraced or keyed to anchor the fill material and prevent slip failures. Each terrace shall be at least 10 feet wide with a

maximum vertical elevation difference between terraces of 10 feet. Terraces shall generally run perpendicular to the fall line of the slope. Terraces shall have grades of not less than 2 percent or more than 5 percent away from the face of the embankment. Surface drainage shall be maintained at all times. This requirement does not apply to structural fills placed within the landfill or surface impoundment such as ramps or berms.

D. After excavation or stripping to final grade, the CQA Engineer will inspect the subgrade on the side slopes of the landfill or surface impoundment. The CQA Engineer will identify areas that require additional excavation of weak or excessively weathered subgrade materials on the slopes of the landfill or surface impoundment excavation. The Owner will direct the Contractor to excavate the soft areas identified by the CQA Engineer. Such excavations shall be backfilled with structural fill or clay liner material. Backfill shall be placed and compacted in accordance with the requirements for structural fill given in this section. If clay liner material is used to backfill these areas, it shall be placed in accordance with Section 02221 of these General Specifications. However, permeability tests will not be required.

E. After excavation to final grade, the CQA Engineer will inspect the subgrade on the base of the landfill or surface impoundment. The CQA Engineer may identify areas of the subgrade to be proofrolled. If proofrolling is necessary, the Contractor shall use a 20-ton pneumatic-tired roller or other equipment approved by the CQA Engineer. If soft spots or unsuitable materials are found, the Owner may direct the Contractor to excavate the soft material and either fill the excavated area with the same material (assuming the existing material will provide adequate support if recompacted) or structural fill material. Backfill shall be placed and compacted in accordance with the requirements for structural fill given in this section or clay liner material given in Section 02221.

F. The Contractor shall scarify the portion of the subgrade on the base of the landfill or surface impoundment that is comprised of soil and not treated for soft spots, to a depth of not less than 8 inches and compact it in accordance with the requirements for structural fill as directed by the Owner.

G. The subgrade surface shall be seal-rolled to prevent moisture infiltration unless fill is to be immediately placed on the subgrade.

H. Excavation of the landfill or surface impoundment shall not be considered complete, and no fill shall be placed on the subgrade, until the CQA Engineer confirms that the minimum elevations and grades shown on the Construction Drawings have been achieved in the field. The Contractor shall be responsible for notifying the CQA Engineer that the excavation (or a significant portion thereof) is complete and the Contractor shall plan for the time required for the CQA Engineer to confirm the elevations and grades of the excavation.

3.04 PLACEMENT AND COMPACTION OF STRUCTURAL FILL

A. Specific requirements for placement and compaction of structural fill shall be as specified herein unless other requirements are given on the Construction Drawings.

B. Fill lifts after compaction shall have an average thickness of no more than 6 inches and a maximum thickness of no more than 7 inches. The loose thickness shall be no greater than the length of the pad foot and drum groove of the compaction equipment (7 to 8 inches for a CAT 825).

C. The CQA Engineer must complete field testing of fill placed and compacted to determine compliance with these specifications in accordance with the CQA Plan. The Contractor shall not place a new lift of fill over a preceding lift until approval is given by the CQA Engineer. If the Contractor fails to comply with this requirement, he will be required to remove and replace all unauthorized work at his own expense.

D. Prior to placement of a lift of fill, the previous compacted lift shall be thoroughly scarified to provide good bonding between lifts. Scarification shall be accomplished by raking with a grader, discing, or an alternate method approved by the Owner.

E. The subgrade may be compacted at its natural moisture content.

F. Unless otherwise required by the Construction Drawings, structural fill shall be compacted at a moisture content between 3 percent dry to 3 percent wet of the optimum moisture content and to a minimum dry unit weight of 95 percent of the maximum dry unit weight determined in the modified Proctor compaction test (ASTM D 1557). If the moisture content of the structural fill is outside of the acceptable range, the soil shall be wetted or dried back, as appropriate. During wetting or drying, the soil shall be regularly disced or otherwise mixed so that uniform moisture conditions are obtained.

G. The Contractor may moisture-condition fill in either the stockpile area or work area.

H. Compaction of lifts shall be performed with an appropriately heavy, properly ballasted, penetrating-foot compactor subject to the approval of the CQA Engineer.

I. The Contractor shall not place frozen fill, nor shall he place fill on frozen ground.

J. If fill freezes during construction, the Contractor shall remove the frozen fill, scarify the remaining unfrozen fill, and then place and compact new fill in accordance with these General Specifications. The frozen fill shall not be reused until it has thawed, and been thoroughly blended, and then reworked to an acceptable moisture content.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the location and elevation of the excavation for the landfill or surface impoundment. He shall also survey the location and elevation of the top of subgrade shown on the Construction Drawings. Surveying shall be performed in general accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide Record Drawings of the location and elevation of the excavation and the top of prepared subgrade (or top of interim cover for cover systems) for the landfill or surface impoundment, in accordance with the requirements of Section 01010 of these General Specifications. The Surveyor shall submit this drawing to the Owner prior to the start of GCL placement or cover GCL placement unless otherwise approved by Owner and CQA Engineer. The Surveyor

may submit a partial Record Drawing to obtain approval for a portion of work. The Owner will define the minimum requirements for a partial submittal.

3.06 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

3.07 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-completed and completed work of these General Specifications.

B. In the event of damage, the Owner will identify areas requiring repair, and the Contractor shall make all repairs and replacements necessary to the approval of the Owner at no additional cost to the Owner.

C. At the end of each day, the Contractor shall verify that the entire work area was left in a state that promotes surface drainage off and away from the area and from finished work. If threatening weather conditions are forecast, compacted surfaces shall be seal-rolled or covered with plastic sheeting to protect finished work.

3.08 REVEGETATION

A. At the end of construction, all disturbed areas with exposed soil (including borrow areas, soil stockpiles, material storage areas, Contractor access roads, etc.) shall be graded and revegetated in accordance with the requirements for revegetation in Specification 02900.

3.09 SEDIMENTATION AND EROSION CONTROL

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of geotextiles for sedimentation and erosion control during construction. The work shall be carried out in accordance with the requirements of Section 603 of the New Mexico State Highway and Transportation Department Standard Specifications for Highway and Bridge Construction pertaining to erosion control and silt fences. Silt fences shall be placed as necessary downslope of all disturbed areas, and shall remain until such areas are successfully revegetated.

3.10 PERFORATIONS

A. Perforations in the subgrade or fill resulting from CQA activities will be filled. Such perforations may include, but are not limited to, the following:

1. Shelby tube sample locations; and,
2. Sand-cone or rubber balloon test locations.

B. All perforations resulting from construction and/or CQA activities shall be filled by the Contractor. The CQA Engineer will provide the Contractor with the locations of any perforations made as part of CQA activities.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with structural fill material. The structural fill material shall be placed and compacted in accordance with the requirements of this section.

[END OF SECTION]

SECTION 02119
PREPARED SUBGRADE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the prepared subgrade for the landfill or surface impoundment. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02221 - Clay Liner
C. Section 02714 - Geotextile filter of Cushion Layer
D. Section 02780 - Geosynthetic Clay Liner

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualifications and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIAL FOR PREPARED SUBGRADE

A. Prepared subgrade material shall be obtained from the landfill or surface impoundment excavation subgrade, borrow areas, or stockpiles identified by the Owner.

B. Purposed subgrade shall classify as CL or CH according to USGS.

C. Prepared subgrade may require processing of in-situ materials, borrow areas, or stockpiles to achieve a maximum particle size of 1-inch..

D. The water used to increase the moisture content of the prepared subgrade shall be provided by the Owner. The Contractor shall maintain an accurate record of his water usage.

PART 3: EXECUTION

3.01 PREPARED SUBGRADE COMPACTION CRITERIA

A. The compaction moisture content of the prepared subgrade material shall be between 3 percent below and 3 percent above optimum moisture content determined in the modified Proctor compaction test (ASTM D1557). The minimum dry unit weight of the prepared subgrade shall be at least 90 percent of the maximum dry unit weight obtained from the modified Proctor compaction test (ASTM D1557).

3.02 PREPARED SUBGRADE MATERIAL PLACEMENT

A. Prepared subgrade shall be placed at the locations and to the thickness shown on the Construction Drawings.

B. Prepared subgrade placement shall begin only after completion of all, or an approved portion of, excavation, structural fill, or cover soil placement in the landfill or surface impoundment.

C. The Contractor shall not place prepared subgrade material on a surface or subgrade that contains debris, branches, vegetation, mud, ice, or frozen material. If frozen subgrade material is encountered, it shall be removed and replaced in accordance with these General Specifications.

D. Prepared subgrade material shall be placed and compacted in lifts parallel to the underlying surface.

E. If normal handling does not reduce the maximum clod size in the prepared subgrade material to an acceptable size, the Contractor shall use a Caterpillar SS250 soil

stabilizer, mechanical mixer, or approved equivalent equipment to break up the clods. The prepared subgrade material shall be pulverized until the maximum soil clod size is reduced to 1 inches or less in largest dimension.

F. Moisture conditioning of the prepared subgrade material shall be accomplished in the processing area prior to prepared subgrade construction. The processing area location shall be approved by the Owner. Prepared subgrade material shall be moisture conditioned using a Caterpillar SS250 soil stabilizer or approved equivalent. If the prepared subgrade material is wetter than required, it shall be repeatedly mixed using a Caterpillar SS250 soil stabilizer, harrow, disc, grader, or equivalent to achieve drying.

G. Prepared subgrade material shall not be placed or compacted during a sustained period of temperature below 32°F that results in frozen material either in place or in the borrow area. Prepared subgrade material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

H. The Contractor shall not place frozen material nor shall the Contractor place material on frozen ground.

I. If prepared subgrade material freezes after compaction, the Contractor shall either rework the material after it thaws or remove the frozen material. The Contractor shall then place and compact new prepared subgrade or rework the prepared subgrade accordance with the General Specifications. Frozen prepared subgrade shall not be reused until it has thawed and been reworked to an acceptable moisture content. The Contractor shall be responsible for protecting compacted lifts of prepared subgrade material from freezing. If extended freezing conditions are anticipated, the Contractor shall prepare a plan for approval of the Owner which outlines the measures he will take to protect finished work.

J. Prepared subgrade material shall not be placed during periods of unfavorable weather conditions.

3.03 PREPARED SUBGRADE COMPACTION

A. The sequence of compaction of the prepared subgrade for the landfill or surface impoundment shall be as described in the General Specifications or as shown on the Construction Drawings.

B. Compaction of prepared subgrade on the landfill or surface impoundment shall be performed using a vibratory steel drum compactor. In areas where geomembranes will be installed on top of the prepared subgrade, Contractor shall prepare the surface in accordance with geomembrane surface preparation requirements identified in the geomembrane specifications.

C. The daily work area shall extend a sufficient distance so as to maintain soil moisture conditions within an acceptable range to allow continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. The CQA Engineer will identify any areas of significant desiccation and crusting of a lift surface. The Contractor shall scarify the surface of such areas to a nominal depth of 1 to 2 inches or to the depth of desiccation identified by the CQA Engineer, and then water condition, disc or mix as necessary, and recompact the area.

E. Corners and other areas inaccessible to driven compaction equipment shall be compacted using hand operated equipment (such as a walk-behind roller) approved by the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevations of the top of the prepared subgrade. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the top of the prepared subgrade. The Surveyor shall submit this drawing prior to liner construction unless otherwise approved by the Owner and the CQA engineer. The Contractor may submit a partial record to obtain approval for a portion of the work. The Owner will define the minimum requirements for a partial submittal.

3.05 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed work of these General Specifications.

B. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The Contractor shall minimize, to the maximum extent feasible, desiccation cracking of prepared subgrade material. The Contractor shall sprinkle the prepared subgrade with water if cracking is observed or if directed by the Owner. The Contractor may seal roll the surface of the prepared subgrade to reduce drying and desiccation. The Contractor may protect exposed surfaces using light colored or translucent membranes, such as Visqueen, to inhibit drying of the prepared subgrade. The CQA Engineer will identify areas of significant cracking of the surface of the prepared subgrade and the Contractor shall repair the identified area to the satisfaction of the Owner and at no additional cost to the Owner.

D. Desiccation cracks larger than 0.2 feet deep or 0.25 inches wide shall be excavated to the full depth of the crack and repaired. Desiccation cracks on the prepared subgrade surface less than 0.2 feet deep and 0.25 inches wide shall be moistened and compacted with a smooth drum roller until the surfaces meet the requirements of the CQA plan.

3.07 PERFORATIONS

A. Perforations in the prepared subgrade resulting from construction and CQA activities shall be filled. Such perforations may include, but are not limited to, the following:

1. Nuclear density test probe locations;
2. Shelby tube sample locations;
3. Sand-cone or rubber-balloon test locations; and,
4. Survey stake locations.

B. Perforations in the prepared subgrade resulting from nuclear density tests will be filled by the CQA Engineer. All other perforations in the prepared subgrade resulting from construction and/or CQA sampling activities shall be filled by the Contractor. The CQA Engineer will provide the Contractor with the locations of any tests made as part of CQA activities, except nuclear density tests.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with prepared subgrade material. The prepared subgrade material shall be placed and compacted (hand tamped) in accordance with the requirements of this section. Perforations in the prepared subgrade from nuclear density tests will be backfilled by the CQA Engineer with prepared subgrade material and compacted by hand tamping.

[END OF SECTION]

SECTION 02221
CLAY LINER

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the clay liner component of the liner system for the landfill or surface impoundment. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02710 - Geocomposite
C. Section 02714 - Filter or Cushion Geotextile
D. Section 02775 - Geomembrane Liners
E. Section 02780 - Geosynthetic Clay Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualifications and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan and shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer's sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

Clay liner material may only be used for construction if it has been shown to be suitable in a test fill program. The test fill program will have been performed prior to construction of the landfill or surface impoundment, and it is not part of the work included in this General Specification. These General Specifications may be modified per the results of the test fill.

A. Clay liner material shall be obtained from borrow areas or stockpiles identified by the Owner.

B. Clay liner material for landfill or surface impoundment construction shall:

1. Be classified according to the Unified Soil Classification System (USCS) as CL or CH (ASTM D 2487) and exhibit a minimum liquid limit of 30 and a minimum plasticity index of 11.

2. Have a percentage of gravel (i.e., dry weight retained on a U.S. No. 4 sieve) of less than 15 percent.

3. Have particles no larger than 2 inches (in largest dimension) after processing but prior to placement and no larger than 1 inch (in largest dimension) after placement and compaction.

4. Have a hydraulic conductivity of not more than 1×10^{-7} cm/sec when compacted in accordance with these General Specifications and tested in the laboratory in accordance with ASTM D 5084 at an average effective confining pressure of 5 psi.

C. The water used to increase the moisture content of the clay liner shall be provided by the Owner. The Contractor shall maintain an accurate record of his water usage.

PART 3: EXECUTION

The requirements of Part 3 may be modified based on the results of the test fill.

3.01 CLAY LINER COMPACTION CRITERIA

A. The compaction moisture content and the minimum dry unit weight of on-site clay, if used as clay liner material, shall plot within the placement window as shown on figure 02221-1.

3.02 CLAY LINER PLACEMENT

A. The clay liner shall be constructed to the elevations, grades, and thicknesses shown on the Construction Drawings. The thickness of the clay liner at any location shall be measured perpendicular to the plane of the slope at that location.

B. Clay liner placement shall begin only after completion of all, or an approved portion of excavation, structural fill placement, geosynthetic installation in the landfill or surface impoundment. Placement shall not begin until the Contractor has verified that prepared elevations and grades conform to the Construction Drawings and the CQA Engineer has completed testing and surveying required by the CQA Plan.

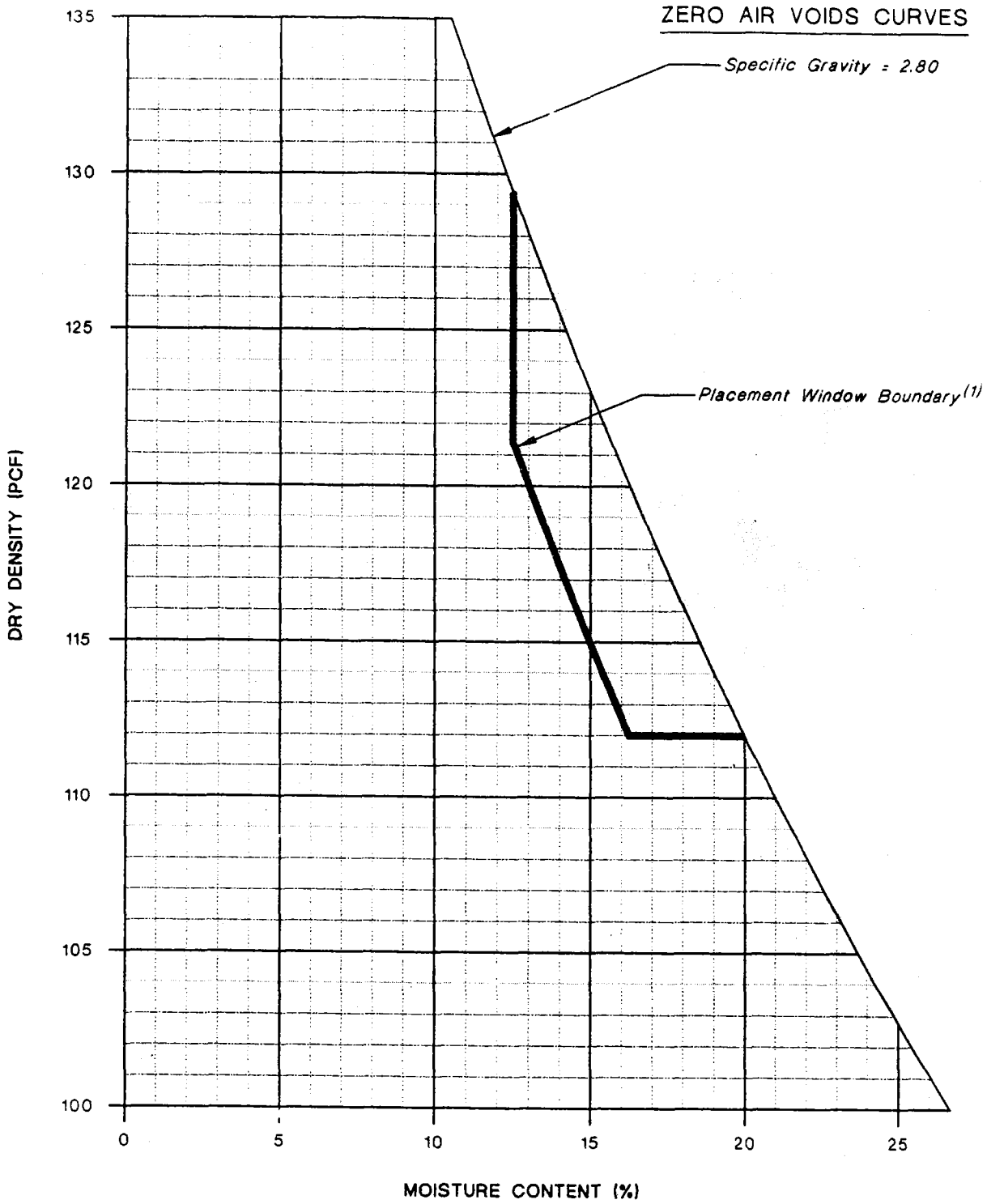
C. The Contractor shall not place clay liner material on a surface or subgrade that contains debris, branches, vegetation, mud, ice, or frozen material. If frozen material is encountered, it shall be removed and replaced in accordance with these General Specifications. Immediately prior to clay liner placement, any wet or soft areas shall be proof-rolled as directed by the Owner. Any excessively wet or soft areas shall be excavated and replaced with properly compacted structural fill.

D. The Contractor shall construct the clay liner in lifts. Each lift of the clay liner shall meet the minimum requirements of this General Specification.

E. The average lift thickness after compaction shall be no more than 6 inches, and the maximum lift thickness shall be 7 inches after compaction.

F. On slopes of 3:1 (horizontal:vertical) or flatter, clay liner material may either be placed and compacted in lifts that are parallel to the slope or in horizontal lifts. For steeper slopes, clay liner material shall be placed and compacted in horizontal lifts.

G. Prior to placement of a lift of clay liner material, Contractor shall allow the CQA Engineer to complete field testing in accordance with the CQA Plan. The Contractor shall not place a new lift of clay liner material over a preceding lift until approval is given by the CQA Engineer. If the Contractor fails to comply with this requirement, he will be required by the Owner to remove and replace all unauthorized work at no additional cost to the Owner.



(1) PLACEMENT WINDOW BOUNDARY MAY BE MODIFIED BASED ON RESULTS OF TEST FILL.

REV No	REVISIONS	REV. DATE	DESIGN BY	DRAWN BY	REVIEWED AND SIGNED BY
0	Part B Permit	11/17/97	J.Pellicer	K.Conrath	J.Pellicer

TerraMatrix
MONTGOMERY WATSON
Mining Group

PROJECT No 602-0200
AutoCAD FILE PLACEWINDOW.DWG
SCALE NA
FIGURE No: 02221-1

Triassic Park Waste Disposal Facility

CLAY LINER PLACEMENT WINDOW

H. Prior to placement of a lift of clay liner material, the previous lift shall be thoroughly scarified to a nominal depth of about 1 to 2 inches to provide good bonding between lifts. Scarification shall be accomplished by discing, ripping with a grader, penetration by a sheepsfoot compactor or an alternative method approved by the Owner.

I. The excessive trafficking of scarified surfaces by non-placement trucks or other equipment shall not be permitted during the period between scarification and placement of the following lift.

J. If normal handling does not reduce the maximum clod size in on-site clay to an acceptable size, the Contractor shall use a Caterpillar SS250 soil stabilizer, mechanical mixer, or approved equivalent equipment to break up the clods. The on-site clay material shall be pulverized until the maximum soil clod size is reduced to 2 inches or less in largest dimension.

K. Moisture conditioning of the clay liner material shall be accomplished in the processing area prior to clay liner construction. The processing area location shall be approved by the Owner. Clay liner material shall be moisture conditioned using a Caterpillar SS250 soil stabilizer or approved equivalent. If the clay liner material is wetter than required, it shall be repeatedly mixed using a Caterpillar SS250 soil stabilizer, harrow disc, grader, or equivalent to achieve drying.

L. No more than 3 percent moisture shall be added to the clay liner material at the time of compaction. Clay liner material requiring more than 3 percent moisture shall be removed, returned to the processing area, and conditioned until the proper moisture content is achieved. If the in-place moisture content is too high, the clay may be dozed, windrowed, disced, and/or otherwise mixed to facilitate drying.

M. Clay liner material shall not be placed or compacted during a sustained period of temperature below 32°F that results in frozen clay, either in place or in the borrow area. Clay liner material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

N. The Contractor shall not place frozen clay nor shall the Contractor place clay on frozen ground.

O. If clay liner material freezes after compaction, the Contractor shall remove the frozen material, scarify the remaining unfrozen clay, and then place and compact new clay in accordance with the General Specifications. Frozen clay shall not be reused until it has thawed and been reworked to an acceptable moisture content. The Contractor shall be responsible for protecting compacted lifts of clay liner material from freezing. If extended freezing conditions are anticipated, the Contractor shall prepare a plan for approval of the Owner which outlines the measures he will take to protect finished work.

P. Clay liner material shall not be placed during periods of unfavorable weather conditions.

Q. The first lift of clay liner material above any geosynthetics be constructed using a 12-inch thick loose lift. The lift shall be placed and spread using a low-ground pressure dozer (e.g., Caterpillar D6H LGP or other equipment approved by the Owner).

Extreme care shall be taken during placement and spreading operations to ensure that the earthwork equipment does not damage the underlying geosynthetics.

3.03 CLAY LINER COMPACTION

A. The sequence of compaction of the clay liner for a landfill or surface impoundment shall be as described in the General Specifications or as shown on the Construction Drawings.

B. Compaction of the clay liner for the landfill or surface impoundment shall be performed using a Caterpillar 825 compactor or equal.

C. The daily work area shall extend a sufficient distance so as to maintain soil moisture conditions within an acceptable range to allow continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. The CQA Engineer will identify any areas of significant desiccation and crusting of a lift surface. The Contractor shall scarify the surface of such areas to a nominal depth of 1 to 2 inches or to the depth of desiccation identified by the CQA Engineer, and then water condition, disc or mix as necessary, and recompact the area.

E. The transition from an existing full-depth section of clay liner to the beginning of an adjacent section that is to be constructed subsequently shall be accomplished by sloping (cutting back) the end of the full-depth section at 3:1 (horizontal:vertical) or flatter, scarifying the slope of the existing full-depth liner at the transition, and then immediately placing the adjacent lifts of clay liner.

F. If a dual-drum compactor which has the drums laterally separated by the operator's cab and the differential (such as a CAT 825) is used, one trip up and a staggered trip back, to cover the uncompacted area between the drums, shall be considered one pass. The minimum number of compactor passes on each lift of the secondary clay liner shall be as follows:

   1. The clay liner shall be compacted with a minimum of 10 passes of the CAT 825 if the on-site clay is used or the number of passes determined during test fill construction.

   It should be noted that more than the minimum number of passes may be necessary to satisfy the compaction criteria.

G. Corners and other areas inaccessible to driven compaction equipment shall be compacted using hand operated equipment (such as a walk-behind roller) approved by the Owner.

H. In areas where geomembranes will be installed on top of the clay liner, Contractor shall prepare the surface in accordance with geomembrane surface preparation requirements identified in the geomembrane specifications.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the clay liner. Surveying shall be performed in accordance with Section 01010 of these General

Specifications. As part of this work, the Surveyor shall survey the location and elevation of the leak detection system sump. The survey will ensure:

1. The specified thickness of the clay liner has been achieved.

2. The top of the clay liner is at the grades and elevations specified on the contract drawings.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the top of the clay liner, in accordance with the requirements of Section 01010 of these General Specifications. The Surveyor shall submit this drawing prior to additional construction unless otherwise approved by the Owner and the CQA engineer. The Contractor may submit a partial record to obtain approval for a portion of the work. The Owner will define the minimum requirements for a partial submittal.

3.05 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

B. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The Contractor shall minimize, to the maximum extent feasible, desiccation cracking of clay liner material. The Contractor shall sprinkle the clay with water if cracking is observed or if directed by the Owner. The Contractor may seal roll the surface of the clay to reduce drying and desiccation. The Contractor may protect exposed surfaces using light-colored or translucent membranes, such as Visqueen, to inhibit drying of the clay. The CQA Engineer will identify areas of significant cracking of the surface of the clay liner and the Contractor shall repair the identified area to the satisfaction of the Owner and at no additional cost to the Owner.

D. The clay liner surface shall be seal rolled and made smooth and free from ruts or indentations at the end of every working day when precipitation is forecast and/or at the completion of compaction operations in an area.

E. The Contractor shall maintain the clay liner surface in a condition suitable for geomembrane installation as specified in the CQA plan until the surface is covered. Desiccation cracks larger than 0.2 feet deep or 0.25 inches wide shall be excavated to

the full depth of the crack and repaired. Desiccation cracks on the liner surface less than 0.2 feet deep and 0.25 inches wide shall be moistened and compacted with a smooth drum roller until the surfaces meet the requirements of the CQA Plan.

F. The layer of over-built material shall be removed prior to placement of overlying materials. The over-built material may be removed in sections to coordinate construction. Where the over-built material is removed, the finished surface shall be protected and maintained as required by the specifications.

G. No synthetic sealants or other chemical treatments may be applied to the clay liner material.

H. The CQA Engineer will issue an approval of the installation of the clay liner to the Owner prior to placement of material over the clay liner in accordance with the requirements of the CQA Plan.

3.07 PERFORATIONS

A. Perforations in the clay liner resulting from construction and CQA activities shall be filled. Such perforations may include, but are not limited to, the following:

1. Nuclear density test probe locations;
2. Shelby tube sample locations;
3. Sand-cone or rubber-balloon test locations; and,
4. Survey stake locations.

B. Perforations in the clay liner resulting from nuclear density tests will be filled by the CQA Engineer. All other perforations in the clay liner resulting from construction and/or CQA sampling activities shall be filled by the Contractor. The CQA Engineer will provide the Contractor with the locations of any tests made as part of CQA activities, except nuclear density tests.

C. Perforations from construction and/or CQA sampling activities (except nuclear density tests) shall be backfilled by the Contractor with clay liner material. The clay liner material shall be placed and compacted (hand tamped) in accordance with the requirements of this section. Perforations in the clay liner from nuclear density tests will be backfilled by the CQA Engineer with clay liner material and compacted by hand tamping.

[END OF SECTION]

SECTION 02224
DRAINAGE GRAVEL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the placement of drainage gravel associated with the landfill and surface impoundment. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02710 - Geocomposite Detection or Collection Layer
B. Section 02714 - Geotextile Filter or Cushion Layer
C. Section 02718 - Polyethylene Pipe and Fittings
D. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule.

C. On-site testing as specified in the CQA Plan for the drainage gravel (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing (in accordance with Part 2.02 of this section) of the drainage gravel at the source shall be the responsibility of the Contractor.

PART 2: PRODUCTS

2.01 MATERIAL FOR DRAINAGE GRAVEL

A. Drainage gravel for the work shall consist of clean, hard, durable, non-carbonate, rounded, sub-rounded to sub-angular particles which are free of metals, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The gravel shall be screened and washed to have a gradation (when tested in accordance with ASTM D 422) after placement equivalent to the following:

Sieve	Percent Passing
1"	100%
¾"	85-100%
3/8"	12-30%
4"	1-4%
40"	0-1%

C. Drainage gravel shall have a hydraulic conductivity of at least 1 cm/sec when hand compacted in the laboratory in 3 lifts and tested in accordance with ASTM D 2434.

D. Drainage gravel shall have less than 30% loss when tested in accordance with ASTM C 131 for abrasion and less than 12% loss when tested in accordance with ASTM C 88.

E. Drainage gravel shall have less than 5 percent loss of weight, when tested for calcium carbonate content in accordance with ASTM D 4373. This requirement may be waived by the Owner if it can be otherwise demonstrated that the material contains no significant carbonate content.

2.02 DRAINAGE GRAVEL SUPPLIER QUALITY CONTROL

A. The Contractor shall require that the drainage gravel Supplier sample and test the gravel to demonstrate that the material conforms to the requirements of Part 2.01 of this section. The Contractor shall require the gravel Supplier provide to the Owner written certification along with test results, that tests have been performed on representative samples of the gravel material that will be delivered to the Owner's site. The analysis shall demonstrate that tests (i.e., ASTM D 422, ASTM D 2434, ASTM D 4373, AASHTO T96, and AASHTO T104) have been performed and that acceptable results were obtained.

B. If a gravel sample fails to meet the quality control requirements of this General Specification, the Contractor shall require the gravel Supplier to perform sufficient sampling and testing to identify the extent of the nonconforming material to the satisfaction of the CQA Engineer. The Contractor shall not use nonconforming material.

C. The Contractor shall require that the gravel Supplier comply with the certification and submittal requirements of the CQA Plan.

D. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.03 TRANSPORTATION

A. Transportation of gravel shall be the responsibility of the Contractor.

2.04 HANDLING AND STORAGE

A. Handling, stockpiling, and protection of the gravel prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for contamination of the material incurred prior to final acceptance.

B. The Contractor shall be responsible for storage of the gravel at the site. The Contractor shall store the gravel at a location approved by the Owner and in such a manner so that it is not contaminated by dirt, mud, vegetation, or excessive dust. During stockpiling, the Contractor may elect to place the gravel on a protective sheet and/or to cover it to prevent contamination. The CQA Engineer will identify contaminated material which will be rejected by the Owner.

PART 3: EXECUTION

3.01 PLACEMENT AND COMPACTION

A. Gravel shall be placed at the locations and to the thicknesses shown on the Construction Drawings.

B. Gravel shall not be placed directly on the geomembrane liner. Gravel may be placed on top of a geotextile cushion layer, geonet, geocomposite drainage layer, or geomembrane rub sheet, as shown on the Construction Drawings. Gravel may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner, as long as the ground-pressure requirements of this Section are not exceeded. The maximum acceptable gravel drop height is 3 feet.

C. Final spreading of the gravel may be performed using a low ground-pressure dozer (Caterpillar D6H-LGP or other similar equipment approved by the CQA Engineer), low-ground pressure front-end loader, or by hand. The tracked equipment shall operate only over previously-placed gravel or other soil. The Contractor shall not operate equipment directly on geosynthetics.

D. Unless otherwise specified by the Owner, the equipment used to spread gravel shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Thickness of Gravel Above Geosynthetic (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

F. Within 1 foot of the toe of a slope, gravel shall be spread by hand. Extreme care shall be taken when placing gravel to protect the installed components of the liner system.

G. Geotextile filter or cushion layers shall be placed as shown on the Construction Drawings. Geotextile filter and cushion layer placement shall be in accordance with Section 02714 of these General Specifications.

3.02 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.03 PROTECTION OF WORK

A. After the gravel has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the drainage gravel. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the drainage gravel, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

SECTION 02225
ROAD BASE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, testing, and installation services necessary for the installation of road base where shown on the Construction Drawings. The work shall be carried out in accordance with the Construction Drawings and the requirements of Section 304 of the New Mexico State Highway and Transportation Department Standard Specification for Road and Bridge Construction.

1.02 RELATED SECTIONS

A. Section 02230 - Subbase
B. Section 02714 - Filter or Cushion Geotextile

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule.

C. On-site testing as specified in the CQA Plan for the road base (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing (in accordance with Part 2.02 of this section) of the road base at the source shall be the responsibility of the Contractor.

PART 2: PRODUCTS

2.01 MATERIAL FOR ROAD BASE AGGREGATE

A. Road base for the work shall consist of clean, hard, durable, non-carbonate, rounded, sub-rounded to sub-angular particles which are free of metals, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The road base shall have a gradation (when tested in accordance with ASTM D 422) of Type II-B aggregate as defined in Section 304 of the New Mexico State Highway and Transportation Department Standard Specification for Road and Bridge Construction.

C. Road base shall have less than 5 percent loss of weight, when tested for calcium carbonate content in accordance with ASTM D 4373. This requirement may be waived by the owner if it can be otherwise demonstrated that the material contains no significant carbonate content.

2.02 ROAD BASE SUPPLIER QUALITY CONTROL

A. The Contractor shall require that the road base Supplier sample and test the road base to demonstrate that the material conforms to the requirements of Part 2.01 of this section. The Contractor shall require the road base Supplier provide to the Owner written certification along with test results, that tests have been performed on representative samples of the road base material that will be delivered to the Owner's site. The analysis shall demonstrate that tests (i.e., ASTM D 422, ASTM D 2434, ASTM D 4373, ASTM C 131, and ASTM C 88) have been performed and that acceptable results were obtained.

B. If a road base sample fails to meet the quality control requirements of this General Specification, the Contractor shall require the road base Supplier to perform sufficient sampling and testing to identify the extent of the nonconforming material to the satisfaction of the CQA Engineer. The Contractor shall not use nonconforming material.

C. The Contractor shall require that the road base Supplier comply with the certification and submittal requirements of the CQA Plan.

D. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.03 TRANSPORTATION

A. Transportation of road base shall be the responsibility of the Contractor.

2.04 HANDLING AND STORAGE

A. Handling, stockpiling, and protection of the road base prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for contamination of the material incurred prior to final acceptance.

B. The Contractor shall be responsible for storage of the road base at the site. The Contractor shall store the road base at a location approved by the Owner and in such a manner so that it is not contaminated by dirt, mud, vegetation, or excessive dust. During stockpiling, the Contractor may elect to place the road base on a protective sheet and/or to cover it to prevent contamination. The CQA Engineer will identify contaminated material which will be rejected by the Owner.

PART 3: EXECUTION

3.01 GRAVEL COMPACTION CRITERIA

A. The compaction moisture content of the road base shall be between 3 percent below and 3 percent above optimum moisture content determined in the modified Proctor compaction test (ASTM D1557). The minimum dry unit weight of the road base aggregate shall be at least 95 percent of the maximum dry unit weight obtained from the modified Proctor compaction test (ASTM D1557).

3.02 PLACEMENT AND COMPACTION

A. Road base shall be placed at the locations and to the thicknesses shown on the Construction Drawings

B. Road base shall not be placed directly on geosynthetics unless required by the General Specifications or the Construction Drawings. Road base may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner in maximum 12-inch loose lifts.

C. Final spreading of the road base may be performed using a dozer or grader. Equipment shall operate only over previously-placed road base or other soil. The Contractor shall not operate equipment directly on geosynthetics.

D. Road base placed on top of geotextile shall have a first lift minimum thickness of 12 inches

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

F. Geotextile filter or cushion layers shall be placed as shown on the Construction Drawings. Geotextile filter and cushion layer placement shall be in accordance with Section 02714 of these General Specifications.

3.03 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.04 PROTECTION OF WORK

A. After the road base has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the road base. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the road base, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

SECTION 02226
PROTECTIVE SOIL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the soil component of the landfill. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02119 - Prepared Subgrade
B. Section 02710 - Geocomposite Detection or Collection Layer

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

A. Soil material shall be obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources.

B. Soil layer material shall classify as CL, ML, SC, GC, SM, or GM according to the Unified Soil Classification System (ASTM D 2487) and shall have a maximum particle size not exceeding 3 inches.

PART 3: EXECUTION

3.01 SOIL LAYER COMPACTION CRITERIA

A. The Contractor shall place and compact the soil as described in this Section.

3.02 PLACEMENT AND COMPACTION

A. Soil material shall be placed above the waste material at the locations and to the thicknesses shown on the Construction Drawings.

B. The Contractor shall not place the soil layer until the CQA Engineer confirms that the constructed grades and elevations of the waste meet the requirements of the Construction Drawings, all field testing is complete, and approved in accordance with the requirements of the CQA Plan.

C. The final in-place thickness of the soil layer shall be not less than 18 inches.

D. The soil material shall be spread in 2 lifts. The Contractor shall not operate equipment directly on geomembranes, geotextiles, GCL's, or geocomposites.

E. Unless otherwise specified by the Owner, the equipment used to haul and spread the soil layer in areas within 5 feet of geosynthetics shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Minimum Thickness of Soil Layer Above the Geosynthetic (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

F. Soil shall be compacted at a moisture content between 3 percent below to 3 percent above optimum moisture content and to a minimum dry unit weight of 90 percent of

the maximum dry unit weight determined in the modified Proctor compaction test (ASTM D 1557).

G. In areas of heavy traffic, the thickness of the soil layer shall be increased at the direction of the Owner to satisfy the requirements of this Section. Heavy traffic areas shall be compacted with a smooth drum roller or other equipment approved by the Owner.

H. The Contractor shall operate equipment in a manner that is protective of underlying geosynthetics. If it is suspected that any damage to the underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove overlying soil layer material to expose the geosynthetics. The Contractor shall repair, at his own expense, any damage of the underlying geosynthetics in accordance with these General Specifications.

I. The Contractor shall minimize to the extent possible the generation of dust during placement of the soil layer. Water may be used for dust control if approved by the Owner. Chemical dust suppressants shall not be used.

J. No soil material shall be placed or compacted during a sustained period of temperature below 32°F that results in frozen material, either in-place or in the borrow area. With the approval of the Owner, soil material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

K. The Contractor shall not place frozen soil material nor shall he place soil material on frozen ground.

L. Soil material shall not be placed during periods of precipitation or unfavorable weather conditions.

3.03 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the soil layer installed by the Contractor. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and elevation of the top of the soil layer to the Owner in accordance with the requirements of Section 01010 of these General Specifications.

3.04 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.05 PROTECTION OF WORK

A. After the soil layer has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

C. In the event of damage, the CQA Engineer will identify any areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02227
VEGETATIVE COVER

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the vegetative cover component of the landfill. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02710 - Geocomposite
B. Section 02714 - Filter or Cushion Geotextile

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area.

The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

A. Vegetative cover material shall be obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources.

B. Vegetative cover material shall classify as CL, ML, SC, GC, SM, or GM according to the Unified Soil Classification System (ASTM D 2487) and shall have a maximum particle size not exceeding 3 inches.

PART 3: EXECUTION

3.01 VEGETATIVE COVER LAYER COMPACTION CRITERIA

A. The Contractor shall place and compact the soil as described in of this Section.

3.02 PLACEMENT AND COMPACTION

A. Vegetative cover material shall be placed above the cover system geocomposite at the locations and to the thicknesses shown on the Construction Drawings.

B. The Contractor shall not place the vegetative soil layer until the CQA Engineer confirms that the constructed grades and elevations of the cover prepared subgrade meet the requirements of the Construction Drawings, all field testing is complete, and the geocomposite has been installed, tested, and approved in accordance with the requirements of the CQA Plan.

C. Prior to placing the vegetative cover layer, the CQA Engineer will verify that the underlying geosynthetic components are free of holes, tears, excessive wrinkles, or foreign objects. As instructed by the Owner, the Contractor shall "work out" or repair all excessive wrinkles to the satisfaction of the CQA Engineer prior to placement of the vegetative cover. In all cases, wrinkles in the geomembrane cover shall not be of a size that they could fold back on themselves.

D. The final in-place thickness of the vegetative cover layer shall be not less than 30 inches.

E. The vegetative cover material shall be spread in one lift using a low ground-pressure dozer (Caterpillar D6H-LGP, or other equipment approved by the Owner), low-ground pressure tracked front-end loader, or belt conveyor. Equipment shall operate only over previously-placed vegetative cover layer material. The Contractor shall not operate equipment directly on geomembranes, geotextiles, gcls, or geocomposites.

F. Unless otherwise specified by the Owner, the equipment used to haul and spread the vegetative cover layer shall not exert ground pressures exceeding the following:

Minimum Thickness

Allowable Equipment Ground Pressure (psi)	*of Protective Soil Layer Above the Geosynthetic (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

G. Vegetative cover material shall be compacted by two passes of tracked equipment such as a Caterpillar D6H-LGP or other equipment approved by the Owner.

H. In areas of heavy traffic, the thickness of the vegetative cover layer shall be increased at the direction of the Owner to satisfy the requirements of this Section. Heavy traffic areas shall be compacted with a smooth drum roller or other equipment approved by the Owner.

I. The Contractor shall operate equipment in a manner that is protective of underlying geosynthetics. If it is suspected that any damage to the underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove overlying vegetative cover material to expose the geosynthetics. The Contractor shall repair, at his own expense, any damage of the underlying geosynthetics in accordance with these General Specifications.

J. The Contractor shall minimize to the extent possible the generation of dust during placement of the vegetative cover layer. Water may be used for dust control if approved by the Owner. Chemical dust suppressants shall not be used.

K. No vegetative cover material shall be placed or compacted during a sustained period of temperature below 32°F that results in frozen material, either in-place or in the borrow area. With the approval of the Owner, vegetative cover material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

L. The Contractor shall not place frozen vegetative cover material nor shall he place vegetative cover material on frozen ground.

M. Vegetative cover material shall not be placed during periods of precipitation or unfavorable weather conditions.

3.03 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the vegetative cover layer installed by the Contractor. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and elevation of the top of the vegetative cover layer to the Owner in accordance with the requirements of Section 01010 of these General Specifications.

3.04 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.05 PROTECTION OF WORK

A. After the vegetative cover layer has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

C. In the event of damage, the CQA Engineer will identify any areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02228
PIPE BEDDING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of pipe bedding material. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02714 - Filter or Cushion Geotextile
B. Section 02718 - Polyethylene Pipe and Fittings

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

A. Pipe bedding material shall be obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources.

B. Pipe bedding material shall classify as ML, SM, SP, SW, or GM according to the Unified Soil Classification System (ASTM D 2487) and shall have a maximum particle size not exceeding 1 inches.

PART 3: EXECUTION

3.01 PIPE BEDDING COMPACTION CRITERIA

A. The Contractor shall place and compact the soil as described in of this Section.

3.02 PLACEMENT AND COMPACTION

A. Pipe bedding shall be placed at the locations and to the thicknesses shown on the Construction Drawings.

B. The Contractor shall not place the pipe bedding material until the CQA Engineer confirms that the constructed grades and elevations of the underlying materials meet the requirements of the Construction Drawings, all field testing is complete, and the underlying materials have been installed, tested, and approved in accordance with the requirements of the CQA Plan.

C. Prior to placing the pipe bedding material, the CQA Engineer will verify that the underlying geosynthetic components are free of holes, tears, excessive wrinkles, or foreign objects. As instructed by the Owner, the Contractor shall "work out" or repair all excessive wrinkles to the satisfaction of the CQA Engineer prior to placement of the pipe bedding. In all cases, wrinkles in the geomembrane shall not be of a size that they could fold back on themselves.

D. Pipe bedding may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner. The maximum drop height is 3 feet.

E. The pipe bedding material shall be shovel sliced into the haunches of the pipe.

F. Contractor shall not operate equipment directly on geosynthetics when placing pipe bedding material.

G. The Contractor shall operate equipment in a manner that is protective of underlying polyethylene pipes and geosynthetics. If it is suspected that any damage to the underlying polyethylene pipes or geosynthetics may have occurred, the Owner will instruct the Contractor to remove overlying pipe bedding material to expose the potentially damaged materials. The Contractor shall repair, at his own expense, any damage of the underlying materials in accordance with these General Specifications.

H. No pipe bedding material shall be placed or compacted during a sustained period of temperature below 32°F that results in frozen material, either in-place or in the borrow area. With the approval of the Owner, pipe bedding material may be placed and compacted during periods of early morning freezing temperatures if above-freezing temperatures are anticipated during the day.

I. The Contractor shall not place frozen pipe bedding material.

J. Pipe bedding material shall not be placed during periods of precipitation or unfavorable weather conditions.

K. Pipe bedding material shall be compacted with two passes of a hand operated vibrating compactor such as a hand tamper or walk-behind vibrating compactor or other method approved by the Owner.

3.03 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the pipe bedding material installed by the Contractor. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and elevation of the top of the pipe bedding material to the Owner in accordance with the requirements of Section 01010 of these General Specifications.

3.04 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.05 PROTECTION OF WORK

A. After the pipe bedding material has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

C. In the event of damage, the CQA Engineer will identify any areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02229
SELECT SUBBASE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, testing, and installation services necessary for the installation of select subbase where shown on the Construction Drawings. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02710 - Geocomposite Detection or Collection Layer
B. Section 02714 - Filter or Cushion Geotextile

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule.

C. On-site testing as specified in the CQA Plan for the select subbase (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing (in accordance with Part 2.02 of this section) of the select subbase at the source shall be the responsibility of the Contractor.

PART 2: PRODUCTS

2.01 MATERIAL FOR SELECT SUBBASE

A. Select subbase for the work shall consist of clean, hard, durable, non-carbonate, rounded, sub-rounded to sub-angular particles which are free of metals, roots, trees,

stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The select subbase shall be screened and washed to have a gradation (when tested in accordance with ASTM D 422) after placement equivalent to the following:

Sieve	Percent Passing
¼"	100
# 10	50-80
# 20	30-60
# 40	10-40
# 60	0-30
# 100	0-10
# 200	0-2

C. Select subbase shall have less than 5 percent loss of weight, when tested for calcium carbonate content in accordance with ASTM D 4373. This requirement may be waived by the owner if it can be otherwise demonstrated that the material contains no significant carbonate content.

2.02 SELECT SUBBASE SUPPLIER QUALITY CONTROL

A. The Contractor shall require that the select subbase Supplier sample and test the select subbase to demonstrate that the material conforms to the requirements of Part 2.01 of this section. The Contractor shall require the select subbase Supplier provide to the Owner written certification along with test results, that tests have been performed on representative samples of the material that will be delivered to the Owner's site. The analysis shall demonstrate that tests (i.e., ASTM D 422, ASTM D 2434, ASTM D 4373, ASTM C 131, and ASTM C 88) have been performed and that acceptable results were obtained.

B. If a select subbase sample fails to meet the quality control requirements of this General Specification, the Contractor shall require the Supplier to perform sufficient sampling and testing to identify the extent of the nonconforming material to the satisfaction of the CQA Engineer. The Contractor shall not use nonconforming material.

C. The Contractor shall require that the gravel Supplier comply with the certification and submittal requirements of the CQA Plan.

D. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.03 TRANSPORTATION

A. Transportation of select subbase shall be the responsibility of the Contractor.

2.04 HANDLING AND STORAGE

A. Handling, stockpiling, and protection of the select subbase prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for contamination of the material incurred prior to final acceptance.

B. The Contractor shall be responsible for storage of the select subbase at the site. The Contractor shall store the select subbase at a location approved by the Owner and in such a manner so that it is not contaminated by dirt, mud, vegetation, or excessive dust. During stockpiling, the Contractor may elect to place the select subbase on a protective sheet and/or to cover it to prevent contamination. The CQA Engineer will identify contaminated material which will be rejected by the Owner.

PART 3: EXECUTION

3.01 SELECT SUBBASE COMPACTION CRITERIA

A. The compaction moisture content of the select subbase shall be between 3 percent and 3 percent above optimum moisture content determined in the modified Proctor compaction test (ASTM D 1557). The minimum dry unit weight of the select subbase shall be at least 95 percent of the maximum dry unit weight obtained from the modified Proctor compaction test (ASTM D 1557).

3.02 PLACEMENT AND COMPACTION

A. Select subbase shall be placed at the locations and to the thicknesses shown on the Construction Drawings

B. Select subbase shall not be placed directly on geosynthetics unless required by the General Specifications or Construction Drawings. Select subbase may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner in maximum 12-inch loose lifts.

C. Final spreading of the select subbase may be performed using a low ground-pressure dozer (Caterpillar D6H-LGP or other similar equipment approved by the CQA Engineer), low-ground pressure front-end loader, or by hand. The tracked equipment shall operate only over previously-placed select subbase or other soil. The Contractor shall not operate equipment directly on geosynthetics.

D. Unless otherwise specified by the Owner, the equipment used to spread select subbase shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Thickness of Gravel Above Geosynthetic (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

3.03 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.04 PROTECTION OF WORK

A. After the select subbase has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the select subbase. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the road base, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

SECTION 02230
SUBBASE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, testing, and installation services necessary for the installation of subbase where shown on the Construction Drawings. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02225 - Road Base

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. On-site testing as specified in the CQA Plan for the subbase (which does not include quality control testing at the source) will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing of the subbase at the source shall be the responsibility of the Contractor.

E. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

F. If the CQA Engineer's tests indicate work does not meet the requirements of the specification, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results area obtained.

PART 2: PRODUCTS

2.01 MATERIAL FOR SUBBASE

A. Subbase for the work shall obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources. Subbase material shall be free of metals, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The subbase shall classify as SM, SW, GM, or GW according to the Unified Soil Classification System (ASTM D2487) and shall have a maximum particle size of 3 inches.

PART 3: EXECUTION

3.01 SUBBASE COMPACTION CRITERIA

A. The compaction moisture content of the subbase shall be between 3 percent and 3 percent above optimum moisture content determined in the modified Proctor compaction test (ASTM D 1557). The minimum dry unit weight of the subbase shall be at least 95 percent of the maximum dry unit weight obtained from the modified Proctor compaction test (ASTM D 1557).

3.02 PLACEMENT AND COMPACTION

A. Subbase shall be placed at the locations and to the thicknesses shown on the Construction Drawings

B. Subbase shall not be placed directly on geosynthetics unless required by the General Specifications or Construction Drawings. Subbase may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner in maximum 12-inch loose lifts.

C. Final spreading of the subbase may be performed using a low ground-pressure dozer (Caterpillar D6H-LGP or other similar equipment approved by the CQA Engineer), low-ground pressure front-end loader, or by hand. The tracked equipment shall operate only over previously-placed subbase or other soil. The Contractor shall not operate equipment directly on geosynthetics.

D. Unless otherwise specified by the Owner, the equipment used to spread subbase shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Thickness of Gravel Above Geosynthetic (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

3.03 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.04 PROTECTION OF WORK

A. After the subbase has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the road base. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the road base, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

SECTION 02231
FOUNDATION SAND

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, testing, and installation services necessary for the installation of foundation sand where shown on the Construction Drawings. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02110 - Site Preparation and Earthwork
B. Section 02718 - Polyethylene Pipe and Fittings
C. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. On-site testing as specified in the CQA Plan for the foundation sand will be the responsibility of the CQA Engineer. The Contractor shall cooperate with the CQA Engineer during all sampling and testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor will repair any damage to finished work caused by the CQA Engineer's sampling and testing activities.

D. Quality control testing of the foundation sand at the source shall be the responsibility of the Contractor.

E. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

F. If the CQA Engineer's tests indicate work does not meet the requirements of the specification, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results area obtained.

PART 2: PRODUCTS

2.01 MATERIAL FOR FOUNDATION SAND

A. Foundation sand for the work shall obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources. Foundation sand material shall be free of metals, roots, trees, stumps, concrete, construction debris, other organic matter, and deleterious materials and coatings.

B. The foundation sand shall classify as SM or SW according to the Unified Soil Classification System (ASTM D2487) and shall have a maximum particle size of 1/4 inches.

PART 3: EXECUTION

3.01 FOUNDATION SAND COMPACTION CRITERIA

A. The compaction moisture content of the foundation sand shall be between 3 percent and 3 percent above optimum moisture content determined in the modified Proctor compaction test (ASTM D 1557). The minimum dry unit weight of the foundation shall be at least 95 percent of the maximum dry unit weight obtained from the modified Proctor compaction test (ASTM D 1557).

3.02 PLACEMENT AND COMPACTION

A. Foundation sand shall be placed at the locations and to the thicknesses shown on the Construction Drawings

B. Foundation sand shall not be placed directly on geosynthetics unless required by the General Specifications or Construction Drawings. Foundation sand may be placed using a backhoe, front-end loader, belt conveyor, spreader box, or other method approved by the Owner in maximum 12-inch loose lifts.

C. Final spreading of the foundation sand may be performed using a low ground-pressure dozer (Caterpillar D6H-LGP or other similar equipment approved by the CQA Engineer), low-ground pressure front-end loader, or by hand. The tracked equipment shall operate only over previously-placed foundation sand or other soil. The Contractor shall not operate equipment directly on geosynthetics.

D. Unless otherwise specified by the Owner, the equipment used to spread subbase shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Thickness of Gravel Above Geosynthetic (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

E. The Contractor shall operate equipment in a manner that is protective of polyethylene pipes and underlying geosynthetics. If it is suspected that damage to polyethylene pipes or underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove the overlying material to expose the potentially-damaged materials. The Contractor shall repair, at his own expense, any observed damage, in accordance with the requirements of these General Specifications.

3.03 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.04 PROTECTION OF WORK

A. After the foundation sand has been incorporated into the work, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all prior work, materials and completed and partially completed work of other Sections of these General Specifications.

C. In the event of damage, the CQA Engineer will identify areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner at no additional cost to the Owner.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the road base. Surveying shall be performed in accordance with of Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing to the Owner of the final location and elevation of the final surface of the road base, in accordance with the requirements of Section 01010 of these General Specifications.

[END OF SECTION]

SECTION 02232
PROTECTIVE SOIL LAYER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the construction of the protective soil layer component of the landfill. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02710 - Geocomposite
B. Section 02714 - Filter or Cushion Geotextile

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all testing activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. Soil testing (both field and laboratory testing) required by the CQA Plan will be the responsibility of the CQA Engineer. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. The Contractor shall cooperate with the CQA Engineer during all testing activities. The Contractor shall provide equipment and labor to assist the CQA Engineer in sampling. The Contractor shall provide access to all areas requiring testing. The Contractor shall repair any damage to finished work caused by the CQA Engineer sampling or testing activities.

D. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area.

The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

A. Protective soil layer material shall be obtained from the landfill or surface impoundment excavation or from on-site or off-site borrow sources identified by the Owner.

B. Protective soil layer material shall classify as CL, ML, SC, GC, SM, or GM according to the Unified Soil Classification System (ASTM D 2487) and shall have a maximum particle size not exceeding 2 inches.

PART 3: EXECUTION

3.01 PROTECTIVE SOIL LAYER COMPACTION CRITERIA

A. The Contractor shall place and compact the soil as described in this Section.

3.02 PLACEMENT AND COMPACTION

A. Protective soil layer material shall be placed at the locations and to the thicknesses shown on the Construction Drawings.

B. The Contractor shall not place the protective soil layer until the CQA Engineer confirms that the constructed grades and elevations of the underlying materials meet the requirements of the Construction Drawings, all field testing is complete, the underlying materials have been installed, tested, and approved in accordance with the requirements of the CQA Plan.

C. Prior to placing the protective soil layer, the CQA Engineer will verify that the underlying geosynthetic components are free of holes, tears, excessive wrinkles, or foreign objects. As instructed by the Owner, the Contractor shall "work out" or repair all excessive wrinkles to the satisfaction of the CQA Engineer prior to placement of the protective soil layer.

D. The final in-place thickness of the protective soil layer shall be not less than 24 inches or as shown on the drawings.

E. The protective soil material shall be spread in one lift using a low ground pressure dozer (Caterpillar D6H-LGP, or other equipment approved by the Owner), low ground pressure tracked front-end loader, or belt conveyor. Equipment shall operate only over previously placed protective soil layer material. The Contractor shall not operate equipment directly on geosynthetics.

F. Unless otherwise specified by the Owner and to prevent damage of the liner system, the equipment used to haul and spread the protective soil layer shall not exert ground pressures exceeding the following:

Allowable Equipment Ground Pressure (psi)	*Minimum Thickness of Protective Soil Layer Above the Geosynthetic Liner (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

G. Protective soil layer material shall be compacted by two passes of tracked equipment such as a Caterpillar D6H-LGP or other equipment approved by the Owner.

H. In areas of heavy traffic, the thickness of the protective soil layer shall be increased at the direction of the Owner to satisfy the requirements of this Section. Heavy traffic areas shall be compacted with a smooth drum roller or other equipment approved by the Owner.

I. The Contractor shall operate equipment in a manner that is protective of underlying geosynthetics. If it is suspected that any damage to the underlying geosynthetics may have occurred, the Owner will instruct the Contractor to remove overlying protective soil layer material to expose the geosynthetics. The Contractor shall repair, at his own expense, any damage of the underlying geosynthetics in accordance with these General Specifications.

J. The Contractor shall minimize to the extent possible the generation of dust during placement of the protective soil layer. Water may be used for dust control if approved by the Owner. Chemical dust suppressants shall not be used.

K. No protective soil layer material shall be placed or compacted during a sustained period of temperature below 32°F that results in frozen material, either in-place or in the borrow area. With the approval of the Owner, protective soil layer material may be placed and compacted during periods of early morning freezing temperatures if above freezing temperatures are anticipated during the day.

L. The Contractor shall not place frozen protective soil layer material nor shall he place protective soil layer material on frozen ground.

M. Protective soil layer material shall not be placed during periods of precipitation or unfavorable weather conditions.

3.03 SURVEY CONTROL

A. The Surveyor shall survey the final location and elevation of the top of the protective soil layer installed by the Contractor. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and elevation of the top of the protective soil layer to the Owner in accordance with the requirements of Section 01010 of these General Specifications.

3.04 FIELD QUALITY CONTROL

A. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

B. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at his own expense until acceptable test results are obtained.

3.05 PROTECTION OF WORK

A. After the protective soil layer has been placed, the Contractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc.

B. The Contractor shall use all means necessary to protect all materials and partially-completed and completed work of these General Specifications.

C. In the event of damage, the CQA Engineer will identify any areas requiring repair, and the Contractor shall make repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

[END OF SECTION]

SECTION 02710
GEOCOMPOSITE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of the geocomposite layer of the landfill or surface impoundment. The work shall be carried out in accordance with these General Specifications, Supplemental Specifications, the CQA Plan, and the Construction Drawings.

B. This specification shall also apply to geocomposite installation in the truck roll off area and truck wash facility, unless otherwise indicated on the drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Clay Liner
B. Section 02229 - Select Subbase
C. Section 02714 - Filter or Cushion Geotextile
D. Section 02232 - Protective Soil Layer
E. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. If testing is not completed prior to delivery to the site, the Contractor shall deliver geocomposite to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Any geocomposite rolls that do not meet the requirements of these General Specifications will be rejected. The Contractor shall replace the rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's test indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 GEOCOMPOSITE PROPERTIES

A. The Contractor shall require that the geocomposite Manufacturer furnish material with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Table 02710-1. The Contractor shall require that the Manufacturer provide results for tests performed using the procedures listed in Table 02710-1, as well as a certification that the material delivered to the site meets or exceeds the specified values.

B. In addition to the property values listed in Table 02710-1, the geocomposite shall:

1. Retain its structure during handling, placement, and long-term service.

2. Be capable of withstanding outdoor (i.e., ultra-violet light) exposure for a minimum of 30 days with no measurable degradation in the specified physical properties.

3. Meet any additional requirements of the Construction Drawings.

4. Be manufactured with a geonet that does not contain any reclaimed polymer, nor any foaming or blowing agents.

5. Consist of a geonet with a geotextile bonded to both sides of geonet.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the geocomposite Manufacturer sample and test the geocomposite to demonstrate that the material conforms to the requirements of these General Specifications. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Test results shall be provided to the Owner. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required. The Contractor shall require that the geocomposite Manufacturer sample and test the geocomposite at a minimum of once every 50,000 ft^2 and perform manufacturing quality control tests as indicated in Table 02710-1.

B. Any geocomposite sample that does not comply with these General Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to the Owner.

C. If a geocomposite sample fails to meet the quality control requirements of this General Specification the Contractor shall require that the geocomposite Manufacturer sample and test each roll manufactured in the same lot, or at the same

time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results as determined by the CQA Engineer is established.

D. Additional sample testing may be performed, at the geocomposite Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. If required by the Owner, the Contractor shall require the geocomposite Manufacturer to retain a coupon of geocomposite (10 feet by 2 feet) provided for the project for every 20,000 ft^2 of geocomposite produced for the project until the work is accepted by the Owner.

F. The Contractor shall require that the geocomposite Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.03 LABELING

A. Geocomposite rolls shall be labeled with the following information.

1. Name of Manufacturer;
2. Product identification;
3. Lot number;
4. Roll number; and,
5. Roll dimensions.

B. If any special handling is required, it shall be so marked on the geocomposite itself, e.g., "This Side Up" or "This Side Against Soil To Be Retained".

2.04 TRANSPORTATION

A. Transportation of the geocomposite shall be the responsibility of the Contractor. The Contractor shall be liable for damage to the geocomposite incurred prior to and during transportation to the site. The Contractor shall replace damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Geocomposite shall be shipped and stored in watertight and opaque protective covers.

B. Handling, storage, and care of the geocomposite prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for damage to the material incurred prior to final acceptance by the Owner. The Contractor shall repair damage in accordance with Part 3.03 of this section and at no additional cost the Owner.

C. The Contractor shall be responsible for storage of the geocomposite at the site. The geocomposite shall be stored off the ground and out of direct sunlight and shall be protected from puncture, cutting, and excessive heat, cold, moisture, mud, dirt, dust or any other damaging or deleterious condition. The geocomposite shall be stored in accordance with any additional requirements of the geocomposite Manufacturer.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Geocomposite shall be installed at all locations shown on the Construction Drawings.

B. The Contractor shall handle the geocomposite in such a manner as to ensure the geocomposite is not damaged in any way.

C. When placing geocomposite on geomembrane, the geomembrane liner that will underlie the geocomposite shall be clean and free of excessive dust and dirt, stones, rocks, or other obstructions that could potentially damage the geomembrane. The geomembrane shall be swept clean prior to geocomposite placement. At the direction of the Owner, the Contractor shall clean the geomembrane with water.

D. The Contractor shall take all necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

E. In the presence of excessive wind, the Contractor shall weight the geocomposite with sandbags or equivalent weight approved by the Owner.

F. On side slopes, the geocomposite shall be secured, by the Contractor, at the top of the slope and then rolled down the slope.

G. If necessary, the Contractor shall position the geocomposite by hand after it is unrolled to minimize wrinkles.

H. Geocomposite shall be clean when installed. During installation, care shall be taken by the Contractor not to entrap stones, excessive dirt, or moisture that could damage the underlying geomembrane, clog drains or filters, or hamper subsequent seaming.

I. Geocomposite shall not be welded to the geomembrane liners. Geocomposite shall only be cut using a cutter approved by the geocomposite Manufacturer and the Owner.

J. Tools shall not be left on or in the geocomposite.

K. After placing the geocomposite, the geocomposite shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the Owner based on a formal demonstration from the Contractor (e.g., a certification from the geocomposite Manufacturer) that the geotextile component of the geocomposite is stabilized against ultra-violet (UV) light degradation for a period in excess of 30 days.

L. If white colored geotextile is used in the geocomposite, precautions shall be taken against "snow blindness" of personnel.

3.02 SEAMS AND OVERLAPS

A. The components of the geocomposite (e.g., geotextile-geonet-geotextile) are not bonded together at the ends and edges of the rolls. Each component shall be secured or seamed to the like component at overlaps.

B. No horizontal seams shall be allowed on slopes steeper than 5:1 (horizontal:vertical), unless approved by the Owner.

C. *Geonet Components*

1. The geonet components shall be overlapped by at least 4 inches. These overlaps shall be secured by tying.

2. Tying shall be achieved by nylon strings, plastic fasteners, or polymer braid. Metallic devices shall not be used. Tying devices shall be provided in a color different than the geonet to allow easy inspection.

3. For slopes steeper than 5:1 (horizontal:vertical), tying shall be every 5 feet along the slope, every 2 feet across the slope, and every 6 inches in the anchor trench. For slopes flatter than 5:1 (horizontal:vertical), tying shall be every 10 feet in both directions and every 6 inches in the anchor trench.

4. In all cases, at least 2 ties per panel dimension shall be installed.

5. When more than one layer of geocomposite is installed, joints shall be staggered at least 1 foot.

6. The joints on adjacent geocomposite panels shall be staggered at least 1 foot.

D. *Geotextile Components*

1. The bottom layers of the geotextile shall be overlapped.

2. The top layers of geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches prior to sewing.

3. Polymeric thread shall be used for all sewing. The seam type shall be Federal Standard (No. 751.a) Type SSa. The seams shall be sewn using Stitch Type 401.

E. *Geocomposite Components*

1. The geocomposite shall be overlapped by at least 4 inches. These overlaps shall be secured by tying.

2. Cut geocomposite using scissors or other cutting tools, approved by the Owner. Do not damage underlying geosynthetics.

3. Tying shall be achieved by nylon strings, plastic fasteners, or polymer braid. Metallic devices shall not be used. Tying devices shall be provided in a color different than the geocomposite to allow easy inspection.

4. For slopes steeper than 5:1 (horizontal:vertical), tying shall be every 5 feet along the slope, every 2 feet across the slope, and every 6 inches in the anchor trench. For slopes flatter that 5:1 (horizontal:vertical), tying shall be every 10 feet in both directions and every 6 inches in the anchor trench.

5. In all cases, at least 2 ties per panel dimension shall be installed.

6. When more than one layer of geocomposite is installed, joints shall be staggered at least 1 foot.

7. The joints on adjacent geocomposite panels shall be staggered at least 1 foot.

8. In areas where this installation method is used, place geotextile over seams which overlap ties 1 foot on each side. This geotextile shall be heat sealed to the top of the geotextile component of the geocomposite.

3.03 REPAIR

A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending 1 foot beyond the edges of the hole or tear. The patch shall be secured over the hole or tear by tying fasteners through the geocomposite patch, and through the top geotextile and geonet beneath the patch. The patch shall be secured every 6 inches with approved tying devices. A larger geotextile patch shall be placed over the geocomposite patch and shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geocomposite shall be joined in accordance with Part 3.02 of this section.

3.04 PLACEMENT OF OVERLYING MATERIALS

A. Overlying materials as required by the Construction Drawings, shall be placed as soon as possible after placement and approval of the geocomposite. Placement of each overlying material shall be in accordance with the appropriate sections of these General Specifications.

B. The Contractor shall place overlying soil materials in such a manner as to ensure that:

1. The geocomposite and underlying geosynthetic materials are not damaged;

2. Minimal slippage occurs between the geocomposite and underlying layers; and,

3. Excessive stresses are not produced in the geocomposite.

C. Unless otherwise specified by the Owner, the equipment operating on soil material overlying a geocomposite shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	*Thickness of Soil Above Geocomposite (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

The requirements do not apply to equipment used to construct the sump secondary or primary clay liners; however, the Owner can restrict the use of equipment that, in the Owner's opinion, may be potentially damaging to the geocomposite.

D. The CQA Engineer will provide monitoring of the spreading of soils over the geocomposite in accordance with the CQA Plan.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall immediately make repairs and replacements necessary, to the approval of the Owner and at no additional cost to Owner.

C. The CQA Engineer will issue an approval of the geocomposite installation to the Owner prior to placement of material over the geocomposite in accordance with the CQA Plan.

TABLE 02710-1
REQUIRED GEOCOMPOSITE PROPERTIES

Properties	Units	Specified Values[4]	Test Method
Geonet Component:			
Polymer composition	%	95 polyethylene by weight	
Polymer specific gravity		0.92	ASTM D 1505
Polymer melt index	g/10 min.	0.1 - 0.5	ASTM D 1238
Carbon black content	%	2 - 3	ASTM D 1603
Nominal thickness	mm	5	ASTM D 374C or D1777
Geotextile Component (both sides of geonet):			
Polymer composition	%	95 polyester polypropylene, or polyethylene by weight	
Mass per unit area	oz/yd^2	7.1	ASTM D 3776
Apparent opening size	mm	O_{95} < 0.210 mm	ASTM D 4751
Permitivity	sec^{-1}	1.47	ASTM D 4491
Grab strength	lb	210	ASTM D 4632[1]
Tear strength	lb	75	ASTM D 4533[2]
Puncture strength	lb	95	ASTM D 4833[3]
Geocomposite:			
Transmissivity	m^2/s	2×10^{-4}	ASTM D 4716[5]
Peel Strength	lb/in.	2	ASTM D 413

NOTES:

(1) Minimum of values measured in machine and cross machine directions with 1 inch clamp on constant rate of extension (CRE) machine.

(2) Minimum value measured in machine and cross machine direction.

(3) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.

(4) Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). Where ranges of values are specified, the average roll value must be within the specified range. The apparent opening size specified is a maximum average roll value.

(5) The design transmissivity is the hydraulic transmissivity of the geocomposite measured using water at 68°F ± 3°F with a hydraulic gradient of 0.1, under a compressive stress of not less than 15,000 psf. For the test, the geocomposite shall be sandwiched between a layer of protective soil material representative of the material that will be used in the landfill and a 60-mil thick textured HDPE geomembrane. The minimum test duration shall be 24 hours and the report of results shall include measurements at intervals over the entire test duration.

[END OF SECTION]

SECTION 02712
GEONET

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of the geonet for the landfill or surface impoundment. The work shall be carried out in accordance with this General Specification, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Clay Liner
B. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. If CQA testing is not completed prior to delivery at the site, the Contractor shall deliver geonet to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Any geonet rolls that do not meet the requirements of these General Specifications will be rejected. The Contractor shall replace the rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 GEONET PROPERTIES

A. The Contractor shall require that the geonet Manufacturer furnish material with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Table 02712-1. The Contractor shall require that the geonet Manufacturer provide results for tests performed using the procedures listed in Table 02712-1, as well as a certification that the material properties for the material delivered to the site will meet or exceed the specified values.

B. In addition to the property values listed in Table 02712-1, the geonet shall:

1. Retain its structure during handling, placement, and long-term service.

2. Meet any additional requirements of the Construction Drawings.

3. Not be manufactured from any reclaimed polymer, nor any foaming or blowing agents.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the geonet Manufacturer sample and test the geonet to demonstrate that the material conforms to the requirements of these General Specifications. All Quality Control testing required by the General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Test results shall be provided to the Owner. Sampling shall, in general, be performed on sacrificial portions of the geonet material such that repair is not required. The Contractor shall require that the geonet Manufacturer sample and test the geonet, at a minimum, once every 50,000 ft^2 and perform the manufacturing quality control tests indicated in Table 02712-1.

B. Any geonet sample that does not comply with these General Specifications shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to the Owner.

C. If a geonet sample fails to meet the quality control requirements of these General Specifications, the Contractor shall require that the geonet Manufacturer sample and test each roll manufactured, in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established as specified within the CQA Plan.

D. Additional sample testing may be performed, at the geonet Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. If requested by Owner, the Contractor shall require the geonet Manufacturer to retain a coupon of geonet (10 feet by 2 feet) provided for the project for every 20,000 ft^2 of geonet produced for the project until the work is accepted by the Owner.

F. The Contractor shall require that the geonet Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.03 LABELING

A. Geonet rolls shall be labeled with the following information.

1. Name of Manufacturer;
2. Product identification;
3. Lot number;
4. Roll number; and,
5. Roll dimensions.

2.04 TRANSPORTATION

A. Transportation of geonet shall be the responsibility of the Contractor. The Contractor shall be liable for damage to the geonet incurred prior to and during transportation to the site. The Contractor shall repair or replace damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Geonet shall be protected from damage during shipping and storage.

B. Handling, storage, and care of the geonet prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for damage to the material incurred prior to final acceptance by the Owner. The Contractor shall repair damage in accordance with Part 3.03 of this Section and at no additional cost to the Owner.

C. The Contractor shall be responsible for storage of the geonet at the site. The geonet shall be stored off the ground and shall be protected from excessive heat or cold, moisture mud, dirt, dust, or any other damaging or deleterious condition. The geonet shall be stored in accordance with any additional requirements of the geonet Manufacturer.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Geonet shall be installed at all locations shown on the Construction Drawings.

B. The Contractor shall handle the geonet in such a manner as to ensure the geonet is not damaged in any way.

C. Just prior to geonet placement, the geomembrane liner that will underlie the geonet shall be clean and free of dust, dirt, stones, rocks, or other obstructions that could potentially damage the geomembrane. The geomembrane shall be swept clean prior to geonet placement. At the direction of the Owner, the Contractor shall clean the geomembrane with water.

D. The Contractor shall take all necessary precautions to prevent damage to underlying layers during placement of the geonet.

E. In the presence of excessive wind, the geonet shall be weighted by the Contractor with sandbags or equivalent weight approved by the Owner.

F. On side slopes, the geonet shall be secured by the Contractor at the top of slope and then rolled down the slope.

G. If necessary, the Contractor shall position the geonet by hand after it is unrolled to minimize wrinkles.

H. Geonet shall be clean when installed. During installation, care shall be taken by the Contractor not to entrap stones and excessive dirt or moisture that could damage the underlying geomembrane or clog drains or filters.

I. Geonet shall not be welded to geomembrane liners. Geonet shall only be cut using a cutter approved by the geonet Manufacturer and the Owner.

J. Tools shall not be left on or in the geonet.

K. Geonet shall not be placed in direct contact with textured geomembrane liner unless specifically called for on the Construction Drawings.

3.02 STACKING AND JOINING

A. When two or more layers of geonets are stacked, care shall be taken to prevent the strands of one layer of geonet from penetrating the channels of an overlying or underlying layer.

B. A layer of geonet shall not be installed in a direction perpendicular to an underlying layer of geonet unless approved by the Owner.

C. In the corners of the side slopes, where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be provided on top of the previously installed geonets, from top to bottom of the slope, as shown on the Construction Drawings.

D. Adjacent rolls of geonet shall be overlapped by at least 4 inches. The overlaps shall be secured by tying.

E. Tying shall be achieved by nylon strings, plastic fasteners, or polymer braid. Metallic devices shall not be used. Tying devices shall be provided in a color different than the geonet to allow for easy inspection.

F. For slopes steeper than 5:1 (horizontal:vertical), tying shall be every 5 feet along the slope, every 2 feet across the slope, and every 6 inches in the anchor trench. For slopes flatter than 5:1 (horizontal:vertical), tying shall be every 10 feet in both directions, and every 6 inches in the anchor trench.

G. In all cases, at lease 2 ties per panel dimension shall be installed.

H. When more than one layer of geonet is installed, joints shall be staggered at least 1 foot.

I. The joints on adjacent geonet panels shall be staggered at least 1 foot.

J. No horizontal seams shall be allowed on slopes steeper than 5:1 (horizontal:vertical), unless approved by the Owner.

3.03 REPAIR

A. Any holes or tears in the geonet shall be repaired by placing a patch over the hole or tear extending 1 foot beyond the edges of the hole or tear. The patch shall be secured to the original geonet by tying every 6 inches with approved tying devices. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with Part 3.02 of this section.

3.04 PLACEMENT OF OVERLYING MATERIALS

A. An installed layer of geonet shall be covered with an overlying layer (geotextile or geomembrane), as required by the Construction Drawings, as soon as possible after installation and approval to minimize the accumulation of dirt or dust in the geonet and the potential for damage to the geonet or the underlying geomembrane. If dust or dirt accumulates in the geonet layer prior to placement of the overlying layer, the Contractor shall clean the geonet by sweeping or washing with water. Placement of each overlying material shall be in accordance with these General Specifications.

B. Soil shall not be placed in direct contact with geonets. Geonets shall be separated from soil materials by a geotextile filter or other material, as indicated on the Construction Drawings. The only exception to this shall be at those locations shown on the Construction Drawings where sump or pipe bedding gravel directly overlies one or more layers of geonet.

C. The Contractor shall place soil above geonet layers (e.g., above a geotextile filter which overlies the geonet) in such a manner as to ensure that:

1. The geonet and underlying geomembrane are not damaged;

2. Minimal slippage occurs between the geonet and the underlying geomembrane; and,

3. Excessive stresses are not produced in the geonet.

D. Unless otherwise specified by the Owner, all equipment operating on soil material overlying a geonet shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	*Thickness of Soil Above Geonet (inches)*
<5	12
<10	18

<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

The equipment pressure requirements do not apply to equipment used to construct the secondary or primary clay liners; however, the Owner may restrict the use of equipment that, in the Owner's opinion, may be potentially damaging to the geonet.

E. The CQA Engineer will provide monitoring of the placement of soil materials over the geonet or overlying layer in accordance with the CQA Plan.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall make repairs and replacements as necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of the geonet detection or collection layer installation to the Owner prior to placement of material over the geonet in accordance with the CQA Plan.

TABLE 02712-1
REQUIRED GEONET PROPERTIES

PROPERTIES	UNITS	SPECIFIED VALUES(2)	TEST METHOD
Polymer composition	%	95 polyethylene by weight	
Polymer specific gravity		0.92	ASTM D 1505(1)
Polymer melt index	g/10 min.	0.1 - 0.5	ASTM D 1238
Carbon black content	%	2-3	ASTM D 1603
Nominal thickness	mm	5	ASTM D 374C or D1777
Transmissivity	m^2/s	5×10^{-3}	ASTM D 4716(3)

NOTES:

(1) The specific gravity of the geonet polymer shall not exceed that of the geomembrane.

(2) Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). Where ranges of values are specified, the average roll values must be within the specified range.

(3) The design transmissivity is the hydraulic transmissivity of the geonet measured using water at 68°F ± 3°F with a hydraulic gradient of not less than 0.1, nor more than 0.5, under a compressive stress of not less than 1000 psf. For the test, the geonet shall be sandwiched between a 60-mil thick HDPE geomembrane on bottom, and on top, and backed with soil representative of clay liner on one side. The minimum test duration shall be 24 hours and the report for the test results shall include measurements at intervals over the entire test duration.

[END OF SECTION]

SECTION 02714
FILTER AND CUSHION GEOTEXTILE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of the filter and cushion geotextile in the landfill or surface impoundment. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

B. This specification shall also apply to geotextile installation in the truck roll off area, the drum handling facility, and the truck wash facility unless otherwise indicated on the drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Clay Liner
B. Section 02224 - Drainage Gravel
C. Section 02225 - Road Base
D. Section 02228 - Pipe Bedding
E. Section 02710 - Geocomposite
F. Section 02232 - Protective Soil Layer
G. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. If CQA testing is not completed prior to delivery, the Contractor shall deliver geotextile to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Any geotextile rolls that do not meet the requirements of these General Specifications will be rejected. The Contractor shall replace the rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 GEOTEXTILE PROPERTIES

A. The Contractor shall require that the geotextile Manufacturer furnish geotextile with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Tables 02714-1 (for filter layers), or Table 02174-2 (for cushion layers). The Contractor shall require that the geotextile Manufacturer provide results for tests performed using the procedures in Table 02714-1, or 02714-2, as well as a certification that the material delivered to the site meets or exceeds the specified values.

B. Geotextile products shall be needle-punched, non-woven materials manufactured from continuous filaments or stapled fibers.

C. In addition to the property values listed in Table 02714-1 or 02714-2, the geotextile filter or cushion layer shall:

1. Retain its structure during handling, placement, and long-term service.

2. Be capable of withstanding outdoor (i.e., ultra-violet) light for a minimum of 30 days with no measurable degradation in the specified physical properties.

3. Meet any additional requirements of the Construction Drawings.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the geotextile Manufacturer sample and test the geotextile to demonstrate that the material conforms to the requirements of this General Specification. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Test results shall be provided to the Owner. Sampling shall, in general, be performed on sacrificial portions of the geotextile material such that repair is not required. The Contractor shall require that the geotextile Manufacturer sample and test the geotextile, at a minimum, once every 50,000 ft^2 and perform the manufacturing quality control tests as indicated in Table 02714-1 and 02714-2.

B. Any geotextile sample that does not comply with this General Specification shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected roll at no additional cost to the Owner.

C. If a geotextile sample fails to meet the quality control requirements of this General Specification, the Contractor shall require that geotextile Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll.

Sampling and testing of rolls shall continue until a pattern of acceptable test results is established in accordance with the CQA Plan.

D. Additional sample testing may be performed, at the geotextile Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.

E. If requested by the Owner, the Contractor shall require the geotextile Manufacturer to retain a coupon of geotextile (10 feet by 2 feet) provided for the project for every 20,000 ft^2 of geotextile produced for the project until the work is accepted by the Owner.

F. The Contractor shall require that the geotextile Manufacturer comply with the certification and submittal requirements of the CQA Plan.

2.03 LABELING

A. Geotextile rolls shall be marked or tagged with the following information:

1. Name of Manufacturer;
2. Product identification;
3. Lot number;
4. Roll number; and,
5. Roll dimensions.

B. If any special handling is required, it shall be so marked on the geotextile itself, e.g., "This Side Up" or "This Side Against Soil to be Retained".

2.04 TRANSPORTATION

A. Transportation of the geotextile is the responsibility of the Contractor. The Contractor shall be liable for damage to the geotextile incurred prior to and during transportation to the site. The Contractor shall repair or replace damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Geotextile shall be shipped and stored in watertight and opaque protective covers.

B. Handling, storage, and care of the geotextile prior to and following incorporation into the work is the responsibility of the Contractor. The Contractor shall be liable for damage to the geotextile incurred prior to final acceptance by the Owner. The Contractor shall repair damage in accordance with Part 3.03 of this section and at no additional cost to the Owner.

C. The Contractor shall be responsible for storage of the geotextile at the site. The geotextile shall be stored off the ground and out of direct sunlight and precipitation, and shall be protected from puncture, cutting, excessive heat, cold, moisture, mud, dirt, dust, or any other damaging or deleterious condition. The geotextile shall be stored in accordance with any additional requirements of the geotextile Manufacturer.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Geotextile shall be installed at the locations shown on the Construction Drawings.

B. The Contractor shall handle the geotextile in such a manner as to ensure the geotextile is not damaged in any way.

C. The Contractor shall take all necessary precautions to prevent damage to underlying layers during placement of the geotextile.

D. After placing the geotextile, the geotextile shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the Owner, based on a demonstration from the Manufacturer (e.g., a certification from the geotextile Manufacturer) that the geotextile is stabilized against ultra-violet light (UV) degradation for a period in excess of 30 days. This requirement does not apply to material used as sacrificial geotextile.

E. If white colored geotextile is used, precautions shall be taken against "snow blindness" of personnel.

F. Just prior to geotextile placement, the layer that will underlie the geotextile, if it is a geosynthetic, shall be clean and free of dust, dirt, stones, rocks, or other obstructions that could potentially damage the liner system. At the direction of the Owner, the Contractor shall clean the underlying layer with water.

G. In the presence of excessive wind, the geotextile shall be weighted with sandbags or equivalent weight approved by the Owner.

H. On side slopes, the geotextile shall be secured at the top of the slope and then rolled down the slope.

I. If necessary, the Contractor shall position the geotextile by hand after it is unrolled to minimize wrinkles.

J. Geotextile shall be clean when installed. During installation, care shall be taken not to entrap stones, and excessive dirt or moisture that could damage the underlying layers, clog drains or filters, or hamper subsequent seaming.

K. Tools shall not be left in or on the geotextile.

L. The Contractor shall examine the entire geotextile surface after installation to ensure that no potentially harmful foreign objects (including broken sewing needles) are present. The Contractor shall remove any such foreign objects and shall replace any damaged geotextile Broken sewing needles may need to be located using a metal detector or other method approved by the Owner.

M. Geotextile shall only be cut using a cutter approved by the geotextile Manufacturer and the Owner.

3.02 SEAMS AND OVERLAPS

A. All geotextile overlaps shall be continuously sewn (i.e., spot sewing and thermal bonding are not allowed). Geotextiles shall be overlapped a minimum 3 inches prior to sewing. No horizontal seams shall be allowed on slopes steeper than 5:1 (horizontal:vertical) (i.e., seams shall be along, not across, the slopes), except as part of a patch, unless approved by the Owner.

B. Polymeric thread shall be used for all sewing. The seam type shall be Federal Standard Type (No. 751.a) SSa. The seams shall be sewn using Stitch Type 401.

3.03 REPAIR

A. Any holes or tears in the geotextile shall be repaired as follows:

1. On slopes steeper than 5:1 (horizontal:vertical), a patch made from the same geotextile shall be overlapped a minimum three inches and double seamed into place (with each seam approximately 0.5 inches apart and no closer than 1 inch from any edge). Should a tear exceed 10 percent of the width of the roll, that roll shall be removed from the work and replaced with new material, at no additional cost to the Owner.

2. On slopes equal to or flatter than 5:1 (horizontal:vertical), a patch made from the same geotextile shall be overlapped a minimum of 3 inches and stitched into place with a single seam.

B. Care shall be taken to remove soil or other material which may have penetrated the torn geotextile.

3.04 PLACEMENT OF OVERLYING MATERIALS

A. The Contractor shall place all overlying soil materials in such manner as to ensure that:

1. The geotextile and underlying geosynthetic materials are not damaged;

2. Minimum slippage occurs between the geotextile and underlying layers; and,

3. Excessive stresses are not produced in the geotextile.

B. The CQA Engineer will monitoring the spreading of soil materials over the geotextile in accordance with the CQA Plan.

C. Unless otherwise specified by the Owner, all equipment operating on soil material overlying the geotextile shall comply with the following (Note: a greater thickness shall be required as per Sections 02710, 02712, and 02775 if the geotextile is directly underlain by a geocomposite, geonet, or geomembrane):

Maximum Allowable Equipment Ground Pressure (psi)	*Thickness of Soil Above Geotextile (inches)*

<5	6
<10	12
<20	18
>20	24

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

The equipment ground pressure requirements do not apply to separator geotextiles used below road base nor to equipment used to construct the clay liners; however, the Owner may restrict the use of equipment that, in the Owner's opinion, may potentially damage the underlying geotextiles.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all prior work, materials and partially-completed and completed work of these General Specifications.

B. The CQA Engineer will identify any areas requiring repair. The Contractor shall make repairs and replacements as necessary, to the approval of the Owner, and at no additional cost to Owner.

C. The CQA Engineer will issue an approval of geotextile filter, cushion, separator, or sacrificial layer installation in accordance with the CQA Plan prior to placement of material over the geotextile.

TABLE 02714-1
REQUIRED FILTER GEOTEXTILE PROPERTIES

Properties	Units	Specified Values [4]	Test Method
Polymer composition	%	95 [polypropylene, polyester, or polyethylene by weight]	
Mass per unit area	oz/yd^2	7	ASTM D 3776
Apparent opening size	mm	O_{95} < 0.210 mm	ASTM D 4751
Permitivity	sec^{-1}	1.47	ASTM D 4491
Grab strength	lb	210	ASTM D 4632[1]
Tear strength	lb	75	ASTM D 4533[2]
Puncture strength	lb	95	ASTM D 4833 [3]

Notes:

(1) Minimum values for both machine and cross machine direction with 1 inch clamp on constant rate of extension (CRE) machine.
(2) Minimum value measured in machine and cross machine direction.
(3) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
(4) Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). The specified apparent opening size is a maximum average roll value.

TABLE 02714-2
REQUIRED CUSHION GEOTEXTILE PROPERTIES

Properties	Qualifier	Units	Specified Values [4]	Test Method
Polymer composition	minimum	%	95 [polypropylene, polyester, or polyethylene by weight]	
Mass per unit area	minimum	oz/yd^2	12	ASTM D 3776
Grab strength	minimum	lb	300	ASTM D 4632[1]
Tear strength	minimum	lb	110	ASTM D 4533[2]
Puncture strength	minimum	lb	135	ASTM D 4833 [3]

Notes:

(1) Minimum values for both machine and cross machine direction with 1 inch clamp on constant rate of extension (CRE) machine.
(2) Minimum value measured in machine and cross machine direction.
(3) Tension testing machine with a 1.75-inch diameter ring clamp, the steel ball being replaced with a 0.31-inch diameter solid steel cylinder with flat tip centered within the ring clamp.
(4) All values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table).

[END OF SECTION]

SECTION 02718
POLYETHYLENE PIPE AND FITTINGS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of all high density polyethylene (HDPE) pipes, pipe fittings, and appurtenances required for landfill or surface impoundment construction. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Clay Liner
B. Section 02224 - Pipe Bedding
C. Section 02710 - Geocomposite Detection or Collection Layer
D. Section 02714 - Filter or Cushion Geotextile
E. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The CQA Engineer will coordinate independent surveying as required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

D. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming materials. The nonconforming area shall be replaced by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 HDPE RESIN PROPERTIES

A. The HDPE pipe and fittings shall be manufactured from new, high molecular weight, HDPE resin conforming to ASTM D 1248 (Type III, Class C Category 5, Grade P 34), ASTM D 3350 (Cell Classification PE 345434C), and having a Plastic Pipe Institute (PPI) Rating of PE 3408. The resin shall be pre-compounded. In plant blending of non-compounded resins shall not be permitted. Pipe and fittings shall be manufactured from the same resin and by the same manufacturer.

B. The polyethylene compound shall contain a minimum of 2 percent carbon black to withstand outdoor exposure without loss of properties.

C. The polyethylene compound shall have minimum resistance of 5,000 hours when tested for environmental stress crack in accordance with requirements of GRI-GM5.

2.02 HDPE PIPE AND FITTINGS PROPERTIES

A. The Contractor shall provide pipe having the nominal diameters shown on the Construction Drawings.

B. All HDPE pipe and fittings shall have a minimum Standard Diameter Ratio (SDR) of 11 unless otherwise indicated on the Construction Drawings.

C. All HDPE pipe and fittings shall have a minimum hydrostatic design basis (HDB) of 1,600 pounds per square inch when determined in accordance with ASTM D 2837 unless otherwise indicated on the Construction Drawings.

D. All HDPE pipe and fittings shall comply with ASTM F 714.

E. HDPE pipe shall be supplied in standard laying lengths not exceeding 50 feet.

F. HDPE pipe shall be furnished non-perforated or perforated to meet the requirements of the Construction Drawings. Perforations, if required, shall be drilled into the pipe after manufacture. If approved by OWNER, perforations to pipe can be made after delivery to the project site.

G. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than intentional manufactured perforations), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

H. Fittings at the ends of pipes shall be HDPE end caps unless otherwise indicated on the Construction Drawings.

I. Geomembrane boots shall be either field or shop-fabricated to the dimensions shown on the Construction Drawings. Pipe boots shall be fabricated from the same resin as the polyethylene geomembrane to which they are welded. Pipe boots shall be installed as indicated on the Construction Drawings.

2.03 MANUFACTURING QUALITY CONTROL

A. The Contractor shall submit to the Owner for approval within 14 days prior to the start of pipe work a complete list of materials to be furnished and the name of the pipe Manufacturer.

B. The Contractor shall submit to the Owner the pipe Manufacturer's certification of compliance with the product requirements of Part 2 of this section, including certification that stress regression testing has been performed in accordance with ASTM D 2837 on the pipe products representative of that delivered to the site. The Manufacturer's Certification must be based on a QC testing frequency of one sample per lot.

C. The Contractor shall submit to the Owner in writing the following documentation from the pipe Manufacturer on the raw materials used to manufacture the pipe and fittings:

1. Certificate identifying the specific resin used, its source, and the information required by ASTM D 1248.

2. Certificate stating that no recycled resin was used in manufacturing the pipe except for a small percentage (15 percent or less) of resin generated in the pipe Manufacturer's own plant from production using the same resin as the recycled material.

D. If requested by the Owner, the Contractor shall require the pipe manufacturer to retain one section of pipe (at least 5 feet in length) provided for the project for every 1,500 lineal feet of pipe produced for the project until the work is accepted by the Owner.

E. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.04 LABELING

A. The following shall be continuously indent-printed on the polyethylene pipe, or spaced at intervals not exceeding 10 feet:

1. Name and/or trademark of the pipe Manufacturer.
2. Nominal pipe size.
3. Standard dimension ratio (SDR).
4. The letters PE followed by the polyethylene grade per ASTM D 1248, followed by the hydrostatic design stress in 100's of psi (i.e., PE 3408).
5. Manufacturing Standard Reference (e.g., ASTM F 714-1).

6. A production code from which the date and place of manufacture can be determined.

2.05 TRANSPORTATION

A. Transportation of polyethylene pipe and fittings shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the polyethylene pipe and fittings incurred prior to and during transportation to the site.

2.06 HANDLING AND STORAGE

A. Handling, storage, and care of the polyethylene pipe and fittings, prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Owner.

B. The Contractor shall be responsible for storage of polyethylene pipe and fittings at the site. Pipe and fittings shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipe under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers that are spaced suitably and of such width as not to allow deformation of the pipe. The pipe shall be stored to minimize bowing.

2.07 PIPE BEDDING MATERIAL

A. Pipe bedding material shall meet the requirements of Section 02228 of this General Specification as well as any other requirements of the Construction Drawings.

2.08 HDPE FLAT STOCK

A. HDPE flat stock installed below polyethylene pipe shall consist of layers of HDPE furnished at the dimensions shown on the Construction Drawings. Flat stock shall be provided from the same resin as the pipe.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Pipe, fittings, and HDPE flat stock shall be installed as indicated on the Construction Drawings.

B. The Contractor shall exercise care when transporting, handling and placing pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

C. The Contractor shall comply with the pipe Manufacturer's recommendations for handling, storage, and installation of all polyethylene pipe fittings.

D. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

E. Pipe or fittings shall not be dropped onto rocky or unprepared ground. The pipe and fittings shall not be dropped into trenches or dragged over sharp objects.

F. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. The CQA Engineer will inspect the pipes in accordance with the CQA Plan. Sections of pipe with excessive cuts, gouges, or scratches will be rejected and the Contractor will be required to remove and replace the rejected pipe, at no additional cost to the Owner.

G. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

H. Where pipes penetrate through geomembranes, an effective seal shall be established in accordance with these General Specifications as well as the details shown on the Construction Drawings.

3.02 INSTALLATION

A. All pipe and fittings shall be installed in accordance with these General Specifications and the pipe Manufacturer's instructions.

B. The Contractor shall carefully examine all pipe and fittings for cracks, damage or defect before installation. Defective materials shall be removed from the site and replaced with non-defective material at no additional cost to the Owner.

C. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.

D. Field cutting of pipe shall be carefully made, without damage to pipe or lining system components, so as to leave a smooth end at right angles to the axis of pipe. The method and device used to cut the pipes shall be approved of by the Owner. Sharp edges of cut ends shall be filed off smooth. Flame cutting will not be allowed.

E. All pipe and fittings shall be laid or placed to the grades and elevations shown on the Construction Drawings with bedding and backfill as shown on the Construction Drawings.

F. Placement of overlying materials shall be carried out in accordance with these General Specifications.

G. No pipe shall be laid until the CQA Engineer has observed the condition of the pipe.

H. Blocking under piping shall not be permitting unless specifically accepted by the Owner.

I. The Contractor shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

3.03 JOINTS AND CONNECTIONS

A. HDPE pipe shall be joined with thermal butt-fusion joints. All joints shall be made in accordance with ASTM D 2657 and the pipe Manufacturer's recommendations, and shall be made by trained personnel authorized by the pipe Manufacturer.

B. Mechanical connections of HDPE pipe to auxiliary equipment such as valves, flow meters, pumps and tanks shall consists of the following unless indicated otherwise on the Construction Drawings:

1. An HDPE flange connection, called a stub end, shall be butt-fused to the HDPE pipe. Outside diameter and drilling shall comply with the requirements indicated on the Construction Drawings.

2. A Type 316 stainless steel back-up flange. Outside diameter and drillings shall comply with the requirements indicated on the Construction Drawings.

3. Other mechanical couplings, such as 360 degree full circle clamps, shall only be used if approved by the Owner.

4. The stub ends shall be connected with corrosion-resistant bolts and nuts of Type 316 stainless steel, as specified in ASTM A 726 and ASTM A 307.

C. Polyethylene stub ends and flanges shall be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction or expansion of the polyethylene pipe. Bolts shall be drawn up evenly and in line.

D. Pipe adjacent to joints and joints themselves shall be rigidly supported for a distance of at least one pipe diameter beyond the backup flanges.

E. Pipe boot connections shall be made in the field using viton rings and stainless steel clamps, or welded directly to pipe as shown on the Construction Drawings. The viton ring material shall have a thickness of 3/16 inch and shall have an inner diameter equal to the outer diameter of the pipe on which the viton ring is to be placed. The stainless steel clamps shall be made of 3/16 inch thick, 1/2 inch wide, Type 316 stainless steel. The clamps shall be joined around the pipe boot using a Type 316 stainless steel clasp, not thicker than 3/8 inch. These materials shall be chosen by the Contractor and approved by the Owner.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the location and final elevation of the invert of all polyethylene leachate collection pipes (excluding laterals). The pipe shall be surveyed at its ends and at approximate 50-foot intervals between the ends. In addition, all joints, etc. shall be located horizontally and vertically and overall length measured. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and final elevation of all pipes.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-complete and completed work of these General Specifications.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of pipe installation and inspection to the Owner prior to completely covering the pipe in accordance with the CQA Plan.

[END OF SECTION]

SECTION 02720
ADS N-12 PIPE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of all ADS N-12 pipe required for the landfill construction. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02224 - Drainage Gravel
B. Section 02714 - Geotextile Filter or Cushion Layer

1.03 QUALIFICATIONS AND SUBMITTALS

A. If "or equal" product is proposed, submit samples, technical data, test data, and specifications sufficient to allow evaluation by the Engineer.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The CQA Engineer will coordinate independent surveying as required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

D. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming materials. The nonconforming materials shall be removed by the Contractor at no cost to the Owner until acceptable materials are installed.

PART 2: PRODUCTS

2.01 ADS N-12 PIPE PROPERTIES

A. Smooth interior corrugated polyethylene pipe (ADS N-12) shall be high density polyethylene with a corrugated exterior and smooth interior. Pipe and fittings shall be made of polyethylene compounds.

2.03 MANUFACTURING QUALITY CONTROL

A. The Contractor shall submit to the Owner for approval within 14 days prior to the start of ADS N-12 pipe work a complete list of materials to be furnished and the name of the pipe Manufacturer.

B. The Contractor shall submit to the Owner the Manufacturer's certification of compliance with the product requirements of Part 2.

2.04 TRANSPORTATION

A. Transportation of ADS N-12 pipe shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the ADS N-12 pipe incurred prior to and during transportation to the site.

2.05 HANDLING AND STORAGE

A. Handling, storage, and care of the ADS N-12 pipe prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Owner.

B. The Contractor shall be responsible for storage of the ADS N-12 pipe at the site.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Pipe shall be installed as indicated on the Construction Drawings.

B. The Contractor shall exercise care when transporting, handling and placing pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

C. The Contractor shall comply with the pipe Manufacturer's recommendations for handling, storage, and installation of all polyethylene pipe fittings.

D. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

E. Pipe or fittings shall not be dropped onto rocky or unprepared ground. The pipe and fittings shall not be dropped into trenches or dragged over sharp objects.

F. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of

pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. The CQA Engineer will inspect the pipes in accordance with the CQA Plan. Sections of pipe with excessive cuts, gouges, or scratches will be rejected and the Contractor will be required to remove and replace the rejected pipe, at no additional cost to the Owner.

G. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

H. Where pipes penetrate through geomembranes, an effective seal shall be established in accordance with these General Specifications as well as the details shown on the Construction Drawings.

3.02 INSTALLATION

A. All pipe and fittings shall be installed in accordance with these General Specifications and the pipe Manufacturer's instructions.

B. The Contractor shall carefully examine all pipe and fittings for cracks, damage or defect before installation. Defective materials shall be removed from the site and replaced with non-defective material at no additional cost to the Owner.

C. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.

D. Field cutting of pipe shall be carefully made, without damage to pipe or lining system components, so as to leave a smooth end at right angles to the axis of pipe. The method and device used to cut the pipes shall be approved of by the Owner. Sharp edges of cut ends shall be filed off smooth. Flame cutting will not be allowed.

E. All pipe and fittings shall be laid or placed to the grades and elevations shown on the Construction Drawings with bedding and backfill as shown on the Construction Drawings.

F. Placement of overlying materials shall be carried out in accordance with these General Specifications.

G. No pipe shall be laid until the CQA Engineer has observed the condition of the pipe.

H. Blocking under piping shall not be permitting unless specifically accepted by the Owner.

I. The Contractor shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

3.04 JOINTS AND CONNECTIONS

A. HDPE pipe shall be joined with split couplers. All joints shall be made in accordance with the pipe Manufacturer's recommendations, and shall be made by trained personnel authorized by the pipe Manufacturer.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the location and final elevation of the invert of all ADS N-12 pipe. The pipe shall be surveyed at its ends and at approximate 50-foot intervals between the ends. In addition, all joints, etc. shall be located horizontally and vertically and overall length measured. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and final elevation of all pipes.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-complete and completed work of these General Specifications.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of pipe installation and inspection to the Owner prior to completely covering the pipe in accordance with the CQA Plan.

[END OF SECTION]

SECTION 02730
ADS SLOTTED CPT

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of all ADS corrugated polyethylene tubing (CPT) required for the landfill construction. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02224 - Drainage Gravel
B. Section 02714 - Geotextile Filter or Cushion Layer

1.03 QUALIFICATIONS AND SUBMITTALS

A. If "or equal" product is proposed, submit samples, technical data, test data, and specifications sufficient to allow evaluation by the Engineer.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The CQA Engineer will coordinate independent surveying as required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

D. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming materials. The nonconforming materials shall be removed by the Contractor at no cost to the Owner until acceptable materials are installed.

PART 2: PRODUCTS

2.01 SLOTTED CPT PROPERTIES

A. Slotted CPT shall conform to ASTM F405 and ASTM F667. Slot dimensions and locations shall be Manufacturer standard for the diameter pipe specified.

2.03 MANUFACTURING QUALITY CONTROL

A. The Contractor shall submit to the Owner for approval within 14 days prior to the start of ADS CPT work a complete list of materials to be furnished and the name of the pipe Manufacturer.

B. The Contractor shall submit to the Owner the Manufacturer's certification of compliance with the product requirements of Part 2.

2.04 TRANSPORTATION

A. Transportation of ADS CPT shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the ADS CPT incurred prior to and during transportation to the site.

2.05 HANDLING AND STORAGE

A. Handling, storage, and care of the ADS CPT prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Owner.

B. The Contractor shall be responsible for storage of the ADS CPT at the site.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Pipe shall be installed as indicated on the Construction Drawings.

B. The Contractor shall exercise care when transporting, handling and placing pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

C. The Contractor shall comply with the pipe Manufacturer's recommendations for handling, storage, and installation of all polyethylene pipe fittings.

D. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe. Slings, straps, etc. shall not be positioned at butt-fused joints. Chains, cables or hooks shall not be inserted into the pipe ends as a means of handling pipe.

E. Pipe or fittings shall not be dropped onto rocky or unprepared ground. The pipe and fittings shall not be dropped into trenches or dragged over sharp objects.

F. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and

fittings shall be free of cuts, gouges and scratches. The CQA Engineer will inspect the pipes in accordance with the CQA Plan. Sections of pipe with excessive cuts, gouges, or scratches will be rejected and the Contractor will be required to remove and replace the rejected pipe, at no additional cost to the Owner.

G. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

H. Where pipes penetrate through geomembranes, an effective seal shall be established in accordance with these General Specifications as well as the details shown on the Construction Drawings.

3.02 INSTALLATION

A. All pipe and fittings shall be installed in accordance with these General Specifications and the pipe Manufacturer's instructions.

B. The Contractor shall carefully examine all pipe and fittings for cracks, damage or defect before installation. Defective materials shall be removed from the site and replaced with non-defective material at no additional cost to the Owner.

C. The interior of all pipe and fittings shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.

D. Field cutting of pipe shall be carefully made, without damage to pipe or lining system components, so as to leave a smooth end at right angles to the axis of pipe. The method and device used to cut the pipes shall be approved of by the Owner. Sharp edges of cut ends shall be filed off smooth. Flame cutting will not be allowed.

E. All pipe and fittings shall be laid or placed to the grades and elevations shown on the Construction Drawings with bedding and backfill as shown on the Construction Drawings.

F. Placement of overlying materials shall be carried out in accordance with these General Specifications.

G. No pipe shall be laid until the CQA Engineer has observed the condition of the pipe.

H. Blocking under piping shall not be permitting unless specifically accepted by the Owner.

I. The Contractor shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

3.04 JOINTS AND CONNECTIONS

A. CPT shall be joined with split couplers. All joints shall be made in accordance with the pipe Manufacturer's recommendations, and shall be made by trained personnel authorized by the pipe Manufacturer.

3.05 SURVEY CONTROL

A. The Surveyor shall survey the location and final elevation of the invert of all ADS CPT. The pipe shall be surveyed at its ends and at approximate 50-foot intervals between the ends. In addition, all joints, etc. shall be located horizontally and vertically and overall length measured. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and final elevation of all pipes.

3.06 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-complete and completed work of these General Specifications.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of pipe installation and inspection to the Owner prior to completely covering the pipe in accordance with the CQA Plan.

[END OF SECTION]

SECTION 02740
CORRUGATED METAL PIPE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation service necessary for the installation of all corrugated metal pipe (CMP) for construction. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. 02228 - Pipe Bedding

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO) most current version:

1. AASHTO M36 - Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

B. American Society for Testing and Materials (ASTM) most current version:

1. ASTM A27 - Specification for Steel Castings, Carbon, for General Application.
2. ASTM A36 - Specification for Structural Steel.
3. ASTM A123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASTM A536 - Specification for Ductile Iron Castings.
5. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections.
6. ASTM D1557 - Test Methods for Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54 kg) Hammer and 18-in. (457 mm) Drop.
7. ASTM D3776 - Test Methods for Mass per Unit Area (Weight) of Woven Fabric.
8. ASTM D3786 - Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.
9. ASTM D4355 - Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Zenon-Arc Type Apparatus).
10. ASTM D4533 - Test Method for Trapezoid Testing Strength of Geotextiles.

11. ASTM D4632 - Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

12. ASTM D4751 - Test Method for Determining Apparent Opening Size of a Geotextile.

13. ASTM D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

C. State of California Department of Transportation (CALTRANS), Standard Specifications, most current version.

1.04 SUBMITTALS

A. Submit manufacturer's and supplier's specifications and test data as required to demonstrate that materials conform to the requirements of this specification.

PART 2: PRODUCTS

2.01 CORRUGATED METAL PIPE (CMP)

A. CMP shall be galvanized steel conforming to AASHTO M36 Type I, with a nominal sheet thickness of 0.079 inches or greater. Diameters shall be as shown on the Construction Drawings.

B. Coupling bands shall be galvanized steel conforming to AASHTO M36 and shall be compatible with the type of CMP provided.

2.02 TRENCH BACKFILL

A. Trench backfill shall conform to the specifications for pipe bedding described in Section 02228.

PART 3: EXECUTION

3.01 CMP CULVERT INSTALLATION

A. Excavate trenches to the lines and grades shown on the Drawings. Overexcavate trenches so that at least 6 inches of pipe bedding material can be placed below the invert of the culvert. Conduct trenching operations in accordance with the applicable provisions of Section 02110.

B. Place a minimum 6-inch-thick layer of pipe bedding material in the trench prior to laying the culvert. Compact pipe bedding material with power tamper or equivalent means. The bottom of the trench shall support the culvert uniformly along its entire length.

C. Handle culvert using methods as recommended by the manufacturer. Join culvert sections using manufacturer's recommended equipment and procedures.

D. Place backfill around culvert in lifts no greater than 1 foot thick prior to compaction. Place soil around haunches of culvert manually or by other approved means so that no voids are present. Compact each lift with power tamper or equivalent means.

[END OF SECTION]

SECTION 02775
GEOMEMBRANE LINERS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment supervision, transportation, and installation services necessary for the installation of the geomembrane liners for the landfill or surface impoundment. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

B. This specification shall also apply to geomembrane installation in the truck roll off area, the drum handling facility, the truck wash facility and the stormwater detention basin unless otherwise indicated on the drawings.

1.02 RELATED SECTIONS

A. Section 02221 - Clay Liner
B. section 02231 - Foundation Sand
C. Section 02710 - Geocomposite
D. Section 02712 - Geonet
E. Section 02714 - Geotextile Filter, or Cushion, Layer
F. Section 02232 - Protective Soil Layer
G. Section 02718 - Polyethylene Pipe and Fittings
H. Section 02780 - Geosynthetic Clay Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan. The Contractor shall require the geomembrane manufacturer to comply with the submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be constructed, monitored, and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The Contractor shall deliver geomembrane to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. Geomembrane rolls that do not meet the requirements of this General Specification will be rejected. The Contractor shall replace rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 RESIN

A. Reclaimed polymer shall not be added to the resin; however, the use of polymer recycled during the manufacturing process will be permitted if the recycled polymer does not exceed 2 percent by weight of the total polymer weight. The product shall be manufactured specifically for use in geomembranes, using new, first-quality polyethylene resin.

B. The resin shall comply with the following properties for high density polyethylene (HDPE):

1. Specific Gravity: 0.94 to 0.96 (ASTM D 792 Method A or ASTM D 1505)

2. Melt Index: 0.1 - 0.3 g/10 min. (ASTM D 1238 Condition E 190/C, 2.16 kg)

3. Water absorption: 0.1% max (ASTM D 570)

2.02 GEOMEMBRANE PROPERTIES

A. Smooth or textured HDPE geomembrane shall be used based on the following schedule:

Facility	Textured/Smooth
Landfill (liner/cover)	Textured
Ditch liners	Smooth
Evaporation Pond and Collection Basin	Smooth
Truck Roll Off	Textured
Drum Storage	Smooth
Liquid Waste Storage	Smooth
Stabilization	NA
Truck Wash	Textured

B. The Contractor shall require that the geomembranes Manufacture furnish geomembrane with minimum average roll values, as defined by the Federal Highway Administration (FHWA), meeting or exceeding the criteria specified in Table 02775-1 and that meet the manufacturing quality control requirements of this section. The Contractor shall require the geomembrane Manufacturer to certify in writing as well

as provide test results that demonstrate that the geomembrane delivered to the site complies with the properties listed in Table 02775-1.

C. In addition to the property values listed in Table 02775-1, the geomembrane material shall:

1. Contain a maximum of 1 percent by weight of additives, fillers, or extenders (not including carbon black).

2. Not have striations, roughness (except in the case of textured HDPE geomembranes where a roughened surface is characteristic), pinholes, or bubbles on the surface.

3. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.

4. Be manufactured in a single layer or coextruded.

2.03 MANUFACTURING QUALITY CONTROL

A. *Resin*:

1. The Contractor shall require the geomembrane Manufacturer to certify in writing that the resin used to manufacture the geomembrane delivered to the project site complies with the product specifications of this section. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor Any geomembrane manufactured from non-complying resin will be rejected.

2. The Contractor shall require the Manufacturer to supply quality control certificates from the resin Supplier that includes the origin (resin production plant), identification (brand name, number) the production date of the resin used in the manufacturer of the geomembrane shipped to the site, and the results of test conducted to verify that the resin used to manufacturer the geomembrane rolls assigned to the project meets the specifications of Part 2.01 of this section.

B. *Rolls*:

1. The Contractor shall require that the geomembrane Manufacturer continuously monitor the geomembrane during the manufacturing process for inclusions, bubbles, or other defects. Geomembrane that exhibits defects will not be accepted.

2. The Contractor shall require that the geomembrane Manufacturer monitor the geomembrane thickness during the manufacturing process. Geomembrane that fails to meet the specified minimum thickness will not be accepted.

3. The Contractor shall require that the geomembrane Manufacturer sample and test the geomembrane, at a minimum, once every 50,000 ft^2 and perform

the tests indicated in Table 02775-1 to demonstrate that the geomembrane properties conform to the values specified in this section. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. Samples shall be taken across the entire width of the roll and shall not include the first wrapping or outer layer of the roll (about 3.3 feet).

4. Geomembrane rolls that do not have acceptable manufacturing quality control test results shall be rejected by the Owner.

5. In the case of the rejection of a roll of geomembrane, the Contractor shall require that the geomembrane Manufacturer sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established in accordance with the CQA Plan.

6. Additional testing may be performed at the geomembrane Manufacturer's discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.

7. If requested by Owner, one coupon of geomembrane (at least 10 feet by 2 feet) for every 40,000 ft^2 of membrane produced shall be retained intact by the geomembrane Manufacturer until construction of landfill or surface impoundment components, for which the geomembrane is used, is complete and the Owner has accepted the completed work.

C. *Manufacturing Plant Visit:*

1. The Manufacturer shall permit the Owner or Owner's representative(s) to visit the manufacturing plant. Visits may be during the manufacturing of the geomembrane rolls for the specific project.

2. During the visit, the Owner or Owner's representative(s) may:

   a. Review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;

   b. Verify that properties guaranteed by the Manufacturer comply with the specifications;

   c. Verify that the measurements of properties by the Manufacturer are properly documented and the test methods used are acceptable;

   d. Inspect select geomembrane rolls for evidence of holes, blisters, or any sign of contamination by foreign matter;

   e. Review packaging and transportation procedures;

   f. Verify that roll packages are labeled in compliance with this Section; and

g. Take conformance samples from geomembrane rolls that are assigned to the project.

2.04 LABELING

A. The geomembrane shall be labeled with the following information:

1. Thickness of the material;
2. Length and width of the roll or factory panel;
3. Name of Manufacturer;
4. Product identification;
5. Lot number; and,
6. Roll or factory panel number.

2.05 TRANSPORTATION

A. Transportation of the geomembrane is the responsibility of the Contractor. The Contractor shall be liable for all damage to materials prior to and during transportation to the site. The Contractor shall replace any damaged rolls at no additional cost to the Owner.

2.06 HANDLING AND STORAGE

A. Handling, storage, and care of the geomembrane prior to and following incorporation in the work is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance of the installation by the Owner. The Contractor shall repair any damage in accordance with this Section and at no additional cost to the Owner.

B. The Contractor shall be responsible for storage of the geomembrane at the site. The geomembrane shall be protected from dirt, excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane shall also be stored in accordance with any additional requirements of the geomembrane Manufacturer.

PART 3: EXECUTION

3.01 EARTHWORK

A. *Surface Preparation*

1. Geomembrane liner shall be installed at all locations shown on the Construction Drawings.

2. The geomembrane liners and the cover geomembrane shall be installed as soon as practical after construction and CQA testing of the underlying materials. Prior to geomembrane liner installation, the Contractor shall verify, by surveying, that the elevations, thicknesses, and grades of the underlying materials conform to the requirements of the Construction Drawings. Installation of the geomembranes shall not begin until the CQA Engineer completes conformance testing and surveying of the appropriate portions of the underlying materials in accordance with the CQA Plan.

3. Areas to receive geomembrane liner shall be smooth and even, and free of ruts, voids, and protrusions or wrinkles. Any surface features, as determined by the CQA Engineer or Owner, which could damage the geomembrane shall be removed by the Contractor. For earth slopes of 3:1 (horizontal:vertical) or flatter, the final surface prior to receiving geomembrane shall be rolled smooth using a smooth drum roller. For slopes steeper than 3H:1V, dressing of the slopes shall be accomplished by back-dragging the surface with a dozer blade or by other methods approved by the Owner (such as raking the surface by hand) until the Owner is satisfied that the surface is smooth and even, and free of ruts, voids, obstructions, etc.. No vehicles shall be allowed on the final dressed surface without the approval of the Owner.

4. The Contractor shall provide written certification that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance for each area under consideration shall be given to the Owner as part of geomembrane installation in that area.

5. Special care shall be taken to maintain the prepared surface on which the geomembrane will be installed.

6. No geomembrane shall be placed in an area which has been softened by precipitation or which has excessively cracked due to desiccation.

7. Any damage to the surface caused by weather, installation activities, or other activities shall be repaired by the Contractor at no expense to the Owner.

B. *Anchor Trenches:*

1. The anchor trench shall be excavated prior to geomembrane placement to the elevations, grades, and width shown on the Construction Drawings.

2. No loose soil shall be allowed beneath the geomembrane in the anchor trench.

3. The anchor trench shall be backfilled as shown on the Construction Drawings. Care shall be taken when backfilling the anchor trench to prevent any damage to the geomembrane or other geosynthetics.

4. Clay liner material shall be placed in the anchor trench to the limits shown on the Construction Drawings. The clay liner material shall be compacted using suitable hand-operated compaction equipment. Clay shall be compacted to the requirements in the General Specifications.

5. Slightly rounded corners shall be provided at the top in-board side of the anchor trench to avoid sharp bends in the geomembrane.

3.02 GEOMEMBRANE DEPLOYMENT

A. *Layout Drawings:*

1. The Contractor shall provide at least 2 sets of geomembrane panel layout drawings to the Owner at least 14 days prior to geomembrane deployment. Drawings shall indicate the geomembrane panel configuration, dimensions, details, seam locations, etc. Field seams shall be differentiated from factory seams (if any). The layout drawings must be approved by the Owner prior to the installation of any geomembranes. These drawings shall not be modified without the prior approval of the Owner.

B. *Field Panel Identification:*

1. A geomembrane field panel is defined as a roll or a portion of a roll cut in the field.

2. Each field panel must be given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Owner, and Contractor. The field panel identification code shall be related, through a table or chart, to the original resin, and the constituent rolls and factory panels.

C. *Field Panel Placement:*

1. Field panels shall be installed at the location and positions indicated in the layout drawings.

2. Field panels shall be placed one at a time, and each field panel shall be seamed shortly after its placement.

3. Geomembrane shall not be placed when the ambient temperature is below 40°F unless the Contractor has previously submitted a geomembrane cold weather placement and seaming plan and such plan has been approved by the Owner.

4. Geomembranes shall not be placed during a precipitation event, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds.

5. The Contractor shall employ placement methods which ensure that:

   a. No vehicular traffic shall be allowed on the geomembrane.

   b. Equipment used shall not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.

   c. Personnel working on the geomembrane shall not smoke, consume food or beverages (except for body fluid replenishment), wear damaging shoes, have cans, glass containers, or tools not required for liner placement on the geomembrane, or engage in other activities which could damage the geomembrane.

   d. The method used to unroll the panels shall not scratch or crimp the geomembrane and shall not damage the supporting soil.

e. The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels).

f. Temporary loads and/or anchors (e.g., sand bags), not likely to damage the geomembrane, shall be placed on the geomembrane to prevent uplift by wind.

6. On slopes, geomembranes shall be installed from the top of the slope to the bottom. The geomembrane shall be temporarily anchored at the top of the slope prior to deployment. Unrestrained release of the geomembrane from the top of the slope is not acceptable.

7. Any field panel or portion thereof which becomes seriously damaged (torn, twisted, or crimped) shall be replaced with new material at no expense to the Owner. Less serious damage may be repaired with the approval of the Owner. Damaged panels or portions of damaged panels which have been rejected shall be removed from the work area at no expense to the Owner.

8. Adjacent geomembrane panels shall be overlapped as described in this Section. Larger overlaps shall be used if thermal contraction of the geomembrane is anticipated prior to seaming. Adjacent panels shall be placed under similar temperature conditions, preferably early in the day when temperatures are cooler, to minimize the potential for differential contraction.

9. If a textured geomembrane is placed over GCL, geotextile, or geocomposite a slip sheet (such as 20-mil smooth HDPE) shall first be placed over it in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

3.03 FIELD SEAMING

A. *Seam Layout:*

1. In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented down, not across, the slope. In corners and at odd-shaped geometric locations, the number of field seams shall be minimized. No horizontal seam shall be permitted less than 10 feet from the toe of the slope, except where approved by the Owner. No panels shall be seamed in the field without the Owner's approval.

B. *Personnel:*

1. All personnel performing seaming operations shall be qualified as required by the CQA Plan. At least one seamer shall have a minimum of 1,000,000 ft^2 of HDPE geomembrane experience. Seamers who don't have a minimum of 1 million ft^2 HDPE geomembrane experience will be considered inexperienced. Qualifications of the seamers shall be provided to the CQA Engineer prior to the start of construction. All personnel performing field seaming shall be qualified by experience or by passing seaming tests. The

seaming tests shall require all inexperienced seamers to make 5 trial seams on-site prior to any actual field seams. The trial seams shall be tested according to this section and shall be performed under the supervision of an experienced seamer. The CQA Engineer, or a designated representative, will observe and record the results of the tests. No seaming shall be performed unless a "master seamer" is present.

C. *Weather Conditions for Seaming:*

1. Seaming shall not be attempted at ambient temperatures below 40°F. At ambient temperatures between 40°F and 50°F, seaming will be allowed if the geomembrane is preheated either by the sun or a hot air device, and if there is no excessive cooling from wind. At ambient temperatures above 50°F, no preheating will be required. In all cases, the geomembrane shall be dry and protected from excessive wind.

2. If the Contractor wishes to perform seaming at ambient temperatures below 40°F, he shall demonstrate that the seam so produced is equivalent to those produced under normally approved conditions, and that the overall quality of the geomembrane is not adversely affected. The Contractor shall submit to the Owner for approval a geomembrane cold weather placement and seaming plan that details all aspects of the cold weather seaming operation.

3. To minimize geomembrane contraction stresses, seaming should ideally be carried out in the morning and late evening when the geomembrane is relatively contracted, and during the middle of the day if overcast conditions prevail. If the geomembrane is to be seamed in the middle of a sunny day, the Contractor shall ensure that there is sufficient slack in the geomembrane to prevent excessive stresses or trampolining when the geomembrane contracts as cooler temperatures prevail. The required amount of slack shall be determined by the Contractor and it should not be so much so as to cause excessive wrinkling of the geomembrane. If excessive trampolining or wrinkling of the geomembrane is observed, the Contractor will be required to make repairs to eliminate the problem at no additional cost to the Owner.

4. Ambient temperatures shall be measured near the crest of the landfill or surface impoundment.

D. *Overlapping and Temporary Bonding:*

1. Geomembrane panels shall be overlapped a minimum of 3 inches for extrusion welding and 4 inches for fusion welding or a greater amount if recommended by the geomembrane Manufacturer, but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.

2. The procedure used to temporarily bond adjacent panels together shall not damage the geomembrane. The temperature of the air at the nozzle of a spot welding apparatus shall be controlled such that the geomembrane is not damaged.

3. No solvent or adhesive shall be used for cleaning or bonding of the geomembrane liner material.

E. *Seam Preparation:*

1. Prior to seaming, the seam area shall be cleaned so that it is free of moisture, dust, dirt, debris of any kind, and foreign material.

2. If seam overlap grinding is required, the process shall be completed according to the geomembrane Manufacturer's instructions and in a manner that does not damage the geomembrane.

3. Seams shall be aligned with the fewest possible number of wrinkles and "fishmouths".

F. *General Seaming Requirements:*

1. All geomembrane overlaps shall be continuously seamed using approved procedures.

2. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

3. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface, directly under the seam overlap to achieve proper support.

4. If seaming operations are carried out at night, adequate illumination shall be provided.

5. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall be patched with an oval or round patch of the same geomembrane that extends a minimum of 6 inches beyond the cut in all directions.

6. At the end of each day or installation segment, all exposed geomembrane edges shall be anchored by sandbags or other approved means. Sandbags securing the geomembrane on side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards with weighted sand bags on top may be used to keep wind from getting under the exposed edge of the geomembrane.

G. *Seaming Process:*

1. Approved processes for field seaming are extrusion welding and fusion welding using equipment that the Owner has approved by make and model. Alternate processes shall not be used unless a plan for their use has been submitted by the Contractor and approved by the Owner. Seaming equipment shall not damage the geomembrane.
2. Extrusion Equipment and Procedures:

a. The Contractor shall maintain at least one spare operable seaming apparatus on site.

b. The extrusion welding apparatus shall be equipped with gauges indicating the temperature in the apparatus and at the nozzle.

c. Prior to beginning a seam, the extruder shall be purged until all heat-degraded extrudate has been removed from the barrel. Whenever the extruder is stopped, the barrel shall be purged of all heat-degraded extrudate.

d. The Contractor shall provide documentation regarding the extrudate to the Owner and shall certify that the extrudate is compatible with the specifications, and consists of the same resin as the geomembrane.

e. The electric generator for the extrusion welders shall be placed either outside the area to be lined or on a smooth base or other such manner that no damage occurs to the geomembrane.

3. Fusion Equipment and Procedures:

a. The Contractor shall maintain at least one spare operable seaming apparatus on site.

b. The fusion welding apparatus shall be an automated vehicular mounted device equipped with gauges indicating the applicable temperatures and pressures

c. The edges of cross seams shall be abraded to a smooth incline (top and bottom) prior to welding.

d. A movable protective layer shall be used directly below each geomembrane overlap to be seamed if deemed necessary by the Owner.

e. The electric generator for the fusion welders shall be placed either outside the area to be lined or on a smooth base or other such manner that no damage occurs to the geomembrane.

f. All fusion welded seam intersections shall be patched in accordance with this Section.

H. *Trial Seams:*

1. Trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period (morning and afternoon). Each seamer shall make at least one trial seam each day. Trials seams shall also be made in the event that the ambient temperature varies more than 20°F since the last passing trial seam. Trial seams shall be made under the same conditions as actual seams. The trial seam sample shall be at least 5 feet long by 1 foot

wide (after seaming) with the seam centered lengthwise for fusion trial seams and at least 3 feet long by 1 foot wide for extrusion trial seams. Seam overlap shall be as indicated in Part 3.03.D. of this Section.

2. Five specimens, each 1 inch wide, shall be cut from the trial seam sample by the Contractor. Two specimens shall be tested for shear strength and three specimens shall be tested for peel strength using a field tensiometer. Both tracks of double fusion welds will be tested for peel strength on each of the three specimens unless otherwise approved by the Owner. The test specimens shall not fail in the seam and shall meet or exceed the strength requirements in Table 02775-2. If a specimen fails, the entire operation shall be repeated. If the second trial seam fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. Trial seam failure is defined as failure of any one of the five specimens.

3. The CQA Engineer will observe trial seam testing procedures. Successful trial seam samples will be assigned a number and marked accordingly by the CQA Engineer, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. The sample itself will be retained only until the construction of the liner is complete, and the liner has been accepted by the Owner.

I. *Nondestructive Seam Continuity Testing:*

1. Except as noted below the Contractor shall nondestructively test for continuity all field seams over their full length, using the vacuum test (primarily for extrusion seams),or air pressure test (for double fusion seams only) methods. All other test methods must be approved by the Owner. These tests shall be carried out as the seaming work progresses, not at the completion of all field seaming. The Contractor shall complete any required repairs in accordance with this Section at no additional cost to the Owner.

2. If the seam cannot be nondestructively tested after final installation, the following procedures shall apply:

   a. Prior to seaming, the seamer shall make a new trial seam.

   b. The seam shall be capped with the same type of geomembrane if the seams of the cap can be nondestructively tested.

   c. If the seam is accessible to nondestructive testing prior to final installation but not after final installation, the seam shall be nondestructively tested prior to final installation.

   d. At the discretion of the Owner, vacuum testing of fusion welded seams may be allowed in lieu of capping fusion welded seams which cannot be air pressure tested.

   e. If none of the above techniques are practical the CQA Engineer will closely observe and document the seaming process.

3. Vacuum Testing

a. The equipment for vacuum box testing shall comprise the following:

i. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

ii. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

iii. A rubber pressure/vacuum hose with fittings and connections.

iv. A bucket and applicator.

v. A soapy solution.

b. The following procedures shall be followed:

i. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi gauge.

ii. Wet a strip of geomembrane seam approximately 4 inches by one and one half times the length (minimum) of the vacuum box with the soapy solution.

iii. Place the box over the wetted area.

iv. Close the bleed valve and open the vacuum valve.

v. Ensure that a leak tight seal is created as evidenced by a negative box pressure of a minimum 5 psi gauge.

vi. Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than 10 seconds.

vii. If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box to the next adjoining area with a minimum 3 inches overlap, and repeat the process.

viii. All areas where soap bubbles appear shall be marked with a marker that will not damage the geomembrane and repaired in accordance with Part 3.03.K. of this Section with no additional cost to the Owner.

4. <u>Air Pressure Testing (For Double-Fusion Seams Only):</u>

a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.

b. The equipment shall comprise the following:

i. An air pump (manual or motor driven), equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 psi, and mounted on a cushion to protect the geomembrane.

ii. A rubber hose with fittings and connections.

iii. A sharp hollow needle, or other approved pressure feed device.

c. The following procedures shall be followed:

i. Seal both ends of the seam to be tested.

ii. Insert needle, or other approved pressure feed device, into the tunnel created by the fusion weld.

iii. Insert a protective cushion between the air pump and the geomembrane.

iv. Energize the air pump to a gauge pressure between 25 and 30 psi, close valve, and sustain the pressure for not less than 5 minutes.

v. If the loss of pressure exceeds 2 psi, or does not stabilize, locate faulty area and repair in accordance with Part 3.03.K. of this Section.

vi. At the end of the test, cut the air channel at the end of the seam opposite the needle and verify air flow to ensure that the entire seam length was tested.

vii. Remove the needle, or other approved pressure feed device, and repair all test penetrations in accordance with Part 3.03.K. of this Section.

J. *Destructive Testing*

1. Destructive seam tests shall be performed on samples collected from selected locations to evaluate seam strength and integrity. Destructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

2. Sampling:

a. Destructive test samples shall be collected at a minimum average frequency of one test location per 500 feet of seam length. Test locations shall be determined during seaming, and may be prompted by suspicion of excess crystallinity, contamination, offset seams, or any other potential cause of imperfect seaming. The CQA Engineer

will be responsible for choosing the locations of destructive seam samples. The Contractor shall not be informed in advance of the locations where the seam samples will be taken. The CQA Engineer may increase the sampling frequency.

b. Samples shall be cut by the Contractor at the locations designated by the CQA Engineer as the seaming progresses in order to obtain laboratory test results before the geomembrane is covered by another material. Each sample shall be numbered and the sample number and location identified on the panel layout drawing. All holes in the geomembrane resulting from the destructive seam sampling shall be immediately covered. The holes shall be repaired in accordance with Part 3.03.K. of this Section. The continuity of the new seams in the repaired areas shall be tested according to this Section.

c. Two test specimens, each 1 inch wide and 6 to 12 inches long with the seam centered parallel to the width, shall be taken. The test specimens shall be spaced a clear distance of approximately 42 inches apart. These specimens shall be tested in the field in accordance with Part 3.03.J.3 of this Section. If these samples pass the field test, a laboratory sample shall be taken. The removed destructive sample shall be at least 12 inches wide by 42 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

i. One 12-inch long portion to the Contractor.

ii. One 18-inch long portion to the CQA Engineer for laboratory testing.

iii. One 12-inch long portion to the CQA Engineer for archive storage.

3. Field Testing:

a. The two 1 inch wide test specimens shall be tested in the field, using a tensiometer, for peel adhesion. Field testing shall be the responsibility of the Contractor and shall be observed by the CQA Engineer. The test specimens shall not fail in the weld more than 10 percent and shall meet the peel strength requirements of Table 02775-2. Both tracks of double fusion welded seams shall be tested in peel on each test specimen unless otherwise approved by the Owner. If any field test sample fails to pass, then the procedures outlined in Part 3.03.K. of this Section shall be followed.

4. Laboratory Testing:

a. Laboratory testing by the CQA Engineer, in accordance with the CQA Plan, shall include seam shear strength and shear strain at yield (ASTM D 3083) and peel adhesion (ASTM D 413). The minimum acceptable values to be obtained in these tests are those

indicated in Table 02775-2. At least 5 specimens shall be tested for each test method. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear). A sample passes the laboratory tests when at least 4 out of 5 of the test specimens meet or exceed all of the test criteria. Both tracks of double fusion welded seams shall be tested in peel.

5. Destructive Test Failure:

a. The following procedures shall apply whenever a sample fails a destructive test, whether the test is conducted by the CQA Engineer's laboratory, the Contractor's laboratory, (if used) or by a field tensiometer. The Contractor shall have two options:

i. The Contractor can reconstruct the seam(s) (e.g., remove the old seam(s) and reseam, or cap the seam(s)) between any two passed test locations.

ii. The Contractor can trace the welding path to an intermediate location, a minimum of 10 feet from the location of the failed test (in each direction) and take test specimens for an additional field destructive tests at each location. If these field destructive tests pass, then full laboratory samples shall be taken. If these laboratory samples pass the tests, then the seam(s) shall be reconstructed between these locations. If either sample fails, then the process shall be repeated to establish the zone in which the seam shall be reconstructed. This will be done by following the chronological order in which the seaming apparatus welded the seam(s) prior to and after it welded the failing test location. In any case, all acceptable seams must be bounded by two locations from which samples passing laboratory destructive tests have been obtained. In cases exceeding 150 feet of reconstructed seam(s), a sample taken from within the reconstructed zone must pass destructive testing. Whenever a sample fails, the CQA Engineer may require additional tests for seams that were formed by the same seamer and/or seaming apparatus or seamed during the same time shift at no additional cost to the Owner.

iii. Should three consecutive failing destructives be performed on a single welding apparatus, the apparatus shall not be permitted to weld until the machine has been repaired and successfully passed three consecutive trial seams.

K. *Defects and Repairs:*

1. The geomembrane will be inspected before and after seaming for evidence of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be

clean at the time of inspection. The geomembrane surface shall be swept or washed by the Contractor if surface contamination inhibits inspection.

2. Each suspect location, both in seam and non-seam areas shall, at the discretion of the CQA Engineer, be either repaired or nondestructively tested using the methods described Part 3.03.I. of this section, as appropriate. Each location which fails nondestructive testing shall be marked by the CQA Engineer and repaired by the Contractor.

3. When geomembrane seaming is completed (or when seaming of a significant area of a geomembrane is completed) and prior to placing overlying materials, the CQA Engineer shall identify all excessive geomembrane wrinkles. The Contractor shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested like any other seams.

4. Repair Procedures:

   a. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Contractor. Repairs to the geomembrane shall be completed to the base of the anchor trench but are not required across the base of the anchor trench. Several repair procedures exist. The final decision as to the appropriate repair procedure shall be agreed upon between the CQA Engineer and the Contractor. The procedures available include:

      i. Patching, used to repair holes, tears, intersections of fusion-welded seams, and undispersed raw materials;

      ii. Abrading and spot extrusion welding, used to repair small sections of extruded seams and air pressure test needle holes;

      iii. Spot seaming, used to repair areas where the geomembrane has been scratched, the geomembrane thickness has been reduced, or other minor, localized flaws exists;

      iv. Capping, used to repair failed seams; and,

      vi. Removing failing seams and replacing them with strips of new material seamed into place (used with long lengths of fusion seams).

   b. In addition, the following shall be satisfied:

      i. Surfaces of the geomembrane which are to be repaired shall be abraded prior to the repair;

      ii. All surfaces must be clean and dry at the time of repair;

      iii. All seaming equipment used in repair procedures must be approved by the Owner;

iv. The repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the CQA Engineer;

v. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches; and,

vi. The geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.

5. Repair Verification:

a. Each repair shall be located, logged, and nondestructively tested using the methods described in Part 3.03.I. of this Section, as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test results. At the discretion of the CQA Engineer, destructive testing may be required on large repairs.

3.04 MATERIALS IN CONTACT WITH THE LINER

A. The Contractor shall not leave any tools or equipment on the geomembrane.

B. The Contractor shall take all necessary precautions to ensure that the geomembrane is not damaged during its installation or during the installation of other components of the liner system or by other construction activities. Installation on rough surfaces shall be performed carefully. If approved by the Owner, additional loosely placed geotextile sections may be used by the Contractor to protect the geomembrane.

C. The CQA Engineer will provide monitoring of the placement and spreading of soil materials over the geomembrane as required by the CQA Plan.

D. Placement of sump and pipe bedding gravel on top of a geomembrane liner shall be carried out in accordance with Section 02224 and 02228 of these General Specifications.

E. Equipment shall not be driven directly on the geomembrane. Unless otherwise specified by the Owner, all equipment operating on materials overlying the geomembrane shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	*Thickness of Soil Above Geomembrane (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

These equipment ground pressure requirements do not apply to any equipment used to construct the secondary or primary clay liners. The Owner may restrict the use of equipment that may potentially damage the geomembrane.

F. *Appurtenances*:

1. Installation of the geomembrane in sump areas, and connection of the geomembrane to appurtenances shall be made according to the specifications. Extreme care shall be taken while seaming around sumps and appurtenances since neither nondestructive nor destructive testing may be feasible in these areas.

2. All clamps, slips, bolts, nuts, or other fasteners used to secure the geomembrane to each appurtenance shall be at least as durable as the geomembrane.

3. Geomembrane boots for pipe penetrations shall be factory fabricated and tested where practical. Geomembrane boots shall be installed as shown on the Construction Drawings and in accordance with any geomembrane Manufacturer recommendations.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work.

B. In the event of damage, the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of the geomembrane liner installation to the Owner in accordance with the CQA Plan prior to placement of any material over the geomembrane.

3.06 RECORD DRAWINGS

A. Within 7 days of the completion of installation of any layer of geomembrane liner and unless otherwise approved by the Owner, the Contractor shall provide 2 copies of a complete "as-built" record drawing to the Owner. This record drawing shall be prepared by the Contractor and shall be at a scale of no less than 1 inch equals 30 feet.

B. Record drawings shall include the following:

1. The surveyed locations, dimensions, and elevations of anchor trenches.

2. The identification, size, and surveyed location of all deployed field panels of geomembrane liner (with date of deployment).

3. The identification, length, and surveyed location of all seams (both factory and field seams).

4. The location, and type of all repairs to seams and field panels.

5. The destructive test sample locations and pass/fail results.

C. The Owner will review the record drawing and either approve it or return it to the Contractor for revision. If the drawing is returned to the Contractor, he shall revise the drawing as requested by the Owner. No additional construction that would cover the installed geomembrane may be performed until the record drawing is approved by the Owner. The Contractor may submit a partial record to obtain approval for a portion of work.

TABLE 02775-1
REQUIRED GEOMEMBRANE

Property	Test Method	60 mil HDPE [1]
Thickness	ASTM D1593 Para 8.1.3 (Smooth)	60 mil
	ASTM D751 (Textured)	57 mil (min)
Specific Gravity	ASTM D1505	0.940
Elongation @ Yield	ASTM D638	13%
Elongation @ Break	ASTM D638 Speed C	500% Smooth 100% Textured
Tensile Strength @ Yield	ASTM D638 Test Specimen Type IV	132 lb/in
Tensile Strength @ Break	ASTM D638	228 lb/in Smooth 132 lb/in Textured
Carbon Black Content	ASTM D1603	2% to 3%
Carbon Black Dispersion	ASTM D3015 and ASTM D2663	A-1, A-2, B-1
Environmental Stress Crack	ASTM D1693	1,500 hrs
Low Temperature Brittleness	ASTM D746 Procedure B	-103°F
Dimensional Stability	ASTM D1204	<1.5% (max)
Puncture Resistance	FTMS 101C	78 lb Smooth 78 lb Textured

Note: [1]Values represent minimum average roll values (i.e., any roll in a lot should meet or exceed the values in this table). Where ranges of values are given, the average roll values must be within the specified range. The specified dimensional stability is a maximum average roll value.

TABLE 02775-2
REQUIRED GEOMEMBRANE SEAM PROPERTIES[1]

ASTM D4437		60 Mil HDPE			
Shear	Fusion lbs/in	120	Smooth	113	Textured
	Extrusion lbs/in	120	Smooth	113	Textured
Peel	Fusion lbs/in	90	Smooth	90	Textured
	Extrusion lbs/in	80	Smooth	80	Textured

Note: (1) Specified properties are minimums.

[END OF SECTION]

SECTION 02780
GEOSYNTHETIC CLAY LINERS

PART 1: ENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment supervision, transportation, and installation services necessary for the installation of the geosynthetic clay liner (GCL) of the landfill or surface impoundment. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02119 - Prepared Subgrade
B. Section 02221 - Clay Liner
C. Section 02710 - Geocomposite
D. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan. The Contractor shall require the GCL manufacturer to comply with the submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be constructed, monitored, and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The Contractor shall deliver GCL to the site at least 14 calendar days prior to installation to allow sufficient time for testing required by the CQA Plan.

D. GCL rolls that do not meet the requirements of this General Specification will be rejected. The Contractor shall replace rejected material with new material that conforms to the specification requirements, at no additional cost to the Owner.

E. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming area. The nonconforming area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 GCL PROPERTIES

The GCL material shall be in accordance with the test methods, test frequencies and material physical properties as listed in Table 02780-1.

A. In addition to the property values listed in Table 02780-1, the GCL material shall:

1. The GCL shall be manufactured by mechanically bonding the geotextiles using a needle punching or stitching process to create frictional and shear strength characteristics.

2. In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needle punch or stitching process. Their use to enhance the physical properties of the GCL is not permitted.

3. Interface Shear Testing of Proposed Equal Materials

   Interface shear tests (ASTM D 5321) shall be performed by the Geosynthetic Laboratory under the direction of the Design Engineer. Interface shear testing will be performed on fully hydrated GCL samples using a 12 inch by 12 inch shear box under test conditions described by the Design Engineer. The number of tests to be performed is based on a ratio of one test per 100,000 ft^2 of material. All costs related to testing and evaluation of proposed equal materials are the responsibility of the Contractor.

4. Interface Shear Testing for QA Conformance Samples

   Interface shear tests (ASTM D 5321) shall be performed by the Geosynthetic Laboratory under the direction of the CQA Engineer using test procedures determined by the Design Engineer. Tests will be performed at a frequency of one test per 100,000 ft^2 of material. All costs related to testing and evaluation of conformance samples is the responsibility of the CQA Engineer.

2.02 MANUFACTURING QUALITY CONTROL

A. The Contractor shall require that the GCL Manufacturer sample and test the GCL, at the frequencies outlined in Table 02780-1 the tests shall demonstrate that the GCL properties conform to the values specified in Table 02780-1. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor. GCL rolls that do not have acceptable manufacturing quality control test results shall be rejected by the Owner.

B. Quality Control certificates shall be issued by the GCL manufacturer to the project engineer, CQA inspector or other designated party for each delivery of material. The certifications shall be signed by the quality control manager of the GCL manufacturer or other responsible party and shall include the following information:

1. *Shipment Packing List* - A list indicating the rolls shipped on a particular truckload.

2. *Bill of Lading* - A list indicating the rolls shipped on a particular truckload.

3. *Letter of Certification* - The letter indicating the material is in conformance with the physical properties specified.

4. *Physical Properties Sheet* - The material specification for the GCL supplied in accordance with this specification.

C. Quality Control submittals shall be issued by the GCL manufacturer to the project engineer, CQA inspector or other designated party for each lot of material if necessary. The submittals shall include the following information:

1. *Bentonite Manufacturer Certification* - Bentonite manufacturer quality documentation for the particular lot of clay used in the production of the rolls delivered.

2. *Geotextile Manufacturer Certification* - Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered.

3. *GCL Manufacturer Tracking List* - Cross referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered.

4. *Manufacturing Quality Control Data* - The manufacturing quality control test data indicating the actual test values obtained when tested at the appropriate frequencies for the properties specified in Table 02780-1.

D. *Manufacturing Plant Visit*:

1. The Manufacturer shall permit the Owner or Owner's representative(s) to visit the manufacturing plant. Visits may be during the manufacturing of the GCL rolls for the specific project.

2. During the visit, the Owner or Owner's representative(s) may:

a. Review the manufacturing process, quality control procedures, laboratory facilities, and testing procedures;

b. Verify that properties guaranteed by the Manufacturer comply with the specifications;

c. Verify that the measurements of properties by the Manufacturer are properly documented and the test methods used are acceptable;

d. Inspect select GCL rolls for evidence of holes, delamination, or any sign of contamination by foreign matter;

e. Review packaging and transportation procedures;

f. Verify that roll packages are labeled in compliance with this Section; and,

g. Take conformance samples from GCL rolls that are assigned to the project.

E. Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself.

2.03 LABELING

A. The geomembrane shall be labeled with the following information:

1. Length and width of the roll or factory panel;
2. Name of Manufacturer;
3. Product identification;
4. Lot number; and,
5. Roll or factory panel number.

2.04 TRANSPORTATION

A. Transportation of the GCL is the responsibility of the Contractor. The Contractor shall be liable for all damage to materials prior to and during transportation to the site. The Contractor shall replace any damaged rolls at no additional cost to the Owner.

2.05 HANDLING AND STORAGE

A. Handling, storage, and care of the GCL prior to and following incorporation in the work is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance of the installation by the Owner. The Contractor shall repair any damage in accordance with this Section and at no additional cost to the Owner.

B. The Contractor shall be responsible for storage of the GCL at the site. The GCL shall be protected from water, dirt, puncture, cutting, or other damaging or deleterious conditions. The GCL shall also be stored in accordance with any additional requirements of the GCL Manufacturer, Owner, or CQA Engineer.

1. GCL should be stored no higher than three to four rolls high or limited to the height at which the handling apparatus may be safely handled by installation personnel. Stacks or tiers of rolls should be situated in a manner that prevents sliding or rolling by chocking the bottom layer of rolls.

2. Rolls shall not be stacked on uneven or discontinuous surfaces as this may cause bending or deformation of the rolls and in turn damage the GCL or cause difficulty inserting the core pipe.

3. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.

4. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

C. GCL must be supported during handling to ensure worker safety and prevent damage to the liner. Under no circumstances should the rolls be dragged, lifted from one end, lifted with only the forks of a lift truck or pushed to the ground from the delivery vehicle.

The CQA inspector shall verify that suitable handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the GCL material itself. Typical handling equipment is described below:

1. *Spreader Bar Assembly* - A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges.

2. *Stinger* - A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to its full length into the roll to prevent excessive bending of the roll when lifted.

3. *Roller Cradles* - Roller cradles consist of two larger diameter rollers spaced approximately 3 inches apart which both support the GCL roll and allow it to be freely unrolled. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.

4. *Straps* - Straps may be used to support the ends of the spreader bars *but are not recommended as the primary support mechanism.* As straps may damage the GCL where around the roll and generally do not provide sufficient uniform support to prevent roll bending or deformation, great care must be exercised when this option is used.

PART 3: EXECUTION

3.01 EARTHWORK

The surface upon which the GCL material will be installed shall be inspected by the CQA inspector and certified by the Earthwork Contractor to be in accordance with the requirements of this specification.

A. Site specific compaction requirements should be followed in accordance with the project drawings and specifications. At a minimum, the level of compaction should be such that no rutting is caused by installation equipment or other construction vehicles which traffic the area of deployment.

B. The surfaces to be lined shall be smooth and free of any debris, vegetation, roots, sticks, sharp rocks, or other deleterious materials larger than two inches as well as free of any voids, large cracks or standing water or ice.

C. Directly prior to deployment of the GCL, the subgrade shall be final graded to fill remaining voids or desiccation cracks, and smooth drum rolled to eliminate sharp irregularities or abrupt elevation changes. The surfaces to be lined shall be maintained in this smooth condition.

3.02 GEOSYNTHETIC SUBGRADE

Prior to GCL deployment on another geosynthetic surface shall be inspected and approved by the third party CQA inspector in accordance with the requirements of the project specification documents.

3.03 ANCHOR TRENCH

An anchor trench shall be excavated by the earthwork contractor or liner installer to the lines and grades shown on the project drawings.

A. The anchor trench shall be constructed free of sharp edges or corners and maintained in a dry condition. No loose soil shall be permitted beneath the GCL within the trench.

B. The anchor trench shall be inspected as well as approved by the CQA inspector prior to the GCL placement, back-filling and compaction of the anchor key material.

3.04 SUBGRADE INSPECTION

The earthen or geosynthetic subgrade shall be continuously inspected, approved and certified by the CQA inspector prior to GCL placement.

Upon approval by the CQA inspector, it shall be the installer's responsibility to indicate to the Engineer any change in the condition of the subgrade that could cause it to be out of compliance with any of the requirements of this section or the project specific specification.

3.05 GCL DEPLOYMENT

A. *GCL Orientation* - In the absence of specific guidelines, GCL panels should be placed with the non-woven side up on slopes to maximize the shear strength characteristics.

B. *GCL Panel Position* - Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation. No horizontal GCL panel seams shall be allowed on slopes steeper than 5%.

C. *Panel Deployment* - GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.
Reinforced GCL shall be used on both slopes as well as the flat areas to ensure the GCL withstands the rigors of the installation and subsequent low load hydration.

1. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.

2. The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.

3. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize dragging the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.

4. Overlaps shall be a minimum of 6 inches and be free of wrinkles, folds or fishmouths.

5. The Contractor shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL shall be covered by a temporary tarpaulin or other such water-resistant sheeting until the next working day.

D. *Anchoring* - All GCL material installed on slopes greater than 7H:1V shall be anchored to prevent potential GCL panel movement.

1. Standard Anchor - The GCL shall be placed into and across the base of the excavated trench, stopping at the back wall of the excavation as shown on the drawing.

E. *Seaming* - A 6-inch lap line and a 9-inch match line shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.

1. Overlap seams shall be a minimum of six inches on panel edges and one foot on panel ends.

2. Loose granular bentonite should be placed between panels at a rate of 1/4 pound per linear foot of seam.

F. *Detailing* - Detail work, defined as the sealing of the liner to pipe penetrations, foundation walls, drainage structures, spillways, and other appurtenances, shall be performed as recommended by the Design Engineer and the GCL Manufacturer.

G. *Damage Repair* - Prior to geomembrane material placement, damage to the GCL shall be identified and repaired by the installer. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles or a displaced panel.

1. Rip and Tear Repair (Flat Surfaces) - Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum of overlap of 12 inches on all edges.

2. Rip and Tear Repair (Slopes) - Damaged GCL material on slopes shall be repaired by the same procedures above. The minimum overlap of 12 inches on all edges may be increased as recommended by the CQA Engineer.

3. Displaced Panels - Displaced panels shall be adjusted to the correct position an orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

4. Premature Hydration - If the GCL is subjected to premature hydration, the GCL installer shall notify the CQA Engineer for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design-dependent upon the degree of damage.

3.06 MATERIALS IN CONTACT WITH THE GCL

A. The Contractor shall not leave any tools or equipment on the GCL.

B. The Contractor shall take all necessary precautions to ensure that the GCL is not damaged during its installation or during the installation of other components of the landfill or by other construction activities. Installation on rough surfaces shall be performed carefully.

C. The CQA Engineer will provide monitoring of the placement and spreading of soil materials over the GCL. Equipment shall not be driven directly on the GCL. Unless otherwise specified by the Owner, all equipment operating on materials overlying the GCL shall comply with the following:

Maximum Allowable Equipment Ground Pressure (psi)	*Thickness of Soil Above GCL (inches)*
<5	12
<10	18
<20	24
>20	36

The maximum allowable equipment ground pressure shall be 65 psi. The acceptability of equipment operating at ground pressures greater than 65 psi will be evaluated by the Owner at the Contractor's expense.

D. Installation of the overlying geosynthetic component can be accomplished through the use of *lightweight*, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

E. Smooth HDPE may be dragged across the GCL surface with equipment or by hand labor during positioning. Similarly, the HDPE may be unrolled with the use of low ground pressure equipment.

F. If a textured geomembrane is placed over the GCL, a slip-sheet (such as 20-mil smooth HDPE) shall first be placed over the GCL in order to allow the geomembrane to slide into its proper position. Once the overlying geomembrane is

properly positioned, the slip-sheet shall be carefully removed paying close attention to avoiding any movement to the geomembrane.

3.07 PROTECTION OF THE WORK

A. The Contractor shall use all means necessary to protect all materials and partially completed and completed work.

B. In the event of damage, the Contractor shall make repairs and replacements necessary to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of the GCL liner installation to the Owner in accordance with the CQA Plan prior to placement of any material over the GCL.

TABLE 02780-1
REQUIRED GCL PROPERTIES[4]

Geotextile Properties	Test Method	Manufacturer's QC Minimum Test Frequency	Value -English-	Value -SI-
Nonwoven Mass/Unit Area	ASTM D 5261	1/ 200,000 sq. ft (1/20,000 sq. m)	7.4 oz./yd^2 Typical 6.0 oz./yd^2 MARV	250 g/m^2 Typical 200 g/m^2 MARV
Woven	ASTM D 5261	1/ 200,000 sq. ft (1/20,000 sq. m)	3.4 oz./yd^2 Typical 3.1 oz./yd^2 MARV	115 g/m^2 Typical 105 g/m^2 MARV
BENTONITE				
Swell Index	ASTM D 5890	1/100,000 lbs. (50,000 kg)	24 ml/2g min.	24 ml/2g min.
Moisture Content	ASTM D 4643	1/100,000 lbs. (50,000 kg)	12% max.	12% max.
Fluid Loss	ASTM D 5891	1/100,000 lbs. (50,000 kg)	18 ml max.	18 ml max.
FINISHED GCL [4]				
Bentonite Mass Per Unit Area[1]	ASTM D 5261	1/ 50,000 sq. ft (1/5,000 sq. m)	0.90 lb./sq. Ft MARV	4.39 kg/m^2 MARV
Grab Strength[2]	ASTM D 4362	1/ 50,000 sq. ft (1/5,000 sq. m)	95 lbs MARV	422 N MARV
Grab Elongation[2]	ASTM D 4632	1/ 50,000 sq. ft (1/5,000 sq. m)	75% Typical	75% Typical
Peel Strength	ASTM D 4632	1/ 50,000 sq. ft (1/5,000 sq. m)	15 lbs. min.	66 N min.
Permeability[3]	ASTM D 5084	1/100,000 sq. ft (1/10,000 sq. m)	5 x 10^{-9} cm/sec max	5 x 10^{-9} cm/sec max
Interface Shear[5]	ASTM 5321	1/100,000 sq.ft. 1/10,000 sq. m)	$\phi = 2°$, C = 440 psf	$\phi = 2°$, C = 21.1 Kpa

Notes:
1. Oven-dried measurement reflecting a moisture content of zero.
2. Measured at maximum peak, in the weakest principal direction.
3. De-Aired Tap Water @ 5 psi maximum effective confining stress and 2 psi head.
4. Internal shear strength testing (ASTM D 5321) of QA conformance samples or proposed equal material will be performed by the CQA Engineer as described in this specification.
5. Residual strength values tested under saturated undrained conditions at normal loads representative of design conditions.

[END OF SECTION]

SECTION 02900
VEGETATION AND SEEDING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services for establishing vegetation on the surface of disturbed areas.

1.02 RELATED SECTIONS

A. Section 02227 Vegetative Cover

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualifications and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION AND QUALITY ASSURANCE

A. Work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The CQA Engineer will coordinate independent surveying required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control and document the work.

C. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extend of the nonconforming area. The nonconformance area shall be reworked by the Contractor at no cost to the Owner until acceptable test results are obtained.

PART 2: PRODUCTS

2.01 MATERIALS

A. Seed mixture for planting shall be as specified by the New Mexico SCS.

PART 3: EXECUTION

3.01 SITE PREPARATION

A. Remove all weeds from areas to be planted. Roughen seed bed to a depth of 2 to 4 inches by scarifying, disking, harrowing, or equivalent methods.

3.02 PLANTING

A. Plant seed using equipment and procedures appropriate for seed type at recommended by the seed supplier.

[END SECTION]

SECTION 03100
CONCRETE FORMWORK

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials for concrete form work, bracing, shoring, and supports and shall design and construct all falsework, all in accordance with the provisions of the General Specifications, the CQA Plan, and the Construction Drawings.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein.

B. Government Standards:

PS 1 Construction and Industrial Plywood

PS 20 American Softwood Lumber Standard

C. Commercial Standards:

ACI 117Standard Tolerances for Concrete Construction and Materials

ACI 347Guide to Formwork for Concrete

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall submit the following.

1. Form ties and all related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

1.04 QUALITY ASSURANCE

A. Tolerances: The variation from established grade or lines shall not exceed 1/4-inch in 10 feet and there shall be no offsets or visible waviness in the finished surface. All other tolerances shall be within the tolerances of ACI 117.

PART 2: PRODUCTS

2.01 GENERAL

A. Except as otherwise expressly accepted by the Engineer, all lumber brought on the job site for use as forms, shoring, or bracing shall be new material. All forms shall be smooth surface forms and shall be of the following materials:

Walls	-	Steel or plywood panel
Columns	-	Steel, plywood or fiber glass
Roof and floor	-	Plywood
All other work	-	Steel panels, plywood or tongue and groove lumber

B. Form materials which may remain or leave residues on or in the concrete shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application or use.

2.02 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of PS 1 for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other approved material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade shown. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

B. Unless otherwise shown, exterior corners in concrete members shall be provided with 3/4-inch chamfers. Re-entrant corners in concrete members shall not have fillets unless otherwise shown.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf (minimum). The minimum design load for combined dead and live loads shall be 100 psf.

2.03 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops. Integral waterstops shall tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be Burke Penta-Tie System by The Burke Company; Richmond Snap-Tys by the Richmond Screw Anchor Company; or equal.

B. Removable taper ties may be used when approved by the Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie. Use Burke Taper-Tie System

by The Burke Company; Taper-Ty by the Richmond Screw Anchor Company; or equal.

PART 3: EXECUTION

3.01 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of all forms, and any forms which are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced at the Contractor's expense. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members as called for on the Drawings, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

3.02 FORM DESIGN

A. All forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the General Specifications, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03300, Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the Engineer.

3.01 CONSTRUCTION

A. Vertical Surfaces: All vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is shown. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties:

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified for "Finish of Concrete Surfaces" in Section 03300 - Cast-in-Place Concrete. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls which are dry on both sides. Exposed faces of walls shall have the outer 2 inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.02 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces

are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.03 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28-day strength specified in Section 03300 - Cast-in-Place Concrete; provided, that no forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the specified 28-day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the Engineer who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7-day minimum, then that time shall be used as the minimum length of time. Forms for all vertical walls of waterholding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for all parts of the work not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347.

3.04 MAINTENANCE OF FORMS

A. Forms shall be maintained at all times in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Forms, when in place, shall conform to the established alignment and grades. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least two weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.05 FALSEWORK

A. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

B. Falsework shall be placed upon a solid footing, safe against undermining, and protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

[END OF SECTION]

SECTION 03200
REINFORCEMENT STEEL

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, fabricate, and place all concrete reinforcement steel, welded wire fabric, couplers, and concrete inserts for use in reinforced concrete and masonry construction and shall perform all appurtenant work, including all the wires, clips, supports, chairs, spacers, and other accessories, all in accordance with the General Specifications, the CQA Plan, and the Construction Drawings.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes: All codes, as referenced herein.

B. Commercial Standards

ACI 315Details and Detailing of Concrete Reinforcement

ACI 318Building Code Requirements for Reinforced Concrete

CRSI MSP-1	Concrete Reinforcing Steel Institute Manual of Standard Practice
WRI	Manual of Standard Practice for Welded Wire Fabric
AWS D1.4	Structural Welding Code - Reinforcing Steel
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 185	Specification for Welded Steel Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 775	Specification for Epoxy-Coated Reinforcing Steel Bars

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish shop bending diagrams, placing lists, and drawings of all reinforcement steel prior to fabrication.

B. Details of the concrete reinforcement steel and concrete inserts shall be submitted by the Contractor at the earliest possible date after receipt by the Contractor of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 and the requirements specified and shown. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the

outside surface. The shop drawings shall include bar placement diagrams which clearly indicate the dimensions of each bar splice.

C. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the Contractor shall submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and shop drawings which show the location of each coupler with details of how they are to be installed in the formwork.

D. If reinforcement steel is spliced by welding at any location, the Contractor shall submit mill test reports which shall contain the information necessary for the determination of the carbon equivalent as specified in AWS D1.4. The Contractor shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

1.4 QUALITY ASSURANCE

A. If requested by the Engineer, the Contractor shall provide samples from each heat of reinforcement steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.

B. If reinforcement steel is spliced by welding at any location, the Contractor shall submit certifications of procedure qualifications for each welding procedure used and certification of welder qualifications, for each welding procedure, and for each welder performing the work. Such qualifications shall be as specified in AWS D1.4.

C. If requested by the Engineer, the Contractor shall provide samples of each type of welded splice used in the work in a quantity and of dimensions adequate for testing. At the discretion of the Engineer, radiographic testing of direct butt welded splices will be performed. The Contractor shall provide assistance necessary to facilitate testing. The Contractor shall repair any weld which fails to meet the requirements of AWS D1.4. The costs of testing will be paid by the Owner; except, the costs of all tests which fail to meet specified requirements shall be paid by the Contractor.

PART 2: PRODUCTS

2.01 MATERIAL REQUIREMENTS

A. Materials specified in this Section which may remain or leave residues on or within the concrete shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application or use.

2.02 REINFORCEMENT STEEL

A. Reinforcement Steel for all cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar reinforcement shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel Reinforcement or as otherwise shown.

2. Welded wire fabric reinforcement shall conform to the requirements of ASTM A 185 and the details shown; provided, that welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches; and provided further, that welded wire fabric with longitudinal wires larger than W4 size shall be furnished in flat sheets only.

3. Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A 82.

B. Accessories

1. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. All bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

2. Concrete blocks (dobies), used to support and position reinforcement steel, shall have the same or higher compressive strength as specified for the concrete in which it is located. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where specified or shown, shall conform to ASTM A 775.

2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where shown and where approved by the Engineer. The couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied. This shall apply to all mechanical splices, including those splices intended for future connections.

C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

D. Couplers shall be Lenton Form Saver as manufactured by Erico Products; Dowel Bar Splicer System as manufactured by Richmond Screw Anchor Company; or equal.

2.04 WELDED SPLICES

A. Welded splices shall be provided where shown and where approved by the Engineer. All welded splices of reinforcement steel shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcement bars which are connected.

B. All materials required to conform the welded splices to the requirements of AWS D1.4 shall be provided.

2.05 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled.

PART 3: EXECUTION

3.01 GENERAL

A. All reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements specified herein.

3.02 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes shown, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings. Stirrups and tie bars shall be bent around a pin having a diameter not less than 1-1/2-inch for No. 3 bars, 2-inch for No. 4 bars, and 2-1/2-inch for No. 5 bars. Bends for other bars shall be made around a pin having a diameter not less than 6 times the bar diameter, except for bars larger than 1 inch, in which case the bends shall be made around a pin of 8 bar diameters. Bars shall be bent cold.

2. The Contractor shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings. Said drawings, diagrams, and lists shall be prepared by the Contractor.

B. Fabricating Tolerances: Bars used for concrete reinforcement shall meet the following requirements for fabricating tolerances:

1. Sheared length: ± 1 inch

2. Depth of truss bars: + 0, - 1/2 inch

3. Stirrups, ties, and spirals: ±1/2 inch

4. All other bends: ±1 inch

3.03 PLACING

A. Reinforcement steel shall be accurately positioned as shown, and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used, in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. All concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the Contractor shall furnish concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies: permitted at all locations except where architectural finish is required.
2. Wire Bar Supports: permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.
3. Plastic Bar Supports: permitted at all locations except on grade.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Bars additional to those shown which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at its own expense.

E. Unless otherwise specified, reinforcement placing tolerances shall be within the limits specified in Section 7.5 of ACI 318 except where in conflict with the requirements of the Building Code.

F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters. Slab bolsters shall be spaced not more than 30 inches on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane shown.

H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

I. Epoxy coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating. Non-abrasive slings made of nylon and similar materials shall be used. Specially coated bar supports shall be used.

All chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

J. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

3.04 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.05 SPLICING

A. General

1. Reinforcement bar splices shall only be used at locations shown. When it is necessary to splice reinforcement at points other than where shown, the character of the splice shall be as acceptable to the Engineer.

2. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise shown shall be in accordance with ACI 318-89, Section 12.15.1 for a Class B splice.

2. Laps of welded wire fabric shall be in accordance with the ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. Bending or Straightening

1. Reinforcement shall not be straightened or rebent in a manner which will injure the material. Bars with kinks or bends not shown shall not be used. All bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field-bent except as shown or specifically permitted by the Engineer.

D. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged .

E. Unless noted otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing shown for the adjacent section.

3.06 CLEANING AND PROTECTION

A. Reinforcement steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

B. The surfaces of all reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary recleaned.

3.07 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 0.25 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless noted otherwise.

3. The hole shall be drilled by methods which do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes to be drilled shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove all dust and loose particles.

6. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that insures that excess material will be expelled from the hole during dowel placement.

7. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.

[END OF SECTION]

SECTION 03290
JOINTS IN CONCRETE

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall construct all joints in concrete at the locations shown on the Construction Drawings. Joints required in concrete structures are of various types and will be permitted only where shown, unless specifically accepted by the Engineer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Federal Specifications:

TT-S-0227E(3) Sealing Compound, elastomeric type, Multi-component for Caulking, Sealing, and Glazing Buildings and Other Structures).

B. U.S. Army Corps of Engineers Specifications:

CRD-C572 PVC Waterstop.

C. Commercial Standards:

ASTM A 775 Specification for Epoxy-Coated Reinforcing Steel Bars

ASTM C 920 Specification for Elastomeric Joint Sealants

ASTM D 412 Test Methods for Rubber Properties in Tension

ASTM D 624 Test Method for Rubber Property -- Tear Resistance

ASTM D 638 Test Method for Tensile Properties of Plastics

ASTM D 746 Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D 747 Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam

ASTM D 1056 Specification for Flexible Cellular Materials -- Sponge or Expanded Rubber

ASTM D 1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 2240 Test Method for Rubber Property -- Durometer Hardness

ASTM D 2241 Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)

1.03 TYPES OF JOINTS

A. **Construction Joints:** When fresh concrete is placed against a hardened concrete surface, the joint between the two pours is called a construction joint. Unless otherwise specified, all joints in water bearing members shall be provided with a waterstop and/or sealant groove of the shape specified and shown. The surface of the first pour may also be required to receive a coating of bond breaker as shown.

B. **Contraction Joints:** Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the first pour, which shall be coated with a bond breaker. The slab reinforcement shall be stopped 4-1/2 inches from the joint; which is provided with a sleeve-type dowel, to allow shrinkage of the concrete of the second pour. Waterstop and/or sealant groove shall also be provided when specified or shown.

C. **Expansion Joints:** To allow the concrete to expand freely, a space is provided between the two pours, the joint shall be formed as shown. This space is obtained by placing a filler joint material against the first pour, which acts as a form for the second pour. Unless otherwise specified, all expansion joints in water bearing members shall be provided with a center-bulb type waterstop as shown.

C. Premolded expansion joint material shall be installed with the edge at the indicated distance below or back from finished concrete surface, and shall have a slightly tapered, dressed, and oiled wood strip secured to or placed at the edge thereof during concrete placement, which shall later be removed to form space for sealing material.

D. The space so formed shall be filled with a joint sealant material as specified in the Paragraph in Part 2 entitled "Joint Sealant." In order to keep the two wall or slab elements in line the joint shall also be provided with a sleeve-type dowel as shown.

E. **Control Joints:** The function of the control joint is to provide a weaker plane in the concrete, where shrinkage cracks will probably occur. A groove, of the shape and dimensions shown, is formed or saw-cut in the concrete. This groove is afterward filled with a joint sealant material as specified in the Paragraph in Part 2 entitled "Joint Sealant."

1.04 CONTRACTOR SUBMITTALS

A. **Waterstops:** Prior to production of the material required under this contract, qualification samples shall be submitted. Such samples shall consist of extruded or molded sections of each size or shape to be used, and shall be accomplished so that the material and workmanship represents in all respects the material to be furnished under this contract. The balance of the material to be used under this contract shall not be produced until after the Engineer has reviewed the qualification samples. Waterstop manufacturer shall certify waterstop material is suitable for chemicals Berog used in containment areas.

B. **Joint Sealant:** Prior to ordering the sealant material, the Contractor shall submit to the Engineer for the Engineer's review, sufficient data to show general compliance with the requirements of the Contract Documents.

C. Certified test reports from the sealant manufacturer on the actual batch of material being supplied indicating compliance with the above requirements shall be furnished the Engineer before the sealant is used on the job.

D. **Shipping Certification:** The Contractor shall provide written certification from the manufacturer as an integral part of the shipping form, to show that all of the material shipped to this project meets or exceeds the physical property requirements of the Contract Documents. Supplier certificates are not acceptable.

E. **Joint Location:** The Contractor shall submit placement shop drawings showing the location and type of all joints for each structure.

1.05 QUALITY ASSURANCE

A. **Waterstop Inspection:** It is required that all waterstop field joints shall be subject to rigid inspection, and no such work shall be scheduled or started without having made prior arrangements with the Engineer to provide for the required inspections. Not less than 24 hours' notice shall be provided to the Engineer for scheduling such inspections.

B. All field joints in waterstops shall be subject to rigid inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which shall pass said inspection, and all faulty material shall be removed from the site and disposed of by the Contractor at its own expense.

C. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. Offsets at joints greater than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.

2. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16-inch or 15 percent of material thickness, at any point, whichever is less.

3. Any combination of offset or exterior crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16-inch or 15 percent of material thickness at any point, whichever is less.

4. Misalignment of joint which result in misalignment of the waterstop in excess of 1/2-inch in 10 feet.

5. Porosity in the welded joint as evidenced by visual inspection.

6. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a pen knife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

D. **Waterstop Samples:** Prior to use of the waterstop material in the field, a sample of a fabricated mitered cross and a tee constructed of each size or shape of material to be used shall be submitted to the Engineer for review. These samples shall be fabricated so that the material and workmanship represent in all respects the fittings to be

furnished under this contract. Field samples of fabricated fittings (crosses, tees, etc.) will be selected at random by the Engineer for testing by a laboratory at the Owner's expense. When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

E. **Construction Joint Sealant:** The Contractor shall prepare adhesion and cohesion test specimens as specified herein, at intervals of 5 working days while sealants are being installed.

F. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

1. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch). Spacing between the blocks shall be 1-inch. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to insure sealant cross-sections of 1/2-inch by 2 inches with a width of 1-inch.

2. Sealant shall be cast and cured according to manufacturer's recommendations except that curing period shall be not less than 24 hours.

3. Following curing period, the gap between blocks shall be widened to 1-1/2-inch. Spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.06 GUARANTEE

A. The Contractor shall provide a 5-year written guarantee of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that it agrees to repair or replace, to the satisfaction of the Owner, at no additional cost to the Owner, any such defective areas which become evident within said 5-year guarantee period.

PART 2: PRODUCTS

2.07 GENERAL

B. All joint materials specified herein shall be classified as acceptable for potable water use, by the Environmental Protection Agency, within 30 days of application.

2.08 PVC WATERSTOPS

A. **General:** Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of these Specifications. No reclaimed or scrap material shall be used. The Contractor shall obtain from the waterstop manufacturer and shall furnish to the Engineer for review, current test reports and a written certification of the manufacturer that the material to be shipped to the job meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572 and those listed herein.

B. **Flatstrip and Center-Bulb Waterstops:** Flatstrip and center-bulb waterstops shall be as detailed and as manufactured by: Kirkhill Rubber Co., Brea, California; Water Seals, Inc., Chicago, Illinois; Progress Unlimited, Inc., New York, New York; Greenstreak Plastic Products Co., St. Louis, Missouri; or equal; provided, that at no place shall the thickness of flat strip waterstops, including the center bulb type, be less than 3/8-inch.

C. **Multi-Rib Waterstops:** Multi-rib waterstops, where required, shall be as detailed and as manufactured by Water Seals, Inc., Chicago, Illinois; Progress Unlimited, Inc., New York, New York; Greenstreak Plastic Products Co., St. Louis, Missouri; or equal. Prefabricated joint fittings shall be used at all intersections of the ribbed-type waterstops.

D. **Other Types of Waterstops:** When other types of waterstops, not listed above are required and shown, they shall be subjected to the same requirements as those listed herein.

E. **Waterstop Testing Requirements:** When tested in accordance with the specified test standards, the waterstop material shall meet or exceed the following requirements:

PHYSICAL PROPERTY SHEET MATERIAL	VALUE	ASTM STD.
Tensile Strength-min (psi)	1750	D 638, Type IV
Ultimate elongation-min (percent)	350	D 638, type IV
Low Temp Brittleness-max (degrees F)	-35	D 746
Stiffness in flexure-min (psi	400	D 747
Accelerated Extraction (CRD-C572)		
Tensile Strength 0min (psi)	1500	D 638, Type IV
Ultimate Elongation-min (percent)	300	D 638, Type IV
Effect of Alkalies (CRD-C572)		
Change in Weight (percent)	+0.25/-0.10	-----
Change in Durometer, Shore A	+5	D 2240
Finish Waterstop		
Tensile Strength-min (psi)	1400	D 638, Type IV
Ultimate Elongation-min (percent)	280	D 638, Type IV

2.09 JOINT SEALANT

A. Joint sealant shall be polyurethane polymer designed for bonding to concrete which is continuously submerged in water. No material will be acceptable which has an unsatisfactory history as to bond or durability when used in the joints of water retaining structures.

B. Joint sealant material shall meet the following requirements (73 degrees F and 50 percent R.H.):

Work Life	45 - 180 minutes
Time to Reach 20 Shore "A" Hardness (at 77 degrees F, 200 gr quantity)	24 hours, maximum
Ultimate Hardness (ASTM D 2240)	20 - 45 Shore "A"

Tensile Strength (ASTM D 412)	175 psi, minimum
Ultimate Elongation (ASTM D 412)	400 percent, minimum
Tear Resistance (Die C ASTM D 624)	75 pounds per inch of thickness, minimum
Color	Light Gray

C. All polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ANSI/ASTM C 920 or Federal Specification TT-S-0227 E(3) for 2-part material, as applicable.
2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C 920 Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.
3. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 35 to 45, shall be used.
4. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the sealant manufacturer.

D. All sealants, wherever shown, or required hereunder shall be PSI-270 as manufactured by Polymeric Systems Inc.; Elastothane 227R as manufactured by Pacific Polymers; Sikaflex 2C, as manufactured by Sika Corporation; or equal.

E. Sealants for non-waterstop joints in concrete shall conform to the requirements of Section [07920], "Sealants and Caulking."

2.10 JOINT MATERIALS

A. **Bearing Pad:** Bearing pad to be neoprene conforming to ASTM D 2000 BC 420, 40 durometer hardness unless otherwise noted.

B. **Neoprene Sponge:** Sponge to be neoprene, closed-cell, expanded, conforming to ASTM D 1056, type 2C3-E1.

C. **Joint Filler:**

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D1056, type 2C5-E1.
2. Joint filler material in other locations shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane

of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise specified herein.

2.11 BACKING ROD

A. Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material used and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.12 BOND BREAKER

A. Bond breaker shall be Super Bond Breaker as manufactured by Burke Company, San Mateo, California; Select Cure CRB as manufactured by Select Products Co., Upland, California; or equal. It shall contain a fugitive dye so that areas of application will be readily distinguishable.

2.13 BENTONITE WATERSTOP

A. Where called for in the Contract Documents, bentonite type waterstop, which shall expand in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast, shall be provided.

B. The bentonite waterstop shall be composed of 75 percent bentonite. The balance of the material shall be butyl rubber-hydrocarbon with less than 1.0 percent volatile matter. The waterstop shall contain no asbestos fibers or asphaltics.

C. The manufacturer's rated application temperature range shall be from 5 to 125 degrees F. The service temperature range shall be from -40 to 212 degrees F.

D. The cross sectional dimensions of the unexpanded waterstop shall be one inch by 3/4-inch.

E. The waterstop shall be provided with an adhesive backing which will provide excellent adhesion to concrete surfaces.

2.14 SLIP DOWELS

A. Slip dowels in joints shall be A36 smooth epoxy-coated bars, conforming to ASTM A 775.

2.15 PVC TUBING

A. PVC tubing in joints shall be Sch. SDR 13.5, conforming to ASTM D 2241.

PART 3: EXECUTION

3.01 GENERAL

A. Waterstops of the type specified herein shall be embedded in the concrete across joints as shown. All waterstops shall be fully continuous for the extent of the joint. Splices necessary to provide such continuity shall be accomplished in conformance to printed instructions of manufacturer of the waterstops. The Contractor shall take suitable precautions and means to support and protect the waterstops during the progress of the work and shall repair or replace at its own expense any waterstops damaged during the progress of the work. All waterstops shall be stored so as to permit free circulation of air around the waterstop material.

B. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure and until the exposed portion of the waterstop is embedded in concrete.

3.02 SPLICES IN WATERSTOPS

A. Splices in waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations. It is essential that:

1. The material not be damaged by heat sealing.

2. The splices have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.

3. The continuity of the waterstop ribs and of its tubular center axis be maintained.

B. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

C. All joints with waterstops involving more than 2 ends to be jointed together, and all joints which involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections shall be prefabricated by the Contractor prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint. Upon being inspected and approved, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.

D. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.03 JOINT CONSTRUCTION

A. **Setting Waterstops:** In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken of the correct positioning of the waterstops during

installation. Adequate provisions must be made to support and anchor the waterstops during the progress of the work and to insure the proper embedment in the concrete. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints. The center axis of the waterstops shall be coincident with the joint openings. Maximum density and imperviousness of the concrete shall be insured by thoroughly working it in the vicinity of all joints.

B. In placing flat-strip waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed. Unless otherwise shown, all waterstops shall be held in place with light wire ties on 12-inch centers which shall be passed through the edge of the waterstop and tied to the curtain of reinforcing steel. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked. In placing concrete around horizontal waterstops, with their flat face in a horizontal plane, concrete shall be worked under the waterstops by hand so as to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material.

D. Waterstop in vertical wall joints shall stop 6 inches from the top of the wall where such waterstop does not connect with any other waterstop and is not to be connected to for a future concrete placement.

E. **Joint Location:** Construction joints, and other types of joints, shall be provided where shown. When not shown, construction joints shall be provided at 25-foot maximum spacing for all concrete construction, unless noted otherwise. Where joints are shown spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing. The location of all joints, of any type, shall be submitted for acceptance by the Engineer.

F. **Joint Preparation:** Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required. Unless otherwise shown, such bonding will be required at all horizontal joints in walls. Surfaces shall be prepared in accordance with the requirements of Section [03300] [03310], "Cast-in-Place Concrete." Except on horizontal wall construction joints, wall to slab joints or where otherwise shown or specified, at all joints where waterstops are required, the joint face of the first pour shall be coated with a bond breaker as specified herein.

G. **Construction Joint Sealant:** Construction joints in water-bearing floor slabs, and elsewhere as shown, shall be provided with tapered grooves which shall be filled with a construction joint sealant. The material used for forming the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant. After removing the forms from the grooves, all laitance and fins shall be removed, and the grooves shall be sand-blasted. The grooves shall be allowed to become thoroughly dry, after which they shall be blown out; immediately thereafter, they shall be primed, bond breaker tape placed in the bottom of the groove, and filled with the construction joint sealant. The primer used shall be supplied by the same manufacturer supplying the sealant. No sealant will be permitted to be used without a primer. Care shall be used to completely fill the sealant grooves. Areas designated to receive a sealant fillet shall be thoroughly cleaned, as outlined for the tapered grooves, prior to application of the sealant.

H. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant. All sealant shall achieve final cure at least 7 days before the structure is filled with water.

I. All sealant shall be installed by a competent waterproofing specialty contractor who has a successful record of performance in similar installations. Before work is commenced, the crew shall be instructed as to the proper method of application by a representative of the sealant manufacturer.

J. Thorough, uniform mixing of 2-part, catalyst-cured materials is essential; special care shall be taken to properly mix the sealer before its application. Before any sealer is placed, the Contractor shall arrange to have the crew doing the work carefully instructed as to the proper method of mixing and application by a representative of the sealant manufacturer.

K. Any joint sealant which, after the manufacturer's recommended curing time for the job conditions of the work hereunder, fails to fully and properly cure shall be completely removed; the groove shall be thoroughly sandblasted to remove all traces of the uncured or partially cured sealant and primer, and shall be re-sealed with the specified joint sealant. All costs of such removal, joint treatment, re-sealing, and appurtenant work shall be at the expense of the Contractor.

L. **Bentonite Waterstop:**

1. Where a bentonite waterstop is called for, it shall be installed with the manufacturer's instructions and recommendations; except, as modified herein.

2. When requested by the Engineer, the manufacturer shall provide technical assistance in the field.

3. Bentonite waterstop shall only be used where complete confinement by concrete is provided. Bentonite waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of any intersecting joint.

4. The bentonite waterstop shall be located as near as possible to the center of the joint and it shall be continuous around the entire joint. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

5. Where the thickness of the concrete member to be placed on the bentonite waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete. The groove shall be at least 3/4 inch deep and 1-1/4 inches wide. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2.5 inches.

6. Where a bentonite waterstop is used in combination with PVC waterstop, the bentonite waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be placed in contact with the PVC waterstop.

7. The bentonite waterstop shall not be placed when the temperature of the waterstop material is below 40 degrees F. The waterstop material may be warmed so that it shall remain above 40 degrees F during placement; however, means used to warm the material shall in no way harm the material or its properties. The waterstop shall not be installed where the air temperature falls outside the manufacturer's recommended range.

8. The concrete surface under the bentonite waterstop shall be smooth and uniform. The concrete shall be ground smooth if needed. Alternately, the bentonite waterstop shall be bonded to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

9. The bentonite waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing. This shall be in addition to the adhesive backing provided with the waterstop.

[END OF SECTION]

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials for concrete in accordance with the provisions of this Section and shall form, mix, place, cure, repair, finish, and do all other work as required to produce finished concrete, in accordance with the requirements of the General Specifications, the CQA Plan, and the Construction Drawings.

B. The following types of concrete are covered in this Section:

1. Structural Concrete: Concrete to be used in all cases except where indicated otherwise.

2. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, pavements, fence and guard post embedment, underground duct bank encasement and all other concrete appurtenant to electrical facilities unless otherwise indicated.

3. Lean Concrete: Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles that are detailed on the Drawings as unreinforced. Lean concrete shall be used as protective cover for dowels intended for future connection.

C. The term "hydraulic structure" used in these specifications means environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, or other fluids.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Federal Specifications:**

UU-B-790A (1) (2)	Building Paper, Vegetable Fiber (Kraft, water-proofed, Water Repellent and Fire Resistant)

B. **Commercial Standards:**

ACI 117	Standard Tolerances for Concrete Construction and Materials
ACI 214	Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	Structural Concrete for Buildings
ACI 306.1	Cold Weather Concreting

ACI 309	Consolidation of Concrete
ACI 315	Details and Detailing of Concrete Reinforcement
ACI 318	Building Code Requirements for Reinforced Concrete
ASTM C 31	Practices for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Ready-Mixed Concrete
ASTM C 136	Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	Portland Cement
ASTM C 156	Test Methods for Water Retention by Concrete Curing Materials
ASTM C 157	Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
ASTM C 192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 260	Air-Entraining Admixtures for Concrete
ASTM C 309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	Chemical Admixtures for Concrete
ASTM C 1077	Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction & Criteria for Laboratory Evaluation
ASTM D 175	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate

ASTM E 119	Method for Fire Tests of Building Construction and Materials

1.03 CONTRACTOR SUBMITTALS

A. **Mix Designs:** Prior to beginning work and within 14 days of the notice to proceed, the Contractor shall submit to the Engineer, for review, preliminary concrete mix designs which shall show the proportions and gradations of all materials proposed for each class and type of concrete specified herein. The mix designs shall be checked by an independent testing laboratory acceptable to the Engineer. All costs related to such checking shall be borne by the Contractor. Since laboratory trial batches require 35 calendar days to complete, the Contractor may consider testing more than one mix design for each class of concrete.

B. **Delivery Tickets:** Where ready-mix concrete is used, the Contractor shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, and the amounts of water in the aggregate added at the batching plant, and the amount allowed to be added at the site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the site, when unloading began, and when unloading was finished.

C. Furnish the following submittals in accordance with ACI 301:

1. Mill tests for cement.
2. Admixture certification. Chloride ion content must be included.
3. Aggregate gradation and certification.
4. Materials and methods for curing.

1.04 CONCRETE CONFERENCE

A. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes and to determine the procedures for producing proper concrete construction shall be held no later than 14 days after the notice to proceed.

B. All parties involved in the concrete work shall attend the conference, including the following at a minimum:

Contractor's representative
Testing laboratory representative
Concrete subcontractor
Reinforcing steel subcontractor and detailer
Concrete supplier
Admixture manufacturer's representative

C. The conference shall be held at a mutually agreed upon time and place. The Engineer shall be notified no less than 5 days prior to the date of the conference.

1.05 QUALITY ASSURANCE

A. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated herein. Test for determining slump will be in accordance with the requirements of ASTM C 143.

2. The cost of all laboratory tests on cement, aggregates, and concrete, will be borne by the Owner. However, the Contractor shall pay the cost of any additional tests and investigation on work performed which does not meet the specifications. The laboratory will meet or exceed the requirements of ASTM C 1077.

3. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall assist the Engineer in obtaining samples, and disposal and cleanup of excess material.

B. Field Compression Tests:

1. Compression test specimens will be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these specifications. Each set of test specimens will be a minimum of 5 cylinders.

2. Compression test specimens for concrete shall be made in accordance with section 9.2 of ASTM C 31. Specimens shall be 6-inch diameter by 12-inch high cylinders.

3. Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at 7 days and 2 at 28 days. The remaining cylinders will be held to verify test results, if needed.

C. Evaluation and Acceptance of Concrete:

1. Evaluation and acceptance of the compressive strength of concrete will be according to the requirements of ACI 318, Chapter 5 "Concrete Quality," and as indicated herein.

2. A statistical analysis of compression test results will be performed according to the requirements of ACI 214. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for all subsequent batches of the type of concrete affected.

4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard of deviation.

5. All concrete which fails to meet the ACI requirements and these specifications, is subject to removal and replacement at no additional cost to the Owner.

D. **Shrinkage Tests:**

1. Drying shrinkage tests shall be performed for the trial batch indicated in the Paragraph in Part 2 entitled "Trial Batch and Laboratory Tests," the first placement of each class of concrete, and during construction to insure continued compliance with these Specifications.

2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10 inches; fabricated, cured, dried, and measured in accordance with ASTM C 157 modified as follows: specimens shall be removed from molds at an age of 23 plus or minus 1 hours after trial batching, shall be placed immediately in water at 70 degrees F plus or minus 3 degrees F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 degrees F plus or minus 3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F plus or minus 3 degrees F and 50 percent plus or minus 4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.

3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as indicated in Part 2 below.

E. **Construction Tolerances:** The Contractor shall set and maintain concrete forms and perform finishing operations to ensure that the completed work is within tolerances. Surface defects and irregularities are defined as finishes and are to be

2.07 IMPACT ANCHOR

A. Impact anchors shall be an expansion type anchor in which a nail type pin is driven to produce the expansive force. It shall have a zinc sleeve with a mushroom style head and stainless steel nail pin. Anchors shall be Metal Hit Anchors, manufactured by Hilti, Inc., Rawl Zamac Nailin, manufactured by the Rawlplug Company; or equal.

PART 3: EXECUTION

3.01 FABRICATION AND INSTALLATION REQUIREMENTS

A. **Fabrication and Erection:** Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. **Power-Driven Pins:** Power-driven pins shall be installed by a craftsman who is certified by the manufacturer as being qualified to install the manufacturer's pins. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration. Driven pins shall conform to the following requirements where "D" = Pin's shank diameter:

Material Penetrated by Pin	Material's Minimum thickness	Pin's Shank Penetration in Supporting Material	Minimum Space from Pin's CL to Edge of Penetrated Material	Minimum Pin Spacing
Concrete	16D	6D minimum	14D	20D
Steel	¼-inch	steel thickness	4D	7D

3.02 WELDING

A. **Method:** All welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards governing same.

B. **Quality:** In assembly and during welding, the component parts shall be adequately clamped, supported and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as indicated by the AWS Code. Upon completion of welding, all weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. All sharp corners of material which is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings. Where tolerances are not stated in the specifications, permissible deviations will be in accordance with ACI 117.

1. The following construction tolerances apply to finished walls and slab unless otherwise indicated:

Item	*Tolerance*
Variation of the constructed linear outline from the established position in plan.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation from the level or from the grades shown.	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation from the plumb	In 10 feet: 1/4-inch; In 20 feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch
Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch

F. Floor Slab Hardener

1. Job Mockup: In a location designated by the Engineer, the Contractor shall place a 100 square foot floor mockup using the materials and procedures proposed for the work. Materials and procedures may be revised as necessary to obtain an acceptable surface, but the same materials and procedures shall be used in the work.

2. Field Service: The Contractor shall obtain onsite proper usage advice from the surface hardener manufacturer while the job mockup is being placed and during initial placement of the work. Notify the surface hardener manufacturer at least 3 days prior to initial use of the product.

3. Installer Qualifications: Installer shall have a minimum of 3 years experience and shall be specialized in application of dry shake surface hardeners.

PART 2: PRODUCTS

2.01 CONCRETE MATERIALS

A. **General:**

1. All materials shall be classified as acceptable for potable water use by the Environmental Protection Agency within 30 days of application.

2. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Cement reclaimed from cleaning bags or leaking containers shall not be used. All cement shall be used in the sequence of receipt of shipments.

B. All materials shall comply with the requirements of Sections 201, 203, and 204 of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of Section 205 of ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand portland cement conforming to ASTM C 150 for Type II or Type V, including Table 2 optional requirements. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the work, and prior to its use, the brand shall be acceptable to the Engineer. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the Engineer, if requested, regarding compliance with these Specifications.

2. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

3. Aggregates shall be obtained from pits acceptable to the Engineer, shall be non-reactive, and shall conform to ASTM C 33. Maximum size of coarse aggregate shall be as indicated herein. Lightweight sand for fine aggregate will not be permitted.

a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall be prepared and handled in two or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the two size groups shall be combined. See the Paragraph in Part 2 entitled "Trial Batch and Laboratory Tests" for the use of the size groups.

b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that are hard and durable. When tested in accordance with ASTM D 2419, the sand equivalency shall not be less than 75 percent for an average of three samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33. The fineness modulus of sand used shall not be over 3.00.

c. Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce a concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

e. When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f. When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions, or 10.5 percent after 100 revolutions.

g. When tested in accordance with ASTM C 33, the loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using sodium sulfate.

4. Ready-mix concrete shall conform to the requirements of ASTM C 94.

5. Admixtures: All admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the Contractor shall discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

a. Air-entraining agent meeting the requirements of ASTM C 260 shall be used. Sufficient air-entraining agent shall be used to provide a total air content of 3 to 5 percent. The Owner reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement. Air entraining agent shall be Micro-Air by Master Builders; Daravair by W.R. Grace; Sika AEA-15 by Sika Corporation; or equal.

b. Set controlling and water reducing admixtures: Admixtures may be added at the Contractor's option, subject to the Engineer's approval, to control the set, effect water reduction, and increase workability. The addition of an admixture shall be at the Contractor's expense. Concrete containing an admixture shall be first placed at a location determined by the Engineer. Admixtures shall conform to the requirements of ASTM C 494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

(1) Concrete shall not contain more than one water reducing admixture.

(2) Set controlling admixture may be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently greater than 80 degrees F, a set retarding admixture such as Plastocrete by Sika Corporation; Pozzolith 300R by Master Builders; Daratard by W.R. Grace; or equal shall be used. Where the air temperature at the time of placement is expected to be consistently less than 40 degrees F, a non-corrosive set accelerating admixture such as Plastocrete 161FL by Sika Corporation; Pozzutec 20 by Master Builders; Daraset by W.R. Grace; or equal shall be used.

(3) Normal range water reducer shall conform to ASTM C 494, Type A. WRDA 79 by W.R. Grace; Pozzolith 322-N by Master Builders; Plastocrete 161 by Sika Corporation; or equal. The quantity of admixture used and the method of mixing shall be in accordance with the Manufacturer's instructions and recommendations.

(4) High range water reducer shall conform to ASTM C 494, Type F or G. Daracem 100 or WDRA 19 by W.R. Grace; Sikament FF or Sikament 86 by Sika Corporation; Rheobuild 1000 or Rheobuild 716 by Master Builders; or equal. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating water cement ratio.

(5) If the high range water reducer is added to the concrete at the job site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3 inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the job site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the job site system.

(6) Concrete shall be mixed at mixing speed for a minimum of 30 mixer revolutions after the addition of the high range water reducer.

(7) **Flyash:** Flyash shall not be used.

2.02 CURING MATERIALS

A. Materials for curing concrete as indicated herein shall conform to the following requirements and ASTM C 309:

1. All curing compounds shall be white pigmented and resin based. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be Kurez by Euclid Chemical Company; MB-429 as manufactured by Master Builders; L&M Cure R; or equal. Water based resin curing compounds shall be used only where local air quality regulations prohibit the use of a solvent based compound. Water based curing compounds shall be Aqua-Cure by Euclid Chemical Company; Masterkure-W by Master Builders; L&M Cure R-2; or equal.

2. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 grams per square centimeter of surface.

3. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a nominal thickness of 2 mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A (1) (2). The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

4. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mil thick, white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with the requirements of ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

5. Curing mats for use in Curing Method 6 as indicated below, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

6. Evaporation retardant shall be a material such as Confilm as manufactured by Master Builders; Eucobar as manufactured by Euclid Chemical Company; E-CON as manufactured by L & M Construction Chemicals, Inc. or equal.

2.03 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. Preformed joint filler shall be a non-extruding, resilient, bituminous type conforming to the requirements of ASTM D 1751.

2. Elastomeric joint sealer shall conform to the requirements of Section 07920 - Sealants and Caulking.

3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and

that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth below, if testing is required by the Engineer.

2.04 MISCELLANEOUS MATERIALS

A. Dampproofing agent shall be an asphalt emulsion, such as Hydrocide 600 by Sonneborn; Damp-proofing Asphalt Coating by Euclid Chemical Company; Sealmastic by W. R. Meadows Inc., or equal.

B. Bonding agents shall be epoxy adhesives conforming to the following:

1. For bonding freshly-mixed, plastic concrete to hardened concrete, Sikadur 32 Hi-Mod Epoxy Adhesive, as manufactured by Sika Corporation; Concresive Liquid (LPL), as manufactured by Master Builders; BurkEpoxy MV as manufactured by The Burke Company; or equal.

2. For bonding hardened concrete or masonry to steel, Sikadur 31 Hi-Mod Gel as manufactured by Sika Corporation; BurkEpoxy NS as manufactured by The Burke Company; Concresive Paste (LPL) as manufactured by Master Builders; or equal.

C. Chemical protection agent shall be a coal tar epoxy, coal CAT 97-640/641 , as manufactured by Pittsburgh Paints. Coal tar shall be used a shown on the construction Drawings. Material shall be applied as directed by the manufacturer specification.

2.05 CONCRETE DESIGN REQUIREMENTS

A. **General:** Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. The exact proportions in which these materials are to be used for different parts of the work will be determined during the trial batch. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. All changes shall be subject to review by the Engineer.

B. **Fine Aggregate Composition:** In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight, shall be as indicated in the following table.

FINE AGGREGATE	
Fineness Modulus	**Maximum Percent**
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.0	44

For other concrete, the maximum percentage of fine aggregate of total aggregate, by weight, shall not exceed 50.

C. **Water-Cement Ratio and Compressive Strength:** Concrete shall have the following minimum properties:

TYPE OF WORK	MIN 28-DAY COMPR. STRENGTH (PSI)	MAX SIZE AGGREGATE (IN)	MINIMUM CEMENT PER CU YD (LBS)	MAX W/C RATIO (BY WEIGHT)
Structural Concrete:				
Roof, floor slabs, columns, walls and all other concrete items not specified elsewhere.	4,000	1	564	0.45
12-inch and thicker walls, slabs on grade and footings. (optional)	4,000	1-1/2	564	0.45
Pea Gravel Mix. Thin sections and areas with congested reinforcing, at the Contractor's option and with the written approval of the Engineer for the specific location. Maximum fine aggregate 50% by weight of aggregate.	4,000	3/8	752	0.40
Sitework concrete	3,000	1	470	0.50
Lean concrete	2,000	1	376	0.60
NOTE: The Contractor is cautioned that the limiting parameters above are not a mix design. Additional cement or water reducing agent may be required to achieve workability required by the Contractor's construction methods and aggregates. The Contractor is responsible for providing concrete with the required workability.				

D. **Adjustments to Mix Design:** The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the Contractor shall be entitled to no additional compensation because of such changes.

2.06 CONSISTENCY

A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete which can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work *Slump (in)*

All concrete, unless indicated otherwise	3 inches plus or minus 1 inch
With high range water reducer added	7 inches plus or minus 2 inches
Pea gravel mix	7 inches plus or minus 2 inches
Ductbanks	5 inches plus or minus 1 inch

2.07 TRIAL BATCH AND LABORATORY TESTS

B. Before placing any concrete, a testing laboratory selected by the Engineer shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the Contractor. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the Contractor. All concrete shall conform to the requirements of this Section, whether the aggregate proportions are from the Contractor's preliminary mix design, or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch.

C. The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured and tested in accordance with ASTM C 192 and ASTM C 39. Three compression test cylinders will be tested at 7 days and 3 at 28 days. The average compressive strength for the 3 cylinders tested at 28 days for any given trial batch shall not be less than 125 percent of the specified compressive strength.

D. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136. Values shall be given for percent passing each sieve.

2.08 SHRINKAGE LIMITATION

A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036 percent or 0.042 percent, respectively. The Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.

B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the Contractor shall take any or all of the following actions at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source or aggregates, cement and/or admixtures; reducing water content; washing

of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage.

2.09 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the Contractor and acceptable to the Engineer.

B. Weighing tolerances:

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

2.10 MEASUREMENT OF WATER

E. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the Engineer and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any specified amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.

2.11 READY-MIXED CONCRETE

F. At the Contractor's option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, and placing as indicated herein and is in accordance with ASTM C 94, including the following supplementary requirements.

G. Ready-mixed concrete shall be delivered to the site of the work, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever is first.

H. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resetable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

I. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolution of mixing.

J. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the required slump is 3 inches or less, or if they differ by more than 2 inches when the required slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

K. Each batch of ready-mixed concrete delivered at the job site shall be accompanied by a delivery ticket furnished to the Engineer in accordance with the Paragraph in Part 1 entitled "Delivery Tickets."

L. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

2.11 FLOOR HARDENER (SURFACE APPLIED)

A. Surface hardener shall be a light reflective non-oxidizing metallic aggregate dry shake material that is premeasured, premixed, and packaged at the factory. Surface hardener shall be applied at the rate of 1.8 to 2.5 lbs/ft^2.

B. Curing compound shall meet the moisture retention requirements of ASTM C 309 and the manufacturer recommendations.

C. Monomolecular film shall maintain concrete moisture during the early placement stages of plastic concrete as recommended by the manufacturer.

D. Manufacturer: Floor hardener shall be "Lumiplate" by Master Builders, or equal.

PART 3: EXECUTION

3.01 PROPORTIONING AND MIXING

A. **Proportioning:** Proportioning of the mix shall conform to the requirements of Chapter 3 "Proportioning" of ACI 301.

B. **Mixing:** Mixing shall conform to the requirements of Chapter 7 of said ACI 301 Specifications.

C. **Slump:** Slumps shall be as indicated herein.

D. **Retempering:** Retempering of concrete or mortar which has partially hardened shall not be permitted.

3.02 PREPARATION OF SURFACES FOR CONCRETING

A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. **Joints in Concrete:** Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the Engineer, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of all laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. All pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. After the surfaces have been prepared, all approximately horizontal construction joints shall be covered with a 6-inch lift of a pea gravel mix. The mix shall be placed and spread uniformly. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

D. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent work; provided that construction joints shall be made only where acceptable to the ENGINEER.

E. **Embedded Items:** No concrete shall be placed until all formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the Engineer at least 4 hours before placement of concrete. All surfaces of forms and embedded items that have become encrusted with dried grout from previous work shall be cleaned before the surrounding or adjacent concrete is placed.

F. All inserts or other embedded items shall conform to the requirements herein.

G. All reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated on the Drawings or shown by shop drawings and shall be acceptable to the Engineer before any concrete is placed. Accuracy of placement is the responsibility of the Contractor.

H. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (any concrete which is greater than 60 days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydro-blasting or sandblasting (exposing aggregate). The joint surface shall be coated with an epoxy bonding agent unless indicated otherwise by the Engineer.

I. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be

deposited underwater nor shall the Contractor allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to the review of the Engineer.

J. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

K. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided during the placing of concrete.

L. Anchor bolts shall be accurately set and shall be maintained in position by templates while being embedded in concrete.

M. **Cleaning:** The surfaces of all metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.03 HANDLING, TRANSPORTING, AND PLACING

A. **General:** Placing of concrete shall conform to the applicable requirements of Chapter 8 of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. **Non-Conforming Work or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the work. Concrete which is not placed in accordance with these Specifications, or which is of inferior quality, shall be removed and replaced by the Contractor at no additional cost to the Owner.

C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the Engineer. The Contractor shall notify the Engineer in writing at least 24 hours in advance of placement of any concrete.

D. **Placement in Wall and Column Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4 feet in walls and 8 feet in columns below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6 feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2 feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5 feet of vertical rise per

hour. Sufficient illumination shall be provided in the interior of all forms so that the concrete at the places of deposit is visible from the deck or runway.

E. **Casting New Concrete Against Old:** Epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations. This provision shall not apply to joints where waterstop is provided. See Section 03290 - Joints in Concrete.

F. **Conveyor Belts and Chutes:** All ends of chutes, hopper gates, and all other points of concrete discharge throughout the Contractor's conveying, hoisting, and placing system shall be designed and arranged so that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the Engineer. Chutes longer than 50 feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. All conveyor belts and chutes shall be covered.

G. **Placement in Slabs:** Concrete placed in sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement. As the work progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 55 degrees F for sections less than 12 inches thick nor less than 50 degrees for all other sections. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the minimum temperature. When the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the Contractor shall employ effective means, such as precooling of aggregates and mixing water using ice or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.

I. **Cold Weather Placement:**

1. Placement of concrete shall conform to ACI 306.1 - Cold Weather Concreting, and the following.

2. Remove all snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches. All reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

3. Maintain the concrete temperature above 50 degrees F for at least 3 days after placement.

3.04 PUMPING OF CONCRETE

A. **General:** If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. **Pumping Equipment:** The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.

C. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R.

D. Pumping equipment and hose conduits that are not functioning properly shall be replaced.

E. Aluminum conduits for conveying the concrete shall not be permitted.

F. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

3.05 ORDER OF PLACING CONCRETE

A. The order of placing concrete in all parts of the work shall be acceptable to the Engineer. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 days for hydraulic structures and 2 days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 days for hydraulic structures and 4 days for all other structures.

B. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and all laitance shall be removed.

3.06 TAMPING AND VIBRATING

C. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be Group 3 per ACI 309, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the Engineer.

D. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that all air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that all air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.

E. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.07 FINISHING CONCRETE SURFACES

F. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions shown are defined as tolerances and are indicated in Part 1, above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

NTS: Acceptable surface finish of basin walls is difficult to define and can vary radically from Owner to Owner. If possible, discuss the issue with the Owner to define the finish they wish to buy. It is better to get the desired finish as part of the original bid than as a change order.

G. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as indicated.

NTS: Chose one of the following:

[1. Surface holes larger than [1/2]-inch in diameter or deeper than [1/4]-inch are defined as surface defects in basins and exposed walls.]

[2. The Owner has identified an acceptable wall finish on an identified panel at an existing structure to be used as a comparative sample for formed finish without architectural treatment. This panel is located [ ]. At walls which are exposed to view or in contact with water, surface roughness or surface holes (considering both size and number per unit surface area as separate criteria) greater than the identified panel shall be considered to have surface defects and shall be repaired to match or exceed the sample finish.]

[3. Basins and exposed walls shall be given a smooth finish as indicated below.]

[4. Basins and exposed walls shall be given two coats of cement based paint as indicated.]

H. **Unformed Surfaces:** After proper and adequate vibration and tamping, all unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each work operation as necessary to prevent drying shrinkage cracks. The classes of finish specified for unformed concrete surfaces are designated and defined as follows:

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.

2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the Engineer.

3. Finish U3 - After the finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of all irregularities.

4. Finish U4 - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light hairbroom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.

I. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE

Area	Finish
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Water bearing slabs with slopes 10 percent and less	U3
Water bearing slabs with slopes greater than 10 percent	U4
Slabs not water bearing	U4

Slabs to be covered with built-up roofing	U2
Interior slabs and floors to receive architectural finish	U3
Top surface of walls	U3

J. Floor Hardener (Surface Applied)

1. The following additional requirements apply to the substrate concrete in areas indicated to be under floor hardener:

   a. Slump shall be no greater than 4 inches when peak ambient temperatures are expected to exceed 65 degrees F and no greater than 3 inches when temperatures will not exceed 65 degrees F.

   b. Air content shall not exceed 3 percent.

   c. No calcium chloride or set accelerating admixture containing calcium chloride shall be used.

   d. Do not use admixtures that increase bleeding.

   e. Do not use fly ash.

2. The Contractor shall finish areas indicated to receive hardener in conformance with the manufacturer's recommendations and the following. After leveling the concrete surface and as soon as the concrete will support an operator and machine without disturbing the level or working up excessive fines, the Contractor shall float the surface of the slab with a mechanical float fitted with detachable float shoes. Then apply 1/2 to 2/3 of the total amount of dry shake surface hardener uniformly to the surface. A mechanical spreader is recommended. Float the surface once the shake has absorbed sufficient moisture, as indicated by darkening of the shake. Immediately apply the remainder of the shake and allow it to absorb moisture. Do not apply shake when bleed water is present.

3. Perform a third floating if time and setting characteristics of the concrete will allow, but do not add water to the surface.

4. As the surface stiffens further and loses sheen, trowel with blades set relatively flat, using hand or mechanical methods. Remove all marks and pinholes in a final raised trowel operation.

5. Cure the finished surface using the fill-forming curing compound recommended by the manufacturer at a coverage rate which will provide moisture retention in excess of the requirements of ASTM C 309. Maintain ambient temperatures above 50 degrees F during the curing period.

6. Keep floors covered and prohibit traffic and loads for 10 days minimum after completion.

3.08 ARCHITECTURAL FINISH

K. **General:** Architectural finishes shall be provided only where specifically indicated on the Drawings. In all other locations, the paragraph entitled Finishing Concrete Surfaces, shall apply.

7. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and all form-tie holes filled as indicated herein.

8. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 days.

9. All architecturally treated concrete surfaces shall conform to the accepted sample in texture, color, and quality. It shall be the Contractor's responsibility to maintain and protect the concrete finish.

L. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush. The grout shall be made by mixing one part portland cement and one part of fine sand that will pass a No. 16 sieve with sufficient water to give it the consistency of thick paint. The cement used in said grout shall be 1/2 gray and 1/2 white portland cement, or other proportion as determined by the Engineer. White portland cement shall be Atlas white, or equal. Calcium chloride at 5 percent by volume of the cement shall be used in the brush coat. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling all small air holes. After all the surface grout had been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely all surface grout so that there is no visible paint-like film of grout on the concrete. The entire cleaning operation for any area shall be completed the day it is started, and no grout shall be left on the surface overnight.

2. Cleaning operations for any given day shall be terminated at panel joints. It is required that the various operations be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.

3. In the event that improper manipulation results in an inferior finish, the Contractor shall rub such inferior areas with carborundum bricks.

4. Before beginning any of the final treatment on exposed surfaces, the Contractor shall treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the Engineer and shall preserve said trial area undisturbed until the completion of the job.

M. Sandblasted Concrete Finish.

1. Sandblasting shall be done in a safe manner acceptable to local authorities and per OSHA requirements. The sandblasting shall be a light sandblast to remove laitance and to produce a uniform fine aggregate surface texture with

approximately 1/32- to 1/16-inch of surface sandblasted off. Corners, patches, form panel joints, and soft spots shall be sandblasted with care.

2. A 3-sq ft sample panel of the sandblasted finish shall be provided by the Contractor for acceptance by the Engineer prior to starting the sandblasting work. The sample panel shall include a corner, plugs, and joints and shall be marked after approval. All other sandblasting shall be equal in finish to the sample panel.

3. Protection against sandblasting shall be provided on all adjacent surfaces and materials not requiring sandblasting. After sandblasting, the concrete surfaces shall be washed with clean water and excess sand removed.

3.09 CURING AND DAMPPROOFING

A. **General:** All concrete shall be cured for not less than 7 days after placing, in accordance with the methods indicated below for the different parts of the work.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall sections with forms removed	6
Construction joints between footings and walls, and between floor slab and columns	2
Encasement concrete and thrust blocks	3
All concrete surfaces not specifically indicated in this Paragraph	4
Floor slabs on grade in hydraulic structures	5
Slabs not on grade	6

B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 days of placing the concrete, curing shall be continued in accordance with Method 6 below.

C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 days after placement of concrete.

E. **Method 4:** The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film which will seal thoroughly.

2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7-day curing period. If the seal is damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2-hour period; provided, however, that any such repairs which cannot be made within the said 2-hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

5. At all locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

6. Prior to final acceptance of the work, all visible traces of curing compound shall be removed from all surfaces in such a manner that does not damage the surface finish.

F. **Method 5:**

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches and fastened together with a waterproof cement to form a continuous watertight joint.

2. The curing blankets shall be left in place during the 7-day curing period and shall not be removed until after concrete for adjacent work has been placed.

If the curing blankets become torn or otherwise ineffective, the Contractor shall replace damaged sections. During the first 3 days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The Contractor shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces at all times.

G. **Method 6:** This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 consecutive days beginning immediately after the concrete has reached final set or forms have been removed.

2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent being dislodged by wind or any other causes. All edges shall be continuously held in place.

4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4 above.

6. The Contractor shall dispose of excess water from the curing operation to avoid damage to the work.

H. **Dampproofing**

1. The exterior surface of all buried roof slabs shall be dampproofed as follows.

2. Immediately after completion of curing the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to 1/2 strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as indicated above.

3. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may

be used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the Contractor shall apply additional whitewash.

3.10 PROTECTION

A. The Contractor shall protect all concrete against injury until final acceptance.

B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The Contractor shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.11 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 3 days immediately following the 72 hours of protection at 50 degrees F.

C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive days, the specified 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.12 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, all exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing

extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. All repairs and replacements herein required shall be promptly executed at no increased cost to the Owner.

B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of all laitance or soft material, plus not less than 1/32-inch depth of the surface film from all hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair proposed shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. Holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. All repairs shall be built up and shaped in such a manner that the completed work will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

E. Prior to filling any structure with water, all cracks that may have developed shall be "vee'd" as indicated and filled with sealant conforming to the requirements of Section 03290 - Joints in Concrete. This repair method shall be done on the water bearing face of members. Prior to backfilling, faces of members in contact with fill which are not covered with a waterproofing membrane shall also have cracks repaired as indicated herein.

3.13 PATCHING HOLES IN CONCRETE

A. **Patching Small Holes:**

4. Holes which are less than 12 inches in the least dimension and extend completely through concrete members shall be filled.

5. Small holes in members which are water-bearing or in contact with soil or other fill material shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2 inches from the finished surface. The remaining 2 inches shall then be patched according to the Paragraph entitled "Treatment of Surface Defects."

6. Small holes through all other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

B. **Patching Large Holes:**

1. Holes which are larger than 12 inches in the least dimension shall have a keyway chipped into the edge of the opening all around, unless a formed keyway exists. The holes shall then be filled with concrete as indicated herein.

2. Holes which are larger than 24 inches in the least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless indicated otherwise.

3. Large holes in members which are water bearing or in contact with soil or other fill shall have a bentonite type waterstop material placed around the perimeter of the hole in accordance with Section 03290 - Joints in Concrete, unless there is an existing waterstop in place.

3.14 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the General Specifications, the CQA Plan, and the Construction Drawings, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

[END OF SECTION]

SECTION 03410
STRUCTURAL PRECAST CONCRETE

PART 1: GENERAL

1.01 SUMMARY

A. Description of Work

1. This section applies to construction of the vertical riser foundation for the landfill as shown on the Drawings.

2. This section applies to precast catch basins and similar items used for surface water drainage.

B. Related Sections

1. 03100 - Concrete Form Work

2. 02718 - Polyethylene Pipe

3. 15600 - Carbon Steel Pipe

4. 15700 - Stainless Steel Pipe

1.02 REFERENCES

A. American Concrete Institute (ACI) most current version:

1. ACI 318 - Building Code Requirements for Reinforced Concrete.

B. American Society for Testing and Materials (ASTM) most current version:

1. ASTM 184 - Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.

2. ASTM A307 - Specification for Carbon Steel Externally Threaded Standard Fasteners.

3. ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

4. ASTM A775 - Specification for Epoxy-Coated Reinforcing Steel Bars.

5. ASTM C31 - Making and Curing Concrete Test Specimens in the Field.

6. ASTM C33 - Specification for Concrete Aggregates.

7. ASTM C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.

8. ASTM C150 - Specification for Portland Cement.

9. ASTM C171 - Specification for Sheet Materials for Curing Concrete.

10. ASTM C185 - Test Method for Air Content of Hydraulic Cement Mortar.

11. ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.

12. ASTM C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

13. ASTM C330 - Specification for Lightweight Aggregates for Structural Concrete.

14. ASTM C494 - Specification for Chemical Admixtures for Concrete.

C. Prestressed Concrete Institute (PCI) most current version:

1. PCI MNL-116 - Manual for Quality Control for Plants and Productions of Precast Prestressed Concrete Products.

1.03 SUBMITTALS

A. Shop Drawings and Product Data

1. Content:

a. Dimensions.

b. Details of inserts, anchors, connections, accessories, formed openings, scheduled field cut openings, anchor bolt layout plan, and fabrication detail.

c. Lifting positions or devices.

d. Reinforcement.

2. Manufacturer's instructions for handling, transporting, and erecting.

B. Certificates

1. Manufacturer's certificates that material and/or procedures are in compliance with specifications.

2. When requested by OWNER, evidence of certification and/or experience qualifications.

C. Test Reports: Reports of tests on concrete.

1.04 QUALITY ASSURANCE

A. Testing

1. Conduct testing in accordance with PCI (Prestressed Concrete Institute) MNL-116.

2. CQA ENGINEER to verify testing.

B. Source Quality Control: In general compliance with applicable provisions of PCI MNL-116.

1. Concrete Compression Tests:

a. ASTM C39.

b. Make one compression test for each day's production of each type of member.

2. Specimens:

a. Provide four test specimens for each compression test.

b. Obtain concrete for specimens from actual production batch.

c. Concrete Cylinders, 6 inch by 12 inch, ASTM C31.

C. Other requirements:

1. Design, fabricate, and install precast sections to meet requirements of ACI 318.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Follow manufacturer's instructions for handling and transporting.

B. Lift members at designated points only, and use lifting inserts if provided.

C. Use lifting slings or spreader bars to keep angle between lifted member and cable greater than 45°.

D. Do not place members in position which will cause overstress, warp, or twist.

E. Handle members to protect from dirt and damage.

F. Place stored items so that identification marks are discernable.

G. Separate stacked items by battens across full width of each bearing surface.

H. Stack items so that lifting points/devices are accessible and undamaged.

PART 2: PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Firms specializing in providing precast concrete products and services normally associated with industry for at least 3 years.

B. Manufacturers meeting requirements of PCI MNL-116.

C. Manufacturers may be required to submit written evidence showing experience; qualifications; and adequacy of plant capability, facilities, and ability to perform work in accordance with these specifications.

1. Evidence shall consist of PCI plant certification or results of tests performed by independent testing laboratory to monitor conformance to provisions of PCI MNL-116 and requirements herein.

2.02 MATERIALS

A. Portland Cement

1. ASTM C150, Type II.

B. Admixtures

1. Air-Entraining: ASTM C260.

2. Water Reduction and Set Retardation: ASTM C494, Type A.

3. Super Plasticizer: ASTM C494, Type A.

C. Aggregates

1. ASTM C33 or C330.

2. Material: Natural.

3. Maximum 1 inch.

D. Water

1. Potable or free from foreign materials in amounts harmful to concrete.

E. Reinforcing Steel

1. Deformed Steel Bars: ASTM A615, including supplementary requirements S1, Grade 60.

2. Epoxy coat reinforcing steel conforming to ASTM A775.

F. Curing Materials

1. Liquid membrane forming compound, ASTM C309, or sheet materials, ASTM C171.

G. Coating

1. Coating shall be Coal Cat Coal Tar epoxy 97-6401/641 or approved equal.

2.03 MIX DESIGN

A. Mix design to be per manufacturer's recommendations.

B. Concrete properties

1. Water-Cement Ratio: Maximum 40 pounds water to 100 pounds cement.

2. Air-Entrainment: Amount produced by adding dosage of air-entraining agent providing 19% ±3% entrained air in standard 1:4 sand mortar as tested according to ASTM C185.

3. Twenty-eight-day Compressive Strength:

a. Minimum 4000 psi.

4. Do not use calcium chloride or other salts.

2.04 FABRICATION

A. Formwork

1. Securely attach anchorage devices to formwork in locations not affecting position of main reinforcement or placing of concrete.

2. Form treatments or curing compounds shall not contain any ingredients which might stain through or otherwise inure concrete or reduce bond with subsequent coatings, finishes, or caulking.

B. Reinforcement

1. Provide reinforcement necessary to resist stresses from handling and erecting stresses as required, in addition to any shown on the Drawings.

2. Place and anchor reinforcement in position.

C. Concrete Placement

1. Batch, mix, and handle concrete in accordance with ACI and PCI recommended practices.

2. Place concrete in continuous operation to prevent formation of seams.

3. Consolidate placed concrete by vibration without dislocation or damage to reinforcement and built-in items.

D. Provide permanent markings in precast units to identify pick-up point.

E. Cure units in accordance with PCI MNL-116.

F. Finishes

1. All exposed surfaces shall have PCI commercial finish.

2. Coat all exposed areas of riser pipe foundation with coal tar epoxy per Article 2-2 G and manufacturer's recommendations.

2.05 HOLES

A. Eight-inch diameter and over shall be formed during manufacture of units.

PART 3: EXECUTION

3.01 ERECTION

A. Align, place, and level units in final position on accepted bearing surfaces.

B. Place no warped, cracked, or broken units.

C. Remove lifting devices and grout surfaces flush with concrete.

D. Refinish damaged surfaces to match adjacent areas.

[END OF SECTION]

SECTION 05100
STRUCTURAL STEEL FRAMING

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the General Specifications, the CQA Plan, and the Construction Drawings.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References herein to "Building Code" or UBC shall mean the [Uniform Building Code of the International Conference of Building Officials (ICBO)]. The edition of the codes adopted as of the date of award of this contract shall apply to the work herein.

B. Federal Specifications and Commercial Standards:

AISC	Code of Standard Practice for Steel Buildings and Bridges
AISC	Structural Steel Buildings-Allowable Stress Design and Plastic Design
AISC	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts approved by the Research Council on Structural Connections of the Engineering Foundation
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
AWS D1.1	Structural Welding Code – Steel

1.03 CONTRACTOR SUBMITTALS

A. Shop drawings shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details

showing all members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

B. Testing laboratory certifications for shop and field welders shall be submitted in triplicate directly to the Engineer with copies to the Contractor and others as required.

PART 2: PRODUCTS

2.01 MATERIALS

A. All structural steel shapes, plates, bars and their products shall be ASTM A36 unless otherwise indicated.

B. Structural steel pipe shall be ASTM A501, or ASTM A53, Type E or S, Grade B.

C. Structural tubing shall be ASTM A500, Grade B. All members shall be furnished full length without splices unless otherwise indicated or approved by the Engineer.

D. Bolts for connections shall be ASTM A325, unless indicated otherwise. Bolts used to connect dissimilar metals shall be ASTM A193 and A194, Type 316 stainless steel.

E. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by Nelson Stud Welding Company, Lorain, OH; Omark Industries, KSM Fastening Systems Division, Seattle, WA, or Portland, OR; or equal.

F. Structural steel shall be cleaned and coated in accordance with Section 09800 - Protective Coating.

G. All steel members in contact with aluminum shall be galvanized per Section 05500 - Miscellaneous Metalwork, unless indicated otherwise.

H. All structural members shall be furnished full length without splices unless otherwise indicated or approved by the Engineer.

2.02 INSPECTION AND TESTING

A. Shop inspection may be required by the Owner at its own expense. The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but it is expressly understood that it will in no way relieve the Contractor from responsibility for proper materials or workmanship under this Specification.

B. The Owner may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.

1. Ten percent of all butt and bevel welds which extend continuously for 24 inches or less shall be completely tested in accordance with AWS D1.1, Part B, Radiographic Testing of Welds, Chapter 6. All butt and bevel welds which extend continuously for more than 24 inches shall be spot tested at intervals not exceeding 36 inches.

2. Welds that are required by the Engineer to be corrected shall be corrected or redone and retested as directed, at the Contractor's expense and to the satisfaction of the Engineer and/or approved independent testing lab.

3. The Contractor shall test to failure three bolts from each heat lot of bolts furnished to the job to verify compliance with this Specification. The testing laboratory shall be approved by the Engineer and all test reports shall be supplied to the Engineer. In addition, high-strength bolts shall be inspected using one of the methods set forth in the AISC Specification "Structural Joints Using ASTM A325 or A490 Bolts".

C. The costs for all initial testing will be paid by the Owner. However, the Contractor shall pay for all costs for any additional testing and investigation on work which does not meet Specifications. The Contractor shall supply material for testing at no cost to the Owner and shall assist the Engineer in obtaining material for test samples.

PART 3: EXECUTION

3.01 MEASUREMENT

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings, and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION

A. Structural steel shall be fabricated in accordance with the Drawings, AISC Specifications, and as shown on the shop drawings.

B. Materials shall be properly marked and match-marked for field assembly.

C. Where finishing is required, assembly shall be completed including bolting and welding of units, before start of finishing operations.

3.03 CONNECTIONS

A. Shop and field connections shall be bolted or welded as shown or specified. All connections shall develop full strength of members joined and shall conform to AISC standard connections.

3.04 WELDED CONSTRUCTION

A. The Contractor shall comply with the current AWS D1.1 Code for procedures, appearance, and quality of welds and welders, and methods used in correcting welding

work. All welded architectural metal work where exposed to view shall have welds ground smooth. Shielded metal are welding method or gas metal arc welding methods shall be used for welding structural steel.

B. Unless otherwise shown, all butt and bevel welds shall be complete penetration.

3.05 HOLES FOR OTHER WORK

A. Holes shall be provided as necessary or as indicated for securing other work to structural steel framing, and for the passage of other work through steel framing members. No torch cut holes will be permitted.

3.06 SHOP PAINT PRIMER

A. Shop paint primer shall be applied in accordance with the manufacturer specification. Omit shop applied primer at field weld locations, for the portion of a member to be embedded in concrete, and where galvanizing with no further coating is required.

3.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

3.08 ERECTION

A. The Contractor shall comply with the AISC Specifications and Code of Standard Practice, and with specified requirements.

NTS: Bearing type connections are less costly than friction type connections and should be noted on the drawings wherever they are appropriate. Bearing type connections shall not be used for lateral force resisting frames and elements.

B. High-strength bolts shall be installed in accordance with the AISC Specification for Structural Joints using ASTM A325 Bolts. The connections shall be the friction type, unless noted otherwise.

C. Anchor bolts and other connectors required for securing structural steel to in-place work and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the Contractor.

D. The Contractor shall be responsible for designing and installing any temporary bracing required for the safe erection of all structural steel members.

3.09 SETTING BASES AND BEARING PLATES

A. Prior to the placement of non-shrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of all bond-reducing materials, and concrete and masonry bearing surface shall also be cleaned of all bond-reducing materials and roughened to improve bonding.

B. Loose and attached baseplates, and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its indicated strength.

D. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.10 FIELD ASSEMBLY

A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

3.11 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

C. The Contractor shall pay for all costs associated with repairing misfits at no increased cost to the Owner.

3.12 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the Engineer. Gas-cut sections shall be finished equal to a sheared appearance.

3.13 TOUCH-UP PAINTING

A. Immediately after erection, field welds, bolted connections, and abraded areas shall be cleaned of the shop paint primer. Touch-up paint primer shall be applied by brush or

spray which is the same thickness and material as that used for the shop paint. Galvanized surfaces which have been field welded or damaged shall be repaired in accordance with Section 05500 - Miscellaneous Metalwork.

[END OF SECTION]

SECTION 05500
MISCELLANEOUS METALWORK

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide miscellaneous metalwork and appurtenances, complete, in accordance with the General Specifications, the CQA Plan, and the Construction Drawings.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Federal Specifications:**

MIL-G-18015 A (3) (Ships) Aluminum Planks. (6063-T6)
MIL-A-907E Antiseize Thread Compound, High Temperature

B. **Commercial Standards:**

AA-M32C22A41	Aluminum Assn.
AASHTO HS-20	Truck Loading
AISC	Specifications and Commentary
AISI	Design of Light Gauge, Cold-Formed Steel Structural Members
ASTM A 36	Structural Steel
ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 125	Steel Springs, Helical, Heat Treated
ASTM A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Services
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	Carbon and Alloy Steel Nuts
ASTM A 575	Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 786	Rolled Steel Floor Plates
ASTM B 98	Copper-Silicon Alloy Rod, Bar, and Shapes
ASTM B 438	Sintered Bronze Bearings (Oil-Impregnated)
ANSI/AWS D1.1	Structural Welding Code - Steel
ANSI/AWS D1.2	Structural Welding Code - Aluminum
ANSI/AWS QC1	Qualification and Certification of Welding Inspectors
NFPA 101	Life Safety Code
NAAMM	Metal Stairs Manual

1.03 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** Shop drawings of all miscellaneous metalwork shall be submitted to the Engineer for review.

B. Layout drawings for grating shall be submitted showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners. Load and deflection tables shall be submitted for each style and depth of grating used.

C. An ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor used shall be submitted to the Engineer for review. Contractor shall submit manufacturer's recommended installation instructions and procedures for all adhesive anchors for Engineer's review. Upon review, by Engineer, these instructions shall be followed specifically.

D. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

1.04 QUALITY ASSURANCE

A. All weld procedures and welder qualification shall be available in the Contractors field office for Engineers review.

B. All welding shall be inspected by a Contractor-provided inspector qualified in accordance with AWS requirements and approved by the Engineer.

PART 2: PRODUCTS

2.01 GENERAL REQUIREMENTS

A. **Steel:**

1.	Shapes, Plates, Bars	ASTM A 36
2.	Pipe, Pipe Columns, Bollards	ASTM A 53, Type E or S, Grade B Standard weight unless noted otherwise
3.	Tubes	ASTM A 500 Grade B

B. **Corrosion Protection:** Unless otherwise indicated, miscellaneous metalwork of fabricated steel, which will be used in a corrosive environment and/or will be submerged in water/wastewater shall be coated in accordance with Section 09800 - Protective Coating and shall not be galvanized prior to coating. All other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication as specified herein.

C. **Stainless Steel:** Unless otherwise indicated, stainless steel metalwork and bolts shall be of Type 316 stainless steel and shall not be galvanized.

D. **Aluminum:** Unless otherwise indicated, aluminum metalwork shall be of Alloy 6061-T6. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the Section 09800 - Protective Coating.

E. **Cast Iron:** Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B or better.

F. **Chemical protection:** Chemical protection agent shall be a coal tar epoxy, Coal Cat 97-640/641, as manufactured by Pittsburgh Parts. Coal tar epoxy shall be used as shown on the construction Drawings. Material shall be applied as directed by the manufacturer specification.

2.02 LADDERS

A. Ladders which may be partially or wholly submerged, or which are located inside a hydraulic structure, shall be entirely of Type 316 stainless steel. All other ladders shall be of [aluminum], [carbon steel, hot-dip galvanized after fabrication] or [as indicated].

B. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension. Pop-up extension device shall be manufactured of the same material and finish as the ladder with telescoping tubular section that locks automatically when fully extended. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms. Units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturers instructions.

2.03 METAL GRATING

A. **General:** Metal grating shall be of the design, sizes and types indicated. All grating shall be completely banded at all edges and cutouts using material and cross section equivalent to the bearing bars. Such banding shall be welded to each cut bearing bar. Grating shall be supported on all sides of an opening by support members. Where grating is supported on concrete, embedded support angles matching grating material shall be used on all sides, unless shown otherwise. Such angles shall be mitered and welded at corners.

1. All pieces of grating shall be fastened in two locations to each support.

2. Where grating forms the landing at the top of a stairway, the edge of the grating, which forms the top riser, shall have an integral non-slip nosing, width equal to that of the stairway.

3. Where grating depth is not given, grating shall be provided which will be within allowable stress levels, and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less. For heavy duty grating, the loading used for determining stresses and deflections shall be AASHTO HS-20, or a 5-ton fork lift, whichever is greater.

B. **Material:**

1. Except where indicated otherwise, bar grating shall be fabricated entirely of galvanized steel.

C. **Standard-Duty Grating:**

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise. Standard duty grating shall be serrated bar grating.

2. Cross bars shall be welded or mechanically locked tightly into position so that there is no movement allowed between bearing and cross bars.

D. **Safety Grating:**

1. Safety grating shall be made of sheet metal punched into an open serrated diamond pattern and formed into plank sections. The open diamond shapes shall be approximately 1-7/8 inch by 11/16 inch in size. Safety grating shall be Grip Strut by Metal Products Division, United States Gypsum Company; Deck Span by IKG Industries, or equal.

E. **Heavy-Duty Grating:** Heavy-duty grating shall be of welded steel, galvanized after fabrication. Cross bars shall be welded in position.

2.04 CHECKERED PLATE

A. Checkered plate shall be not less than 1/4-inch thick, and shall have a pattern of raised lugs on one face and shall be smooth on the opposite face. Lugs shall be a minimum of one inch in length and raised a minimum of 0.050 inch above the surface. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in two orthogonal directions. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

B. Where no plate material is indicated on the drawings, aluminum shall be provided. Unless noted otherwise on the drawings, the minimum plate thickness shall be as required to limit deflection, resulting from a live load of 100 psf, to 1/4-inch or the span divided by 240, whichever is less.

2.05 BOLTS AND ANCHORS

A. **Standard Service (Non-Corrosive Application):** Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be steel, galvanized after fabrication as indicated herein. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing. Except as otherwise indicated, steel for bolts, anchor bolts and cap screws shall be in accordance with the requirements of ASTM A 193 Grade B-7.

NTS: In the list of corrosive service locations below, project-specific trouble areas are not covered, such as (1) all outdoor locations, (2) all locations subject to continuous or intermittent wetting or spraying other than weather. If stainless steel nuts, bolts, and washes are to be provided there, call these areas out on the Drawings.

B. **Corrosive Service:** All bolts, nuts, and washers in the locations listed below shall be stainless steel as indicated below.

1. All buried locations.

2. All submerged locations.

3. All locations subject to seasonal or occasional flooding.

4. Inside hydraulic structures below the top of the structure.

5. Inside buried vaults, manholes, and structures which do not drain through a gravity sewer or to a sump with a pump.

6. All chemical handling areas.

7. Inside trenches, containment walls, and curbed areas.

8. Locations indicated by the Contract Documents or designated by the Engineer to be provided with stainless steel bolts.

NTS: *In cases where the galling characteristics of stainless steel bolts and nuts would present a serious problem, use the subparagraph C in this NTS instead of the subparagraph C below the NTS. It should be recognized, however, that the bronze nuts are more expensive and more difficult to obtain in some areas.):*

C *Stainless steel bolts, nuts, anchor bolts, and washers shall be of Type 316 stainless steel, with bronze nuts, or cap screws (where screwed into stainless steel), of copper-silicon alloy, conforming to ASTM B 98, alloy C 65100, designation H04, or alloy C 65500, designation H04. Wherever stainless steel bolts and nuts are indicated, it shall refer to the above material combination, unless specifically excluded.*

C. Unless otherwise indicated, stainless steel bolts, anchor bolts, nuts, and washers shall be Type 316 stainless steel, class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts. All threads on stainless steel bolts shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, to meet government specification MIL-A-907E. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

1. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

2. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL, 60131, AS-470 by Dixon Ticonderoga Company, Lakehurst, NJ, 08733, or equal.

D. **Bolt Requirements:**

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads. All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

3. All bolts and nuts shall be installed with washers fabricated of material matching the base material of bolts, except that hardened washers for high strength bolts shall conform to the requirements of the AISC Specification. Lock washers shall be installed with washers where indicated and shall be fabricated of material matching the bolts.

4. The length of all bolts shall be such that after joints are made up, each bolt shall extend through the entire nut, but in no case more than 1/2-inch beyond the nut.

E. **Adhesive Anchors:** Unless otherwise indicated, all drilled, concrete or masonry anchors shall be adhesive anchors. No substitutions will be considered unless accompanied with ICBO report verifying strength and material equivalency.

1. Epoxy adhesive anchors are required for drilled anchors where exposed to weather, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails, pumps, mechanical equipment, and reinforcing bars. Epoxy anchor grout shall comply with Section 03315 - Grout. Threaded rod shall be stainless steel Type 316.

2. Unless otherwise indicated, glass capsule, polyester resin adhesive anchors will be permitted in locations not indicated above and shall be Hilti HVA or Molly Parabond. Threaded rod shall be galvanized steel.

F. **Expanding-Type Anchors:** Expanding-type anchors if indicated or permitted, shall be steel expansion type ITW Ramset/Redhead "Trubolt" anchors; McCullock Industries "Kwick-Bolt;" or equal. Lead caulking anchors will not be permitted. Size shall be as indicated. Expansion type anchors which are to be embedded in grout may be steel. Non-embedded buried or submerged anchors shall be stainless steel.

2.06 POWDER-DRIVEN PINS

A. **Materials:** Powder-driven pins for installation in concrete or steel shall be heat-treated steel alloy. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they are to be exposed, they shall be protected in an acceptable manner. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support. Pins that are connected to steel shall have longitudinal serrations around the circumference of the shank.

3.03 GALVANIZING

C. All structural steel plates shapes, bars and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123. Any galvanized part that becomes warped during the galvanizing operation shall be straightened. Bolts, anchor bolts, nuts and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153. Field repairs to galvanizing shall be made using "Galvinox," "Galvo-Weld," or equal.

3.04 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, cleaned and dry. Drilled anchors shall not be installed until the concrete has reached the specified 28-day compressive strength. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

[END OF SECTION]

SECTION 07920
SEALANTS AND CAULKING

NTS: This Section has "M" status: it has been through the process of technical discipline review, manufacturer review, and construction experience feedback. Upgrading was completed in November, 1995. Bill Brumm has been a major contributor toward technical upgrading of this Section and is aware of the details of its contents. Bill Brumm may be a resource to answer questions.

The Section cross references the following sections:

Use professional care in customizing this master Section for use in project specifications. Not only are there square brackets to address, the Specifier must also consider whether the rest of the text is appropriate for the unique needs of the project, making additions and deletions if necessary to make it so.

Section 07920 specifies joint sealants and caulking, joint fillers, compressible seals and other joint sealers for a variety of applications. Moisture barrier film is also included.

PART 1: GENERAL

1.01 THE REQUIREMENT

A. The CONTRACTOR shall provide caulking, sealing, and appurtenant work, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE STANDARDS

A. General: Portions of the following standards are incorporated into this Section by references below. The standards are listed here for convenience.

B. Federal Specifications:

TT-S-001543A	Sealing Compound, Silicone Rubber Base, (For Caulking, Sealing and Glazing in Buildings and Other Structures)
SS-S-200D	Sealants, Joint, Two Compound, Jet Blast Resistant, Cold Applied for Portland Cement Concrete Pavement.
TT-S-00227E	Sealing Compound, Elastomeric Type, Multi-Component, (For Caulking, Sealing and Glazing in Buildings and Other Structures).

TT-S-00230C	Sealing Compound, Elastomeric Type, Single Component, (For Caulking, Sealing, and Glazing in Buildings and Other Structures)

C. Commercial Standards:

ASTM C 557	Adhesives for Fastening Cypsum Wallboard to Wood Framing.
ASTM C 834	Latex Sealing Compounds.
ASTM C 919	Practice for Use of Sealants in Acoustical Applications.
ASTM C 920	Elastomeric Joint Sealants.
ASTM C 1056	Flexible Cellular Material-Sponge or Expanded Rubber.
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
ASTM E 84	Surface Burning Characteristics of Building Materials.
ASTM E 814	Methods for Fire Tests of Through Penetrations: Firestops.
UL 1479	Underwriter's Laboratory Standard for Safety Fire Tests of Through Penetrations Firestops.

1.03 CONTRACTOR SUBMITTALS

D. General: Submittals shall be in accordance with Section 01300 - Contractor Submittals.

E. Technical Data: A complete materials list along with the manufacturer's technical data and literature, specifications, joint width and depth tables, and installation instructions.

F. Samples: Samples (including color samples) of all the caulking and sealant materials and other materials proposed for use on the WORK. The samples shall be clearly marked with the manufacturer's name and product identification.

G. Certificates: If requested by the ENGINEER, certificates from an independent testing laboratory approved by the ENGINEER, certifying that the submitted materials meet all the requirements of the ASTM and Federal Specifications cited.

H. Warranty: A copy of the manufacturer's warranty covering all sealants, caulking materials, and other materials against defects in materials.

PART 2: PRODUCTS

2.01 SEALANTS AND CAULKING MATERIALS

A. General:

1. Manufacturer's Standards: In addition to the standards listed below, the sealants and caulking products and application shall be in accordance with the manufacturer's published recommendations and specifications.

2. Wherever manufacturer's names and products are listed in this Section, "or equal" products will be considered in accordance with Section 01300 - Contractor Submittals.

B. Materials shall conform to the following requirements:

1. Significant Movement Sealants (plus or minus 25% movement capability)

a. For expansion wall joints; masonry and metal curtainwall joints; precast concrete joints and concrete panels; perimeter sealing (windows, doors, and panels); control joints; interior and non-traffic horizontal joints.

(1) Two component, non-sag, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-227E, Class A, Type II, and ASTM C 920, Type M, Class 25, Grade NS.

Products Research & Chemical Corp. "RC-2"
Progress Unlimited "Iso-Flex 2000"

(2) One component, non-sag, low modulus, polyurethane or polysulfide sealant conforming to Federal Specification TT-S230C, Class A, Type II, and ASTM C 920, Type S, Class 25, Grade NS.

Products Research & Chemical Corp. "RC-1"
Tremco "Dymonic"

(3) One component, non-sag, medium modulus, neutral cure, silicone sealant conforming to Federal Specification TT-S-1543A, Class A, and ASTM C 920, Type S, Class 25, Grade NS.

Products Research & Chemical Corp. "PRC-4000"
Dow Corning "795"

b. For horizontal joints exposed to fuel spillage.

(4) Two component, self-leveling, fuel resistant, polyurethane or polysulfide sealant conforming to Federal Specification SS-S-200D, Type H, and ASTM C 920, Type M, Class 25, Grade P.

Products Research & Chemical Corp. "3105-S"
Pacific Polymere Inc. "ElastoThane 200"

c. For horizontal joints not exposed to fuel spillage.

(5) Two component, self-leveling, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-227E, Class A, Type I, and ASTM C 920, Type M, Class 25, Grade P.

Products Research & Chemical Corp. "RC-2SL"
Bostic "Chem-Calk 550"

(6) One component, self-leveling, polyurethane or polysulfide sealant conforming to Federal Specification TT-S-230C, Class A, Type I, and ASTM C 920, Type S, Class 25, Grade P.

Products Research & Chemical Corp. "6006"
Mameco "Vulkem 45"]

2. Glazing Sealants

a. For non-structural applications

(1) One component non-sag, medium modulus, neutral cure, silicone sealant conforming to Federal Specification TT-S-1543A, Class A, and ASTM C 920, Type S, Class 25, Grade NS.

Products Research & Chemical Corp. "4000"
Dow Corning "795"

(2) One component, non-sag, high modulus, acetoxy cure, silicone sealant conforming to Federal Specification TT-S-1543A, Class A, and ASTM C 920, Type S, Class 25, Grade NS.

3. Interior Sealant and Caulking

a. For general applications

(1) One component, acrylic latex caulking conforming to ASTM C 834

Pecora Corp. "AC-20"
Bostic "Chem-Calk 600"

b. For non-exposed acoustical applications

(1) One component, non-drying, non-hardening, non-shrinking, acoustical caulking conforming to ASTM C 557 and ASTM C 919.

Inmont Company "Prestite 579.64"
Tremco, "Acoustical Sealant"
United States Gypsum, "Acoustical Sealant"
W.W. Henry, "Type 313, Acoustical Sealant"

4. Acoustic Sheet Caulking: For use on all outlet boxes including intercoms, telephone or other services that require penetrations in the walls, acoustic sheet caulking shall be resilient synthetic polymer, self-adhesive, 1/8-inch thick, 6-inch x 8-inch, sheet acoustic sealer. Pads shall be Lowry's Electrical Box Pads as manufactured by Harry A. Lowry & Associates, Inc., 11176 Penrose Street, Sun Valley, CA 91352, (818) 768-4661, (213) 875-0225; or equal.

5. Firestop Sealant: Where piping, conduit, wire, or other materials pass through fire rated walls, floors, ceilings or roofs, provide a [1] [3]-hour fire rated sealant in accordance with ASTM E 814 and UL 1479. Fire-resistant penetration sealant shall be a medium density fire-resistant foam that retains form and stability at high temperature. Fire-resistant sealant shall be Dow-Corning Corporation "3-6548 Silicone RTV" foam; 3M Corporation "Fire Barrier Caulk CP25N, No-sag "or "CP25 S/L, Self-Leveling", as appropriate for the use intended. Equivalent products of General Electric and Metalines, Inc. will also be considered.

6. Preformed Sealants: Preformed sealant shall be polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air, and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant shall be non-bleeding and shall have no loss of adhesion.

7. Tape sealant: Dimensions shall be as required for application conditions. Tape sealants shall be type recommended by tape manufacturer for connecting and bonding to surfaces.

8. Filler material shall be resilient, closed-cell polyethylene foam conforming to ASTM D 1752, Type II or III, and/or bond breakers of proper size for joint widths. Filler shall be compatible with sealant manufacturer's product and shall not stain the sealant nor the materials to which applied.

9. Primer: Primers shall be as recommended in the manufacturer's printed instructions for caulking and sealants, and shall not stain the sealant nor the materials to which applied. Manufacturer shall be consulted for all surfaces not specifically covered in submittal application instructions. Primer shall be used in accordance with manufacturer's instructions with all primers being applied prior to the installation of any backer rod or bond breaker tape.

10. Cleaning and cleanup solvents, agents, and accessory materials shall be as recommended in the manufacturer's printed instructions for cleaning up.

2.02 COLOR OF SEALANTS

A. Color of sealants that are visible after installation shall match adjacent building finish. If in doubt of color match, obtain color approval from ENGINEER.

2.03 SUB-SLAB MEMBRANE

A. Sub-slab membrane shall be 6-mil, odorless, nontoxic, polyethylene film without holes, complying with FHA requirements for below-slab moisture barrier, and shall be Sisalkraft "Moisture-stop"; Dampproof "XX"; or equal.

PART 3: EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken packages or containers bearing the manufacturer's label. Packages or containers shall be delivered to the site with seals unbroken.

B. Shelf Life: Materials whose shelf life dates have expired shall not be used in the WORK. Such materials shall be promptly removed from the project site.

C. Storage: All materials shall be carefully stored in accordance with the manufacturer's instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the product. Materials shall be stored at temperatures between 40 and 90 degrees unless otherwise specified by the manufacturer.

3.02 INSTALLATION

A. Manufacturer's Recommendations: All work under this Section and all testing, where applicable, shall be performed in accordance with manufacturer's printed recommendations, specifications, and installation instructions except where more stringent requirements are indicated herein; and, except where project conditions require extra precautions or provisions to assure performance of the waterproofing system.

B. Authorized Installers: Caulking and sealants shall be complete systems and be installed only by installers authorized and approved by the respective manufacturers.

C. Surface Preparation

1. General: The surfaces of joints to be sealed shall be dry. Oil, grease, dirt, chalk, particles of mortar, dust, loose rust, loose mill scale, and other foreign substances shall be removed from surfaces of joints which will be in contact with the sealant. Ferrous metal surfaces shall be cleaned of all rust, mill scale, and other coatings by wire brush, grinding, or sandblasting. Oil and grease shall be removed by cleaning in accordance with sealant manufacturer's printed recommendations. Protective coatings shall be removed from all aluminum surfaces against which caulking or sealing compound is to be placed. Bituminous or resinous materials shall be removed from surfaces to receive caulking or sealants.

2. Concrete and Masonry Surfaces: Where surfaces have been treated with curing compounds, oil, or other such materials, the materials shall be removed by sandblasting or wire brushing. Laitance, efflorescence, and loose mortar shall be removed from the joint cavity.

3. Steel Surfaces: Steel surfaces to be in contact with sealant shall be sandblasted or, if sandblasting would not be practical or would damage adjacent finish work, the metal shall be scraped and wire brushed to remove loose mill scale. Protective coatings on steel surfaces shall be removed by sandblasting or by a solvent that leaves no residue.

4. Aluminum Surfaces: Aluminum surfaces to be in contact with sealants shall be cleaned of temporary protective coatings. When masking tape is used for a protective cover, the tape and any residual adhesive shall be removed just prior to applying the sealant. Solvents used to remove protective coating shall be as recommended by the manufacturer of the aluminum work and shall be non-staining.

5. Wood Surfaces: Wood surfaces to be in contact with sealants shall be free of splinters and sawdust or other loose particles.

D. Joint Types and Sizes: Joint shapes and sizes shall be as indicated or as necessary for job conditions where not indicated. Joints to be caulked or sealed include through-bolt holes, door frames, louver and ventilator frames, joints between openings where items pass through exterior walls, concrete masonry, or combination of these surfaces, and as otherwise indicated or required for watertightness, weatherproofing, or airtightness. Use sealing compound at both exterior and interior surfaces of exterior wall penetrations.

3.03 SEALANT FILLED JOINTS

A. Manufacturer's Representative: The CONTRACTOR shall furnish the on-site services of the sealant manufacturer's representative prior to sealant work for inspection of the joints to be sealed and for instructing the installer in the proper use of the materials[.] [if requested by the ENGINEER.]

B. Sealant: Sealant shall be used before expiration of shelf life. Multi-component sealants shall be mixed according to manufacturer's printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Sealant shall be installed to the required depth without displacing the backing. Unless otherwise indicated or recommended by the manufacturer, the installed sealant shall be tooled so that the surface is uniformly smooth and free of wrinkles and to assure full adhesion to the sides of the joint. Sealants shall be installed free of air pockets, foreign embedded matter, ridges, and sags. Sealer shall be applied over the sealant if recommended by the sealant manufacturer.

C. Sealant Depth: Sealant depth in joints shall be 1/2 the width of joint, but not less than 1/8-inch deep and 1/4-inch wide nor more than 1/2-inch deep and 1-inch wide. All joints shall have a rigid filler material installed to proper depth prior to application of sealant.

D. Masking Tape: Masking tape shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking tape shall be removed within 10 minutes after joint has been filled and tooled.

E. Backing: Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

F. Bond-Breaker: Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

G. Primer: Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

H. Applications: A full bead of sealant shall be applied into the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application, the tip of the nozzle shall be kept at the bottom of the joint thereby forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with a caulking tool or soft bristled brush moistened with solvent. The finished sealant-filled joint shall be slightly concave unless otherwise indicated.

I. Acoustic Partition Joints: Acoustic partition joints shall be made air and sound-tight with acoustic caulking material.

1. Partitions shall be sealed where indicated on the Drawings. Gypsum panels may have joint treatment applied in the normal manner over sealed joints, or panels may be finished with base or trim as required.

2. A 1/4-inch minimum round bead of sealant shall be applied around all cut-outs, such as at electrical boxes and air conditioning ducts, sufficient to seal the openings.

3.04 ACOUSTIC CAULKING

A. Preparation: Joints and surfaces to be sealed shall be clean, dry, and free of loose materials.

B. Concealed Joints: Concealed joints in acoustic partitions including perimeters and intersections of walls and penetrations through finish work and at conduit ends with boxes shall be sealed with acoustic caulking compound. Backs of electrical boxes shall be sealed with acoustic sheet caulking, covering all holes and knock-outs.

3.05 SUB-SLAB MEMBRANE

A. A sub-slab membrane shall be installed under floor slabs over which a finish flooring system will be installed and at other locations as indicated.

3.06 CLEANING

A. After application of sealant and caulking materials, adjacent materials which have been soiled shall be cleaned and left in a neat, clean, undamaged, or unstained condition. On porous surfaces, excess sealant shall be removed per sealant or caulking manufacturer's printed instructions.

[END OF SECTION]

SECTION 11210
LEACHATE PUMPS

PART 1: GENERAL

1.01 SUMMARY

A. Description of Work

1. This section includes supply and installation of leachate removal pumps for the Landfill. The following pumps are included:

   a. The submersible pump in the Primary Leachate Collection System. This will be the principal pump used to remove leachate from the landfill.

   b. The self-priming pump in the vertical riser of the Primary Leachate Collection System. This higher capacity pump will be used to remove storm water from the primary sump.

   c. The submersible pump in the Secondary Leachate Collection System. This pump will be used to remove leachate that leaks through the primary system into the secondary collection system.

   d. The submersible pump in the Vadose Sump. This pump will be used to remove leachate that leaks through the secondary lining system.

B. Related Sections

1. 15600 - Welded Steel Pipe

2. 15700 - Stainless Steel Pipe

1.02 SUBMITTALS

A. Submit detailed information on proposed pumps, motors, materials, connections, and electrical requirements.

B. If "or equal" product is proposed, submit technical data and specifications sufficient to allow evaluation by the ENGINEER.

1.03 QUALITY ASSURANCE

A. Prior to installing, test pumps and demonstrate their operation in accordance with manufactures recommendations

PART 2: PRODUCTS

2.01 GENERAL

A. Pumps shall be constructed such that all wetted parts are type 316 stainless steel, or other highly corrosion resistent materials.

B. Submersible pumps and their motors shall have bearings which permit the pump to be operated in continuous or intermittent service in the horizontal position.

C. The external portions of the case shall be free of sharp edges or burrs which might prevent the free sliding of the pump along the enclosing pipe.

D. Electrical characteristics of pump motors shall be compatible with power available at the site.

2.02 SUBMERSIBLE PUMPS

A. The submersible pump for the Primary and Secondary Leachate Collection System shall be a Grundfos Model 40S30-9 or equal as approved by the ENGINEER.

B. The submersible pumps for the Vadose Sump shall be Grundfos Model 25S15-9 or equal as approved by the ENGINEER.

2.03 SELF-PRIMING SUMP PUMP

A. The larger capacity sump pump to be installed in the vertical riser shall be a self-priming type, capable of drawing water 10 ft or more at sea level. The pump shall be a Gorman Rupp Model S4C18 or equal as approved by the ENGINEER.

PART 3: EXECUTION

3.01 PUMP INSTALLATION

A. The OWNER shall install all pumps and motors in accordance with manufacturers' instructions, at locations as shown on the Drawings.

B. Installation shall include all discharge piping and wiring.

C. Install pumps in side slope riser pipes prior to placing backfill over the pipes, in order to confirm pump installation location. When pump is in correct position as determined by visual inspection through holes in perforated pipe section, mark discharge tube or support cable as appropriate at top of riser pipe. Survey location (coordinates and elevation) of pump prior to trench backfilling.

[END OF SECTION]

SECTION 13205
POLYETHYLENE TANK

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of all polyethylene tanks required for the landfill or surface impoundment construction. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

B. This specification shall also apply to polyethylene tank installation in the truck wash area and liquid waste storage facility, unless otherwise indicated on the construction drawings.

1.02 RELATED SECTIONS

A. Section 02718 - Polyethylene Pipe and Fittings

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The CQA Engineer will coordinate independent surveying as required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

D. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming materials. The nonconforming materials shall be removed by the Contractor at no cost to the Owner until acceptable materials are installed.

PART 2: PRODUCTS

2.01 POLYETHYLENE TANK PROPERTIES

A. The polythylene tank shall be Model Number 10 VCT 09K manufactured by Central California Cntainer and conform to the following specifications or equal:

Item	*Primart Tank Description*	*Secondary Tank Description*
Diameter	10 feet	12 feet
Height	16 feet 1 inch	21 feet 3 inches
Material	Cross Linked Polyethylene Resin	Cross linked polyethylene resin
Type	Enclosed Top Containment Tank	Ethylene Resin
Primary Tank Volume	9,000 gallons	Enclosed top tank
Secondary Tank		15,500 gallons

2.03 MANUFACTURING QUALITY CONTROL

A. The Contractor shall submit to the Owner for approval within 14 days prior to the start of polyethylene tank work a complete list of materials to be furnished and the name of the polyethylene tank Manufacturer.

B. The Contractor shall submit to the Owner the polyethylene tank Manufacturer's certification of compliance with the product requirements of Part 2.

C. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.04 TRANSPORTATION

A. Transportation of polyethylene tanks shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the polyethylene tanks incurred prior to and during transportation to the site.

2.05 HANDLING AND STORAGE

A. Handling, storage, and care of the steel pipe prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Owner.

B. The Contractor shall be responsible for storage of the polyethylene tanks at the site. Polyethylene tanks shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the polyethylene tanks.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Polyethylene tanks shall be installed as indicated on the Construction Drawings.

B. The Contractor shall exercise care when transporting, handling and placing polyethylene tanks, such that they will not be damaged.

C. The Contractor shall comply with the polyethylene tanks Manufacturer's recommendations for handling, storage, and installation of all tanks.

D. Polyethylene tanks shall not be dropped onto rocky or unprepared ground.

F. The exterior of the polyethylene tanks shall be free of cuts, gouges and scratches. The CQA Engineer will inspect the polyethylene tanks in accordance with the CQA Plan. Polyethylene tanks with excessive cuts, gouges, or scratches will be rejected and the Contractor will be required to remove and replace the rejected polyethylene tanks, at no additional cost to the Owner.

3.02 INSTALLATION

A. All polyethylene tanks shall be installed in accordance with these General Specifications and the polyethylene tanks Manufacturer's instructions.

B. The Contractor shall carefully examine all polyethylene tanks for cracks, damage or defect before installation. Defective materials shall be removed from the site and replaced with non-defective material at no additional cost to the Owner.

C. All polyethylene tanks shall be placed to the grades and elevations shown on the Construction Drawings.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the location and final elevation of all polyethylene tanks. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location all polyethylene tanks.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-complete and completed work of these General Specifications.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of polyethylene tank installation and inspection to the Owner following installation of the polyethylene tank in accordance with the CQA Plan.

[END OF SECTION]

SECTION 15600
CARBON STEEL PIPE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, tools, equipment, supervision, transportation, and installation services necessary for the installation of all steel pipe required for landfill. The work shall be carried out in accordance with these General Specifications, the CQA Plan, and the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 02222 - Sump Primary Clay Liner
B. Section 02224 - Sump and Pipe Bedding Gravel
C. Section 02225 - Road Base Aggregate
D. Section 02710 - Geocomposite Detection or Collection Layer
E. Section 02714 - Geotextile Filter or Cushion Layer
F. Section 02775 - Geomembrane Liners

1.03 QUALIFICATIONS AND SUBMITTALS

A. The Contractor shall abide by all qualification and submittal requirements of the CQA Plan.

1.04 CONSTRUCTION QUALITY ASSURANCE

A. All work will be monitored and tested in accordance with the requirements of the CQA Plan.

B. The Contractor shall be aware of all activities outlined in the CQA Plan, and the Contractor shall account for these activities in the construction schedule. No additional costs to the Owner shall be allowed by the Contractor as a result of the performance of the CQA activities.

C. The CQA Engineer will coordinate independent surveying as required by the CQA Plan. Surveying by the CQA Engineer does not relieve the Contractor of his responsibility to lay out, control, and document the work.

D. If the CQA Engineer's tests indicate work does not meet the requirements of the specifications, the CQA Engineer will establish the extent of the nonconforming materials. The nonconforming materials shall be removed by the Contractor at no cost to the Owner until acceptable materials are installed.

E. Qualify and certify welding procedures, welders, and operators in accordance with ANSI B31.1, Paragraph 127.5, for shop and project site welding of piping work.

PART 2: PRODUCTS

2.01 STEEL PIPE PROPERTIES

A. The steel pipe shall be Schedule 40 and conform to all requirements of ASTM A53 Grade B, or API 5L Grade B.

2.03 MANUFACTURING QUALITY CONTROL

A. The Contractor shall submit to the Owner for approval within 14 days prior to the start of pipe work a complete list of materials to be furnished and the name of the pipe Manufacturer.

B. The Contractor shall submit to the Owner the pipe Manufacturer's certification of compliance with the product requirements of Part 2.

C. If requested by the Owner, the Contractor shall require the pipe manufacturer to retain one section of pipe (at least 5 feet in length) provided for the project for every 1,500 lineal feet of pipe produced for the project until the work is accepted by the Owner.

D. All Quality Control testing required by these General Specifications and/or conducted at the discretion of the Contractor shall be the responsibility of the Contractor.

2.04 LABELING

A. The following shall be continuously indent-printed on the steel pipe, or spaced at intervals not exceeding 10 feet:

1. Name and/or trademark of the pipe Manufacturer.
2. Nominal pipe size.
3. Schedule.
4. Manufacturing Standard Reference (e.g., ASTM F 714-1).
5. A production code from which the date and place of manufacture can be determined.

2.05 TRANSPORTATION

A. Transportation of steel pipe shall be the responsibility of the Contractor. The Contractor shall be liable for all damage to the steel pipe incurred prior to and during transportation to the site.

2.06 HANDLING AND STORAGE

A. Handling, storage, and care of the steel pipe prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damage to the material incurred prior to final acceptance by the Owner.

B. The Contractor shall be responsible for storage of the steel pipe at the site. Pipe shall be stored on clean level ground, preferably turf or sand, free of sharp objects which could damage the pipe.

2.07 PIPE BEDDING MATERIAL

A. Pipe bedding material shall meet the requirements of Section 02228 of this General Specification as well as any other requirements of the Construction Drawings.

PART 3: EXECUTION

3.01 HANDLING AND PLACEMENT

A. Pipe shall be installed as indicated on the Construction Drawings.

B. The Contractor shall exercise care when transporting, handling and placing pipe, such that they will not be damaged.

C. The Contractor shall comply with the pipe Manufacturer's recommendations for handling, storage, and installation of all pipe.

D. Ropes, fabric, or rubber-protected slings and straps shall be used when handling pipe.

E. Pipe or fittings shall not be dropped onto rocky or unprepared ground. The pipe and fittings shall not be dropped into trenches or dragged over sharp objects.

F. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. The CQA Engineer will inspect the pipes in accordance with the CQA Plan. Sections of pipe with excessive cuts, gouges, or scratches will be rejected and the Contractor will be required to remove and replace the rejected pipe, at no additional cost to the Owner.

3.02 INSTALLATION

A. All pipe shall be installed in accordance with these General Specifications and the pipe Manufacturer's instructions.

B. The Contractor shall carefully examine all pipe for cracks, damage or defect before installation. Defective materials shall be removed from the site and replaced with non-defective material at no additional cost to the Owner.

C. The interior of all pipe shall be inspected, and any foreign material shall be completely removed from the pipe interior before it is moved into final position.

D. Field cutting of pipe shall be carefully made, without damage to pipe or lining system components, so as to leave a smooth end at right angles to the axis of pipe. The

method and device used to cut the pipes shall be approved of by the Owner. Sharp edges of cut ends shall be filed off smooth. Flame cutting will not be allowed.

E. All pipe and fittings shall be laid or placed to the grades and elevations shown on the Construction Drawings with bedding and backfill as shown on the Construction Drawings.

F. Placement of surrounding pipe bedding shall be carried out in accordance with Section 02228 of these General Specifications.

G. No pipe shall be laid until the CQA Engineer has observed the condition of the pipe.

H. Blocking under piping shall not be permitting unless specifically accepted by the Owner.

I. The Contractor shall provide all necessary adapters and/or connection pieces required when connecting different types and sizes of pipe or when connecting pipe made by different manufacturers.

3.03 JOINTS AND CONNECTIONS

A. Welds shall be sound and free from embedded scale of slag, have tensile strength across weld not less than that of thinner of connected section, and be watertight.

B. Use buttwelds for welded joint in line pipe assemblies and fabrication of bends and other specials:

C. Conform field welding of joints and preparation of pipe ends to AWWA C206.

1. Yield point determination of field welded joint shall be made by independent testing laboratory at the beginning of installation. Costs for laboratory testing shall be paid for by the Contractor.

2. The Contractor shall provide specimens for weld tests to the CQA Engineer for testing by an independent testing laboratory if the CQA Engineer suspects unsatisfactory welding.

3. Use of back-up welding strips or rings for welds is not permitted.

3.04 SURVEY CONTROL

A. The Surveyor shall survey the location and final elevation of all steel pipe. The pipe shall be surveyed at its ends. In addition, all joints, etc. shall be located horizontally and vertically and overall length measured. Surveying shall be performed in accordance with Section 01010 of these General Specifications.

B. The Surveyor shall provide a Record Drawing of the location and final elevation of all steel pipe.

3.05 PROTECTION OF WORK

A. The Contractor shall use all means necessary to protect all materials and all partially-complete and completed work of these General Specifications.

B. In the event of damage, the Contractor shall make all repairs and replacements necessary, to the approval of the Owner and at no additional cost to the Owner.

C. The CQA Engineer will issue an approval of pipe installation and inspection to the Owner prior to completely covering the pipe in accordance with the CQA Plan.

[END OF SECTION]

SECTION 15700
STAINLESS STEEL PIPE

PART 1: GENERAL

1.01 SUMMARY

A. Description of Work

1. This section describes the lower portion of the vertical riser pipe for the landfill leachate removal system.

B. Related Sections

1. 11210 - Leachate Pumps

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM) most current version:

1. ASTM A312 - Specification for Seamless and Welded Austenitic Stainless Steel Pipe.

2. ASTM A403 - Specification for Wrought Austenitic Stainless Steel Piping Fittings.

3. ASTM A182 - Specification for Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High Temperature Service.

4. ASTM A240 - Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels.

5. ASTM A193 - Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service.

6. ASTM A194 - Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.

7. ASTM A307 - Specification for Carbon Steel Externally Threaded Standard Fasteners.

B. American Society of Mechanical Engineers (ASME) most current version:

1. ASME Boiler and Pressure Vessel Code, Section IX, Article III.

C. American National Standards Institute (ANSI) most current version:

1. ANSI B16.5 - Pipe Flanges and Flanged Fittings.

2. ANSI B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.

3. ANSI B16.25 - Buttwelding Ends.

4. ANSI B31.2 - Fuel Gas Piping.

5. ANSI B31.3 - Chemical Plant and Petroleum Refinery Piping.

D. American Welding Society (AWS) most current version:

1. AWS A5.4 - Specification for Corrosion Resisting Chromium and Chromium-Nickel Steel Covered Electrodes.

2. AWS A5.9 - Specification for Corrosion Resisting Chromium and Chromium-Nickel Steel Bare and Composite Metal Cored and Stranded Arc Welding Electrodes and Welding Rods.

1.03 SUBMITTALS

A. Welding Qualifications

1. Furnish procedure specifications and qualification records of welding procedures for pipe welding to be performed under this section in accordance with Section IX, Article III of ASME Boiler and Pressure Vessel Code.

2. Prior to start of work, submit list of welders CONTRACTOR proposes using and type of welding for which each has been qualified.

3. Submit in accordance with Section 01300.

1.04 QUALITY ASSURANCE

A. Welder's Qualifications

1. Quality welders and welding operators by approved testing laboratory or pipe supplier/manufacturer before performing welding required under this section.

   a. Qualification tests in accordance with Section IX, Article III of ASME Boiler and Pressure Vessel Code.

   b. Welders and welding operators to be qualified for making groove welds in Type 304 and 316 stainless steel pipe in positions 2g and 5g for each welding process to be used.

2. Qualification tests may be waived if evidence of prior qualification is deemed suitable by CQA ENGINEER.

   a. The CONTRACTOR shall retest welders at any time CQA ENGINEER considers quality of welder's work substandard.

2. Other reasons for rejecting welded joints will be incomplete penetration, weld undercutting, excessive weld reinforcement, porosity, and slag inclusions in excess of limits prescribed in Chapter V of ANSI B31.2 and B31.3, as applicable.

[END OF SECTION]